MTR Corporation Limited
香港鐵路有限公司
www.mtr.com.hk

MTR

The EIA Ordinance Register Office,
27th Floor, Southorn Centre,
130 Hennessy Road,
Wanchai,
Hong Kong

Your ref :

Our ref: C747-COR-HSD-ENV-010654

Attention: Mr. Victor Yeung

BY HAND

Dear Mr. Yeung,

MTR West Island Line
Environmental Permit No. EP-313/2008C
EP Condition 6.4: Environmental Monitoring and Audit Report No. 17

In compliance with WIL EP Condition 6.4, I enclose herewith 6 hard copies and one electronic copy of the Environmental Monitoring and Audit Report No.17 dated January 2011 which has been certified by the ET Leader and verified by the IEC.

Yours sincerely,

Glenn Frommer

Dr. Glenn Frommer
Head of Sustainability Development

Encls.

GF/EL/bl

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Kowloon, Hong Kong. GPO Box 9916, Hong Kong
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MTR Corporation Limited

West Island Line Project

Environmental Monitoring and Audit Report No.17

(January 2011)

Verified by: ______________________________

Position: Independent Environmental Checker

Date: 21 January 2011

MTR Corporation Limited

West Island Line Project

Environmental Monitoring and Audit Report No.17

(January 2011)

Certified by: Glenn Frommes

Position: Environmental Team Leader

Date: 19 January 2011

EXECUTIVE SUMMARY

The West Island Line Project commenced on 10 July 2009. The EM&A programme for the West Island Line Project commenced on 10 August 2009, the commencement date of construction of the Project. This is the seventeenth monthly Environmental Monitoring and Audit (EM&A) Report for West Island Line Project. The Report presents the results of EM&A works and the impact monitoring for the construction works undertaken during the period of 10 December 2010 to 9 January 2011. The major construction activities in the reporting period included slope works at Works Areas A1/A2, shaft excavation at Works Area A, erection of barging point at Works Area B, excavation and pipe piling at Works Area C, operation of barging point at Works Area E, excavation by drill and blast for Praya construction adit at Works Area G, excavation at Works Area H, pipe piling and box culvert diversion at Works Area J3, pipe piling at Works Areas I/L1, shaft excavation inside noise enclosure at Works Area M, shaft excavation and bored piling at Works Area N1 and grouting at Works Area O3.

Impact monitoring for air quality and noise were conducted in accordance with the EM&A Manual in the reporting period, no exceedance was found and there was no breach of Limit Levels for air and noise monitoring.

No environmental notification of summon and prosecution was received in the reporting period. Five environmental complaints were received in the reporting period. The complaints had been handled in accordance with the procedures stipulated in the EM&A Manual.

Site inspections were conducted by the Environmental Team on a weekly basis to monitor proper implementation of environmental pollution control and mitigation measures for the Project. No non-conformance to the environmental requirements was identified by the Environmental Team in the reporting period.

The Environmental Permit (EP-313/2008/C) issued by EPD on 31 August 2009 is being used for the WIL Project.

In the reporting period, there was no reporting change of circumstances which may affect the compliance with the recommendations of the EIA Report.

List of Appendices

1 INTRODUCTION

1.1 Project Background

MTR Corporation Limited (MTRCL) proposes to build a new railway line, the West Island Line (WIL) which is an extension of the Island Line to the Western District. The route length of the fully underground WIL is approximately 3 km with three new underground stations namely Sai Ying Pun Station (SYP), University Station (UNI) and Kennedy Town Station (KET).

1.2 Project Programme

The West Island Line Project commenced on 10 July 2009. Commencement of construction was on 10 August 2009. The commencement of operation of the Project is scheduled to be in mid 2014.

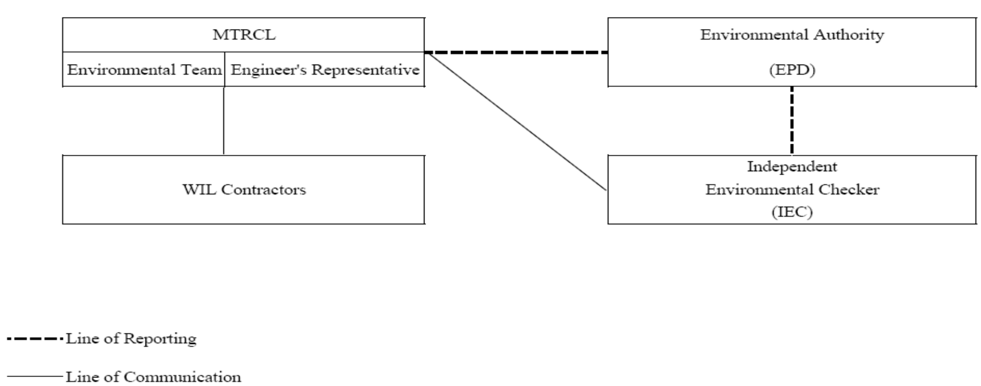
1.3 Coverage of the EM&A Report

The EM&A programme for the West Island Line Project commenced on 10 August 2009. This is the seventeenth Monthly Environmental Monitoring and Audit (EM&A) Report for the Project. The Report presents the results of EM&A works and the impact monitoring for the construction works undertaken during the period of 10 December 2010 to 9 January 2011.

2 PROJECT INFORMATION

2.1 Project Management Organization and Contact Details

The WIL Project organization chart is presented in Figure 1. Contacts of key environmental personnel of the Project are shown in Tables 1a, 1b and 1c respectively.



PROJECT ORGANIZATION
Figure 1

Table 1a Contact List of Key Personnel for Project Management

Organization	Name	Telephone
Engineer's Representative		
Project Manager – WIL Civil	Mr. Julian Saunders	3411 9828 / 9738 8634
Construction Manager(Contract 703/705/706A)	Mr. David Salisbury	3411 9818
Construction Manager(Contract 704/706/708)	Mr. Stephen Hamill	34119811
Independent Environmental Checker		
Senior Environmental Consultant	Mr. Coleman Ng	2268 3097
Environmental Team		
Environmental Team Leader	Mr. Glenn Frommer	2688 1552 / 9018 0644
Deputy Environmental Team Leader	Mr. Richard Kwan	2688 1179 / 9819 9027
Contact 703 Contractor		
Project Director	Mr. Seved Robin	2541 1511
General Construction Manager	Mr. Emmanuel Clech	2541 1586
Contact 704 Contractor		
Project Director	Mr. V.H. Elias	3559 9001
Project Manager	Mr. C.C. Hau	3559 9003
Contact 705 Contractor		
Project Director	Mr. Brian Gowran	9865 0100
Project Manager	Mr. Harry Tsang	9467 0226
Contact 706A Contractor		
Project Manager	Mr. Hobby H.M. Lau	9828 0638
Site Agent	Mr. Stan Y.S. Lo	6276 0908

Table 1b Contact List of Key Personnel for Emergency Response

Organization	Name	Telephone
Engineer's Representative		
Project Manager – WIL Civil	Mr. Julian Saunders	3411 9828 / 9738 8634
Construction Manager(Contract 703/705/706A)	Mr. David Salisbury	3411 9818

Organization	Name	Telephone
Construction Manager(Contract 704/706/708)	Mr. Stephen Hamill	3411 9811
Independent Environmental Checker		
Senior Environmental Consultant	Mr. Coleman Ng	2268 3097
Environmental Team		
Environmental Team Leader	Mr. Glenn Frommer	2688 1552 / 9018 0644
Deputy Environmental Team Leader	Mr. Richard Kwan	2688 1179 / 9819 9027
Contact 703 Contractor		
Project Director	Mr. Seved Robin	6300 0374
General Construction Manager	Mr. Emmanuel Clech	6392 8991
Environmental Officer	Mr. Keith Lee	5191 8251
Contact 704 Contractor		
Project Director	Mr. V.H. Elias	3559 9001
Project Manager	Mr. C.C. Hau	3559 9003
Environmental Manager	Mr. Eddie Tse	3559 9053
Contact 705 Contractor		
Project Director	Mr. Brian Gowran	9865 0100
Project Manager	Mr. Harry Tsang	9467 0226
Project Environmental Manager	Mr. M.K. Cheung	9096 7254
Contact 706A Contractor		
Project Manager	Mr. Hobby H.M. Lau	9828 0638
Site Agent	Mr. Stan Y.S. Lo	6276 0908
Environmental Officer	Mr. Lee Ho Cheong	9416 8347

Table 1c Contact List of Environmental Authority

Organization	Name	Telephone
Environmental Protection Department		
Sr Env Protection Offr(Metro Assessment) 3	Mr. Steve Li	2835 1142
Sr Env Protection Offr(Regional S) 1	Mr. Sean Law	2516 1806

2.2 *Project Works Areas and Environmental Monitoring Locations*

The WIL Project works areas and the locations of environmental monitoring stations are shown in Figures 2 and 3 to 7 respectively. Table 2 shows the details of the active monitoring stations as reported in Sections 3.1 and 3.2 below.

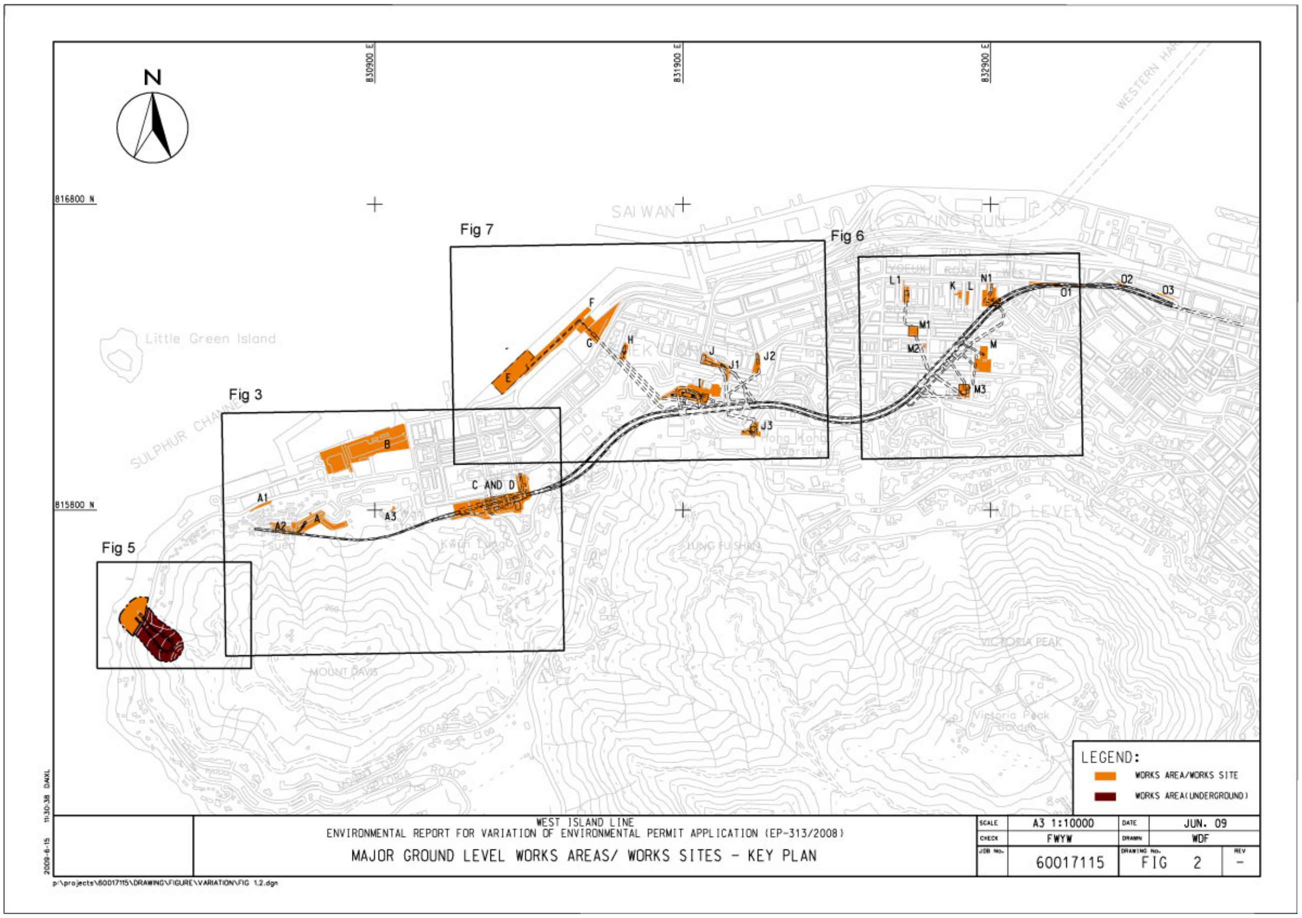


Table 2 Summary of impact air quality and noise monitoring stations

ID	Premise	Monitoring Location (Active)
Air		
AM1a+	Kwun Lung Lau Block 1	Building facing Works Area C
AM2	Victoria Public Mortuary	Building facing Works Area B
AM3a*	Hong Kong Institute of Vocational Education (Tsing Yi) Kennedy Town Centre	Building facing Works Area A
AM4	Chee Sing Kok Social Centre of the Humanity Love (current name for the premise)	Adjacent to building and facing Works Area MA
AM5a%	Kennedy Town Fire Station	Building facing Works Area E
AM6a*	St. Paul’s College Primary School	Building facing Works Area I
AM7a*	Hill Court	Building facing Works Area J
AM9a^	No. 28 Sai Woo Lane	Building facing Works Area N1

ID	Premise	Monitoring Location (Active)
Noise		
CN1	Chee Sing Kok Social Centre of the Humanity Love (current name for the premise)	Adjacent to building and facing Works Area MA
CN2	Hong Kong Institute of Vocational Education (Tsing Yi) Kennedy Town Centre	Building facing Works Area A
CN3	Lui Ming Choi Primary School	Building facing Works Area B
CN4	Luen Tak Apartments	Building facing Works Area C
CN6	Yick Fung Garden (Block A)	Building facing Works Area G
CN7a#	Bowie Court	Building facing Works Area J3
CN8	St. Paul's College Primary School	Building facing Works Area I
CN9	Hill Court	Building facing Works Area J
CN11a#	Yick Fung Garden (Block B)	Building facing Works Area H
CN12	Wah Po Building	Building facing Works Area E
CN13	No. 18-20 Eastern Street	Building facing Works Area N1
CN16	No. 9-11 Ki Ling Lane	Building facing Works Area L1
CN17	No. 1 Third Street	Building facing Works Area M
CN18	Princeton Tower	Building facing Works Area O1
CN20	Ka On Building	Building facing Works Area O3
CN21	The Merton (Block 2)	Building facing Works Area B

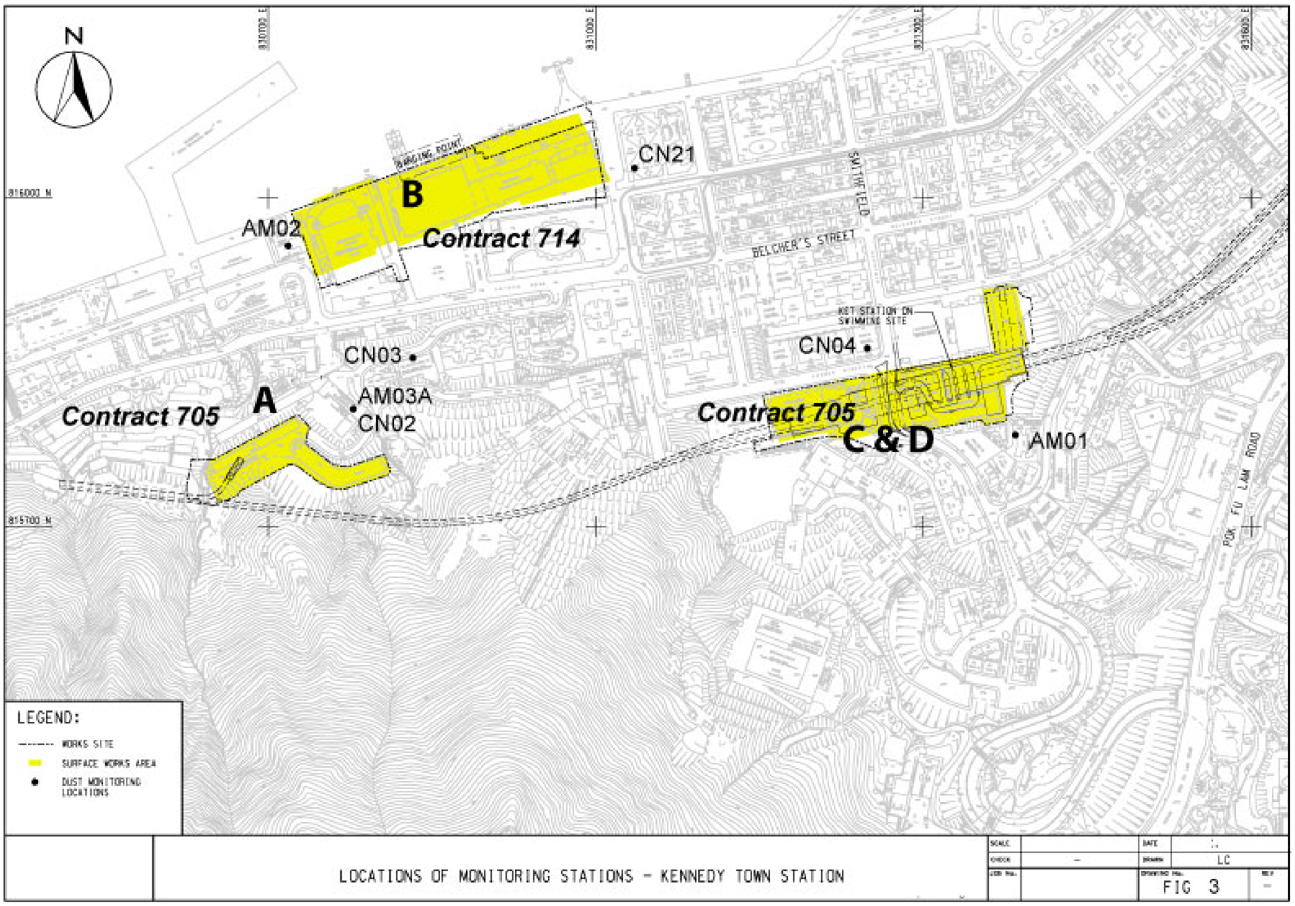
* The alternative air monitoring stations AM3a, AM6a and AM7a were approved by EPD on 10 August 2009

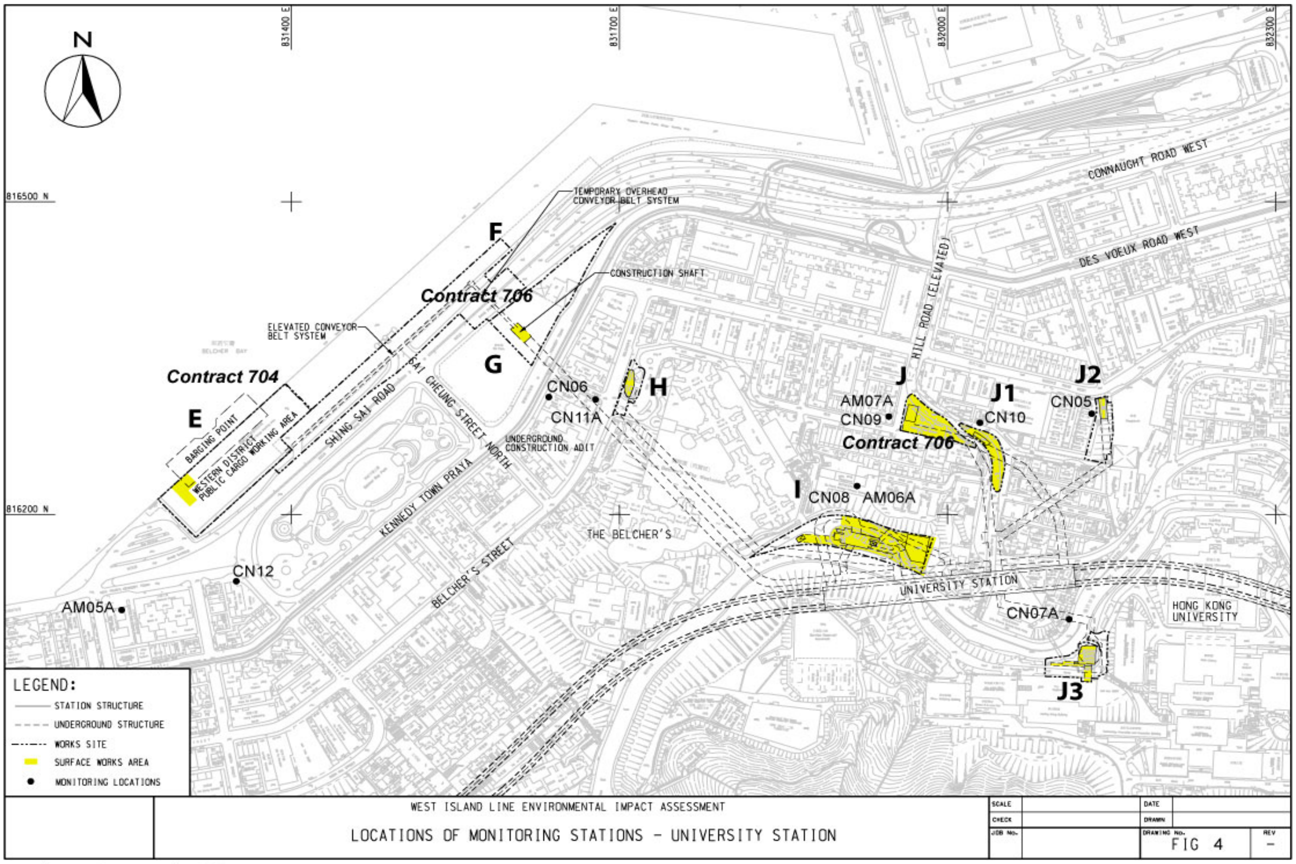
^The alternative air monitoring station AM9a was approved by EPD on 26 November 2009

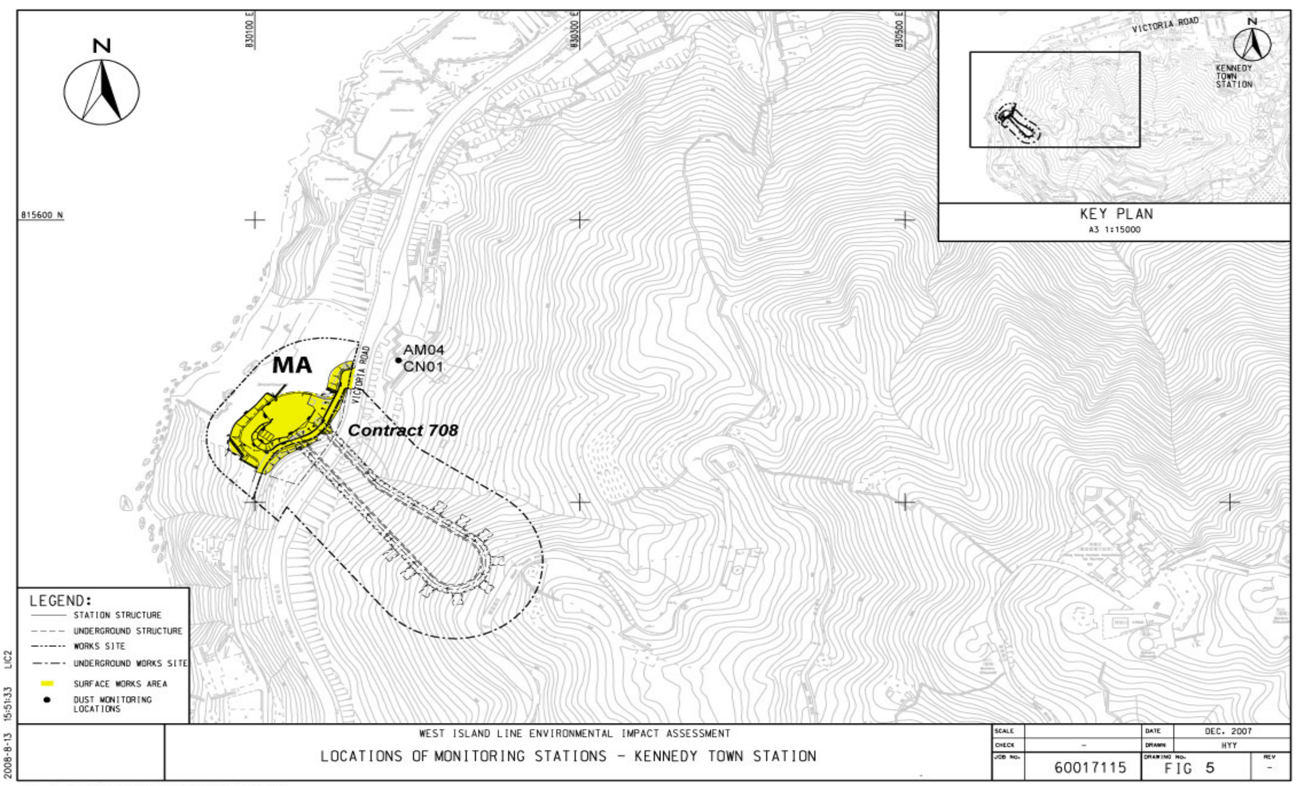
+The alternative air monitoring station AM1a was approved by EPD on 7 September 2010

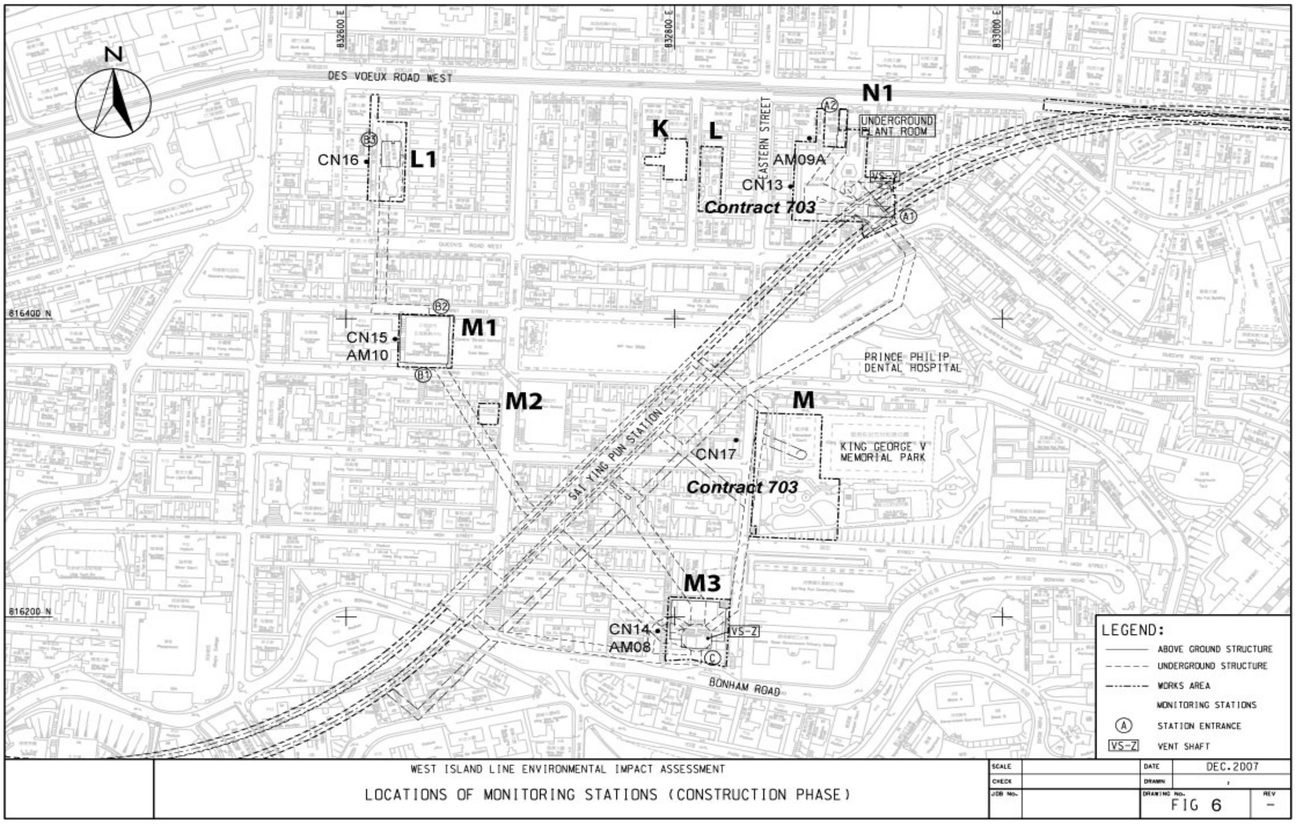
%The alternative air monitoring station AM5a proposal was submitted to EPD on 22 September 2010

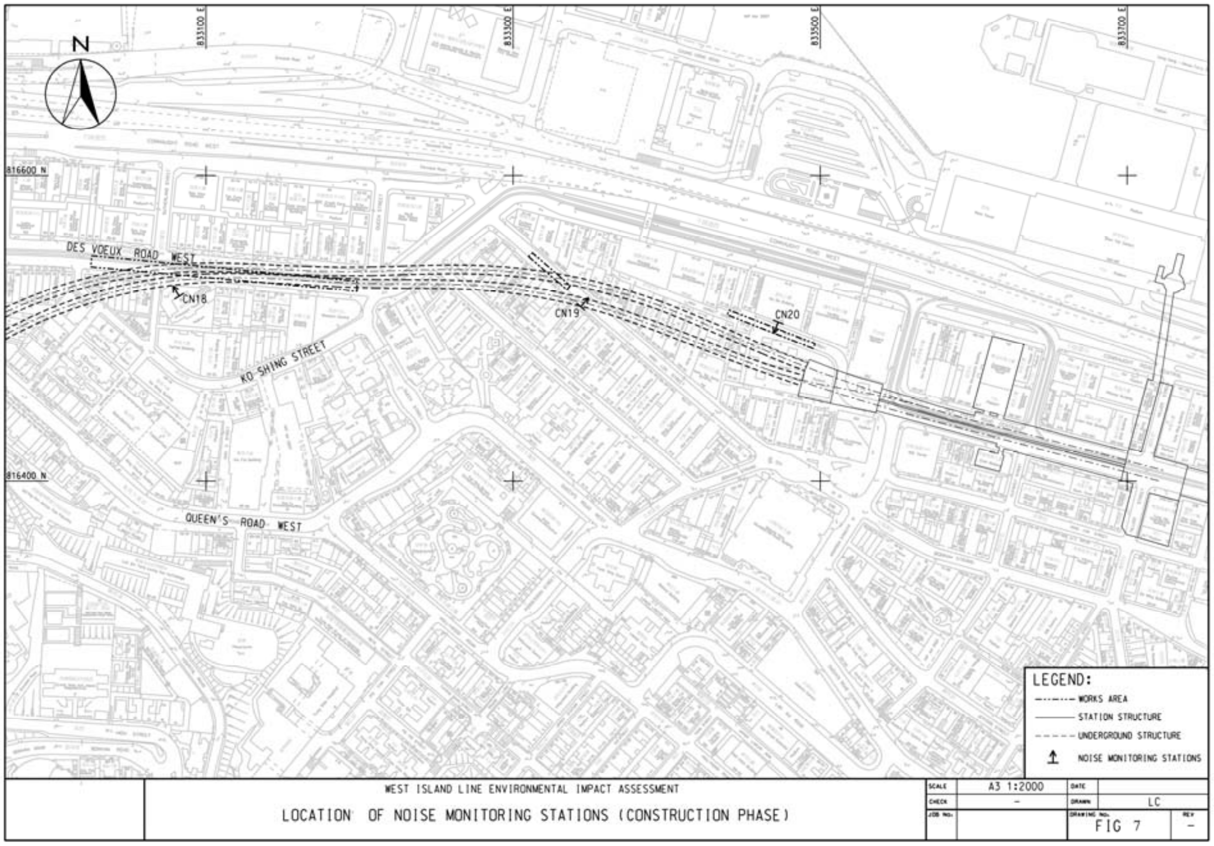
The alternative noise monitoring stations CN7a and CN11a were approved by EPD on 1 September 2010


N
CN21
B
AM02
Contract 714
BELCHER'S STREET
SMITHFIELD
CN03
CN04
A
AM03A
CN02
Contract 705
Contract 705
C & D
AM01
POK FU LAM ROAD
LEGEND:
WORKS SITE
SURFACE WORKS AREA
DUST MONITORING LOCATIONS
LOCATIONS OF MONITORING STATIONS - KENNEDY TOWN STATION
FIG 3


N
Contract 704
Contract 706
Contract 706
E
F
G
H
I
J
J1
J2
J3
CN06
CN11A
AM07A
CN09
CN10
CN05
CN08
AM06A
CN12
AM05A
CN07A
TEMPORARY OVERHEAD CONVEYOR BELT SYSTEM
CONSTRUCTION SHAFT
ELEVATED CONVEYOR BELT SYSTEM
BARGING POINT
WESTERN DISTRICT PUBLIC CARGO WORKING AREA
SHING SAI ROAD
SAI CHEUNG STREET NORTH
KENNEDY TOWN PRAYA
BELCHER'S STREET
UNDERGROUND CONSTRUCTION ADIT
THE BELCHER'S
HILL ROAD (ELEVATED)
CONNAUGHT ROAD WEST
DES VOEUX ROAD WEST
UNIVERSITY STATION
HONG KONG UNIVERSITY
LEGEND:
STATION STRUCTURE
UNDERGROUND STRUCTURE
WORKS SITE
SURFACE WORKS AREA
MONITORING LOCATIONS
WEST ISLAND LINE ENVIRONMENTAL IMPACT ASSESSMENT
LOCATIONS OF MONITORING STATIONS - UNIVERSITY STATION
FIG 4


N
MA
AM04
CN01
Contract 708
VICTORIA ROAD
KEY PLAN
A3 1:15000
KENNEDY TOWN STATION
LEGEND:
STATION STRUCTURE
UNDERGROUND STRUCTURE
WORKS SITE
UNDERGROUND WORKS SITE
SURFACE WORKS AREA
DUST MONITORING LOCATIONS
WEST ISLAND LINE ENVIRONMENTAL IMPACT ASSESSMENT
LOCATIONS OF MONITORING STATIONS - KENNEDY TOWN STATION
DEC. 2007
HYY
60017115
FIG 5
2008-8-13 15:51:33 LIC2
p:\projects\60017115\DRAWING\FIGURE\FIG 9.1_2.dgn


N
DES VOEUX ROAD WEST
N1
UNDERGROUND PLANT ROOM
K
L
EASTERN STREET
AM09A
CN13
Contract 703
L1
CN16
816400 N
M1
CN15
AM10
M2
PRINCE PHILIP DENTAL HOSPITAL
M
SAI YING PUN STATION
CN17
KING GEORGE V MEMORIAL PARK
Contract 703
M3
816200 N
CN14
AM08
VS-Z
BONHAM ROAD
832600 E
832800 E
833000 E
LEGEND:
ABOVE GROUND STRUCTURE
UNDERGROUND STRUCTURE
WORKS AREA
MONITORING STATIONS
STATION ENTRANCE
VENT SHAFT
WEST ISLAND LINE ENVIRONMENTAL IMPACT ASSESSMENT
LOCATIONS OF MONITORING STATIONS (CONSTRUCTION PHASE)
SCALE
CHECK
JOB No.
DATE DEC.2007
DRAWN
DRAWING No. FIG 6
REV -



2.3 Summary of EM&A Requirements

The EM&A programme requires environmental monitoring for air quality, noise, water quality and waste management as specified in the EM&A Manual.

In the reporting month, 24-hour TSP levels at the air monitoring stations shown in Table 2 were monitored during the construction stage.

In the reporting month, construction noise levels at the noise monitoring stations shown in Table 2 were monitored during the construction stage.

A summary of impact EM&A requirements as applicable to this EM&A Report is presented in Table 3 below.

Table 3 Summary of impact EM&A Requirements

Parameters	Descriptions	Locations	Frequencies	Duration
Air Quality	24-hr TSP	Shown in Table 2	Once every 6 days	During construction stage
Noise	Leq(30min)	Shown in Table 2	Once a week	During construction stage

Parameters	Descriptions	Locations	Frequencies	Duration
Waste	On-Site Audit	Active Works Sites	Monthly	During construction stage
Wastewater	On-Site Audit	Active Works Sites	Monthly	During construction stage
General Site Conditions	Environmental Site Inspection	Active Works Sites	Weekly	During construction stage

Environmental Quality Performance Limits for air quality and noise are shown in Appendix A. The Event Action Plan for air quality and noise are shown in Appendix B.

2.4 *Implementation of Environmental Mitigation Measures*

The WIL Civil Works Contractors are required to implement the mitigation measures as specified in the EP, EIA Report and EM&A Manual. During the regular environmental site inspections, the Contractors' implementation of mitigation measures were inspected and reviewed. A schedule of the implementation of mitigation measures identified in the WIL EIA is given in Appendix C.

2.5 *Construction Activities in the Reporting Month*

Major construction activities carried out by the respective WIL Civil Works Contractors during the reporting period include:

Contract 703 - Works Area K/L
- No site work

Contract 703 - Works Area M
- Tunnel excavation by blasting from KGV to SWL inside noise enclosure

Contract 703 - Works Area N1
- Shaft excavation
- Bored piling

Contract 703 - Works Areas O1/O2/O3
- Site preparation at Works Area O1
- Grouting at Works Area O3

Contract 704 - Works Area E
- Operation of barging point

Contract 704 - Works Area G
- Excavation by blasting for Praya construction adit

Contract 704 - Works Area H
- Excavation

Contract 704 - Works Area I/L1

- Pipe piling

Contract 704 - Works Area J/J2
- Site preparation

Contract 704 - Works Areas J3
- Pipe piling
- Box culvert diversion

Contract 704 - Works Area M2
- Reprovisioning of transformer and public toilet completed

Contract 704 - Works Area MA
- Management of magazine

Contract 705 - Works Area A
- Shaft excavation

Contract 705 - Works Area B
- Management of Works Area B
- Operation of barging point

Contract 705 - Works Area C
- Excavation
- Pipe piling

Contract 706A - Works Areas A/A1/A2/A3
- Slope works at Works Area A1/A2

Contract 706 - Works Area G/I/J
- Contract completed

Contract 708 - Works Area MA
- Contract completed

Contract 714 - Works Area B
- Contract completed

2.6 Construction Activities for the Coming Month

According to the construction programme for the Civil Works Contracts, the scheduled major construction activities in the next reporting month are as follows:

Contract 703 - Works Areas K/L
- No site work

Contract 703 - Works Area M
- Tunnel excavation by blasting from KGV to SWL inside noise enclosure

Contract 703 - Works Area N1

- Shaft excavation
- Bored piling

Contract 703 - Works Areas O1/O2/O3
- Grouting at Works Area O3
- Site preparation at Works Area O1

Contract 704 - Works Area E
- Operation of barging point

Contract 704 - Works Area G
- Excavation by blasting for Praya construction adit

Contract 704 - Works Area H
- Excavation

Contract 704 - Works Area I/L1
- Pipe piling

Contract 704 - Works Area J/J2
- Site preparation
- Excavation by blasting for Hill Road Entrance adit
- Building demolition at Works Area J2

Contract 704 - Works Areas J3
- Pipe piling
- Box culvert diversion

Contract 704 - Works Area M2
- Reprovisioning of transformer and public toilet completed

Contract 704 - Works Area MA
- Management of magazine

Contract 705 - Works Area A
- Shaft excavation

Contract 705 - Works Area B
- Management of Works Area B
- Operation of barging point

Contract 705 - Works Area C
- Excavation

Contract 706A - Works Areas A/A1/A2/A3
- Slope work at Works Areas A1/A2

Contract 706 - Works Areas G/I/J
- Contract completed

Contract 708 - Works Area MA
- Contract completed

Contract 714 - Works Area B

- Contract completed

3 IMPACT MONITORING

3.1 Air Quality

24-Hour TSP Levels Monitoring

The sampling procedure follows that described in the App. B of Pt 50 in 40CFR Ch.1 (U.S. Environmental Protection Agency). TSP is sampled by drawing air through a conditioned, pre-weighed filter paper inside the high volume sampler at a controlled rate. After 24-hour sampling the filter paper with retained particles is collected and returned to the laboratory for drying in a desiccator followed by weighing. TSP levels are calculated from the ratio of the mass of particulate retained on the filter paper to the total volume of air sampled.

The samplers should be properly maintained. Prior to dust monitoring commencing, appropriate checks should be made to ensure that all equipment and necessary power supply are in good working condition.

Calibration Requirements

The flow rate of the high volume sampler with mass flow controller will be calibrated using an orifice calibrator. Initial calibration (five points) will be conducted upon installation and prior to commissioning. Calibration will be carried out every six months. Calibration certificates are attached in Appendix E.

The sensing system of MIE will be calibrated by clean filtered air passing through the flow-sensing system, providing a controlled check of the zero-concentration condition. Calibration of the MIE by certified laboratory or manufacturer shall be carried out every two years and properly documented. Calibration certificate is attached in Appendix E.

To examine the construction dust levels, 24-hour TSP monitoring was undertaken according to the EM&A Manual. The dust monitoring locations are shown in the Section 2.2 above. Monitoring results are presented in the following table (see Appendix D for graphical plot). The 24-hour TSP levels when there were construction activities during the monitoring period were within the Action Level. No exceedance was found. This indicates that the construction activities did not have a noticeable adverse effect on the general air quality for the works areas.

For the Complaint Case 3 mentioned in Section 8 below on construction dust, three 1-hour TSP monitoring were undertaken at monitoring station AM1a according to the EM&A Manual. Monitoring results are presented in the following table. The 1-hour TSP levels when the highest dust impacts were likely to occur when construction activities were being carried out were within the Action Level. No exceedance was found.

Monitoring schedules are shown in Appendix F.

In addition, air baseline check for monitoring station AM6a was conducted on Sunday when no construction activities were carried out in the vicinity. It is observed that there is no significant deviation from the air baseline level obtained during the baseline monitoring before commencement of construction work.

Date	TSP (μg/m3)	Action Level (μg/m3)	Limit Level (μg/m3)	Compliance (Yes/No)	Weather Condition
AM1a- Kwun Lung Lau Block 1+					
13/12/2010	155.7	170	260	Yes	Fine
18/12/2010	160.3	170	260	Yes	Fine
23/12/2010#	103.2	301	500	Yes	Fine
23/12/2010#	128.9	301	500	Yes	Fine
23/12/2010#	156.8	301	500	Yes	Fine
24/12/2010	138.4	170	260	Yes	Fine
30/12/2010	166.8	170	260	Yes	Fine
05/01/2011	153.6	170	260	Yes	Fine
AM2- Victoria Public Mortuary					
13/12/2010	149.0	155	260	Yes	Fine
18/12/2010	102.4	155	260	Yes	Fine
24/12/2010	143.2	155	260	Yes	Fine
30/12/2010	144.6	155	260	Yes	Fine
05/01/2011	139.4	155	260	Yes	Fine
AM3a- Hong Kong Institute of Vocational Education (Tsing Yi) Kennedy Town Centre*					
13/12/2010	129.1	155	260	Yes	Fine
18/12/2010	136.0	155	260	Yes	Fine
24/12/2010	116.3	155	260	Yes	Fine
30/12/2010	140.8	155	260	Yes	Fine
05/01/2011	136.1	155	260	Yes	Fine
AM5a- Kennedy Town Fire Station%					
13/12/2010	140.9	178	260	Yes	Fine
18/12/2010	160.6	178	260	Yes	Fine
24/12/2010	144.4	178	260	Yes	Fine
30/12/2010	150.3	178	260	Yes	Fine
05/01/2011	155.9	178	260	Yes	Fine
AM6a- St. Paul's College Primary School*					
12/12/2010@	69.7	157	260	Yes	Fine
13/12/2010	147.3	157	260	Yes	Fine
18/12/2010	133.3	157	260	Yes	Fine
24/12/2010	126.3	157	260	Yes	Fine
30/12/2010	140.4	157	260	Yes	Fine
05/01/2011	96.5	157	260	Yes	Fine
AM7a- Hill Court*					
13/12/2010	127.3	151	260	Yes	Fine
18/12/2010	134.6	151	260	Yes	Fine
24/12/2010	144.5	151	260	Yes	Fine
30/12/2010	83.5	151	260	Yes	Fine
05/01/2011	140.6	151	260	Yes	Fine
AM9a- No.28 Sai Woo Lane^					
13/12/2010	148.0	168	260	Yes	Fine
18/12/2010	150.0	168	260	Yes	Fine
24/12/2010	162.6	168	260	Yes	Fine
30/12/2010	146.9	168	260	Yes	Fine
05/01/2011	143.8	168	260	Yes	Fine

*The alternative air monitoring stations AM3a, AM6a and AM7a were approved by EPD on 10 August

2009
^The alternative air monitoring station AM9a was approved by EPD on 26 November 2009
+The alternative air monitoring station AM1a was approved by EPD on 7 September 2010
%The alternative air monitoring station AM5a proposal was submitted to EPD on 22 September 2010
#Additional 3nos. 1-hr TSP monitoring for the complaint case
@ Baseline Check

3.2 Noise

B&K 2236 sound level meters which complied with the International Electrotechnical Commission Publication 651:1979 (Type 1) and 804:1985 (Type 1), specification as referred to in the Technical Memoranda to the NCO were used for the construction noise impact monitoring. The B&K sound level meters and B&K 4231 calibrator are verified by the certified laboratory or manufacturer once every two years to ensure they perform to the same level of accuracy as stated in the manufacturer's specifications. Calibration certificates are attached in Appendix E.

Immediately prior to and following each set of measurements at any NSR, the accuracy of the sound level meter was checked using an acoustic calibrator generating a known sound pressure level at a known frequency. If the calibration levels before and after the measurement differ by more than 1.0dB the measurement shall be repeated to obtain a reliable result (note: maximum deviation during this initial baseline monitoring period was 0.3dB). Periods of prolonged or repeated overloading of the sound level meter detector were avoided by setting the meter with adequate headroom prior to commencing measurements. Measurements were recorded to the nearest 0.1 dB, with values of 0.05 being rounded up.

Impact noise monitoring of $L_{A,eq30}$ was undertaken to measure construction noise levels in accordance with the EM&A Manual. The noise monitoring locations are shown in Section 2.2 above.

Monitoring results are presented in the following table (see Appendix D for graphical plot). No exceedance was found. Monitoring schedules are shown in Appendix F.

In addition, noise baseline check for monitoring station CN8 were conducted during noon time when no construction work was carried out in the vicinity. It is observed that there is no significant deviation from the noise baseline level obtained during the baseline monitoring before commencement of construction work.

CN2- Hong Kong Institute of Vocational Education (Tsing Yi) Kennedy Town Centre					
Date	Time	Leq(dBA)	Limit Level (dBA)	Compliance (Yes/No)	Weather Conditions
14/12/2010	10:35	69.3	70	Yes	Fine, wind<2m/s
14/12/2010%	16:15	69.5	70	Yes	Fine, wind<2m/s
21/12/2010	10:36	68.9	70	Yes	Fine, wind<2m/s
29/12/2010	10:00	68.8	70	Yes	Fine, wind<2m/s
05/01/2011	10:39	69.3	70	Yes	Fine, wind<2m/s
CN3- Lui Ming Choi Primary School					
10/12/2010	14:50	67.0	70	Yes	Fine, wind<2m/s
15/12/2010	14:55	66.7	70	Yes	Fine, wind<4m/s

21/12/2010	16:20	65.2	70	Yes	Fine, wind<2m/s
30/12/2010	15:55	67.5	70	Yes	Fine, wind<2m/s
05/01/2011	15:15	66.7	70	Yes	Fine, wind<2m/s
CN4 - Luen Tak Apartments					
15/12/2010	15:40	72.4	75	Yes	Fine, wind<4m/s
21/12/2010	15:30	74.1	75	Yes	Fine, wind<2m/s
31/12/2010	10:10	74.3	75	Yes	Fine, wind<2m/s
05/01/2011	10:50	74.6	75	Yes	Fine, wind<2m/s
CN6- Yick Fung Garden (BlockA)					
14/12/2010	10:15	72.8	75	Yes	Fine, wind<2m/s
21/12/2010	10:24	72.5	75	Yes	Fine, wind<2m/s
28/12/2010	10:23	72.9	75	Yes	Fine, wind<2m/s
04/01/2011	10:17	72.2	75	Yes	Fine, wind<2m/s
CN7a- Bowie Court#					
14/12/2010	14:52	73.9	75	Yes	Fine, wind<2m/s
21/12/2010	15:42	72.9	75	Yes	Fine, wind<2m/s
28/12/2010	15:49	73.8	75	Yes	Fine, wind<2m/s
04/01/2011	15:39	73.7	75	Yes	Fine, wind<2m/s
CN8- St. Paul's College Primary School					
13/12/2010	16:04	68.8	70	Yes	Fine, wind<2m/s
20/12/2010	15:58	69.2	70	Yes	Fine, wind<2m/s
28/12/2010@	12:30	64.8	70	Yes	Fine, wind<2m/s
28/12/2010	13:07	68.2	70	Yes	Fine, wind<2m/s
03/01/2011	16:21	69.2	70	Yes	Fine, wind<2m/s
CN9- Hill Court					
14/12/2010	16:29	73.2	75	Yes	Fine, wind<2m/s
21/12/2010	16:35	72.2	75	Yes	Fine, wind<2m/s
28/12/2010	16:52	73.2	75	Yes	Fine, wind<2m/s
04/01/2011	16:35	72.6	75	Yes	Fine, wind<2m/s
CN11a- Yick Fung Garden (BlockB)#					
14/12/2010	10:58	74.7	75	Yes	Fine, wind<2m/s
21/12/2010	11:09	74.4	75	Yes	Fine, wind<2m/s
28/12/2010	11:12	74.7	75	Yes	Fine, wind<2m/s
04/01/2011%	11:13	74.6	75	Yes	Fine, wind<2m/s
05/01/2011	15:30	74.8	75	Yes	Fine, wind<2m/s
CN12- Wah Po Building					
13/12/2010	11:27	70.2	75	Yes	Fine, wind<2m/s
20/12/2010	11:15	69.7	75	Yes	Fine, wind<2m/s
28/12/2010	13:17	70.3	75	Yes	Fine, wind<2m/s
03/01/2011	11:21	69.3	75	Yes	Fine, wind<2m/s
CN13- No. 18-20 Eastern Street					
14/12/2010	13:15	74.6	75	Yes	Fine, wind<2m/s
22/12/2010	11:30	73.7	75	Yes	Fine, wind<2m/s
29/12/2010	16:35	74.1	75	Yes	Fine, wind<2m/s
05/01/2011	16:30	74.5	75	Yes	Fine, wind<2m/s
CN16- No.9-11 Ki Ling Lane					
14/12/2010	15:45	74.0	75	Yes	Fine, wind<2m/s
21/12/2010	15:30	74.9	75	Yes	Fine, wind<2m/s
28/12/2010	15:45	74.5	75	Yes	Fine, wind<2m/s
04/01/2011	15:25	73.8	75	Yes	Fine, wind<2m/s
CN17- No.1 Third Street					

14/12/2010	13:55	72.4	75	Yes	Fine, wind<2m/s
17/12/2010%	08:00	72.8	75	Yes	Fine, wind<2m/s
22/12/2010	13:30	72.5	75	Yes	Fine, wind<2m/s
29/12/2010	13:50	73.0	75	Yes	Fine, wind<2m/s
05/01/2011	15:45	72.3	75	Yes	Fine, wind<2m/s
CN18- Princeton Tower					
14/12/2010	09:00	72.5	75	Yes	Fine, wind<2m/s
21/12/2010	08:50	73.2	75	Yes	Fine, wind<2m/s
28/12/2010	13:00	72.8	75	Yes	Fine, wind<2m/s
04/01/2011	09:05	73.4	75	Yes	Fine, wind<2m/s
CN20- Ka On Building					
14/12/2010	17:00	75.0	75	Yes	Fine, wind<2m/s
23/12/2010	16:38	74.3	75	Yes	Fine, wind<2m/s
30/12/2010	16:55	73.5	75	Yes	Fine, wind<2m/s
06/01/2011	16:45	74.1	75	Yes	Fine, wind<2m/s
CN21- The Merton (Block 2)					
09/12/2010	15:50	72.6	75	Yes	Fine, wind<2m/s
17/12/2010	14:10	71.5	75	Yes	Fine, wind<2m/s
24/12/2010	11:00	72.0	75	Yes	Fine, wind<2m/s
31/12/2010	11:30	70.9	75	Yes	Fine, wind<2m/s
08/01/2011	15:45	72.8	75	Yes	Fine, wind<2m/s

The alternative noise monitoring stations CN7a and CN11a were approved by EPD on 1 September 2010

@ Baseline Check

%Additional monitoring due to complaint as per Noise Event Action Plan

3.3 Action taken in Event of Exceedence

There was no exceedance in air quality and noise monitoring parameters recorded in the reporting period, therefore no action was taken.

4 LANDSCAPE AND VISUAL

4.1 Monitoring Requirements

Monitoring of the implementation of the landscape and visual mitigation measures during construction phase was conducted in accordance with the requirements as stipulated in the EM&A Manual.

The landscape and visual monitoring and audit will be conducted once a month throughout the construction stage covering the entire project site areas.

4.2 Audit Results

Monthly monitoring and audit was undertaken in accordance with the EM&A Manual.

Tree Felling at Contract 703 Works Area L

15 nos. of trees were removed in accordance with the approved Tree Removal Application during

the site clearance work as mentioned in the EM&A Report for October 2009.

Tree Felling at Contract 703 Works Area M

11 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for October 2009.

Tree Felling at Contract 703 Works Area N1

29 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for October 2009.

Tree Felling at Contract 704 Works Area L1

19 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for June 2010.

Tree Felling at Contract 704 Works Area I

42 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for June 2010.

Tree Felling at Contract 705 Works Area C

31 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for March 2010. 6 nos. of trees were removed during the site clearance work as mentioned in the EM&A Report for June 2010.

Tree Felling at Contract 706 Works Area G

4 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for September 2009.

Tree Felling at Contract 706 Works Area J

16 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for September 2009.

Tree Felling at Contract 708 Works Area MA

107 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for September 2009.

Tree Felling at Contract 714 Works Area B

2 nos. of trees were removed in accordance with the approved Tree Removal Application during the site clearance work as mentioned in the EM&A Report for October 2009.

Tree Transplantation in past reporting periods

7 nos. of trees were transplanted from Works Area J to the Receptor Sites at Sheung Wan

Pumping Station site (4nos.), Junction of Shing Sai Road/New Praya (2 nos.) and Shing Sai Road (1 no.) in accordance with the approved Tree Removal Application. In the approved Tree Removal Application, 5nos. of trees were approved to be transplanted in Works Area J, 2 nos. additional trees were transplanted in response to the request made by LCSD with a view to preserving the landscape resources as much as practicable.

In addition, 2nos. of trees from Works Area C and 6nos. of trees from Works Area J3 were transplanted to the Receptor Site at Sheung Wan Pumping Station site in accordance with the approved Tree Removal Application. The tree transplanting works for these two works areas were carried out prior to the construction contracts award.

3 nos. of trees were transplanted from Works Area N1 to the Receptor Sites at Sheung Wan Pumping Station site, road side planter at Shing Sai Road and Connaught Road West. 1 no. of tree was transplanted from Works Area L to the Receptor Site at road side planter at Connaught Road West. 14 nos. of trees were transplanted within the park area for Works Area M.

11 nos. of trees were transplanted from Works Area C to the Receptor Site at the road side planter at Shing Sai Road.

20 nos. of trees were transplanted from Works Area I to the Receptor Site at Shing Sai Road/Pok Fu Lam Road Playground and CEDD's GMP sites. 17 nos. of trees were transplanted from Works Area L1 to the CEDD's GMP sites. 2 nos. of trees were transplanted from Works Area G to the Receptor Site at Shing Sai Road.

Tree Transplantation in this reporting period

There was no tree transplant carried out in the reporting period.

The Certified Arborist as required by the EP has conducted inspections and audits and found that the transplanting works and the tree protection works being carried out by the civil works and transplanting contractors were in accordance with the EP/EIA, Tree Protection Plan and contract requirements. No non compliance was identified in the reporting period. Monthly inspection record for December 2010 is attached in Appendix G.

Others

In accordance with EP Condition 2.8, the two individual plants, *Pavetta hongkongensis* located at the Works Area MA shall be transplanted.

It was identified that only one of the plant as mentioned above require transplanting and the other can be retained at its original location.

With consent from AFCD on the proposed method statement for transplanting the plant and protecting the retained plant, the plant was transplanted to a nearby location with similar habitat in September 2009 as agreed by AFCD and supervised by the Certified Arborist. The retained plant was properly protected in accordance with the agreed method.

The existing trees and species of conservation importance (ie the two identified *Artocarpus hypargyreus*) located near the Works Area MA were fenced off and the trunk protected with hessian sacking.

In addition, the tree (no. BT049A) at Pok Fu Lam Road which was originally proposed for transplant was toppled by Typhoon Koppu on 14 September 2009 and was removed by LCSD. Access to this site had not been given to MTR and no work had been carried out to the tree. This incident will be included in the revised Tree Protection Plan accordingly.

The ET had reminded the ER and the civil works contractors to implement appropriate tree protection measures to ensure tree stability. In addition, as there was safety concern for the trees no. BT92 and BT93 at Works Area I, decision was made by the Project Team to fell the trees which posed potential safety risk to the residents of the Hillview Garden. The trees had been felled in the reporting period for October 2010 due to public safety consideration in accordance with Emergency Tree Felling procedures stipulated in LAO practice note 7/2007 Appendix II Section III. The felling of the two trees had been requested and strongly supported by the Incorporated Owners of Hillview Garden in order to mitigate the saftety risk to the Hillview Garden residents and the public.

5 WASTE MANAGEMENT

Mitigation measures on waste management have been implemented in accordance with the Waste Management Plans for the respective civil works contracts submitted under the Environmental Permit. The C&D materials are to be disposed of at the public filling reception facilities while C&D wastes are to be disposed of at the landfills. Quantities of wastes disposed in the reporting period are summarized in the following table:

Amount of Construction Wastes Disposed				
Reporting Period	**Inert C&D Materials to Public Fill (ton)**	**Inert C&D Materials Reused (ton)**	**Non-inert Waste to Landfill (ton)**	**Chemical Waste to designated treatment facility (litre)**
<u>Contract 703</u>				
Aug – Sept 2009	305.1	0	5.9	0
Oct – Dec 2009	4158.4	0	51.1	0
Jan – Mar 2010	7855.6	0	86.8	0
Apr – Jun 2010	11000.8	0	71.2	0
Jul – Sept 2010	14525.7	0	109.3	2.9m3^
Oct 2010	6738.6	0	27.8	0
Nov 2010	3944.0	0	22.2	0
Dec 2010	8048.9	0	15.2	200kg+1200 litres
Cumulative	56577.1	0	389.5	0
<u>Contract 704</u>				
Apr – Jun 2010	3261.1	0	77	0
Jul - Sept 2010	4342.1	0	80.1	0
Oct 2010	1623.7	5412	125.1	0
Nov 2010	3545.9	6832.9	69.1	0
Dec 2010	13229.6	1540	69	0
Cumulative	26002.4	13784.9	581.9	0
<u>Contract 705</u>				
Dec 2009	0	0	0	0

Jan – Mar 2010	826	0	67	0
Apr - Jun 2010	4146	0	54	125kg^+400 litres
Jul - Sept 2010	14457	0	126.4	0
Oct 2010	1730	0	37.9	0
Nov 2010	460	8725	33.6	0
Dec 2010	8753	9905	250	0
Cumulative	30372	18630	568.9	400
<u>Contract 706 (Contract completed in November 2010)</u>				
Jul – Sept 2009	1746.6	0	12.7	0
Oct – Dec 2009	5641.3	0	10.4	200
Jan – Mar 2010	13633.9	0	54.9	0
Apr – Jun 2010	21208.8	0	72.6	0
Jul – Sept 2010	5657.9	0	39.3	0
Oct 2010	742.7	0	2.4	0
Nov 2010	0	0	0	0
Cumulative	48631.2	0	192.3	200
<u>Contract 706A</u>				
Dec 2009	0	0	0	0
Jan – Mar 2010	8238.6	0	96.2	0
Apr – Jun 2010	1054.7	0	1724	0
Jul - Sept 2010	195.7	0	196.6	0
Oct 2010	85.7	0	54.1	0
Nov 2010	53.9	0	16.4	0
Dec 2010	1091.9	0	20.1	0
Cumulative	10720.4	0	2107.4	0
<u>Contract 708 (Contract completed in August 2010)</u>				
Jul – Sept 2009	0	0	181	0
Oct - Dec 2009	5698.9	0	12	0
Jan – Mar 2010	9989.6	0	12.5	0
Apr – Jun 2010	2741	0	54.3	0
Jul 2010	1035.4	0	13.3	0
Aug 2010	0	0	0	0
Cumulative	19464.9	0	273.1	0
<u>Contract 714 (Contract completed in April 2010)</u>				
Jul – Sept 2009	0	0	42.1	0
Oct - Dec 2009	271.9	0	161.6	0
Jan – Mar 2010	87.7	0	124.7	0
Apr 2010	0	0	0	0
Cumulative	359.6	0	328.4	0

^ACM disposal from buildings demolition

6 WATER QUALITY

Monitoring of the implementation of the water quality mitigation measures during construction phase was conducted in accordance with the requirements as stipulated in the EM&A Manual.

Weekly site inspection will be conducted throughout the construction stage covering the entire project site areas to ensure the recommended mitigation measures are properly implemented.

In the reporting period, the water quality mitigation measures were implemented in accordance with the requirements as stipulated in the EM&A Manual.

Water sample tests was conducted for Works Areas A, C, E, H, I and J in the reporting period. Results were satisfactory and were in compliance with the requirement under the WPCO licence.

7 CULTURAL HERITAGE

Archaeological Watching Brief monitoring for Works Areas C and H were conducted in accordance with the approved Archaeological Watching Brief Proposal at one half day site visit per week during the excavation work. Archaeological Watching Brief monitoring for Works Area I were conducted in accordance with the approved Archaeological Watching Brief Proposal at one half day site visit per two week during the excavation work. No archaeological finding was observed for these works areas in the reporting period.

Archaeological Watching Brief monitoring for Works Area J conducted in accordance with the approved Archaeological Watching Brief Proposal at Works Area J at two half day site visits per week during the shaft excavation was completed. No archaeological finding was observed.

Archaeological Watching Brief monitoring for Works Area M had been completed as mentioned in the EM&A Report for July 2010. No archaeological finding was observed.

Archaeological Watching Brief monitoring for Works Area M2 had been completed as mentioned in the EM&A Report for May 2010. No archaeological finding was observed.

8 RECORD OF ENVIRONMENTAL COMPLAINTS

Five environmental complaints were referred from EPD in the reporting period as follows:

1. An environmental complaint referred to the ET on 13 December 2010 regarding percussive piling noise from construction site at Kennedy Town Ex-police Quarters.

2. An environmental complaint referred to the ET on 16 December 2010 regarding the warning noise for blast before 7:00am around KGV works site.

3. An environmental complaint on received on 20 December 2010 regarding dust emission from construction site near the swimming pool at Smithfield Road.

4. An environmental complaint referred to the ET on 31 December 2010 regarding day time construction noise from the works site at Belcher's Street affecting The Belcher's Tower.

5. An environmental complaint referred to the ET on 4 January 2011 regarding the tunnel blastings near KGV works site.

<u>Complaint case 1</u>

Upon investigation of the complaint, the major construction activities carried out by the Contract 705 Contractor was mechanical rock breaking for the excavation of the shaft. There was no percussive piling taking place at the captioned works site.

The ER had reiterated to the Contractor to increase efforts to reduce the noise impact to nearby NSRs as far as practicable.

Additional noise impact monitoring had been conducted for this environmental complaint as per the Event Action Plan in the EM&A Manual and no exceedance was recorded.

<u>Complaint case 2</u>

Upon investigation of the complaint, the Contract 703 Contractor played the warning gongs prior to blast few minutes before 7:00am as required by the blasting permit.

The current planning of the work is to blast twice a day between 7 am to 7 pm (except contingency cases in which blast not later than 10pm). The Contractor will update and maintain the display board in order to be in-line with every blast.

In addition, the Contractor will play the warning gongs as light as possible before the morning blast to minimize the noise nuisance to the surrounding resident and will try to cancel the gong playing action as soon as the measured air overpressure is low enough that there is no need to alarm the public.

Additional noise impact monitoring had been conducted for this environmental complaint as per the Event Action Plan in the EM&A Manual and no exceedance was recorded.

<u>Complaint case 3</u>

Upon investigation of the complaint, the dust and smoke was likely emitted from the piling works being carried out by the Contract 705 Contractor at the works site near the swimming pool at Smithfield Road.

As a result of the complaint, in order to address the concern of dust impact raised by the complainant, the ER had required the Contractor to erect tarpaulin sheets to enclose the pilling works area and increase the height of the hoardings. In addition, watering jet is provided for dust suppression.

Additional dust impact monitoring had been conducted for this environmental complaint as per the Event Action Plan in the EM&A Manual and no exceedance was recorded.

<u>Complaint case 4</u>

Upon investigation of the complaint, the construction activities carried out by the Contract 704 Contractor were pavement breaking using a breaker at the southern excavation area with the use of movable noise barrier. The breaker head was also wrapped with acoustic sheets to reduce the breaking noise. In addition, manual rock breaking was being carried out at the northern excavation area with the whole area covered by noise blankets.

As a result of the complaint, in order to address the concerns of noise impacts raised by the complainants in the adjacent Belcher's Towers, the Contractor had implemented the following enhanced mitigation measures in order to further reduce the noise impacts to the adjacent noise sensitive receivers:-

1. More movable noise barriers were used to shield the breaking noise.

2. Height of the acoustic blankets mounted on top of the hoarding was increased.

Additional noise impact monitoring had been conducted for this environmental complaint as per the Event Action Plan in the EM&A Manual in order to check the mitigation effectiveness and no exceedance was recorded. It is demonstrated from the monitoring result that the mitigation measures as mentioned above are effective in reducing the construction noise impacts arising from the construction activities carried out for the period as mentioned in the complaint.

<u>Complaint case 5</u>

The current planning of the work is to blast twice a day between 7 am to 7 pm (except contingency cases in which blast not later than 10pm). The contingency cases include ground conditions (the stronger the rock the longer it takes to drill) or other issues (plant breakdowns etc), if it is not safe to blast the ER/Contractor will have to postpone until it is safe to do so. The Contractor will update and maintain the display board in order to be in-line with every blast.

It is specified in the approved documentation by CEDD/Mines that blasting between 07.00-22.00hr is allowed but the Contractor will try to limit this to between 07.00-19.00hr with blast occurring after 19.00 to 22.00hr if the Contractor has experienced problems.

The Contractor is not required to play the warning gongs as tunnelling work had completed about 70m from the KGV shaft and the measured air overpressure is low enough that there is no need to close the roads and alarm the public.

In addition, in the reporting period, there was an enquiry raised by the LegCo Member regarding the temporary material stockpile at the PCWA barging site, a follow-up discussion meeting was held on 21 December 2010. In order to address the concerns of potential environmental impacts raised, the ET is working with the ER/the Contractor to investigate how environmental nuisances can be minimized and the further mitigation measures that can be practicably implemented.

A summary of environmental complaints since commencement of construction is shown below:

Reporting Period	Frequency	Cumulative	Nature	Status
10 Aug 2009 – 9 Nov 2009	3	3	3nos. Noise	Cases closed
10 Nov 2009 – 9 Feb 2010	6	9	3 nos. - Noise/Air 3 nos. – Noise	Cases closed
10 Feb 2010 – 9 May 2010	10	19	6 nos. - Noise 4 nos. – Dust/Smoke	Cases closed
10 May 2010 – 9 Aug 2010	5	24	1 no. – Dust/Smoke 2 nos – Other 1 no. - Noise 1 no. – Water	Cases closed
10 Aug 2010 – 9 Nov 2010	14	38	7 nos. - Noise 2 nos. – Smoke/Smell 2 nos. – Dust/Noise 2 nos. – Dust 1 no. – Water	Cases closed
10 Nov 2010 – 9 Dec 2010	4	42	4 nos. - Noise	Cases closed
10 Dec 2010 – 9 Jan 2011	5	47	3 nos. - Noise 1 no. – Dust 1 no. – Other	Cases closed

9 RECORD OF NON-COMPLIANCES

There was no non-compliance identified in the reporting period.

10 NOTIFICATION OF SUMMONS AND SUCCESSFUL PROSECUTIONS

No summon or prosecution related to environmental issue was received or made against the Project in the reporting period. A summary of environmental prosecution since commencement of construction is shown below:-

Reporting Period	Frequency	Cumulative	Nature	Status
10 Aug – 9 Nov 2009	0	0	N/A	N/A
10 Nov 2009– 9 Feb 2010	0	0	N/A	N/A
10 Feb 2010 – 9 May 2010	1	1	Noise	Summon served
10 May 2010 – 9 Aug 2010	0	1	N/A	N/A
10 Aug 2010 – 9 Nov 2010	0	1	N/A	N/A
10 Nov 2010 – 9 Dec 2010	0	1	N/A	N/A
10 Dec 2010 – 9 Jan 2011	0	1	N/A	N/A

11 STATUS OF STATUTORY SUBMISSIONS

11.1 Submissions required under Environmental Permit

A summary of the status of submissions required under the WIL Environmental Permit as of 9

January 2011 is shown below:

EP-313/2008/C Clause No.	Description		Status
1.11	1	Commencement date of construction	submitted on 10 July 2009
2.1 & 2.2	2	Employment of IEC, ET Leader	submitted on 23 June 2009
2.3	3	Contractor Management Organization for Civil Works Contracts 706, 708 and 714	submitted on 24 July 2009
2.3	4	Contractor Management Organization for Civil Works Contract 703	submitted on 14 September 2009 and 6 October 2009
2.3	5	Contractor Management Organization for Civil Works Contracts 705 and 706A	submitted on 22 January 2010
2.3	6	Contractor Management Organization for Civil Works Contract 704	submitted on 16 April 2010
2.5 & 2.7	7	Certified Arborist and Tree Protection Plan	submitted on 24 July 2009 and 5 August 2009
2.5 & 2.7	8	Certified Arborist and Tree Protection Plan – Responses to Comments	submitted on 10 September 2009
2.5 & 2.7	9	Certified Arborist and Tree Protection Plan – Certified Arborist	submitted on 3 November 2009
2.5 & 2.7	10	Tree Protection Plan Rev A	submitted on 19 July 2010
2.5 & 2.7	11	Tree Protection Plan Rev B	submitted on 13 October 2010
2.5	12	Certified Arborist	submitted on 22 June 2010
2.6	13	Set up of Community Liaison Groups and designated complaint hotline	submitted on 20 July 2009
2.11.1	14	Archaeological Watching Brief Proposal	submitted on 31 August 2009
2.11.1	15	Revised Archaeological Watching Brief Proposal	submitted on 23 September 2009
2.11.1	16	Revised Archaeological Watching Brief Proposal	submitted on 16 October 2009
2.12	17	Waste Management Plans for Civil Works Contracts 706, 708 and 714	submitted on 24 July 2009
2.12	18	Revised Waste Management Plans for Civil Works Contracts 706, 708 and 714 Rev A	submitted on 7 September 2009
2.12	19	Revised Waste Management Plans for Civil Works Contracts 706, 708 and 714 Rev B	submitted on 16 October 2009
2.12	20	Waste Management Plan for Civil Works Contract 703	submitted on 2 December 2009
2.12	21	Revised Waste Management Plan for Civil Works Contract 703 Rev A	submitted on 14 January 2010
2.12	22	Waste Management Plan for Civil Works Contract 706A	submitted on 22 January 2010
2.12	23	Waste Management Plan for Civil Works Contract 705	submitted on 5 February 2010
2.12	24	Revised Waste Management Plan for Civil Works Contract 705 Rev A	submitted on 2 September 2010
2.12	25	Waste Management Plan for Civil Works Contract 704	submitted on 22 July 2010
3.1.1(a) & 2.4	26	Works Area B programme, site layout plan and drawings of mitigation measures	submitted on 23 June 2009
3.1.1(a)	27	Remediation Report for Works Area B	submitted on 10 June 2009

3.1.2(a) & 3.1.2(b)	28	Appointment of ISC and certification of additional concrete paving for the small western portion of Works Area B occupied by HyD Depot	submitted on 13 July 2009 and 25 August 2009
3.1.2(a) & 3.1.2(b)	29	Appointment of ISC and certification of additional concrete paving for Works Area B for WIL Project	submitted on 30 October 2009
6.3	30	Baseline Monitoring Report (Part 1) for Works Area B	submitted on 10 July 2009
6.3	31	Baseline Monitoring Report (Part 2) for Works Area MA	submitted on 12 August 2009
6.3	32	Baseline Monitoring Report (Part 3) for Works Areas G and J	submitted on 28 August 2009
6.3	33	Baseline Monitoring Report (Part 4) for Works Areas M and N1	submitted on 9 October 2009
6.3	34	Baseline Monitoring Report (Part 5) for Works Area I	submitted on 8 December 2009
6.3	35	Baseline Monitoring Report (Part 6) for Works Area C	submitted on 10 February 2010
6.3	36	Baseline Monitoring Report (Part 7) for Works Areas C and D	submitted on 15 April 2010
6.3	37	Baseline Monitoring Report (Part 7) Rev A for Works Areas C and D	submitted on 11 June 2010
6.3	37	Baseline Monitoring Report (Part 8) for Works Area A	submitted on 23 April 2010
6.3	38	Baseline Monitoring Report (Part 8) Rev A for Works Area A	submitted on 15 June 2010
6.3	39	Baseline Monitoring Report (Part 9) for Works Area L1	submitted on 7 July 2010
6.3	40	Baseline Monitoring Report (Part 10) for Works Areas H and J3	submitted on 6 October 2010
6.3	41	Baseline Monitoring Report (Part 11) for Works Areas O1, O2 and O3	submitted on 12 October 2010
6.3	42	Baseline Monitoring Report (Part 12) for Works Area E	submitted on 4 November 2010
6.3	43	Baseline Monitoring Report (Part 12) Rev A for Works Area E	submitted on 17 December 2010
6.4	44	EM&A Report for September 2009	submitted on 23 September 2009
6.4	45	EM&A Report for October 2009	submitted on 23 October 2009
6.4	46	EM&A Report for November 2009	submitted on 23 November 2009
6.4	47	EM&A Report for December 2009	submitted on 23 December 2009
6.4	48	EM&A Report for January 2010	submitted on 22 January 2010
6.4	49	EM&A Report for February 2010	submitted on 25 February 2010
6.4	50	EM&A Report for March 2010	submitted on 23 March 2010
6.4	51	EM&A Report for April 2010	submitted on 23 April 2010
6.4	52	EM&A Report for May 2010	submitted on 24 May 2010
6.4	53	EM&A Report for June 2010	submitted on 24 June 2010

6.4	54	EM&A Report for July 2010	submitted on 23 July 2010
6.4	55	EM&A Report for August 2010	submitted on 23 August 2010
6.4	56	EM&A Report for September 2010	submitted on 24 September 2010
6.4	57	EM&A Report for October 2010	submitted on 25 October 2010
6.4	58	EM&A Report for November 2010	submitted on 23 November 2010
6.4	59	EM&A Report for December 2010	submitted on 23 December 2010
6.1	60	Final EM&A Report for Works Area MA	submitted on 29 December 2010
7.2	61	Internet address of web site for environmental monitoring and project data	submitted on 23 September 2009

11.2 Statutory Permits and Licenses

A summary of the status of all relevant environmental permits and licenses as of 9 January 2011 is shown below:

Description	**Status**
Environmental Permit for West Island Line Project (EP-313/2008)	Issued on 12 January 2009 and superseded
Environmental Permit for West Island Line Project (EP-313/2008/A)	Issued on 26 June 2009 and superseded
Environmental Permit for West Island Line Project (EP-313/2008/B)	Issued on 22 July 2009 and superseded
Environmental Permit for West Island Line Project (EP-313/2008/C)	Issued on 31 August 2009
<u>Contract 703</u>	
Wastewater Discharge License	WT00005106-2009, WT00005108-2009, WT00006066-2010 and WT00007598-2010
Registration as a Chemical Waste Producer	Approved on 2 September 2009 Permit no. 5213-113-D2422-01 Permit no. 5213-113-D2422-02 Permit no. 5213-113-D2422-03
Disposal of Construction Waste	Billing Account no. 7009262 activated on 21 August 2009
Construction Noise Permit	GW-RS0867-09 (expired) GW-RS0025-10 (expired) GW-RS0176-10 (expired) GW-RS0086-10 (expired) GW-RS0297-10 (expired) GW-RS0367-10 (surrendered) GW-RS0448-10 (expired) GW-RS0467-10 (surrendered) GW-RS0606-10 (surrendered) GW-RS0673-10 (11 Aug 10– 10 Jan 11)

	GW-RS0849-10 (30 Sept 10– 21 Mar 11) GW-RS0876-10 (09 Oct 10– 06 Apr 11) GW-RS1052-10 (26 Nov 10– 25 May 11)
Contract 704	
Wastewater Discharge License	WT00006664-2010, WT00006823-2010 WT00006826-2010, WT00006925-2010, WT00006958-2010 WT00006961-2010, WT00006962-2010, WT00007021-2010, WT00007939-2010, WT00007998-2010
Registration as a Chemical Waste Producer	Approved on 2 June 2010 Permit no. 5214-111-G2260-03 Approved on 12 November 2010 Permit no. 5213-116-G2260-04 Approved on 25 November 2010 Permit no. 5213-112-G2525-02 Approved on 26 November 2010 Permit no. 5213-111-G2525-01
Disposal of Construction Waste	Billing Account no. 7010555 activated on 8 April 2010, Billing Account no. 70111159 (by vessel) activated on 10 September 2010
Construction Noise Permit	GW-RS0413-10 (expired) GW-RS0552-10 (expired) GW-RS0572-10 (expired) GW-RS0738-10 (surrendered) GW-RS0836-10 (surrendered) GW-RS0838-10 (surrendered) GW-RS0918-10 (expired) GW-RS1015-10 (19 Nov 10– 30 Apr 11) GW-RS1167-10 (5 Dec 10– 30 Jan 11)
Contract 705	
Wastewater Discharge License	WT00006145-2010(superseded), WT00006685-2010, WT00006686-2010, WT00007225-2010 and WT00007226-2010
Registration as a Chemical Waste Producer	Approved on 8 February 2010 Permit no. 5213-111-G2347-17
Disposal of Construction Waste	Billing Account no. 7009116 activated on 8 January 2010, Billing Account no. 7010026 (by vessel) activated on 30 November 2010
Construction Noise Permit	GW-RS0661-10 (1 Aug 10– 31 Jan 11) GW-RS0703-10 (surrendered) GW-RS0873-10 (6 Oct 10– 5 Mar 11)
Contract 706	
Wastewater Discharge License	WT00004519-2009, WT00004526-2009 and WT00005600-2009
Registration as a Chemical Waste Producer	Approved on 6 October 2009

	Permit no. 5213-116-P2781-16
Disposal of Construction Waste	Billing Account no. 7009056 activated on 16 July 2009
Construction Noise Permit	GW-RS0703-09 for using PME for general construction works at Kennedy Town Praya works site was cancelled by EPD on 18 November 2009 GW-RS0174-10 for using PME for general construction works at Kennedy Town Praya works site was cancelled by EPD on 19 May 2010
Contract 706A	
Wastewater Discharge License	WT00005647-2009
Registration as a Chemical Waste Producer	Approved on 17 December 2009 Permit no. 5213-111-F2541-02
Disposal of Construction Waste	Billing Account no. 7009743 activated on 17 November 2009
Contract 708	
Wastewater Discharge License	WT00004902-2009
Registration as a Chemical Waste Producer	Approved on 7 September 2009 Permit no. 5213-111-G2347-08
Disposal of Construction Waste	Billing Account no. 7009116 activated on 12 August 2009
Construction Noise Permit	GW-RS0938-09 (expired) GW-RS0283-10 (expired)
Contract 714	
Wastewater Discharge License	WT00004893-2009
Registration as a Chemical Waste Producer	Approved on 21 September 2009 Permit no. 5213-111-S3305-02
Disposal of Construction Waste	Billing Account no. 7009127 activated on 14 August 2009

12 SITE INSPECTIONS

12.1 Observations

Regular site inspections were undertaken by the ET in accordance with the EM&A Manual. The contractors' performance on environmental matters were assessed. The inspection findings and the associated recommendations on improvement to the environmental protection and pollution control works were raised to the contractors for reference and/ or action.

In addition, the ET carried out night time inspections to Works Areas J, H, L1, M1 and N1 in the reporting period in order to check for compliance with the NCO, the results were in general satisfactory with no construction work was observed.

Observations against the implementation of the mitigation measures recommended in the EP/EIA are summarized as follows:

Item	Description	Follow-up Status
	Contract 703	
1	The contractor was reminded to clear stagnant water inside surface channels to avoid mosquito bleeding	Ongoing
2	The contractor was reminded to provide sufficient movable noise barriers to minimize noise nuisance to nearby residents	Improved and the standard to be maintained
3	The contractor was reminded to properly implement wastes sorting	Ongoing
4	No water sample test was conducted in the reporting month	N/A
	Contract 704	
1	The contractor was reminded to properly implement wastes sorting	Ongoing
2	The contractor was reminded to provide sufficient movable noise barriers/acoustic fabric to minimize noise nuisance to nearby residents during site clearance works	Ongoing
3	Water sample test was conducted in the reporting month for Works Areas E, H, I and J, results were satisfactory	N/A
	Contract 705	
1	The contractor was reminded to properly implement wastes sorting	Ongoing
2	The contractor was reminded to provide sufficient movable noise barriers/acoustic fabric to minimize noise nuisance to nearby residents	Ongoing
3	The contractor advised that rock crusher will not be adopted in Works Area B and wastewater treatment plant will be used instead of sedimentation tank	Ongoing
4	Water sample test was conducted in the reporting month for Works Areas A and C, results were satisfactory	N/A
	Contract 706A	
1	The contractor was reminded to properly implement wastes sorting	Ongoing
2	The contractor was reminded to provide proper sedimentation tank to treat site water	Ongoing
3	No water sample test was conducted in the reporting month	N/A
	Contract 706	
1	No water sample test was conducted in the reporting month	Contract Completed
	Contract 708	
1	No water sample test was conducted in the reporting month	Contract Completed
	Contract 714	
1	No water sample test was conducted in the reporting month	Contract

		Completed

12.2 Other Notable Events

IEC Site Inspections

The IEC conducted site inspections for Works Areas A, C, E, G, H, I, J, J3, L1, M, N1 and O3 on 29 December 2010, minor irregularities were observed during the site inspections and the respective civil works contractors had followed up and satisfactorily rectified the issues as identified in the site inspections promptly.

Works Area B

The small western portion of Works Area B had been occupied by Highways Department as a depot upon the completion of the additional concrete paving and certification of the paving design by ISC in accordance with the EP requirements. Monthly inspections on the condition of the additional paving, site drainage and foul sewerage systems had been carried out in accordance with EP Condition 3.2.2. No new crack was found in the reporting period, the surface cracks identified previously had been satisfactorily sealed such that the structural integrity of the additional concrete paving can be maintained.

Works Area MA

As the construction of the WIL magazine had completed and a portion of land at Works Area MA had been handed over to Lands Department. The concerned plants (2nos. Hong Kong Pavetta and 2nos. Silver-back Artocarpus) as mentioned in WIL EP Condition 2.8 are located in the land area which had been handed over to Lands Department. As these plants falls outside the revised Works Area MA, the regular inspection to these plants by the ET/Certified Arborist had stopped in the reporting period for October 2010. In addition, as there will be no construction activities carried out in Works Area MA, the regular construction dust and noise monitoring at the monitoring stations AM4 and CN1 for Works Area MA had stopped in the reporting period for October 2010.

Proposed Alternative Construction Method for Tunnel Works from KGV to Sai Woo Lane(SWL)

The Contract 703 Contractor proposed an alternative construction method tunnel works from KGV to SWL instead of from SWL to KGV. The proposed change in tunnel works will shorten the overall adit and tunnel construction by around seven months. Environmental Review was conducted and concluded that the proposed alternative method for tunnel construction from KGV to SWL will not constitute a material change to the WIL Project. No adverse environmental impacts are anticipated from the proposed changes and the environmental performance requirements set out in the WIL EIA Report will not be exceeded. It is believed that there will be a societal benefit from the proposed alternative construction method with shortened construction period and the associated environmental nuisances. The Contract 703 Contractor commenced the captioned tunnel works in November 2010. The Environmental Review Report is attached in Appendix H.

Community Liaison Groups

The Community Liaison Groups were established on 10 July 2009 in accordance with the EP Condition 2.6. Three CLGs, namely, Sai Ying Pun, University and Kennedy Town have been set up to provide direct communication channel for the local communities to MTR during the construction stage of the Project on the project matters including enquiries and complaints handling on all environmental issues. Members of CLGs include the Central & Western District Councillors, Chairmen of Area Committees, representatives of local groups and government departments. Property management office, schools, and other local committees will be invited to participate in the CLGs. The CLG meetings are being held quarterly with the first CLG meetings held in July 2009. The sixth CLG meeting had be held in October 2010 and the seventh CLG meeting will be held in January 2011.

In the sixth CLG meetings, concerns were raised on the construction noise emitted from the works site at Forbes Street, MTRCL responded that the Contractor has adopted noise curtains to reduce the noise impacts to the adjacent residents and will try to start the use of major construction plants with high sound power level after 8:00am as far as practicable. The Contractor will be using electricity supply from the power company after November 2010 and thereby progressively reducing the use of generators in order to reduce the environmental nuisances. In order to further reduce construction noise impacts to the nearby residents in the vicinity of Hill Road works site, noise enclosure are being built which will be completed in early 2011. In addition, MTRCL responded to the concerns raised on the construction noise impacts from the works sites for SYP Station that construction noise impacts are mitigated at source such as the use of silent construction plants, installation of noise curtains on top of hoardings and cover the plants with noise curtains. In the event that there is residual noise impact after the implementation of mitigation measures of 5 dB(A) over the noise limit for duration of longer than one month, indirect technical remedy will be implemented.

In addition, a MTR Project hotline at 2993 3333 is in operation for public enquiries on the WIL Project and it also serves as the complaint hotline during the construction stage of the Project.

13 FUTURE KEY ISSUES

13.1 Key Issues for the Coming Month

Future key issues envisaged in the coming month include the followings:-

- Disposal of C&D waste;
- Dust generation from site activities;
- Noise impact from operating equipment;
- Site water discharge;
- Chemical wastes;
- Tree protection.

13.2 Solid and Liquid Waste Management Status

Base on the findings of the weekly site inspections, the Contractors' performance in solid and liquid waste management were acceptable and compliance with the EIA requirements were demonstrated. Solid wastes and liquid waste were properly disposed of. The current management standard should be maintained.

13.3 Effectiveness and Efficiency of Mitigation Measures

Based on the environmental monitoring results, the effectiveness and efficiency of the mitigation measures implemented were found to be satisfactory. The current practice should be maintained.

14 CONCLUSIONS

The Report presents the results of EM&A works and the impact monitoring for the construction works undertaken during the period of 10 December 2010 to 9 January 2011. The major construction activities in the reporting period included slope works at Works Areas A1/A2, shaft excavation at Works Area A, erection of barging point at Works Area B, excavation and pipe piling at Works Area C, operation of barging point at Works Area E, excavation by drill and blast for Praya construction adit at Works Area G, excavation at Works Area H, pipe piling and box culvert diversion at Works Area J3, pipe piling at Works Areas I/L1, shaft excavation inside noise enclosure at Works Area M, shaft excavation and bored piling at Works Area N1 and grouting at Works Area O3.

Impact monitoring for air quality and noise were conducted in accordance with the EM&A Manual in the reporting period, no exceedance was found and there was no breach of Limit Levels for air and noise monitoring.

No environmental notification of summon and prosecution was received in the reporting period. Five environmental complaints were received in the reporting period. The complaints had been handled in accordance with the procedures stipulated in the EM&A Manual.

Site inspections were conducted by the Environmental Team on a weekly basis to monitor proper implementation of environmental pollution control and mitigation measures for the Project. No non-conformance to the environmental requirements was identified by the Environmental Team in the reporting period.

The Environmental Permit (EP-313/2008/C) issued by EPD on 31 August 2009 is being used for the WIL Project.

In the reporting period, there was no reporting change of circumstances which may affect the compliance with the recommendations of the EIA Report.

It is concluded from the environmental monitoring and audit works for the West Island Line Project that the construction works were undertaken in an appropriately environmentally sensitive manner in the reporting period. The environmental protection and pollution control measures provided by the contractors were generally acceptable apart from some minor irregularities which were rectified timely by the respective civil works contractors.

The ET will continue the implementation of the environmental monitoring and audit programme in accordance to the EM&A Manual and to a level consistent with MTRCL's Corporate Sustainability Policy.

Appendix A
Environmental Quality Performance Limits

Action and Limit Levels for 24-hour TSP

Monitoring Station	Action Level (μg/m3)	Limit Level (μg/m3)
AM1a	170	260
AM2	155	260
AM3a	155	260
AM4	158	260
AM5a	178	260
AM6a	157	260
AM7a	151	260
AM9a	168	260

Action and Limit Levels for 1-hour TSP for Complaint Handling

Monitoring Station	Action Level (μg/m3)	Limit Level (μg/m3)
AM1a	301	500

Action and Limit Levels for Construction Noise

Time Period	Action Level	Limit Level (dB(A)), Leq(30min)
0700-1900 hr on normal weekdays	When one documented complaint is received	75*
0700-2300 hr on holidays including Sundays and 1900-2300 hr on all other days		Subject to requirements stipulated in Construction Noise Permits
2300-0700 hr of next day		

* Limit for school is 70 dB(A) and 65 dB(A) during school examination periods.

Appendix B
Event Action Plans

Table 2.4 Event and Action Plan for Construction Noise Monitoring

EVENT	ACTION			
	ET	**IEC**	**ER**	**CONTRACTOR**
Action Level	1. Notify IEC and ER 2. Carry out investigation 3. Report the results of investigation to the IEC and ER 4. Discuss jointly with the ER and Contractor and formulate remedial measures 5. Increase monitoring frequency to check mitigation effectiveness	1. Review the analysed results submitted by the ET 2. Review the proposed remedial measures by the Contractor and advise the ER accordingly 3. Supervise the implementation of remedial measures	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Require Contractor to propose remedial measures for the analysed noise problem 4. Ensure remedial measures are properly implemented	1. Submit noise mitigation proposals to ER with copy to IEC 2. Implement noise mitigation proposals
Limit Level	1. Notify IEC, ER, EPD and Contractor 2. Identify source 3. Repeat measurement to confirm findings 4. Increase monitoring frequency 5. Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented 6. Inform IEC, ER, EPD the causes and actions taken for the exceedances 7. Assess effectiveness of Contractor's remedial actions and keep IEC, EPD and ER informed of the results 8. If exceedance stops, cease additional monitoring	1. Discuss amongst ER, ET and Contractor on the potential remedial actions 2. Review Contractor's remedial actions whenever necessary to assure their effectiveness and advise the ER accordingly 3. Supervise the implementation of remedial measures	1. Confirm receipt of notification of failure in writing 2. Notify Contractor 3. Require Contractor to propose remedial measures for the analysed noise problem 4. Ensure remedial measures are properly implemented 5. If exceedance continues, consider what portion of the work is responsible and instruct the Contractor to stop that portion of work until the exceedance is abated	1. Take immediate action to avoid further exceedance 2. Submit proposals for remedial actions to ER with copy to IEC 3. Implement the agreed proposals 4. Revise and resubmit proposals if problem still not under control 5. Stop the relevant portion of works as determined by the ER until the exceedance is abated

Table 9.4 Event and Action Plan for Ambient Air Quality Monitoring (Construction)

EVENT	ACTION			
	ET	IEC	ER	CONTRACTOR
ACTION LEVEL				
1. Exceedance for one sample	1. Identify source, investigate the causes of complaint and propose remedial measures; 2. Inform IEC and ER; 3. Repeat measurement to confirm finding; 4. Increase monitoring frequency to daily.	1. Check monitoring data submitted by ET; 2. Check Contractor's working method.	1. Notify Contractor.	1. Rectify any unacceptable practice; 2. Amend working methods if appropriate.
2. Exceedance for two or more consecutive samples	1. Identify source; 2. Inform IEC and ER; 3. Advise the ER on the effectiveness of the proposed remedial measures; 4. Repeat measurements to confirm findings; 5. Increase monitoring frequency to daily; 6. Discuss with IEC and ER (together with the Contractor) on remedial actions required; 7. If exceedance continues, arrange meeting with IEC and ER; 8. If exceedance stops, cease additional monitoring.	1. Check monitoring data submitted by ET; 2. Check Contractor's working method; 3. Discuss with ET and ER (together with the Contractor) on possible remedial measures; 4. Advise the ET/ER on the effectiveness of the proposed remedial measures; 5. Supervise Implementation of remedial measures.	1. Confirm receipt of notification of exceedance in writing; 2. Notify Contractor; 3. Ensure remedial measures properly implemented.	1. Submit proposals for remedial to ER within three working days of notification; 2. Implement the agreed proposals; 3. Amend proposal if appropriate.
LIMIT LEVEL				
1. Exceedance for one sample	1. Identify source, investigate the causes of exceedance and propose remedial measures; 2. Inform IEC, ER, Contractor and EPD; 3. Repeat measurement to confirm finding; 4. Increase monitoring frequency to daily; 5. Assess effectiveness of Contractor's remedial actions and keep IEC, EPD and ER informed of the results.	1. Check monitoring data submitted by ET; 2. Check Contractor's working method; 3. Discuss with ET and ER (together with the Contractor) on possible remedial measures; 4. Advise the ER on the effectiveness of the proposed remedial measures; 5. Supervise implementation of remedial measures.	1. Confirm receipt of notification of exceedance in writing; 2. Notify Contractor; 3. Ensure remedial measures properly implemented.	1. Take immediate action to avoid further exceedance; 2. Submit proposals for remedial actions to ER with a copy to IEC within three working days of notification; 3. Implement the agreed proposals; 4. Amend proposal if appropriate.
2. Exceedance for two or more consecutive samples	1. Notify IEC, ER, Contractor and EPD; 2. Identify source; 3. Repeat measurement to confirm findings; 4. Increase monitoring frequency to daily; 5. Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented; 6. Arrange meeting with IEC and ER to discuss the remedial actions to be taken; 7. Assess effectiveness of Contractor's remedial actions and keep IEC, EPD and ER informed of the results; 8. If exceedance stops, cease additional monitoring.	1. Discuss amongst ER, ET, and Contractor on the potential remedial actions; 2. Review Contractor's remedial actions whenever necessary to assure their effectiveness and advise the ER accordingly; 3. Supervise the implementation of remedial measures.	1. Confirm receipt of notification of exceedance in writing; 2. Notify Contractor; 3. In consultation with the IEC, agree with the Contractor on the remedial measures to be implemented; 4. Ensure remedial measures properly implemented; 5. If exceedance continues, consider what portion of the work is responsible and instruct the Contractor to stop that portion of work until the exceedance is abated.	1. Take immediate action to avoid further exceedance; 2. Submit proposals for remedial actions to ER with a copy to IEC within three working days of notification; 3. Implement the agreed proposals; 4. Revise and resubmit proposals if problem still not under control; 5. Stop the relevant portion of works as determined by the ER until the exceedance is abated.

Appendix C
Implementation of Environmental Mitigation Measures

Table C1 Project Implementation Schedule for All Works Areas (Status as of 9 January 2011)

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
Airborne Noise Impact (Construction Phase)							
S 3.55	S 2.23	The following good site practices shall be implemented: - Only well-maintained plant shall be operated on-site and plant shall be serviced regularly during the construction program - Silencers or mufflers on construction equipment shall be utilized and shall be properly maintained during the construction program - Mobile plant, if any, shall be sited as far from NSRs as possible - Machines and plant (such as trucks) that may be in intermittent use shall be shut down between work periods or shall be throttled down to a minimum - Plant known to emit noise strongly in one direction shall, wherever possible, be orientated so that the noise is directed away from the nearby NSRs - Material stockpiles and other structures shall be effectively utilized, wherever practicable, in screening noise from on-site construction activities.	To reduce construction noise impact	MTRC / Contractor	All works areas	Construction phase	Being implemented
S 3.56-3.57, Table 3.10	S 2.23	Quieter plant shall be used for the following PME: - Truck - Crane/ Mobile Crane - Backhoe/Excavator/Wheel Loader/ Front-end-loader - Breaker - Concrete Mixer Truck - Pokers, vibratory, hand held - Pile Extractor - Roller, vibratory - Asphalt Paver - Hydraulic Breaker	To reduce construction noise impacts	MTRC / Contractor	All works areas	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		- Pile Rig - Crawler Crane - Sheet Pilling Machine/ Piling, Hydraulic					
S 3.58-3.59	S 2.23	Movable noise barrier shall be used for the following PME where practicable: - Breaker - Mini Backhoe - Generator, super silenced - Backhoe - Crane - Poker, vibratory, hand-held - Hydraulic Breaker - Wheel Loader - Crusher - Hand Held Breaker - Compressor - Grout Plant - Grout Mixer - Concrete Pump - Excavator - Lorry Crane - Mobile Crane - Crawler Crane	To reduce construction noise impacts	MTRC / Contractor	Works areas A, C, D, H, I, J, J1, L1, M1, N1, M3, O1, O2 and O3.	Construction phase	Being implemented
S 3.60	S 2.23	Noise enclosure/acoustic shed shall be used for the following PME where practicable: - Air Compressor - Concrete Pump - Shotcrete Pump - Hand Held Breaker - Grout Pump - Concrete Corer	To reduce construction noise impacts	MTRC / Contractor	All works areas	Construction phase	Being implemented
S 3.61	S 2.23	Acoustic Enclosure shall be used for enclosing the rock drill as fully as possible.	To reduce construction noise	MTRC / Contractor	Works areas H,	Construction phase	To be implemented as per construction

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
			impacts		N1 and M		programme
S 3.62	S 2.23	Noise insulating cover shall be used to cover the following PME: - Breaker - Backhoe - Water pump, submersible (electric) - Crawler mounted rock drill trucks - Rock drill - Air compressor - Electric Winch - Concrete pump - Poker, vibratory, hand-held - Hand Held Breaker - Crane - Shotcrete pump	To reduce construction noise impacts	MTRC / Contractor	Works areas J1, N1, M1 and M3	Construction phase	Being implemented
S 3.63	S 2.23	Silencer shall be used for the ventilation fan	To reduce construction noise impacts	MTRC / Contractor	Works areas MA, A, C, D, G, H, I, J, J1, J2, J3, L1, M, M1, M3, N1, O1, O2 and O3.	Construction phase	Being implemented
S 3.64	S 2.23	Noise insulating fabric shall be applied where practicable to cover the following PME: - Pile Rig - Drill rig - Pile Extractor - Power Rammer - Pilling, earth auger - Piling, hydraulic	To reduce construction noise impacts	MTRC / Contractor	Works areas MA, C, D, G, H, I, J, J1, J2, J3, L1, M, M1, M3, N1, O1, O2 and O3.	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		- Sheet Piling Machine					
S 3.65	S 2.23	Use of "Noise Control Curtain" - a noise insulating fabric to be mounted on the steel scaffold erected on the buildings to be demolished to an extent such that the line of sight between the noise source and NSR would be blocked	To reduce construction noise impacts	MTRC / Contractor	Works area A	Construction Phase – during the demolition of Block A & C of Kennedy Town Ex-Police Quarter	To be implemented as per construction programme
S 3.67-3.70, Figure 3.17 and 3.18.	S 2.23	Temporary noise barriers shall be erected at the works areas of West of KET Station and SYP Entrance A1 & A2.	To reduce construction noise impacts	MTRC / Contractor	Works areas C and N1	Construction phase	To be implemented as per construction programme
S 3.71	S 2.23	Decking over would be provided to cover the excavation area.	To reduce construction noise impacts	MTRC / Contractor	Works areas J, J3, G and L1	Construction phase	Completed for Works Areas G and J
S3.72	S 2.23	Full enclosure of entire works area	To reduce construction noise impacts	MTRC / Contractor	Works area J2	Construction Phase (after piling is completed)	To be implemented as per construction programme
S3.73 – 3.74	S 2.23	Use of concrete crusher instead of hydraulic breaker	To reduce construction noise	MTRC / Contractor	Works area J2, M1 and	Construction Phase	To be implemented as per construction

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
			impacts		M3		programme
Airborne Noise Impact (Operation Phase)							
S 3.50-3.51, Table 3.9	Appendix B	The maximum permissible sound power levels (Max SWLs) for the fixed plant shall be complied with during the selection of equipment and mitigation measures.	To comply with the noise criteria of Noise Control Ordinance	MTRC / Contractor	Vent shafts and chiller plants at KET Station, UNI Entrance C1 and SYP Entrance C, and vent shafts at KET Ex-Police Quarter, UNI Vent Shaft-Y and SYP Entrance A1&A2.	Design and operation phases	To be implemented in operation phase
S 3.77	Appendix A	The following shall be considered as far as possible in the detailed design of fixed plant: - Choose quieter plant such as those which have been effectively silenced. - Include noise levels specification when ordering new plant (including chiller and E/M equipment).	To comply with the noise criteria of Noise Control Ordinance	MTRC / Contractor	Vent shafts and chiller plants at KET Station, UNI Entrance	Design and operation phases	To be implemented in operation phase

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		- Locate fixed plant/louver away from any NSRs as far as practicable. - Locate fixed plant in walled plant rooms or in specially designed enclosures. - Locate noisy machines in a basement or a completely separate building. - Install direct noise mitigation measures including silencers, acoustic louvers and acoustic enclosure where necessary.			C1 and SYP Entrance C, and vent shafts at KET Ex-Police Quarter, UNI Vent Shaft-Y and SYP Entrance A1&A2.		
Groundborne Noise Impact							
S4.91	S3.1	Ground-borne construction noise monitoring shall be conducted. The measurement locations shall be above the cutting face of the TBM, and shall be located as close to the cutting face as practicable.	To comply with the noise criteria of Noise Control Ordinance	MTRC / Contractor	Works areas of tunneling by TBM	Construction phase	To be implemented as per construction programme
S 4.88 & Table 4.10	S 3.2	Type 1a Trackform – Resilient Baseplate with stiffness of about 25 KN/mm shall be installed at both the west- and east-bounds starting from turnout in proximity of Hongway Garden towards the Sai Ying Pun Station and also the alignment under Po Shu Lau to Sai Wan Estate. A commissioning test shall be included in the Contract document in order to ensure compliance of the operational ground-borne noise criteria.	To comply with the noise criteria of Noise Control Ordinance	MTRC	Tunnel alignment	Operation phase	To be implemented as per construction programme
Landscape and Visual Impact (Construction Phase)							
Table 5.4	Table 4.2	Re-use of Existing Soil Existing topsoil shall be re-used where possible for new planting areas within the project. The construction program shall consider	To reduce the volume of soil for disposal	MTRC / Contractor	All Works areas	Construction phase	Being Implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		using the soil removed from one phase for backfilling another. Suitable storage ground, gathering ground and mixing ground may be set up on-site as necessary. ▪					
Table 5.4	Table 4.2	No-intrusion Zone To maximize protection to existing trees, ground vegetation and the associated understory habitats, construction contracts may designate "No-intrusion Zone" to various areas within the site boundary with rigid and durable fencing for each individual no-intrusion zone. The contractor should close monitor and restrict the site working staff not to enter the "no-intrusion zone", even for non-direct construction activities and storage of equipment.	To protect the existing trees, ground vegetation and the associated understory habitats.	MTRC / Contractor	All Works areas	Construction phase	Being Implemented
Table 5.4	Table 4.2	Decorative Hoarding Erection of decorative screen hoarding should be designed to be compatible with the existing urban context.	To reduce visual impact due to construction	MTRC / Contractor	All Works areas	Construction phase	Being Implemented
Table 5.4	Table 4.2	Minimize light pollution and control of night-time glare All security floodlights for construction sites shall be equipped with adjustable shield, frosted diffusers and reflective covers, and be carefully controlled to minimize light pollution and night-time glare to nearby residences and GIC users. The Contractor shall consider other security measures which shall minimize the visual impacts.	To minimize the visual impacts.	MTRC / Contractor	All Works areas	Construction phase	Being Implemented
Table 5.4	Table 4.2	Aesthetic design of the conveyor belt system The removal of excavated material requires installation of a conveyor and a barging point. The conveyor will be covered, except the portion where it meets the barging point. The aim of covering or	To minimize the visual intrusion as well as the air and noise quality issues	MTRC / Contractor	Works areas E & F	Construction phase	To be implemented as per construction programme

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		enclosing the conveyor is to avoid noise and air quality issues; however, the conveyor where above-ground should be adequately screened and /or constructed of suitable materials and in colours/tones that minimize visual intrusion.					
Table 5.4	Table 4.2	Protection of Retained Trees All retained trees should be recorded photographically at the commencement of the Contract, and carefully protected during the construction period. Detailed tree protection specification shall be allowed and included in the Contract Specification, which specifying the tree protection requirement, submission and approval system, and the tree monitoring system. In addition, the Contractor shall be required to submit, for approval, a detailed working method statement for the protection of trees prior to undertaking any works adjacent to all retained trees, including trees in contractor's works areas. All implementation of tree protection works and tree preservation measures shall be supervised by a landscape specialist on site.	To protect the retained trees within the site boundary	MTRC / Contractor	All Works areas	Construction phase	Being Implemented
Table 5.4	Table 4.2	Protection of Registered Old and Valuable Trees Detailed tree protection measures as stipulated in WBTC No. 29/2004 – Registration of Old and Valuable Trees, and Guidelines for their Preservation, shall be allowed and included in the Contract Specification. All implementation of OVT protection measures shall be supervised by a landscape specialist on site.	To protect the OVT within the site boundary	MTRC / Contractor	All Works areas	Construction phase	Being Implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
Table 5.4	Table 4.2	Protection of Old Stone Wall-cum-trees Detailed tree protection specification shall be allowed and included in the Contract Specification, which specifying the tree protection requirement, submission and approval system, and the tree monitoring system. All implementation of Old stone wall-cum-trees protection measures shall be supervised by a landscape specialist on site.	To protect the existing trees-cum-wall	MTRC / Contractor	All Works areas	Construction phase	Being Implemented
Landscape and Visual Impact (Operation Phase)							
Table 5.5	Table 4.3	Tree Transplanting Trees of high to medium survival rate after transplanting to be affected by the works shall be transplanted where possible and practicable. Tree transplanting proposal including final location for transplanted trees will be submitted separately to seek relevant government department's approval.	Tree preservation	MTRC / Contractor	All Works areas	Detail design and operation phase	Being Implemented
Table 5.5	Table 4.3	Compensation Tree Planting Compensatory tree planting should be provided to compensate for felled trees. Compensatory tree planting proposal including location of compensation will be submitted separately to seek relevant government department's approval.	To reduce impact to existing trees.	MTRC / Contractor	All Works areas	Detail design and operation phase	Being Implemented
Table 5.5	Table 4.3	Aesthetic landscape and architectural treatment on Station / Entrance / vent shaft All station entrances, vent shafts and all above ground structures shall be sensitively designed to ensure the element with colour, texture and tonal quality being compatible to the existing urban context, which shall include tree planting where space permits, to minimize the potential adverse landscape and visual impacts. For	To ensure the elements are compatible to the existing urban context and minimize the landscape and	MTRC / Contractor	Stations / Entrances / Vent Shafts	Detail design and operation phase	To be implemented as per construction programme

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		example, roof greening and vertical greening would be applied where possible subject to technical operational and maintenance constraints.	visual impacts.				
Table 5.5	Table 4.3	Re-instatement of excavated Area All excavated area and disturbed area for utilities diversion, temporary road diversion, and pipeline woks shall be reinstated to former conditions or even better, to the satisfaction of the relevant Government departments.	To minimize the visual impacts.	MTRC / Contractor	All Works areas	Operation phase	Being implemented
Table 5.5	Table 4.3	Re-provision of public open space Every effort should be made to so that no public open space would be unnecessarily affected by the Project and if affected, they should be reprovided as far as possible and practicable. Sensitive design and reprovision of the affected Public Open Space (Forbes Street Playground, Hill Road Rest Garden, Ki Ling Lane Children's Playground, Mui Fong Street Children Playground, Sai Woo Lane Playground, Centre Street Market Sitting-out Area, King George V Memorial Park) incorporating replacement facilities for those provided at present, using materials of quality suitable for long term use and acceptable to relevant Government authority. Relevant government departments including LCSD and PlanD should be consulted on the design of the reprovisioned public open spaces at the early stage of the design process.	Re-provision of landscape amenity area and facilities	Contractor	All Works areas	Operation phase	To be implemented as per construction programme
Cultural Heritage Impact (Construction Phase)							
S6.45, S6.51-6.55	S 5.4 – 5.11	The construction vibration control limits shall be followed. Compliance monitoring of vibration limits shall be conducted and reported as a requirement of EM&A programme The location and installation of the monitoring stations should be	To minimize vibration impacts on the identified vibration sensitive	MTRC / Contractor	All Works Areas	Detail design, construction and operational	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		discussed and agreed with AMO before installation.	historical buildings.			phase	
S6.46	S5.3	Hoardings or boundary fencing shall be designed in a manner that responds to the existing urban context.	To minimize visual impacts	MTRC / Contractor	All Works Area	Detailed design and operational phase	Being Implemented
S6.44	S5.12-5.14	Archaeological watching brief shall be conducted for the identification of any historical finds in the directly impacted works areas which might have a potential for finds and remains of archaeological interest to be found. Details of the frequency of inspection shall be provided to AMO for review and comment once the detailed construction programme has been finalized. The inspection should be carried out by the qualified archaeologist who have applied to the Antiquities Authority for a License	To indentify any historical finds in the works areas	MTRC / Qualified Archaeologist	Works Area C, H, I, J, J1, J2, J3, M and M2	Construction phase	Being implemented
Cultural Heritage Impact (Operation Phase)							
Table 6.2	5.3	Aboveground structures shall be designed in a manner that responds to the existing urban context.	To minimize visual impacts	MTRC / Contractor	Stations / Entrances / Vent Shafts	Detail design and operation phase	To be implemented as per construction programme
S6.60	S 5.15	Recommended measures for mitigating operational phase landscape and visual impacts shall be implemented.	To minimize potential visual impact on heritage sites	MTRC / Contractor	Stations / Entrances / Vent Shafts	Detail design and operational phase	To be implemented as per construction programme
Waste Management Implications (Construction Phase)							
S7.30	S 6.5	Good site practices - Nomination of an approved person, such as a site manager, to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility, of all	To reduce waste management impacts	MTRC / Contractor	All works areas	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		wastes generated at the site - Training of site personnel in proper waste management and chemical handling procedures - Provision of sufficient waste disposal points and regular collection of waste - Appropriate measures to minimise windblown litter and dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers - Regular cleaning and maintenance programme for drainage systems, sumps and oil interceptors. - Separation of chemical wastes for special handling and appropriate treatment at the Chemical Waste Treatment Centre.					
S7.31 & S7.32	S 6.6 – S 6.7	Waste reduction measures - Sort C&D waste from demolition of existing facilities to recover recyclable portions such as metals - Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal - Encourage collection of aluminium cans by providing separate labelled bins to enable this waste to be segregated from other general refuse generated by the work force - Proper storage and site practices to minimise the potential for damage or contamination of construction materials	To achieve waste reduction	MTRC / Contractor	All works areas	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		- Plan and stock construction materials carefully to minimise amount of waste generated and avoid unnecessary generation of waste. - A recording system for the amount of wastes generated, recycled and disposed (including disposal sites) should be proposed - Training should be provided to workers about the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycle. - A Waste Management Plan shall be prepared by the Contractor prior to the commencement of construction work to provide an overall framework for waste management and reduction.					
S7.34 & S7.35	S 6.9 & S6.10	C&D Material - In order to minimise impacts resulting from collection and transportation of C&D material for off-site disposal, the excavated materials arising from station and tunnel construction shall be reused on-site as backfilling material and for landscaping works as far as practicable. - Surplus rock generated from the tunnelling works, shafts/adits construction and the stations cavern construction should be reused in reclamation and site formation projects either in the Mainland or Macau, or disposed of at a PFRF, as agreed with the Secretary of the Public Fill Committee, for other beneficial uses. - C&D waste generated site clearance from the proposed works areas would require disposal to the designated landfill site.	To minimize environmental impacts during the handling, transportation and disposal of C&D material	MTRC / Contractor	All works areas	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		- In order to monitor the disposal of inert C&D material and C&D waste at PFRFs and landfills, respectively, and to control fly-tipping, a trip-ticket system shall be established in accordance with ETWB TCW No. 31/2004. - Material delivered to PFRFs should be of size less than 250mm or other sizes as agreed with the Secretary of the Public Fill Committee.					
S7.36	S 6.11	General refuse - General refuse shall be stored in enclosed bins or compaction units separate from C&D material and chemical wastes. - A reputable waste collector shall be employed by the contractor to remove general refuse from the site, separately from C&D material and chemical wastes. Preferably an enclosed and covered area shall be provided to reduce the occurrence of 'wind blown' light material.	To minimize environmental impacts during the handling, transportation and disposal of general refuse	MTRC / Contractor	All works areas	Construction phase	Being implemented
S7.37	S 6.12	Chemical waste - Contractor would be required to register with the EPD as a chemical waste producer and to follow the guidelines stated in the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*. - Good quality containers compatible with the chemical wastes shall be used, and incompatible chemicals shall be stored separately. - Appropriate labels shall be securely attached on each chemical waste container indicating the corresponding chemical characteristics of the waste, such as explosive, flammable, oxidizing, irritant, toxic, harmful, corrosive, etc.	To minimize environmental impacts during the handling, transportation and disposal of chemical refuse	MTRC / Contractor	All works areas	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		- The Contractor shall use a licensed collector to transport and dispose of the chemical wastes, either to the approved Chemical Waste Treatment Centre, or another licensed facility, in accordance with the *Waste Disposal (Chemical Waste) (General) Regulation*.					
Waste Management Implications (Operation Phase)							
S7.39	S 6.11	General Refuse and Industrial Waste ▪ A reputable waste collector should be employed to remove general refuse and industrial wastes from the stations on a daily basis to minimise odour, pest and litter impacts.	Storage and handling of waste	MTRC	Stations and entrances	Operational stage	Being implemented
S7.40	S 6.12	Chemical Waste ▪ The requirements given in the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* should be followed in handling of these chemical wastes. ▪ A trip-ticket system should be operated in accordance with the *Waste Disposal (Chemical Waste) (General) Regulation* to monitor all movements of chemical wastes which would be collected by a licensed collector to a licensed facility for final treatment and disposal. ▪ The guidelines covered under the construction phase mitigation of chemical wastes should be referred.	Storage and handling of the chemical waste to avoid environmental and health hazard	MTRC	Stations and entrances	Operational stage	Being implemented
Water Quality Impact (Construction Phase)							

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
S9.31	S 8.4	Construction Site Run-off and Drainage The site practices outlined in ProPECC PN 1/94 "Construction Site Drainage" should be followed as far as practicable in order to minimise surface runoff and the chance of erosion. The following measures are recommended to protect water quality and sensitive uses of the coastal area i.e. WSD flushing water intakes along the harbour front, and when properly implemented should be sufficient to adequately control site discharges so as to avoid water quality impacts: - At the start of site establishment (including the barging facilities), perimeter cut-off drains to direct off-site water around the site shall be constructed with internal drainage works and erosion and sedimentation control facilities implemented. Channels (both temporary and permanent drainage pipes and culverts), earth bunds or sand bag barriers shall be provided on site to direct stormwater to silt removal facilities. The design of the temporary on-site drainage system would be undertaken by the contractor prior to the commencement of construction. - The dikes or embankments for flood protection should be implemented around the boundaries of earthwork areas. Temporary ditches should be provided to facilitate the runoff discharge into an appropriate watercourse, through a site/sediment trap. The sediment/silt traps should be incorporated in the permanent drainage channels to enhance deposition rates - Sand/silt removal facilities such as sand/silt traps and sediment basins shall be provided to remove sand/silt particles from runoff to meet the requirements of the TM standards under the WPCO. The design of efficient silt removal facilities shall be based on the guidelines in Appendix A1 of ProPECC PN 1/94, which states that the retention time for silt/sand traps shall be 5	To minimize water quality impacts	MTRC / Contractor	All works areas	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		minutes under maximum flow conditions. Sizes may vary depending upon the flow rate, but for a flowrate of 0.1m^3/s a sedimentation basin of 30m^3 would be required and for a flow rate of 0.5 m^3/s the basin would be 150m^3. The detailed design of the sand/silt traps shall be undertaken by the contractor prior to the commencement of construction. - All drainage facilities and erosion and sediment control structures shall be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly during rainstorms. Deposited silt and grit shall be regularly removed, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times. - Measures shall be taken to minimize the ingress of site drainage into excavations. If excavation of trenches in wet periods is necessary, they should be dug and backfilled in short sections wherever practicable. Water pumped out from foundation excavations shall be discharged into storm drains via silt removal facilities. - If surface excavation works cannot be avoided during the wet season (April to September), temporarily exposed slope/soil surfaces shall be covered by a tarpaulin or other means, as far as practicable, and temporary access roads shall be protected by crushed stone or gravel, as excavation proceeds. Interception channels shall be provided (e.g. along the crest/ edge of the excavation) to prevent storm runoff from washing across exposed soil surfaces. Arrangements shall always be in place to ensure that adequate surface protection measures can be safely carried out well before the arrival of a rainstorm. Other measures that need to be implemented before, during and after rainstorms are summarized in ProPECC PN 1/94. - The overall slope of the site should be kept to a minimum to					

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		reduce the erosive potential of surface water flows, and all trafficked areas and access roads protected by coarse stone ballast. An additional advantage accruing from the use of crushed stone is the positive traction gained during prolonged periods of inclement weather and the reduction of surface sheet flows - All vehicles and plant shall be cleaned before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. An adequately designed and sited wheel washing facility shall be provided at every construction site exit where practicable. Wash-water shall have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency of the process. The section of access road leading to, and exiting from, the wheel-wash bay to the public road shall be paved with sufficient backfill toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains. - Open stockpiles of construction materials or construction wastes on-site should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system. - Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm runoff being directed into foul sewers. - Precautions be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecasted, and actions to be taken during or after rainstorms are summarised in Appendix A2 of ProPECC PN 1/94.					

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		Particular attention should be paid to the control of silty surface runoff during storm events, especially for areas located near steep slopes. - Bentonite slurries used in diaphragm wall construction shall be reconditioned and reused wherever practicable. Temporary enclosed storage locations shall be provided on-site for any unused bentonite that needs to be transported away after all the related construction activities are completed. The requirements in ProPECC PN 1/94 shall be adhered to in the handling and disposal of bentonite slurries.					
S9.32 & S9.33	S 8.5 & S 8.6	General Construction Activities - Construction solid waste, debris and refuse generated on-site shall be collected, handled and disposed of properly to avoid entering any nearby stormwater drain. Stockpiles of cement and other construction materials shall be kept covered when not being used. Requirements of the solid waste management are described in Section 7 of this EIA Report. - Oils and fuels shall only be used and stored in designated areas which have pollution prevention facilities. To prevent spillage of fuels and solvents to nearby stormwater drain, all fuel tanks and storage areas shall be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank. The bund shall be drained of rainwater after a rain event.	To minimize water quality impacts	MTRC / Contractor	All works areas	Construction phase	Being implemented
S9.34	S 8.7	Sewage from Construction Workforce - Temporary sanitary facilities, such as portable chemical toilets, shall be employed on-site where necessary to handle sewage from the workforce. A licensed contractor should be employed to provide appropriate and adequate portable toilets and would be responsible for appropriate disposal of waste matter and	To minimize water quality impacts	MTRC / Contractor	All works areas with on-site sanitary facilities	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		maintenance of these facilities.					
S9.35	S 8.8	Tunnelling Wastewater Discharge Wastewater with a high level of suspended solids should be treated before discharge by settlement in tanks with sufficient retention time. Oil interceptors would also be required to remove the oil, lubricants and grease from the wastewater. In case of very high levels of suspended solids, an on-site pre-packaged treatment plant may be required with the addition of flocculants to improve the settlement of solids. A discharge licence under the WPCO would be required for discharge to the stormwater drain. It may be a stipulation of the WPCO licence to require the Contractor to monitor the quality / quantity of the discharge to show compliance with the conditions of the licence.	To minimize water quality impacts	MTRC / Contractor	All works areas with tunneling works	Construction phase	To be implemented as per construction programme
S9.36	S8.9	Groundwater Monitoring Monitoring of groundwater table shall be conducted on a weekly basis and recharge wells will be installed.	To control the potential impact on tree walls at Forbes Street due to groundwater drawdown induced by tunneling	MTRC / Contractor	Works Areas C & D	Construction phase	To be implemented as per construction programme
Water Quality Impact (Operation Phase)							
S9.27	S8.10-S8.11	Runoff from Rail Track and operational tunnel drainage - The tunnel wall would be equipped with water-tight liner and designed for no seepage. - Standard designed silt trap or grease trap (if necessary) and oil interceptor would be provided to remove the oil, lubricants, grease, silt and grit from the tunnel runoff before discharge into	To control runoff from rail track and tunnel seepage	MTRC	Tunnels and rail tracks	Operation phase	To be implemented in operation phase

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		stormwater drainage.					
S9.37	S8.12-S8.14	- Track drainage channels discharge should pass through oil/grit interceptors/chambers to remove oil, grease and sediment before being pumped to the public stormwater drainage system. - The silt traps and oil interceptors should be cleaned and maintained regularly. - Oily contents of the oil interceptors should be transferred to an appropriate disposal facility, or to be collected for reuse, if possible.					
S9.27	S8.15-S8.16	Sewage from Station - Sewage and wastewater effluents generated from the staff at stations and food and beverage outlets, if any, would be connected to the existing foul sewerage system. - Runoff from cleaning activities at the stations which would enter floor drains would also be connected to the foul sewer.	To control sewage from stations	MTRC	WIL Stations	Operation phase	To be implemented in operation phase
Hazard to Life							
S10	S10.1	Blasting activities regarding transport, storage and use of explosives should be supervised and audited by competent site staff to ensure strict compliance with the blasting permit conditions.	To ensure that the risks from the proposed explosives storage, handling and transport would be acceptable	MTRC / Contractor	Works areas at which explosives would be stored and/or used.	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
S10	S10.1	Delivery vehicles shall not be permitted to remain unattended within the magazine. In addition, they shall not be allowed to park overnight, or when not in use, within the magazine and its audits	To reduce the risk of fire within the magazine	MTRC / Contractor	Explosive Magazine	Operational phase	Being implemented
S10	S10.1	Blast doors or heavy duty blast curtains should be installed at the access adits and shafts to prevent flyrock, and control the air over-pressure	To reduce the risk of injury due to flyrock during the WIL construction	MTRC / Contractor	At suitable locations, access adits and shafts	Construction phase	Being implemented
S10	S10.1	Detonators shall not be transported in the same vehicle with other Class 1 explosives	To reduce the risk of explosion during the transport of cartridged emulsion	MTRC / Contractor	-	Construction phase	Being implemented
Air Quality (Construction Phase)							
Table 11.6	Table 9.5	Rock Crushing Plants The unloading process would be undertaken within enclosed rock crushing facility. Water spraying would be provided at the unloading point. The crushing process is the secondary crushing. The rock crushing plant is enclosed and water spraying system would be installed. Dust extraction and collection system with 80% dust removal efficiency would be provided. The crushed stone/rock would be screened by the screening and sorting facility before transporting to the temporary stockpile via enclosed conveyor. Water spraying system would be installed. Dust extraction and collection system with 80% dust removal efficiency would be provided.	To minimize dust impacts	MTRC / Contractor	Rock crushing plants at works areas B and E	Construction phase	To be implemented as per construction programme
Table 11.7	Table 9.6	Temporary Stockpiles Kennedy Town Abattoir Site:	To minimize dust impacts	MTRC / Contractor	Temporary stockpiles at works	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		Loading point – Loading of crushed materials from rock crushing facility onto stockpile - The transportation would be via an enclosed conveyor belt system and water spraying and flexible dust curtains would be provided at the loading point to suppress the dust impact. Storage of materials - Active area for loading & unloading materials - The active area would be minimized to 20% of the total area of the stock piles. The 80% inactive area would be well covered with impervious sheeting. Water spraying system would be applied on the active area and watering with complete coverage of active area four times a day would be required. Transportation of materials to Barging Point 1 - Wheel wash facilities provided at the site exit. The vehicles would be washed before leaving the stockpiles. The spoils would also be well covered before leaving the site in order to minimise generation of dusty materials. - The haul roads within the site would be all paved and water spraying would be provided to keep the wet condition. Western PCWA: Loading point – Loading of crushed materials from rock crushing facility onto stockpile - The transportation would be via an enclosed conveyor belt system and water spraying and flexible dust curtains would be provided at the loading point to suppress the dust impact. Storage of materials - Active area for loading & unloading materials - Water spraying system would be applied on the active area and watering with complete of active area four times a day would be required.			areas B and E		

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		Transportation of materials to Barging Point 2 - The vehicles would be washed before leaving the stockpiles. The spoils would also be well covered before leaving the site in order to minimise generation of dusty materials. - The haul road would be paved and water spraying would be provided to keep the wet condition					
Table 11.8	Table 9.7	Barging Facilities Kennedy Town Abattoir Site Transportation of spoils to Barging Point 1 - All road surfaces within the barging facilities would be paved and water spraying would be provided to keep the wet condition. Unloading of spoil materials - The unloading process would be undertaken within enclosed tipping hall. Flexible dust curtains and water spraying would be provided at the discharge point for dust suppression. Vehicles leaving the barging facility - Vehicle wheel washing facilities provided at site exit Western PCWA Transportation of spoils to Barging Point 2 - All road surfaces within the barging facilities would be paved and water spraying would be provided to keep the wet condition. Unloading of spoil materials from trucks to Barging Point 2 - The unloading process should be undertaken within the enclosed tipping hall. Flexible dust curtains and water spraying would be provided at the discharge point for dust suppression. Unloading of spoil materials from enclosed tipping hall to Barging	To minimize dust impacts	MTRC / Contractor	Barging points at works areas B and E	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		Point 3 - The tipping hall would be enclosed structure. The conveyor from tipping hall to the Barging Point 3 would be enclosed. Water spraying and flexible dust curtains would be provided at the receiving point of the tipping hall. Flexible dust curtains and water spraying would be provided at the discharge point of barging facilities for dust suppression. Vehicles leaving the barging facility - Vehicle wheel washing facilities provided at site exit					
Table 11.9	S 9.26	Rock Crushing Plant at Kennedy Town Abattoir Site - Dust extraction and collection system (80% dust removal efficiency) should be installed at the rock crushing facility and the discharge point is located at least 39m away from the west boundary of the rock crushing facility under the preliminary design	To minimize dust impacts	MTRC / Contractor	Rock Crushing Plant at works area B - Kennedy Town Abattoir Site	Construction phase	To be implemented as per construction programme
Table 11.10	S 9.27	Works areas at KET station construction site Active operating area of 50% Watering four times a day with complete coverage of active construction area	To minimize dust impacts	MTRC / Contractor	Works area A, C and D	Construction phase	To be implemented as per construction programme
Table 11.10	S9.27	Open work areas at temporary magazine site Active operating area of 50% Watering two times a day with complete coverage of active construction area	To minimize dust impacts	MTRC / Contractor	Open works area at magazine site	Construction phase	To be implemented as per construction programme
S 11.42	S 9.28	For both rock crushing plants, the requirements and mitigation measures stipulated in the *Guidance Note on the Best Practicable*	To minimize dust impacts	MTRC / Contractor	Rock crushing	Construction phase	To be implemented as

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		Means for Mineral Works (Stone Crushing Plants) BPM 11/1 should be followed and implemented.			plants		per construction programme
S 11.42	S 9.28	Dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation and good site practices: - Use of regular watering, with complete coverage, to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather. - Use of frequent watering for particularly dusty construction areas and areas close to ASRs. - Side enclosure and covering of any aggregate or dusty material storage piles to reduce emissions. Where this is not practicable owing to frequent usage, watering shall be applied to aggregate fines. - Open stockpiles shall be avoided or covered. Where possible, prevent placing dusty material storage piles near ASRs. - Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations. - Establishment and use of vehicle wheel and body washing facilities at the exit points of the site. - Provision of wind shield and dust extraction units or similar dust mitigation measures at the loading points, and use of water sprinklers at the loading area where dust generation is likely during the loading process of loose material, particularly in dry seasons/ periods. - Imposition of speed controls for vehicles on unpaved site roads. 8 kilometers per hour is the recommended limit. - Where possible, routing of vehicles and positioning of	To minimize dust impacts	MTRC / Contractor	All works areas	Construction phase	Being implemented

EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Implementation Status
		construction plant shall be at the maximum possible distance from ASRs. - Every stock of more than 20 bags of cement or dry pulverised fuel ash (PFA) shall be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides. - Cement or dry PFA delivered in bulk shall be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed. - Loading, unloading, transfer, handling or storage of bulk cement or dry PFA shall be carried out in a totally enclosed system or facility, and any vent or exhaust shall be fitted with an effective fabric filter or equivalent air pollution control system.					

Table C2 **Implementation Schedule Specific for Works Area MA - Underground Magazine Site (Status as of 9 January 2011)**

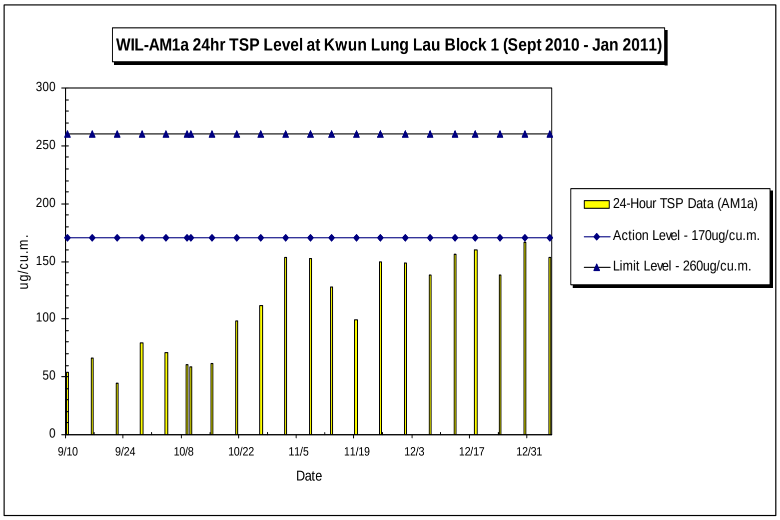
EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Reference
Ecological Impact (Construction Phase)							
App.2.3 – S. 6.1		Proposed works shall be designed to avoid or minimize direct impacts to natural habitats in the works area wherever possible.	To protect the natural habitats in the works area	MTRC / Contractor	Works Area MA	Design and construction of the magazine site	Implemented
App.2.3 – S. 6.2		Planting of vegetation shall be provided to compensate for the unavoidable loss of tall shrubland and woodland habitats. It shall be provided to re-vegetate the areas which would be 1m beyond the security fencing and temporarily affected by the construction works (e.g. slope works, erecting security fence) after the construction phase. The plant species selected for re-vegetation shall make reference to the existing habitats.	To compensate for the ecological impacts associated with the loss of vegetation	MTRC / Contractor	Works Area MA	Construction phase of the magazine site	To be implemented
App.2.3 – S. 6.2		Suitable plants, preferably with native species, shall be planted within the boundary of the completed magazine site to compensate for unavoidable loss of understorey vegetation resulting from the proposed works on-site after the decommissioning of the magazine site. The compensatory planting shall make use of native plant species with flowers/fruits to attract wildlife.	To compensate for the ecological impacts associated with the loss of vegetation	MTRC / Contractor	Works Area MA	After completing the construction of the magazine site	To be implemented
App.2.3 – S. 6.3		The two individuals of Hong Kong Pavetta (*Pavetta hongkongensis*) located within the footprint of the proposed tunnel portal and access entrance shall be transplanted to a suitable nearby tall shrubland or woodland habitats. Transplantation shall be supervised by a suitably qualified ecologist/horticulturalist	To protect the 2 species from the proposed works within the works area	MTRC / Contractor	Works Area MA	Prior to the construction phase of the magazine site	Implemented
App.2.3 – S. 6.4		The trees located within the works area shall be preserved as far as practicable. If tree felling is unavoidable, feasibility of tree transplantation and compensatory planting shall be explored shall be implemented.	To protect the existing trees within the works area	MTRC / Contractor	Works Area MA	Prior to the construction phase of the	Implemented

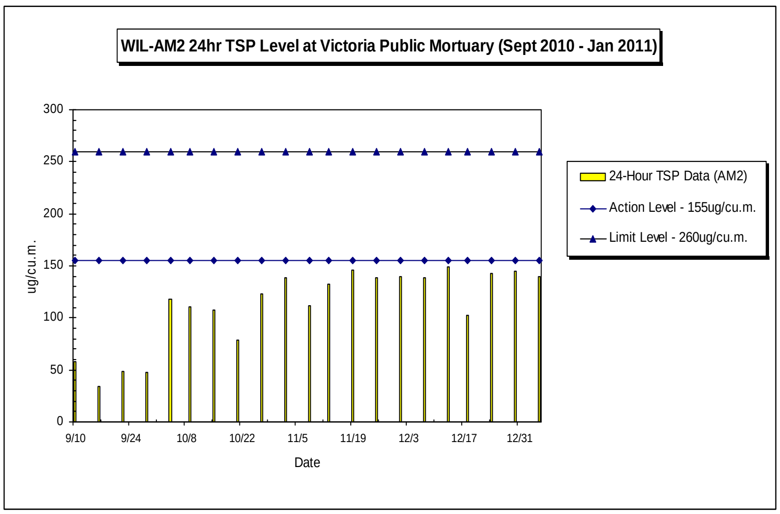
EIA Ref.	EM&A Ref.	Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Reference
						magazine site	
App.2.3 – S. 6.5		All the existing trees and species of conservation importance (i.e. the two identified Silver-back Artocarpus, *Artocarpus hypargyreus*) located near the proposed works site shall be fenced off and the trunk shall be protected with hessian sacking as far as possible.	To protect the existing trees and the species of conservation importance near the works area	MTRC / Contractor	Works Area MA	Construction and operation phase of the magazine site	Implemented
App.2.3 – S. 6.6		Noise control measures including the use of quiet excavation methods, quiet construction plant and temporary noise barriers shall be implemented	To minimize the noise disturbance to the wildlife near the works area	MTRC / Contractor	Works Area MA	Construction and operation phase of the magazine site	Implemented
App.2.3 – S. 6.7		Standard good site practice measures shall be implemented, including • Placement of equipment or stockpile in designated works areas and access routes selected on existing disturbed land to minimise disturbance to natural habitats. • Construction activities should be restricted to work areas that would be clearly demarcated. The work areas should be reinstated after completion of the works. • Waste skips should be provided to collect general refuse and construction wastes. The wastes would be disposed of timely and properly off-site. • General drainage arrangements should include sediment and oil traps to collect and control construction site run-off. • Open burning on works sites is illegal, and should be strictly prohibited.	To minimize ecological impacts	MTRC / Contractor	Works Area MA	Construction and operation phase of the magazine site	Implemented

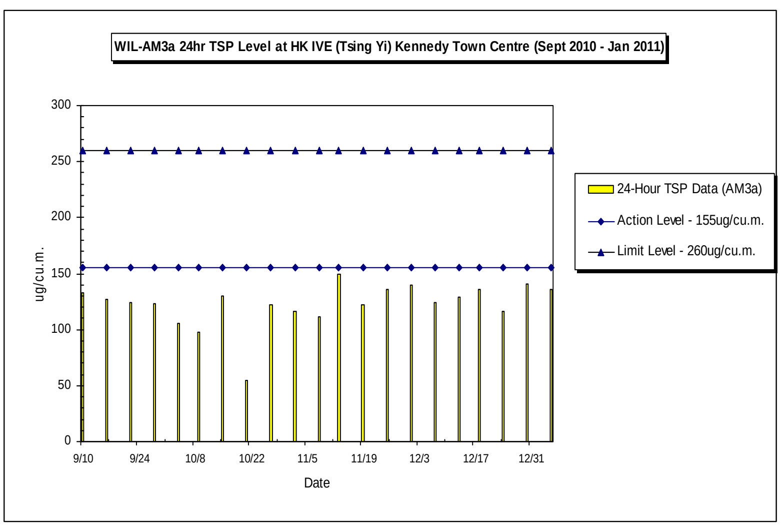
Table C3 Implementation Schedule Specific for Works Area B – Kennedy Town Abattoir and Incinerator Area (Status as of 9 January 2011)

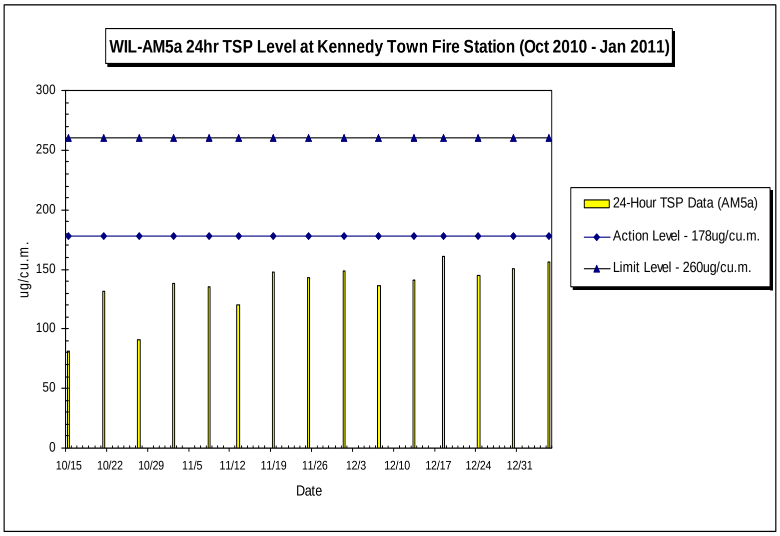
Recommended Mitigation Measures	Objectives of the Recommended Measure & Main Concern to Address	Who to implement the measure?	Location of the measure	When to implement the measure?	Reference
The existing ground slab/pavement within the works area shall be kept intact.	To minimize human health risk associated with the contaminated soil and groundwater in the works area.	MTRC / Contractor	Works Area B	Construction phase	Implemented
A reinforced concrete paving of no less than 200mm thick for the cleared site shall be provided after the demolition and clearance works. A debonding layer shall be placed between the existing and new concrete slabs to allow the latter to be removed prior to the former.	To minimize human health risk associated with the contaminated soil and groundwater in the works area.	MTRC / Contractor	Works Area B	Construction phase	Implemented
Monthly site inspection shall be conducted to ensure the integrity of the existing and/or the new paving layer. Any surface cracks identified shall be filled out such that underneath soil would not be exposed.	To minimize human health risk associated with the contaminated soil and groundwater in the works area.	MTRC / Contractor	Works Area B	Construction phase	Being implemented
A clear void between the structure slab of the site office and the ground surface shall be created, i.e. the site office is a raised structure.	To allow ventilation by natural air movements to dilute the contaminant vapour released from the soil and groundwater.	MTRC / Contractor	Works Area B	During the construction of the site offices	Implemented
Incorporate gas-resistant membranes into the raised floor of the site office.	To prevent contaminant vapour under the floor slab from entering the site office to protect the staff working in the site office.	MTRC / Contractor	Works Area B	During the construction of the site offices	Implemented
Site hoardings shall be erected around the works area, and they shall be properly maintained to restrict access of trespassers.	To protect the trespassers from the contaminated soil and groundwater in the works area.	MTRC / Contractor	Works Area B	Construction phase	Implemented

Appendix D
Impact Monitoring Graphical Plots

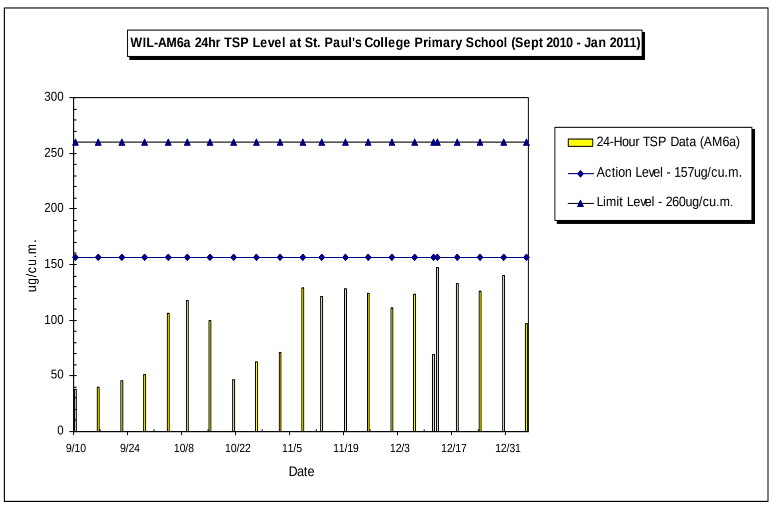

WIL-AM1a 24hr TSP Level at Kwun Lung Lau Block 1 (Sept 2010 - Jan 2011)
300
250
200
150
100
50
0
ug/cu.m.
9/10
9/24
10/8
10/22
11/5
11/19
12/3
12/17
12/31
Date
24-Hour TSP Data (AM1a)
Action Level - 170ug/cu.m.
Limit Level - 260ug/cu.m.


WIL-AM2 24hr TSP Level at Victoria Public Mortuary (Sept 2010 - Jan 2011)
300
250
200
150
100
50
0
ug/cu.m.
9/10
9/24
10/8
10/22
11/5
11/19
12/3
12/17
12/31
Date
24-Hour TSP Data (AM2)
Action Level - 155ug/cu.m.
Limit Level - 260ug/cu.m.

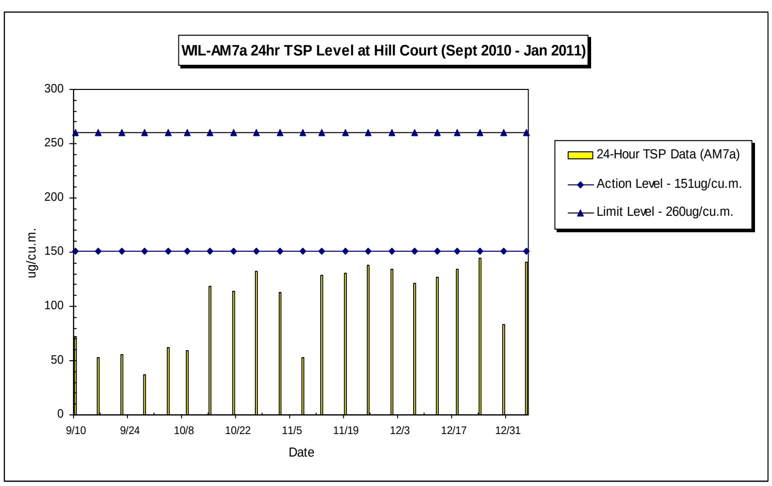

WIL-AM3a 24hr TSP Level at HK IVE (Tsing Yi) Kennedy Town Centre (Sept 2010 - Jan 2011)
300
250
200
150
100
50
0
ug/cu.m.
9/10
9/24
10/8
10/22
11/5
11/19
12/3
12/17
12/31
Date
24-Hour TSP Data (AM3a)
Action Level - 155ug/cu.m.
Limit Level - 260ug/cu.m.



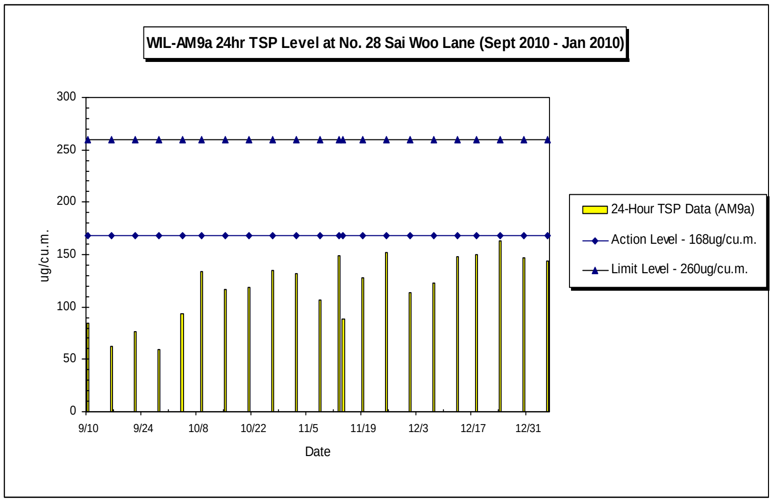
WIL-AM5a 24hr TSP Level at Kennedy Town Fire Station (Oct 2010 - Jan 2011)
300
250
200
150
100
50
0
ug/cu.m.
10/15
10/22
10/29
11/5
11/12
11/19
11/26
12/3
12/10
12/17
12/24
12/31
Date
24-Hour TSP Data (AM5a)
Action Level - 178ug/cu.m.
Limit Level - 260ug/cu.m.



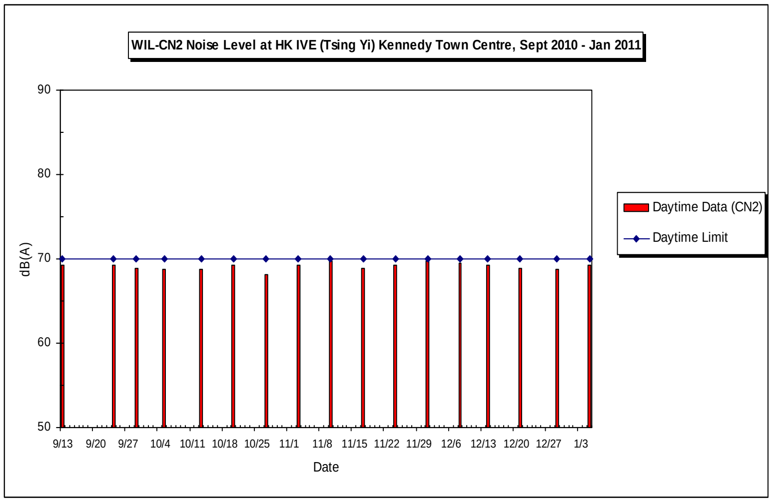
WIL-AM6a 24hr TSP Level at St. Paul's College Primary School (Sept 2010 - Jan 2011)
300
250
200
150
100
50
0
ug/cu.m.
9/10
9/24
10/8
10/22
11/5
11/19
12/3
12/17
12/31
Date
24-Hour TSP Data (AM6a)
Action Level - 157ug/cu.m.
Limit Level - 260ug/cu.m.

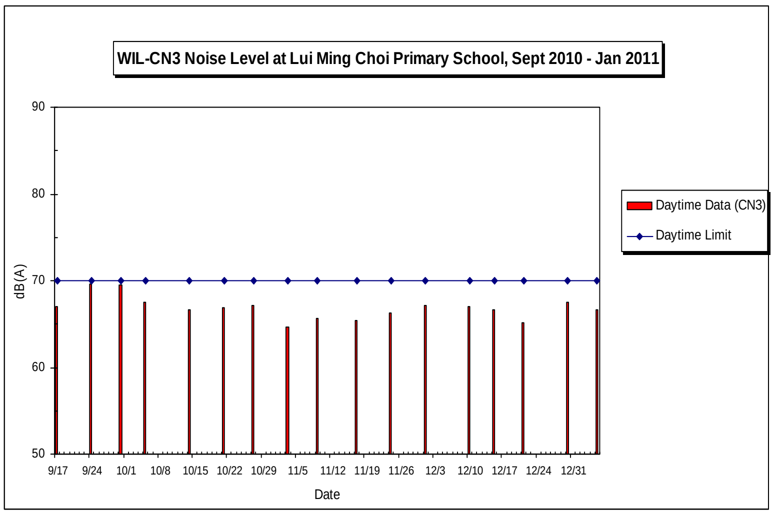


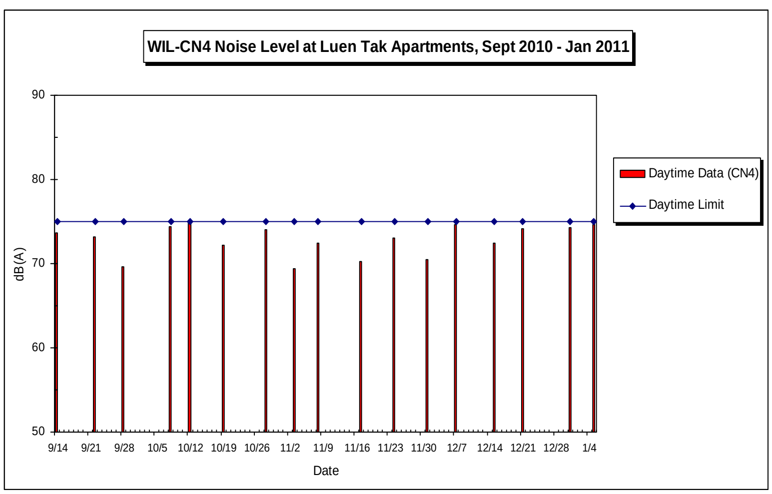
WIL-AM7a 24hr TSP Level at Hill Court (Sept 2010 - Jan 2011)
300
250
200
150
100
50
0
ug/cu.m.
9/10
9/24
10/8
10/22
11/5
11/19
12/3
12/17
12/31
Date
24-Hour TSP Data (AM7a)
Action Level - 151ug/cu.m.
Limit Level - 260ug/cu.m.

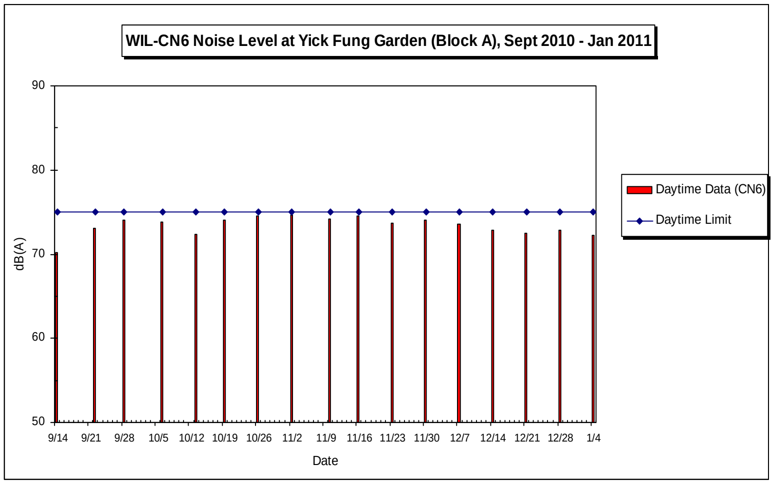


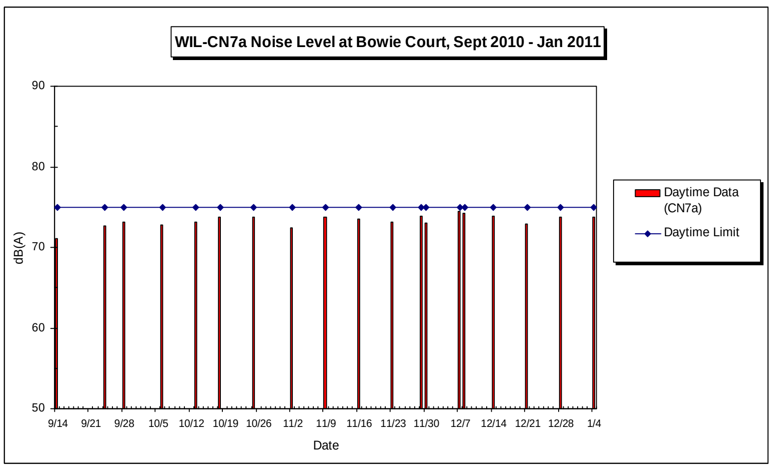
WIL-AM9a 24hr TSP Level at No. 28 Sai Woo Lane (Sept 2010 - Jan 2010)
ug/cu.m.
300
250
200
150
100
50
0
9/10
9/24
10/8
10/22
11/5
11/19
12/3
12/17
12/31
Date
24-Hour TSP Data (AM9a)
Action Level - 168ug/cu.m.
Limit Level - 260ug/cu.m.

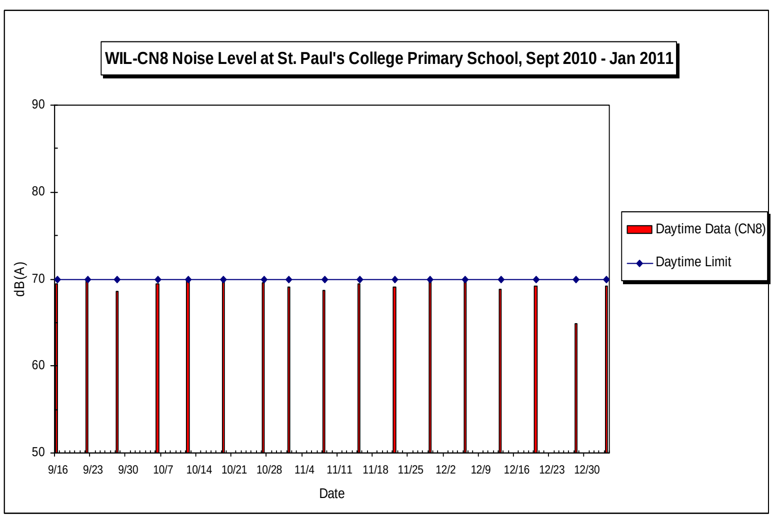

WIL-CN2 Noise Level at HK IVE (Tsing Yi) Kennedy Town Centre, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/13 9/20 9/27 10/4 10/11 10/18 10/25 11/1 11/8 11/15 11/22 11/29 12/6 12/13 12/20 12/27 1/3
Date
Daytime Data (CN2)
Daytime Limit

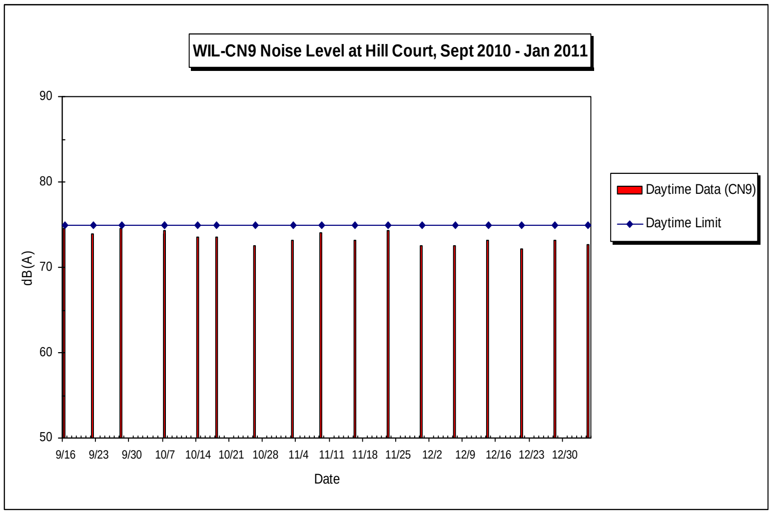

WIL-CN3 Noise Level at Lui Ming Choi Primary School, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/17 9/24 10/1 10/8 10/15 10/22 10/29 11/5 11/12 11/19 11/26 12/3 12/10 12/17 12/24 12/31
Date
Daytime Data (CN3)
Daytime Limit


WIL-CN4 Noise Level at Luen Tak Apartments, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/14 9/21 9/28 10/5 10/12 10/19 10/26 11/2 11/9 11/16 11/23 11/30 12/7 12/14 12/21 12/28 1/4
Date
Daytime Data (CN4)
Daytime Limit

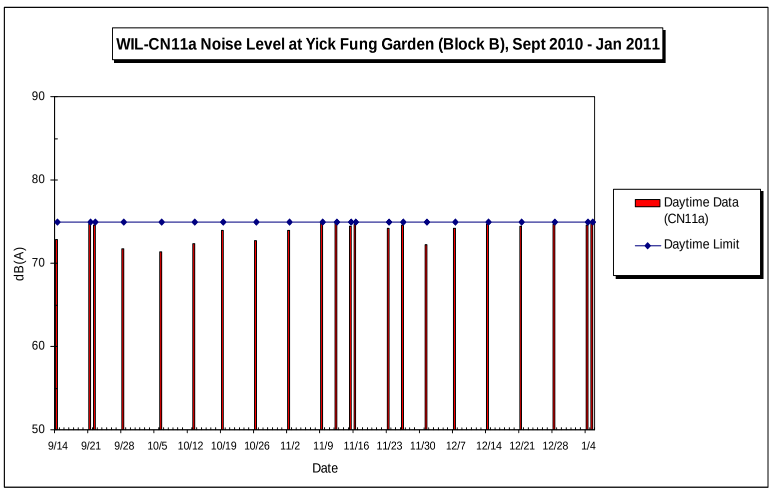

WIL-CN6 Noise Level at Yick Fung Garden (Block A), Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/14 9/21 9/28 10/5 10/12 10/19 10/26 11/2 11/9 11/16 11/23 11/30 12/7 12/14 12/21 12/28 1/4
Date
Daytime Data (CN6)
Daytime Limit


WIL-CN7a Noise Level at Bowie Court, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/14 9/21 9/28 10/5 10/12 10/19 10/26 11/2 11/9 11/16 11/23 11/30 12/7 12/14 12/21 12/28 1/4
Date
Daytime Data (CN7a)
Daytime Limit

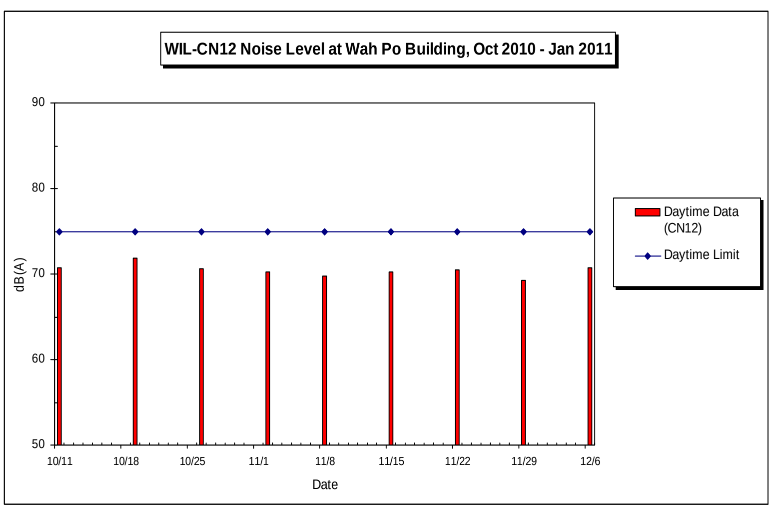

WIL-CN8 Noise Level at St. Paul's College Primary School, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/16 9/23 9/30 10/7 10/14 10/21 10/28 11/4 11/11 11/18 11/25 12/2 12/9 12/16 12/23 12/30
Date
Daytime Data (CN8)
Daytime Limit



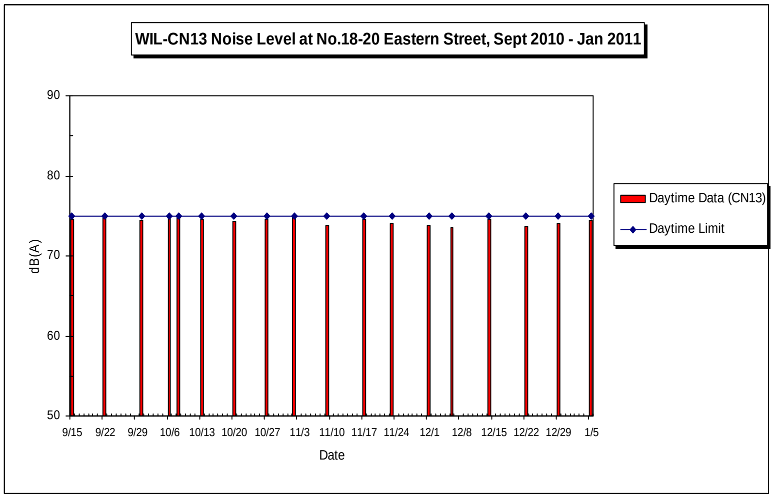
WIL-CN9 Noise Level at Hill Court, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/16
9/23
9/30
10/7
10/14
10/21
10/28
11/4
11/11
11/18
11/25
12/2
12/9
12/16
12/23
12/30
Date
Daytime Data (CN9)
Daytime Limit



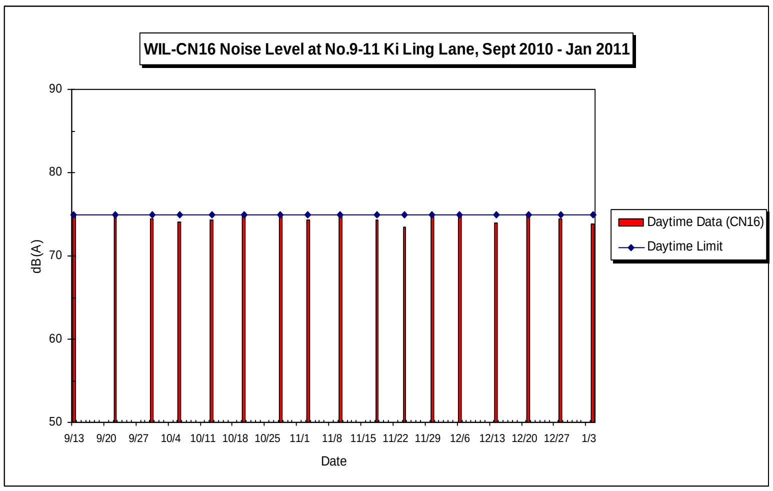
WIL-CN11a Noise Level at Yick Fung Garden (Block B), Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/14
9/21
9/28
10/5
10/12
10/19
10/26
11/2
11/9
11/16
11/23
11/30
12/7
12/14
12/21
12/28
1/4
Date
Daytime Data (CN11a)
Daytime Limit



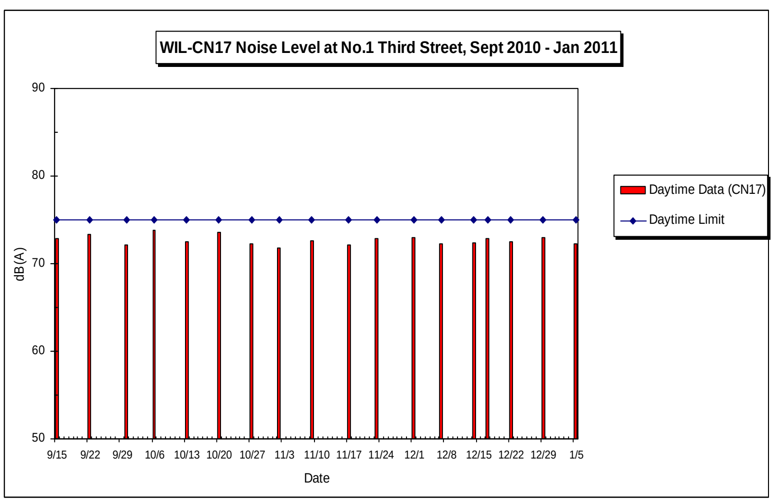
WIL-CN12 Noise Level at Wah Po Building, Oct 2010 - Jan 2011
90
80
70
60
50
dB(A)
10/11
10/18
10/25
11/1
11/8
11/15
11/22
11/29
12/6
Date
Daytime Data (CN12)
Daytime Limit



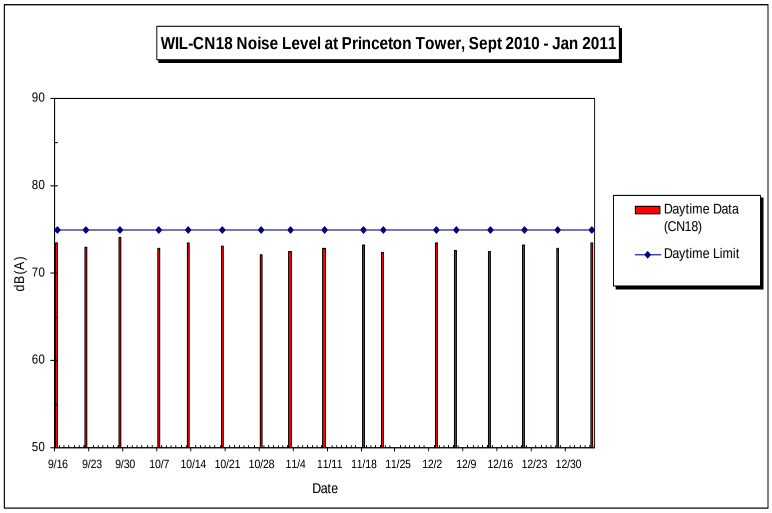
WIL-CN13 Noise Level at No.18-20 Eastern Street, Sept 2010 - Jan 2011
dB(A)
90
80
70
60
50
9/15 9/22 9/29 10/6 10/13 10/20 10/27 11/3 11/10 11/17 11/24 12/1 12/8 12/15 12/22 12/29 1/5
Date
Daytime Data (CN13)
Daytime Limit

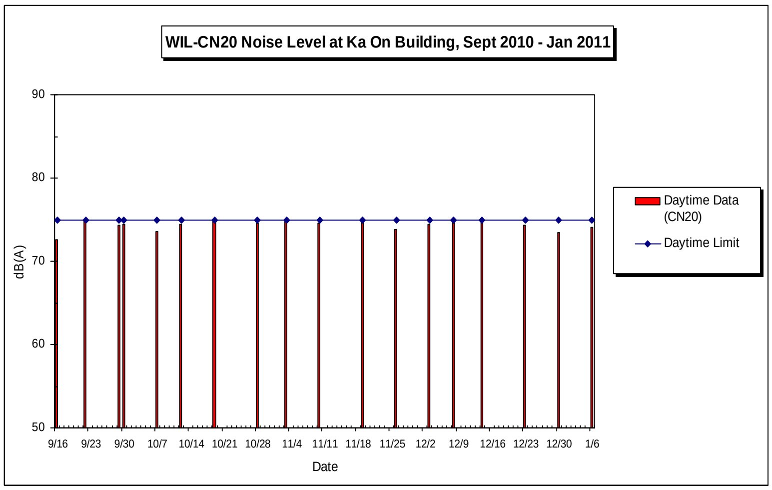


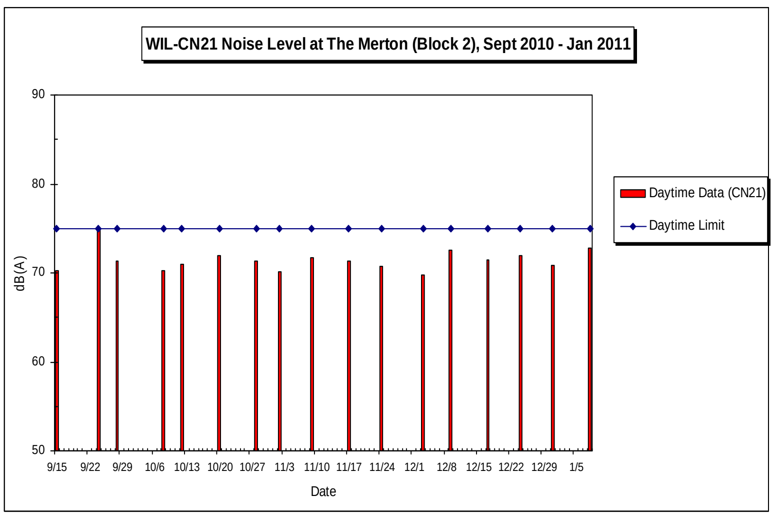
WIL-CN16 Noise Level at No.9-11 Ki Ling Lane, Sept 2010 - Jan 2011
dB(A)
90
80
70
60
50
9/13 9/20 9/27 10/4 10/11 10/18 10/25 11/1 11/8 11/15 11/22 11/29 12/6 12/13 12/20 12/27 1/3
Date
Daytime Data (CN16)
Daytime Limit



WIL-CN17 Noise Level at No.1 Third Street, Sept 2010 - Jan 2011
dB(A)
90
80
70
60
50
9/15 9/22 9/29 10/6 10/13 10/20 10/27 11/3 11/10 11/17 11/24 12/1 12/8 12/15 12/22 12/29 1/5
Date
Daytime Data (CN17)
Daytime Limit


WIL-CN18 Noise Level at Princeton Tower, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/16
9/23
9/30
10/7
10/14
10/21
10/28
11/4
11/11
11/18
11/25
12/2
12/9
12/16
12/23
12/30
Date
Daytime Data (CN18)
Daytime Limit


WIL-CN20 Noise Level at Ka On Building, Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/16
9/23
9/30
10/7
10/14
10/21
10/28
11/4
11/11
11/18
11/25
12/2
12/9
12/16
12/23
12/30
1/6
Date
Daytime Data (CN20)
Daytime Limit


WIL-CN21 Noise Level at The Merton (Block 2), Sept 2010 - Jan 2011
90
80
70
60
50
dB(A)
9/15
9/22
9/29
10/6
10/13
10/20
10/27
11/3
11/10
11/17
11/24
12/1
12/8
12/15
12/22
12/29
1/5
Date
Daytime Data (CN21)
Daytime Limit

Appendix E
Calibration Details

ThermoFisher
SCIENTIFIC
27 FORGE PARKWAY
FRANKLIN MA 02038
TOLL FREE: 866-282-0430
TEL: 508-553-6949
FAX: 508-541-8366
www.thermo.com/aqi

DR2000 CALIBRATION CERTIFICATE

This calibration is traceable to the National Institute of Standards and Testing

SERIAL NUMBER:	2003
CALIBRATION RATIO:	0.991
AVG. DR CONCENTRATION:	2.47 mg/m3
MASTER AVG CONCENTRATION:	2.04 mg/m3
PDR BACKROUND CONCENTRATION:	0.332 mg/m3

TEMPERATURE: 73 F
RH: 39 %

CALIBRATION MASTER: D187
LAST CALIBRATED: 5/1/2009

TECHNICIAN: KL

DATE: 5/19/2009

ANDERSEN INSTRUMENTS INC.

GS2310 Series Sampler Calibration

(Dickson Recorder)

Customer ->	MTRC	SITE	
Location ->	Kwun Lung Lau	Date ->	16-Jul-10
Sampler ->	994-0879	Tech ->	Chan Kin Fung

CONDITIONS

Sea Level Pressure	(hpa)	1009	Sampler Elevation	(feet)	100
Sea Level Pressure	(in Hg)	29.80	Corrected Pressure	(mm Hg)	754.22
Temperature	(deg C)	25	Temperature	(deg K)	298.00
Seasonal SL Pressure	(in Hg)	29.80	Corrected Seasonal	(mm Hg)	754.22
Seasonal Temperature	(deg C)	25.00	Seasonal Temperature	(deg K)	298.00

CALIBRATION ORIFICE

Make ->	Andersen Instruments Inc.	Qstd Slope ->	1.99
Model ->	25A	Qstd Intercept ->	-0.014012
Serial# ->	5303	Date Certified ->	

CALIBRATION

	Plate or Test #	H_2O (in)	Qstd (M^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	18	12.5	1.777	60	59.772	Slope =	31.9408
2	13	9.9	1.582	54	53.794	Intercept =	3.1887
3	10	7.8	1.405	48	47.817	Corr. Coeff. =	0.9984
4	7	4.9	1.115	40	39.848		
5	5	3.1	0.888	31	30.882		

Calculations

Qstd = 1/m [Sqrt (H_2O (Pa/Pstd) (Tstd/Ta)) - b]

IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m ((I) [Sqrt (298/Tav) (Pav/760)] - b)

SCIENCE INTERNATIONAL CORPORATION 新儀公司 HONG KONG

m = sampler slope
b = sampler intercept
I = chart response
Tav = daily average temperature
Pav = daily average pressure

This is to certify that the above equipment has been calibrated in accordance with manufacturer's procedure.

ANDERSEN INSTRUMENTS INC.

GS2310 Series Sampler Calibration
(Dickson Recorder)

Customer ->	MTRC	SITE	
Location ->	Victoria Public Mortuary	Date ->	14-Dec-10
Sampler ->	994-0871	Tech ->	Chan Kin Fung

CONDITIONS

Sea Level Pressure	(hpa)	1015	Sampler Elevation	(feet)	30
Sea Level Pressure	(in Hg)	29.97	Corrected Pressure	(mm Hg)	760.49
Temperature	(deg C)	23	Temperature	(deg K)	296.00
Seasonal SL Pressure	(in Hg)	29.97	Corrected Seasonal	(mm Hg)	760.49
Seasonal Temperature	(deg C)	23.00	Seasonal Temperature	(deg K)	296.00

CALIBRATION ORIFICE

Make ->	Andersen Instruments Inc.	Qstd Slope ->	1.99
Model ->	25A	Qstd Intercept ->	-0.014012
Serial# ->	5303	Date Certified ->	

CALIBRATION

	Plate or Test #	H_2O (in)	Qstd (M^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	18	11.9	1.747	63	63.233	Slope =	36.5579
2	13	9.9	1.594	56	56.207	Intercept =	-1.2648
3	10	7.5	1.388	49	49.181	Corr. Coeff. =	0.9987
4	7	4.8	1.112	40	40.148		
5	5	2.9	0.866	30	30.111		

Calculations

Qstd = 1/m [Sqrt (H_2O (Pa/Pstd) (Tstd/Ta)) - b]

IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m ((I) [Sqrt (298/Tav) (Pav/760)] - b)

m = sampler slope
b = sampler intercept
I = chart response
Tav = daily average temperature
Pav = daily average pressure

This is to certify that the above equipment has been calibrated in accordance with manufacturer's procedure.

SCIENCE INTERNATIONAL CORPORATION 新儀公司 HONG KONG

ANDERSEN INSTRUMENTS INC.

GS2310 Series Sampler Calibration

(Dickson Recorder)

Customer ->	MTRC	SITE	
Location ->	HKIVE (Tsing Yi) Kennedy Town Centre	Date ->	16-Jul-10
Sampler ->	994-0875	Tech ->	Chan Kin Fung

CONDITIONS

Sea Level Pressure	(hpa)	1009	Sampler Elevation	(feet)	100
Sea Level Pressure	(in Hg)	29.80	Corrected Pressure	(mm Hg)	754.22
Temperature	(deg C)	26	Temperature	(deg K)	299.00
Seasonal SL Pressure	(in Hg)	29.80	Corrected Seasonal	(mm Hg)	754.22
Seasonal Temperature	(deg C)	26.00	Seasonal Temperature	(deg K)	299.00

CALIBRATION ORIFICE

Make ->	Andersen Instruments Inc.	Qstd Slope ->	1.99
Model ->	25A	Qstd Intercept ->	-0.014012
Serial# ->	5303	Date Certified ->	

CALIBRATION

	Plate or Test #	H_2O (in)	Qstd (M^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	18	12.3	1.760	60	59.672	Slope =	33.1122
2	13	9.6	1.555	53	52.710	Intercept =	1.6664
3	10	7.4	1.367	48	47.737	Corr. Coeff. =	0.9983
4	7	4.8	1.102	39	38.787		
5	5	3	0.873	30	29.836		

Calculations

Qstd = 1/m [Sqrt (H_2O (Pa/Pstd) (Tstd/Ta)) - b]

IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m ((I) [Sqrt (298/Tav) (Pav/760)] - b)

SCIENCE INTERNATIONAL CORPORATION 新儀公司 HONG KONG

m = sampler slope
b = sampler intercept
I = chart response
Tav = daily average temperature
Pav = daily average pressure

This is to certify that the above equipment has been calibrated in accordance with manufacturer's procedure.

ANDERSEN INSTRUMENTS INC.

GS2310 Series Sampler Calibration
(Dickson Recorder)

Customer ->	MTRC	SITE	
Location ->	Kennedy Town FSD	Date ->	16-Jul-10
Sampler ->	294-0406	Tech ->	Chan Kin Fung

CONDITIONS

Sea Level Pressure	(hpa)	1009	Sampler Elevation	(feet)	100
Sea Level Pressure	(in Hg)	29.80	Corrected Pressure	(mm Hg)	754.22
Temperature	(deg C)	29	Temperature	(deg K)	302.00
Seasonal SL Pressure	(in Hg)	29.80	Corrected Seasonal	(mm Hg)	754.22
Seasonal Temperature	(deg C)	29.00	Seasonal Temperature	(deg K)	302.00

CALIBRATION ORIFICE

Make ->	Andersen Instruments Inc.	Qstd Slope ->	1.99
Model ->	25A	Qstd Intercept ->	-0.014012
Serial# ->	5303	Date Certified ->	

CALIBRATION

	Plate or Test #	H_2O (in)	Qstd (M^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	18	11.3	1.679	56	55.416	Slope =	28.9758
2	13	9.2	1.515	51	50.468	Intercept =	6.8755
3	10	7	1.323	46	45.520	Corr. Coeff. =	0.9989
4	7	4.6	1.074	39	38.593		
5	5	2.8	0.839	31	30.677		

Calculations

Qstd = 1/m [Sqrt (H_2O (Pa/Pstd) (Tstd/Ta)) - b]

IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m ((I) [Sqrt (298/Tav) (Pav/760)] - b)

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HONG KONG

m = sampler slope
b = sampler intercept
I = chart response
Tav = daily average temperature
Pav = daily average pressure

This is to certify that the above equipment has been calibrated in accordance with manufacturer's procedure.

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GS2310 Series Sampler Calibration
(Dickson Recorder)

Customer ->	MTRC	SITE	
Location ->	St' Paul's College Primary	Date ->	14-Dec-10
Sampler ->	1294-1113	Tech ->	Chan Kin Fung

CONDITIONS

Sea Level Pressure	(hpa)	1012	Sampler Elevation	(feet)	300
Sea Level Pressure	(in Hg)	29.88	Corrected Pressure	(mm Hg)	751.42
Temperature	(deg C)	24	Temperature	(deg K)	297.00
Seasonal SL Pressure	(in Hg)	29.88	Corrected Seasonal	(mm Hg)	751.42
Seasonal Temperature	(deg C)	24.00	Seasonal Temperature	(deg K)	297.00

CALIBRATION ORIFICE

Make ->	Andersen Instruments Inc.	Qstd Slope ->	1.99
Model ->	25A	Qstd Intercept ->	-0.014012
Serial# ->	5303	Date Certified ->	

CALIBRATION

	Plate or Test #	H_2O (in)	Qstd (M^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	18	12.2	1.755	62	61.753	Slope =	36.0371
2	13	9.9	1.582	56	55.777	Intercept =	-1.1184
3	10	7.7	1.396	50	49.801	Corr. Coeff. =	0.9993
4	7	5	1.126	40	39.841		
5	5	3	0.874	30	29.880		

Calculations

Qstd = 1/m [Sqrt (H_2O (Pa/Pstd) (Tstd/Ta)) - b]

IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m ((I) [Sqrt (298/Tav) (Pav/760)] - b)

m = sampler slope
b = sampler intercept
I = chart response
Tav = daily average temperature
Pav = daily average pressure

This is to certify that the above equipment has been calibrated in accordance with manufacturer's procedure.

ANDERSEN INSTRUMENTS INC.

GS2310 Series Sampler Calibration
(Dickson Recorder)

SITE

Customer ->	MTRC		
Location ->	Hill Court	Date ->	14-Dec-10
Sampler ->	694-0662	Tech ->	Chan Kin Fung

CONDITIONS

Sea Level Pressure	(hpa)	1012	Sampler Elevation	(feet)	400
Sea Level Pressure	(in Hg)	29.88	Corrected Pressure	(mm Hg)	748.90
Temperature	(deg C)	24	Temperature	(deg K)	297.00
Seasonal SL Pressure	(in Hg)	29.88	Corrected Seasonal	(mm Hg)	748.90
Seasonal Temperature	(deg C)	24.00	Seasonal Temperature	(deg K)	297.00

CALIBRATION ORIFICE

Make ->	Andersen Instruments Inc.	Qstd Slope ->	1.99
Model ->	25A	Qstd Intercept ->	-0.014012
Serial# ->	5303	Date Certified ->	

CALIBRATION

	Plate or Test #	H_2O (in)	Qstd (M^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	18	11.5	1.701	58	57.672	Slope =	32.9113
2	13	9.2	1.523	52	51.706	Intercept =	1.8280
3	10	7.2	1.348	47	46.734	Corr. Coeff. =	0.9996
4	7	4.7	1.090	38	37.785		
5	5	2.9	0.858	30	29.830		

Calculations

Qstd = 1/m [Sqrt (H_2O (Pa/Pstd) (Tstd/Ta)) - b]

IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m ((I) [Sqrt (298/Tav) (Pav/760)] - b)

m = sampler slope
b = sampler intercept
I = chart response
Tav = daily average temperature
Pav = daily average pressure

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This is to certify that the above equipment has been calibrated in accordance with manufacturer's procedure.

ANDERSEN INSTRUMENTS INC.

GS2310 Series Sampler Calibration

(Dickson Recorder)

Customer ->	MTRC	SITE	
Location ->	No.28 Sai Woo Lane	Date ->	14-Dec-10
Sampler ->	894-0834	Tech ->	Chan Kin Fung

CONDITIONS

Sea Level Pressure	(hpa)	1013	Sampler Elevation	(feet)	30
Sea Level Pressure	(in Hg)	29.91	Corrected Pressure	(mm Hg)	758.99
Temperature	(deg C)	24	Temperature	(deg K)	297.00
Seasonal SL Pressure	(in Hg)	29.91	Corrected Seasonal	(mm Hg)	758.99
Seasonal Temperature	(deg C)	24.00	Seasonal Temperature	(deg K)	297.00

CALIBRATION ORIFICE

Make ->	Andersen Instruments Inc.	Qstd Slope ->	1.99
Model ->	25A	Qstd Intercept ->	-0.014012
Serial# ->	5303	Date Certified ->	

CALIBRATION

	Plate or Test #	H_2O (in)	Qstd (M^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	18	11.6	1.720	61	61.062	Slope =	36.2085
2	13	9.3	1.541	54	54.055	Intercept =	-1.3988
3	10	7.2	1.357	48	48.049	Corr. Coeff. =	0.9997
4	7	4.7	1.098	38	38.039		
5	5	2.9	0.864	30	30.031		

Calculations

Qstd = 1/m [Sqrt (H_2O (Pa/Pstd) (Tstd/Ta)) - b]

IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)
Tstd = 298 deg K
Pstd = 760 mm Hg
For subsequent calculation of sampler flow:
1/m ((I) [Sqrt (298/Tav) (Pav/760)] - b)

m = sampler slope
b = sampler intercept
I = chart response
Tav = daily average temperature
Pav = daily average pressure

This is to certify that the above equipment has been calibrated in accordance with manufacturer's procedure.

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MTR Corporation
Internal Calibration

Project Laboratory MTR

Balance Calibration Report
Tested to MTRC Method WI/707M/01

Laboratory Equipment Identification Number			BA0011		
Manufacturer	Sartorius	Model	A200S-**DIB	Serial No.	1065989
Capacity	120g	Discrimination	0.1mg	Type	Top Loading
Location	Concrete Testing Area		Temperature	25℃	

Reference Mass Set Used (Equip. ID. No.)		RM001	
Manufacturer	Troemner	OIML Classification	F1
Last Calibration Date	29-04-2002	Calibrated By	South China National Centre of Metrology

(1) Repeatability of Reading

Reference Mass (g)	Standard Deviation of Balance Reading (g)	Maximum Difference Between Successive Readings (g)
10	0.000071	0.0002
60	0.0001333	0.0002
120	0.0001287	0.0003

Standard Deviation of the Balance = 0.0001333

(2) Departure from Nominal Value

Reading (g)	Correction (g)	Uncertainty (g)
10.0001	-0.0001	±0.000361
20.0001	-0.00005	
30.0001	-0.00005	
40.0001	0.00003	
50.0002	-0.00028	
60.0001	-0.00018	
70.000	0.00002	
80.0001	-0.00008	
90.0000	0.00005	
100.0001	-0.00025	

Maximum Correction = -0.00028

(3) Off-Centre Loading

A mass of approximately 60 was moved to various position on the balance pan. The balance readings obtained at different position are given in the table.

Centre	Front	Back	Left	Right
60.0001	60.0001	60.0004	59.9997	59.9997

Maximum Difference = 0.0007

(4) Hysteresis

Load (g)	Hysteresis (g)
50	-0.0001333

(5) Limit of Performance of the Balance = ± 0.000680

Checked by : Kenny Li

Date : 13-02-2009

Certified by : Au Ho

Date : 16/2/2009

Notes:

1.The balance has been tested according to the specifications laid down in Chapter 6 of the CSIRO Publication "The Calibration of Balances - by David B. Prowse".

2.Uncertainties quoted in this report have been estimated on the basis of there being not more than one chance in one hundred that any value differs from the true value by more than the stated uncertainty.

3.The Limit of Performance is the tolerance band within which all readings of the balance will fall.

MAXLAB

CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081194S

Customer Information

Company Name	MTR Corporation Limited
Address	MTR Tower, Telford Plaza, 33 Wai Yip St., Kowloon Bay, Kowloon, Hong Kong

Unit Under Test (UUT)

Description	Precision Integrating Sound Level Meter
Manufacturer	Brüel & Kjær
Model Number	Type 2236
Serial Number	1794284
Equipment Number	-

Calibration Result

* The UUT range indication was found defective, but range selection and measurement were not affected.
* All calibration results are within the manufacturer's specification.
* Calibration data are detailed on the attached sheet(s).

Approved By

Laboratory Manager

* Calibration equipment used for this calibration are traceable to national / international standards.
* The results on this Calibration Certificate only relate to the values measured at the time of the calibration and the uncertainties quoted will not include allowance for the UUT long term drift, variation with environmental changes, vibration and shock during transportation, overloading, mishandling, misuse, and the capacity of any other laboratory to repeat the measurement.
* MaxLab Calibration Centre Limited shall not be liable for any loss or damage resulting from the use of the UUT.
*

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MAXLAB
CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	***Certificate Number***	MLCN081194S

Calibration Status

Date of Calibration			30th December, 2008
Calibration Equipment Used			4231 (MLTE008)/ CA0801167/ 24th Feb 2010
Calibration Procedure			MLCG00 & MLCG15.
Calibration Uncertainty			±0.2 dB
Calibration Condition	***Lab***	***Temperature***	23 °C ± 5 °C
		Relative Humidity	55% ± 25%
	UUT	***Stabilizing Time***	24 hours
		Warm-up Time	10 minutes
		Supply Voltage	Not applicable

Calibration Data

UUT Setting				UUT Rdg	Std Rdg	UUT Error	UUT Error Limit
Frequency Wt.	**Parameter**	**Response**	**Range (dB)**				
A (1 kHz Input)	SPL	F	20 - 100	93.9 dB	94 dB	-0.1 dB	0.7 dB
		S		93.9 dB	94 dB	-0.1 dB	0.7 dB
		I		93.9 dB	94 dB	-0.1 dB	0.7 dB
C (1 kHz Input)		F	20 - 100	93.9 dB	94 dB	-0.1 dB	0.7 dB
		S		93.9 dB	94 dB	-0.1 dB	0.7 dB
		I		93.9 dB	94 dB	-0.1 dB	0.7 dB
L (1 kHz Input)		F	20 - 100	94.0 dB	94 dB	0.0 dB	0.7 dB
		S		94.0 dB	94 dB	0.0 dB	0.7 dB
		I		94.0 dB	94 dB	0.0 dB	0.7 dB
A (1 kHz Input)		F	40 - 120	113.9 dB	114 dB	-0.1 dB	0.7 dB
		S		113.9 dB	114 dB	-0.1 dB	0.7 dB
		I		113.9 dB	114 dB	-0.1 dB	0.7 dB

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CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081193S

Customer Information

Company Name	MTR Corporation Limited
Address	MTR Tower, Telford Plaza, 33 Wai Yip St., Kowloon Bay, Kowloon, Hong Kong

Unit Under Test (UUT)

Description	Precision Integrating Sound Level Meter
Manufacturer	Brüel & Kjær
Model Number	Type 2236
Serial Number	1814957
Equipment Number	-

Calibration Result

* All calibration results are within the manufacturer's specification.
* Calibration data are detailed on the attached sheet(s).

Approved By

Laboratory Manager

* Calibration equipment used for this calibration are traceable to national / international standards.
* The results on this Calibration Certificate only relate to the values measured at the time of the calibration and the uncertainties quoted will not include allowance for the UUT long term drift, variation with environmental changes, vibration and shock during transportation, overloading, mishandling, misuse, and the capacity of any other laboratory to repeat the measurement.
* MaxLab Calibration Centre Limited shall not be liable for any loss or damage resulting from the use of the UUT.

The service is provided under a HKQAA ISO9001:2000 certified quality system of Certificate No. CC1929.

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CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081193S

Calibration Status

Date of Calibration	30th December, 2008
Calibration Equipment Used	4231 (MLTE008)/ CA0801167/ 24th Feb 2010
Calibration Procedure	MLCG00 & MLCG15.
Calibration Uncertainty	±0.2 dB

Calibration Condition	*Lab*	*Temperature*	23 °C ± 5 °C
		Relative Humidity	55% ± 25%
	UUT	*Stabilizing Time*	24 hours
		Warm-up Time	10 minutes
		Supply Voltage	Not applicable

Calibration Data

UUT Setting				UUT Rdg	Std Rdg	UUT Error	UUT Error Limit
Frequency Wt.	Parameter	Response	Range (dB)				
A (1 kHz Input)	SPL	F	20 - 100	93.9 dB	94 dB	-0.1 dB	0.7 dB
		S		93.9 dB	94 dB	-0.1 dB	0.7 dB
		I		93.9 dB	94 dB	-0.1 dB	0.7 dB
C (1 kHz Input)		F	20 - 100	93.9 dB	94 dB	-0.1 dB	0.7 dB
		S		93.9 dB	94 dB	-0.1 dB	0.7 dB
		I		93.9 dB	94 dB	-0.1 dB	0.7 dB
L (1 kHz Input)		F	20 - 100	93.9 dB	94 dB	-0.1 dB	0.7 dB
		S		93.9 dB	94 dB	-0.1 dB	0.7 dB
		I		93.9 dB	94 dB	-0.1 dB	0.7 dB
A (1 kHz Input)		F	40 - 120	113.9 dB	114 dB	-0.1 dB	0.7 dB
		S		113.9 dB	114 dB	-0.1 dB	0.7 dB
		I		113.9 dB	114 dB	-0.1 dB	0.7 dB

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MAXLAB

CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081195S

Customer Information

Company Name	MTR Corporation Limited
Address	MTR Tower, Telford Plaza, 33 Wai Yip St., Kowloon Bay, Kowloon, Hong Kong

Unit Under Test (UUT)

Description	Precision Integrating Sound Level Meter
Manufacturer	Brüel & Kjær
Model Number	Type 2236
Serial Number	1814960
Equipment Number	-

Calibration Result

* All calibration results are within the manufacturer's specification.
* Calibration data are detailed on the attached sheet(s).

Approved By

Laboratory Manager

* Calibration equipment used for this calibration are traceable to national / international standards.
* The results on this Calibration Certificate only relate to the values measured at the time of the calibration and the uncertainties quoted will not include allowance for the UUT long term drift, variation with environmental changes, vibration and shock during transportation, overloading, mishandling, misuse, and the capacity of any other laboratory to repeat the measurement.
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MAXLAB

CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081195S

Calibration Status

Date of Calibration	30th December, 2008
Calibration Equipment Used	4231 (MLTE008)/ CA0801167/ 24th Feb 2010
Calibration Procedure	MLCG00 & MLCG15.
Calibration Uncertainty	±0.2 dB

Calibration Condition	*Lab*	*Temperature*	23 °C ± 5 °C
		Relative Humidity	55% ± 25%
	UUT	*Stabilizing Time*	24 hours
		Warm-up Time	10 minutes
		Supply Voltage	Not applicable

Calibration Data

UUT Setting				**UUT Rdg**	**Std Rdg**	**UUT Error**	**UUT Error Limit**
Frequency Wt.	**Parameter**	**Response**	Range (dB)				
A (1 kHz Input)	SPL	F	20 - 100	94.1 dB	94 dB	0.1 dB	0.7 dB
		S		94.1 dB	94 dB	0.1 dB	0.7 dB
		I		94.1 dB	94 dB	0.1 dB	0.7 dB
C (1 kHz Input)		F	20 - 100	94.1 dB	94 dB	0.1 dB	0.7 dB
		S		94.1 dB	94 dB	0.1 dB	0.7 dB
		I		94.1 dB	94 dB	0.1 dB	0.7 dB
L (1 kHz Input)		F	20 - 100	94.1 dB	94 dB	0.1 dB	0.7 dB
		S		94.1 dB	94 dB	0.1 dB	0.7 dB
		I		94.1 dB	94 dB	0.1 dB	0.7 dB
A (1 kHz Input)		F	40 - 120	114.0 dB	114 dB	0.0 dB	0.7 dB
		S		114.0 dB	114 dB	0.0 dB	0.7 dB
		I		114.0 dB	114 dB	0.0 dB	0.7 dB

The service is provided under a HKQAA ISO9001:2000 certified quality system of Certificate No. CC1929.

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香港九龍觀塘巧明街 111-113 號富利廣場 22 樓 1 室 電話：(852) 2116 1380 傳真：(852) 2264 6480 電郵：info@maxlab.com.hk

MAXLAB
CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081192S

Customer Information

Company Name	MTR Corporation Limited
Address	MTR Tower, Telford Plaza, 33 Wai Yip St., Kowloon Bay, Kowloon, Hong Kong

Unit Under Test (UUT)

Description	Sound Level Calibrator
Manufacturer	Brüel & Kjær
Model Number	4231
Serial Number	1807710
Equipment Number	-

Calibration Result

* All calibration results within the manufacturer's specification.
* Calibration data are detailed on the attached sheet(s).

Approved By

Laboratory Manager

* Calibration equipment used for this calibration are traceable to national / international standards.
* The results on this Calibration Certificate only relate to the values measured at the time of the calibration and the uncertainties quoted will not include allowance for the UUT long term drift, variation with environmental changes, vibration and shock during transportation, overloading, mishandling, misuse, and the capacity of any other laboratory to repeat the measurement.
* MaxLab Calibration Centre Limited shall not be liable for any loss or damage resulting from the use of the UUT.
*

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MAXLAB

CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081192S

Calibration Status

Date of Calibration	30th December, 2008
Calibration Equipment Used	4231 (Spec) (MLTE008)/ CA0801167/ 24th Feb 2010 1351 (MLTE049)/ MLEC08/06/02/ 14th Jun 2009
Calibration Procedure	MLCG00 & MLCG15.
Calibration Uncertainty	± 0.1 dB

Calibration Condition	*Lab*	*Temperature*	23 °C ± 5 °C
		Relative Humidity	55% ± 25%
	UUT	*Stabilizing Time*	24 hours
		Warm-up Time	Not applicable
		Supply Voltage	Not applicable

Calibration Data

UUT Setting	STD Rdg	UUT Error from Setting	UUT Error Limit
94 dB	94.1 dB	0.1 dB	0.2 dB
114 dB	114.1 dB	0.1 dB	0.2 dB

The service is provided under a HKQAA ISO9001:2000 certified quality system of Certificate No. CC1929.

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MAXLAB
CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081191S

Customer Information

Company Name	MTR Corporation Limited
Address	MTR Tower, Telford Plaza, 33 Wai Yip St., Kowloon Bay, Kowloon, Hong Kong

Unit Under Test (UUT)

Description	Sound Level Calibrator
Manufacturer	Brüel & Kjær
Model Number	4231
Serial Number	2326445
Equipment Number	-

Calibration Result

* All calibration results within the manufacturer's specification.
* Calibration data are detailed on the attached sheet(s).

Approved By

Laboratory Manager

* Calibration equipment used for this calibration are traceable to national / international standards.
* The results on this Calibration Certificate only relate to the values measured at the time of the calibration and the uncertainties quoted will not include allowance for the UUT long term drift, variation with environmental changes, vibration and shock during transportation, overloading, mishandling, misuse, and the capacity of any other laboratory to repeat the measurement.
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MAXLAB
CALIBRATION CERTIFICATE

Certificate Information

Date of Issue	30th December, 2008	*Certificate Number*	MLCN081191S

Calibration Status

Date of Calibration			30th December, 2008
Calibration Equipment Used			4231 (Spec) (MLTE008)/ CA0801167/ 24th Feb 2010 1351 (MLTE049)/ MLEC08/06/02/ 14th Jun 2009
Calibration Procedure			MLCG00 & MLCG15.
Calibration Uncertainty			± 0.1 dB
Calibration Condition	*Lab*	*Temperature*	23 °C ± 5 °C
		Relative Humidity	55% ± 25%
	UUT	*Stabilizing Time*	24 hours
		Warm-up Time	Not applicable
		Supply Voltage	Not applicable

Calibration Data

UUT Setting	STD Rdg	UUT Error from Setting	UUT Error Limit
94 dB	93.9 dB	-0.1 dB	0.2 dB
114 dB	114.0 dB	0.0 dB	0.2 dB

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Unit 1, 22/F., Futura Plaza, 111-113 How Ming Street, Kwun Tong, Kowloon, Hong Kong Tel : (852) 2116 1380 Fax : (852) 2264 6480 Email : info@maxlab.com.hk
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Appendix F
Monitoring Schedules

Air Impact Monitoring

1. The air impact monitoring schedule for the present reporting period is shown in Section 3.1.

2. The air impact monitoring schedule for the next reporting period will commence on 10 January 2011 and will be conducted at a sampling frequency of at least once in every six days.

Noise Impact Monitoring

1. The noise impact monitoring schedule for the present reporting period is shown in Section 3.2.

2. The noise impact monitoring schedule for the next reporting period will commence on 10 January 2011 and will be conducted at a frequency of once a week when construction activities are underway.

Appendix G

Certified Arborist Monthly Inspection Record for December 2010

WEST ISLAND LINE

Consultancy Agreement No. : C735F - Arborist for Tree Protection

Consultant : Muni Arborist Limited

Name : Mike Leung (Certified Arborist)

Monthly Inspection Record for December 2010

Date	Activity Description	Purpose
03 December 2010	Regular Inspection for December	Monitor the conditions of transplanted and retained trees
23 December 2010	Regular Inspection for December	Monitor the conditions of transplanted and retained trees

Signed by Muni Arborist Limited : ______________________

Date : 3 January 2011

The Transplant and protection works were carried out in accordance with requirement of the Tree Protection Plan in general

Appendix H

Environmental Review Report for Tunnel Works from KGV to SWL

REPORT

MTR Corporation Limited

Mass Transit Railway West Island Line (WIL) – Use of King George V Memorial Park as Delivery Point and Mucking Out: *Environmental Review*

October 2010

Environmental Resources Management
21/F Lincoln House
979 King's Road
Taikoo Place
Island East, Hong Kong
Telephone: (852) 2271 3000
Facsimile: (852) 2723 5660
E-mail: post.hk@erm.com
http://www.erm.com

REPORT

MTR Corporation Limited

Mass Transit Railway West Island Line (WIL) - Use of King George V Memorial Park as Delivery Point and Mucking Out: *Environmental Review*

October 2010

Reference 0119988

For and on behalf of
ERM-Hong Kong, Limited

Approved by: Venkatesh S.

Signed:

Position: Director

Date: 15 October 2010

CONTENTS

ANNEXES

1 INTRODUCTION

1.1 BACKGROUND

Following the approval of the West Island Line Environmental Impact Assessment (WIL EIA) Report[1] by the Environmental Protection Department (EPD) on 23 December 2008, an Environmental Permit (EP-313/2008) was granted on 12 January 2009 for the West Island Line (WIL) and further amendments to the EP were approved in June, July and August 2009 respectively. The construction of the WIL is now progressing under various works contracts led by the MTR Corporation Limited (MTR).

Dragages Hong Kong, Maeda & Bachy Joint Venture (DMBJV) has been appointed by MTR to undertake the construction of WIL Works Contract No. 703, which includes the construction of running tunnels between the existing Sheung Wan Station and the finger platforms of the proposed Sai Ying Pun Station, construction shaft at King George V Memorial Park (KGV) and construction adit linking to the running tunnels, and Sai Woo Lane (SWL) entrance.

For the assessments in the WIL EIA Report, it was originally assumed that the tunnels will be blasted from SWL to KGV (referred to as Works Area M in the WIL EIA Report) from April 2011 to February 2012, ie. for a period of eleven months. It was also assumed in the WIL EIA Report that the construction shaft at KGV would not be used for mucking out but for personnel and material access only.

Further to the WIL Environmental Review (ER) Report[2] submitted with no objection received from the EPD on the proposed alternative method for the construction of access shaft at KGV by drill-and-blast, MTR and DMBJV are now proposing to blast the tunnels from KGV instead of SWL, with the intention to shorten the excavation period and to further reduce the environmental nuisance to the surroundings. With the proposed alternative blasting programme, changes to the information presented in the WIL EIA Report and the WIL ER Report will be introduced and the potential implications of such changes under the Environmental Impact Assessment Ordinance (EIAO) need to be reviewed.

1.2 OBJECTIVES OF THIS REVIEW

The objectives of this Review are as follows:

[1] West Island Line Environmental Impact Assessment Report (Register No.: AEIAR-126/2008) (WIL EIA Report)

[2] West Island Line Environmental Review Report for Proposed Alternative Method for Construction of Access Shaft at King George V Memorial Park (Works Area M) dated July 2010 (WIL ER Report)

- To identify changes in the works activities at KGV and SWL, if any;
- To identify the potential environmental impacts associated with the proposed changes in works activities;
- To update the environmental assessment results in the approved WIL EIA Report and WIL ER Report, if necessary;
- To review the requirements for environmental mitigation measures in the approved WIL EIA Report and WIL ER Report; and
- To ascertain if the proposed changes would result in any implications under the provisions of EIAO.

1.3 STRUCTURE OF THIS REPORT

After this introductory section, the remainder of this Report is arranged as follows:

Section 2 describes the proposed changes and the key environmental issues associated with them;

Section 3 presents an assessment of the potential impacts on the environment from the proposed changes, compares the results with that in the approved WIL EIA report and WIL ER Report, and review the requirements for environmental mitigation measures in the approved WIL EIA Report and WIL ER Report; and

Section 4 concludes the findings of the environmental review.

2 PROPOSED CHANGES AND ASSOCIATED KEY ENVIRONMENTAL ISSUES

2.1 PROPOSED CHANGES

The approved WIL EIA Report assumed that the tunnels will be blasted from SWL, from April 2011 to February 2012, ie for a period of eleven months (Appendix 2.2 of the WIL EIA Report and *Annex B*). It was also assumed in the WIL EIA Report that the construction shaft at KGV would not be used for mucking out but for personnel and material access only (Section 2.8 of the WIL EIA Report).

MTR and DMBJV are now proposing to blast the tunnels from KGV instead of SWL, from end of October 2010 to July 2011, ie for a period of nine months. With the proposed change in the blasting programme, the changes to the information presented in the WIL EIA Report and the WIL ER Report are summarised below:

- the time required for adit and tunnel construction will be shortened and completed earlier (*Annex B*);
- change of explosives delivery point 7 from SWL to KGV (*Annex C*) which include the following associated changes:
  - change in the explosives delivery route from WIL Magazine to KGV delivery point (*Annex C*);
  - reduction in the quantity of explosives per delivery to be transported from the WIL Magazine to KGV (Annex C);
  - increase of the explosive transport frequency from once per day to twice per day (Annex C);
  - flexibility to use either electronic detonators or conventional detonators (Annex C); and
- the construction shaft at KGV will be used for mucking out of excavated material from the drill-and-blast tunnels.

The total amount of C&D material expected from the proposed change in the blasting programme will remain the same as that presented in the WIL EIA Report. The excavated material from the drill-and-blast tunnels will be mucked out from KGV, and the remaining material excavated by the Tunnel Boring Machine (TBM) will be mucked out from SWL. All excavated material from the drill-and-blast tunnels will be removed from KGV before the TBM tunnels commence at SWL in September 2011.

The proposed change in the blasting programme will shorten the adit and tunnel construction time by about two months and the overall adit and tunnel construction will be able to achieve earlier completion in July 2011 instead of February 2012, ie seven months earlier (*Annex B*).

The construction site layout plan of KGV and the change in construction programme are illustrated in *Annexes A* and *B*, respectively.

2.2 *REASONS FOR THE PROPOSED CHANGES*

The main reasons for the proposed changes are summarised as follows:

- With the tunnels being blasted from KGV, the adit and tunnel construction time is shortened by about two months and the overall adit and tunnel construction will be able to achieve earlier completion in July 2011 instead of February 2012, ie seven months earlier, when compared with the original blasting programme with blast from SWL (see *Section 2.1* above); and

- With the earlier completion of adit and tunnel construction, the nuisance to the neighbourhood will be shortened accordingly.

- If the tunnel blasting was to remain at SWL then, this would produce a greater possibility that the overall project may be delayed increasing the construction exposure time to the local residents, this has been brought about by several issues including the late handover of the resumed buildings from Lands Department by 36 days and actual site geology being different to that originally assessed from the bore hole data.

2.3 *KEY ENVIRONMENTAL ISSUES ASSOCIATED WITH THE PROPOSED CHANGES*

Table 2.1 identifies the potential sources of environmental impacts associated with the proposed changes.

Table 2.1 Potential Environmental Issues

Type of Potential Impact	**Likelihood of Impact Arising from the Proposed Changes**
Gaseous emissions	✘
Dust	✘
Odour	✘
Noisy operation	✘
Night-time operation	✘
Traffic generation	✘
Liquid effluent, discharge, or contaminated run-off	✘
Generation of waste or by-products	✘
Storage, handling, transport, or disposal of hazardous materials or wastes	✘
Risk of accidents which would result in pollution or hazard	✓
Disposal of spoil material including potentially contaminated material	✘

Type of Potential Impact	**Likelihood of Impact Arising from the Proposed Changes**
Disruption of water movement	✗
Unsightly visual appearance	✗
Ecology	✗
Effects on existing landscape	✗
Cultural heritage	✗

✓ possible
✗ not expected

The potential impact arising from the proposed changes is assessed by comparing with the assumptions and assessments conducted in the approved WIL EIA Report and WIL ER Report. In consideration of the dust and noise impacts, the potential impacts due to the blasting at KGV and the mitigation measures required were addressed in the WIL ER Report and therefore, the likelihood of impact arising from the proposed changes is not expected.

The maximum nos. of trucks to be used on-site in any 30 minutes at SWL and KGV will remain the same as that presented in the approved WIL EIA Report and the WIL ER Report, respectively. The potential risk associated with the proposed change of construction programme is assessed in details, as presented in *Section 3.8*. The C&D material expected from the proposed changes will also be the same as that presented in the WIL EIA Report. In view of the above, the environmental impacts associated with the proposed changes are expected to be similar to those presented in the approved WIL EIA Report and WIL ER Report. These are discussed further in subsequent sections.

3 POSSIBLE IMPACT ON THE ENVIRONMENT AND MITIGATION MEASURES

3.1 AIRBORNE CONSTRUCTION NOISE IMPACT

DMBJV and MTR confirmed that the construction plant inventory, including the type, quantity and utilisation rates of Powered Mechanical Equipment (PME) and the noise mitigation measures, required for the adit and tunnel construction works at KGV due to the proposed change in blasting programme will be the same as that provided in the WIL ER Report for the construction of KGV shaft. All the above-mentioned construction plant inventory and noise mitigation measures had been implemented at KGV in accordance with the WIL ER Report. As the tunnels will be blasted from KGV instead of SWL, the overall adit and tunnel construction time will be completed earlier for about seven months. In line with the requirement of Condition 2.10.1 of EP-313/2008/C, an acoustic enclosure has been provided on top of the shaft at KGV (ie Works Area M as referred to in the EP). The acoustic enclosure comprises a full noise enclosure and a blast cover. Details of these components of the acoustic enclosure and the blast cover were given in the WIL ER Report.

With the same construction plant inventory and implementation of the noise mitigation measures at KGV, the construction noise levels will remain the same as that predicted in the WIL ER Report.

Results of the on-going noise monitoring conducted at No.1 Third Street (construction noise monitoring location CN 17, ie SYP14) also indicated that there is no noise exceedance during the shaft blasting at KGV during July and August 2010.

There will be no change to the site layout and construction plant inventory at SWL. The only change is that the excavated material from the adit and tunnel construction by drill-and-blast will not be removed from the SWL.

3.2 GROUNDBORNE CONSTRUCTION NOISE IMPACT

No change as indicated in the WIL ER Report.

3.3 LANDSCAPE AND VISUAL IMPACT

No change as indicated in the WIL ER Report.

3.4 CULTURAL HERITAGE IMPACT

No change as indicated in the WIL ER Report.

3.5 *WASTE MANAGEMENT*

The major portion of waste generated from the adit and tunnel construction at KGV will mainly be inert excavated materials. The total amount of excavated material expected from the proposed change in the blasting programme is 49,200 m^3, ie remain the same as that presented in the WIL EIA Report. Instead of all excavated material would be removed from SWL as assumed in the approved WIL EIA Report, 23,875 m^3 of the material excavated from the drill-and-blast tunnels will be mucked out from KGV, and the remaining 25,325m^3 of the material excavated by the TBM will be mucked out from SWL. All excavated material from the drill-and-blast tunnels will be removed from KGV before the TBM tunnels commence at SWL in September 2011.

Provided that all the wastes are handled, transported and disposed of using approved methods and that the good site practices recommended in the WIL EIA Report are strictly followed, adverse environmental impacts associated with the handling, transportation and disposal of the surplus C&D materials and other general waste are not expected.

3.6 *LAND CONTAMINATION*

No change as indicated in the WIL ER Report.

3.7 *WATER QUALITY IMPACT*

Despite the proposed change in the blasting programme, the location of the adit and tunnel will remain the same as that assumed in the approved WIL EIA Report. On this basis, the degree and extent of potential water quality impact arising from the need to treat and dispose of the groundwater generated during the adit and tunnel construction will remain the same as that indicated in the approved WIL EIA Report.

The mitigation measures recommended in the approved WIL EIA Report have been implemented at KGV, no additional water quality impact is anticipated with the proposed change in the blasting programme.

3.8 *HAZARD TO LIFE*

In order to meet the construction programme, the WIL contractor for Work Contract 703 will use explosives for the blasting of tunnels and adits.

This review has assessed the risk associated with the proposed change of construction programme involving the change of delivery point from SWL to KGV which includes a number of associated changes further described in *Annex C*.

A Quantitative Risk Assessment (QRA) study has been performed to assess the potential risk as the result of these changes to compare the overall WIL project risk with the Hong Kong Risk Guidelines (HKRG). The QRA concluded that the risks associated with proposed changes are within the acceptable region of the HKRG and will not constitute a material change to the Environment Permit for West Island Line related to Hazard to Life.

The Quantitative Risk Assessment Report is given in *Annex C*.

3.9 *AIR QUALITY IMPACT*

All dust control measures, including blast cover (blast screen), noise enclosure, ventilation system, dust collector and sprinkler system, have been implemented at KGV in accordance with the WIL ER Report. The proposed change in the blasting programme will not affect the findings in the WIL ER Report. Details of the dust control measures extracted from the WIL ER Report are given in *Annex D*.

In accordance with Section 11.22 of the WIL EIA Report, the spoil removal process would be conducted within the enclosed structure. No adverse dust impact to the nearby Air Sensitive Receivers would be expected. The dusty materials would be covered entirely by impervious sheeting and the trucks would be washed before leaving the mucking-out area. Therefore, no adverse dust impact arising from the transportation of spoil would be anticipated. The above-mentioned dust control measures are being implemented on-site currently.

As mentioned in *Sections 2.3* and *3.1* of this Review, the maximum nos. of trucks to be used on-site in any 30 minutes at SWL and KGV will remain the same as that presented in the approved WIL EIA Report and the WIL ER Report, respectively. With the same nos. of trucks and implementation of the dust control measures at KGV, the construction dust impact will remain the same as that described in the WIL EIA Report and WIL ER Report.

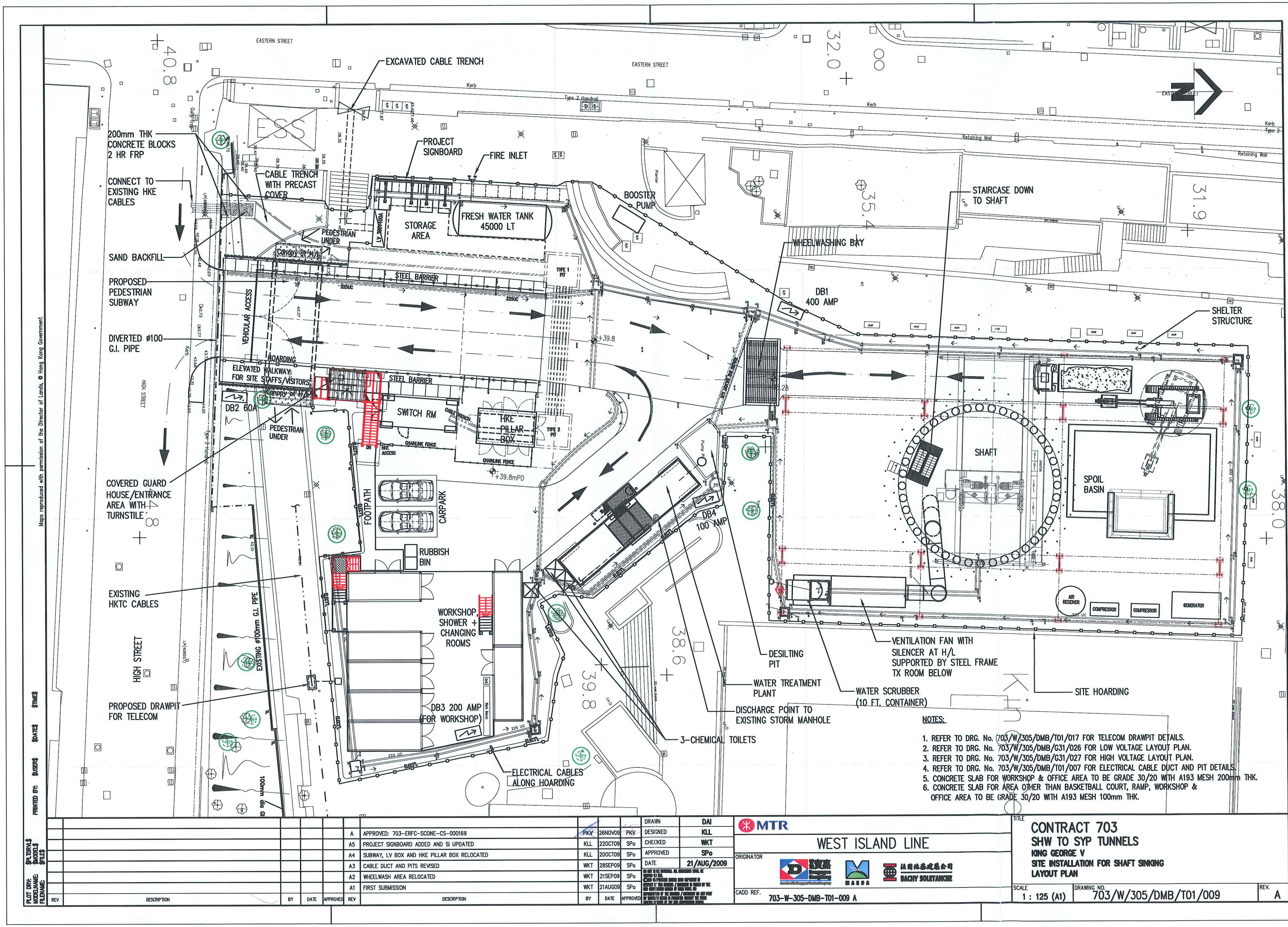
Results of the TSP monitoring conducted at HKSPC Thomas Tam Day Nursery also indicated that there is no exceedance in the TSP level before and after the commencement of shaft blasting at KGV. Results of the TSP monitoring for the shaft blasting at KGV are given in *Annex E*.

4 CONCLUSIONS

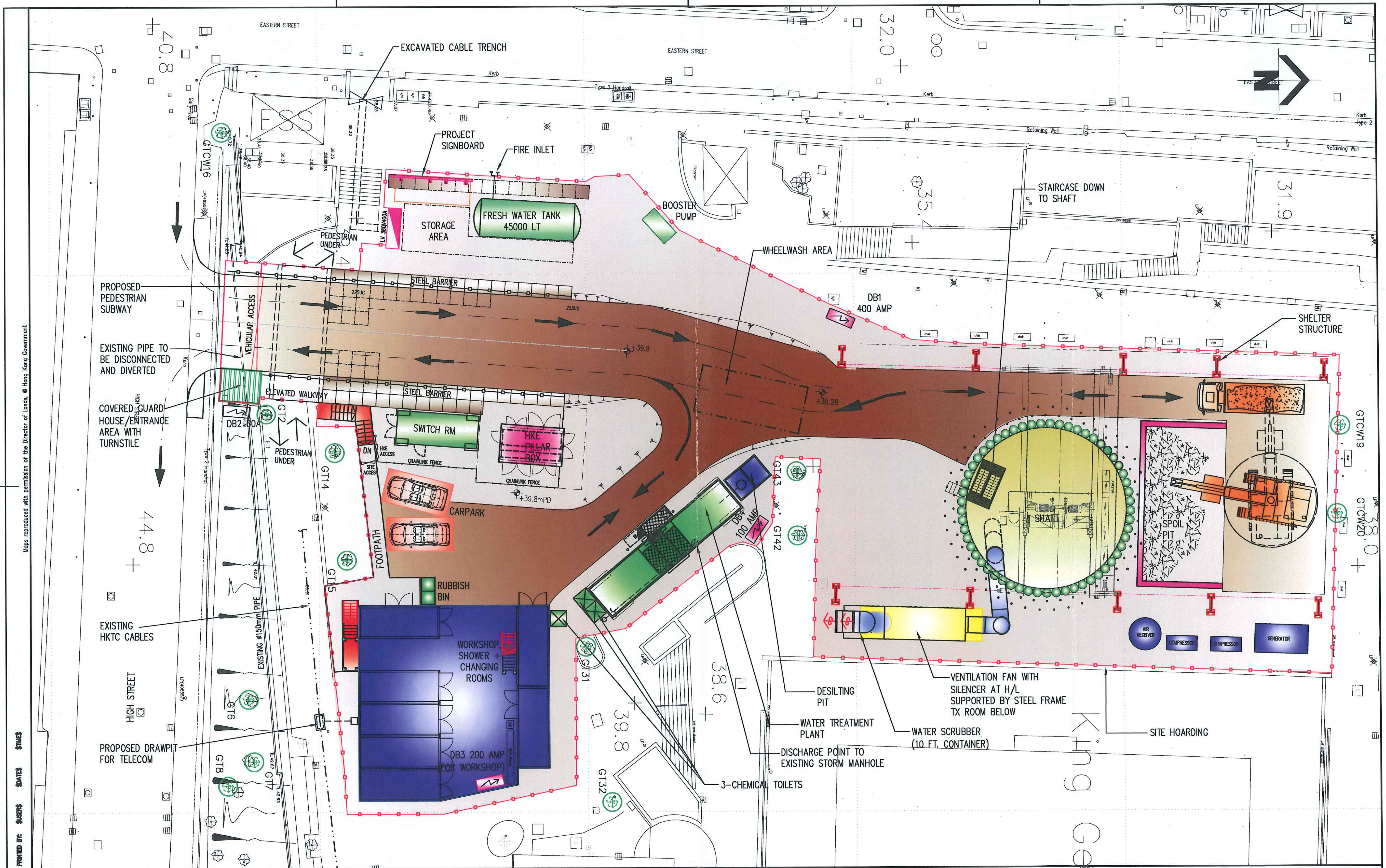
An environmental review has been carried out to assess the potential environmental impacts associated with the proposed changes in the blasting programme, explosives delivery point and delivery route. The assessment indicates that no adverse environmental impacts are anticipated from the proposed changes and the environmental performance requirements set out in the WIL EIA Report and the WIL ER Report will not be exceeded. With the proposed change in the blasting programme, the adit and tunnel construction period will be shortened by about two months and the overall adit and tunnel construction will be completed earlier by about seven months. Based on the findings of the review, the proposed changes will not constitute a material change to the WIL Project. It is also considered that the proposed changes will not pose any requirement for the variation of any conditions in the current EP for the project. As a result, MTR intends to provide an update in the subsequent Monthly EM&A Report.

Annex A

Site Layout Plan at KGV



REV	DESCRIPTION	BY	DATE	APPROVED
A	APPROVED: 703-ERFC-SCONE-CS-000169	PKV	26NOV09	PKV
A5	PROJECT SIGNBOARD ADDED AND SI UPDATED	KLL	22OCT09	SPo
A4	SUBWAY, LV BOX AND HKE PILLAR BOX RELOCATED	KLL	20OCT09	SPo
A3	CABLE DUCT AND PITS REVISED	WKT	28SEP09	SPo
A2	WHEELWASH AREA RELOCATED	WKT	21SEP09	SPo
A1	FIRST SUBMISSION	WKT	21AUG09	SPo



					A1	FIRST SUBMISSION	KLL	23OCT09	SPo		
REV	DESCRIPTION	BY	DATE	APPROVED	REV	DESCRIPTION	BY	DATE	APPROVED		

DRAWN	DAI
DESIGNED	KLL
CHECKED	SPo
APPROVED	SPo
DATE	23/OCT/2009

MTR

WEST ISLAND LINE

ORIGINATOR

MAEDA

BACHY SOLETANCHE

CADD REF. 703-W-305-DMB-T01-100 A1

TITLE

CONTRACT 703
SHW TO SYP TUNNELS

KING GEORGE V
SITE LAYOUT PLAN

SCALE 1 : 125 (A1)

DRAWING NO. 703/W/305/DMB/T01/100

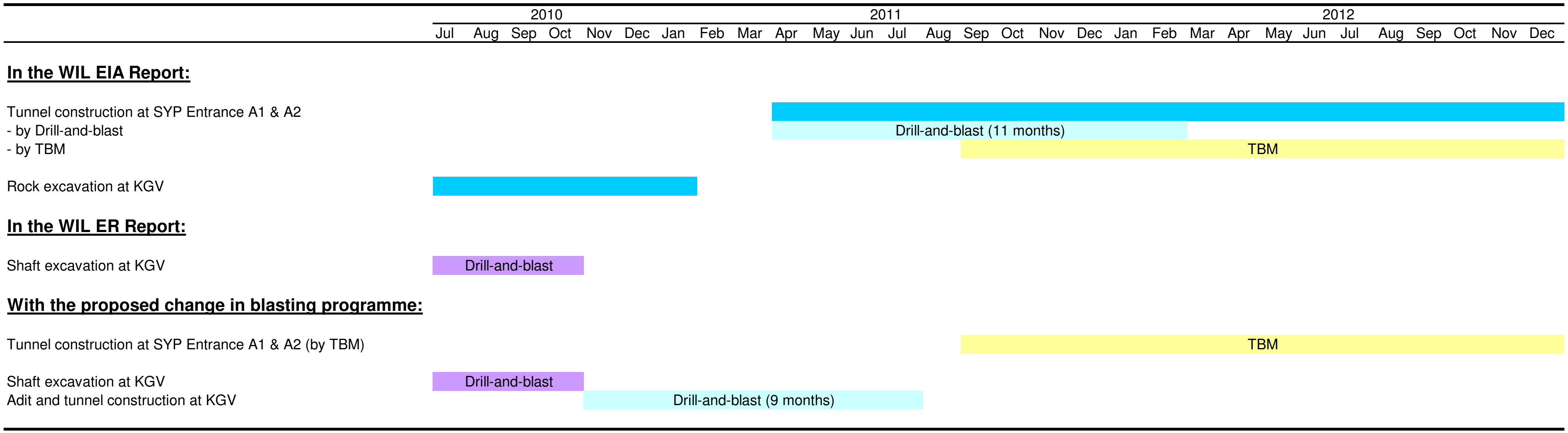
REV. A1

PLOT DRV: $PLTDRVR$
MODELNAME: $MODELS$
FILENAME: $FILES$
PRINTED BY: $USER$ $DATE$ $TIME$

Annex B

Change in Construction Programme

Annex B   Comparison of Construction Programme based on the Approved WIL EIA Report, WIL ER Report and the Proposed Change in Blasting Programme



Annex C

Quantitative Risk Assessment – Change in Construction Programme for WIL Work Contract 703

CONTENTS

1 QUANTITATIVE RISK ASSESSMENT

1.1 INTRODUCTION TO THE CHANGES ASSOCIATED WITH THE CHANGE IN CONSTRUCTION PERIOD

As described in the main section of this Environmental Review (ER), for the works within the scope of West Island Line (WIL) project Work Contract 703, it is proposed to shorten the construction period to reduce environment nuisances. Associated to this change, a number of activities differ to the activities assumed in the Hazard to Life (HtL) section of the Environmental Impact Assessment (EIA) study (referred to as the WIL EIA (2008) study hereafter) [1]. To support the shortening of the construction period, the following construction activity changes which impact the basis for the HtL section of the WIL EIA (2008) are required to be assessed:

- change in the explosives delivery route from WIL Magazine to KGV delivery point using a shorter transport route when compared to SWL;
- change of explosives delivery point from SWL to KGV (blasting will not be carried out concurrently from both KGV and SWL);
- reduction in the quantity of explosives per delivery to be transported from the WIL Magazine to KGV using cast boosters and bulk emulsion instead of cartridged emulsion;
- increase of the explosive transport frequency from once per day to twice per day; and
- adding the flexibility to use either electronic detonators or conventional detonators.

Regarding the use of explosives, the only changes to the original assumptions made in the WIL EIA are those associated with the option of using the electronic detonators and the reduced quantity of explosives to be transported within the tunnel. Other assumptions made in the WIL EIA (2008) remain valid.

Regarding the storage of explosives, all assumptions made in the WIL EIA (2008) remain valid.

1.2 BACKGROUND AND OBJECTIVES

1.2.1 *Original WIL Assessment, 2008*

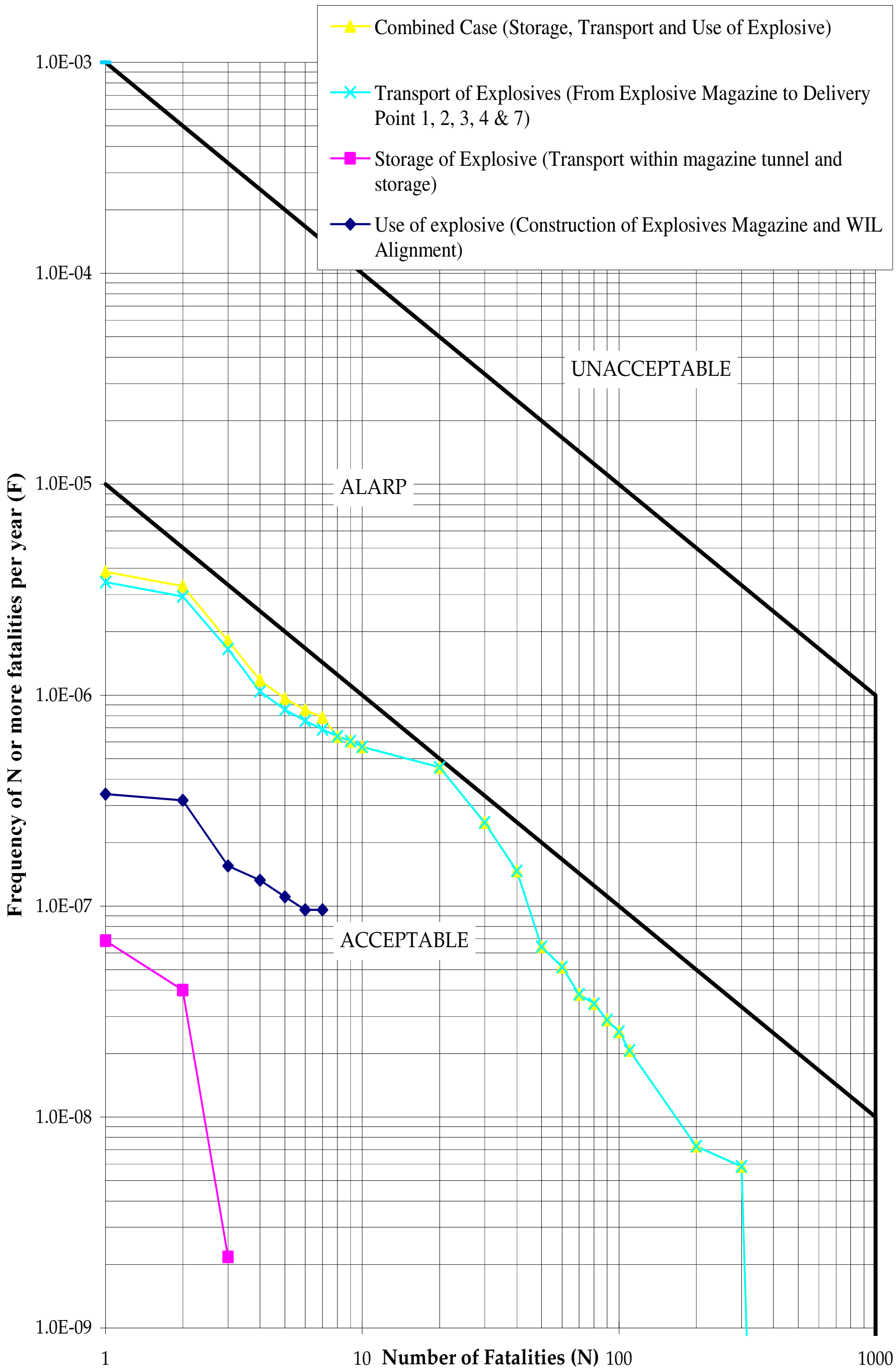
In 2008, ERM was commissioned by MTR Corporation Ltd. (MTR) to conduct a HtL Assessment of the Transport, Storage and Use of Explosives for the WIL conducted in accordance with previous explosives studies in Hong Kong and was approved by the relevant government departments in late 2008. The societal risk results (F-N curve) are shown in *Figure 1.1*

1.2.2 *Re-examination of WIL Transport Risk Assessment with Updated Transport Explosion Frequency and Latest Delivery Schedule, May 2010*

ERM was subsequently commissioned by MTR to re-examine the WIL EIA (2008) study taking into account the reduced explosives quantities and the revised explosion frequency related to explosives transportation. Two representative cases were considered in order to appropriately capture the variation of explosives consumption during the construction period. Case 1 covered the predicted peak consumption at delivery points 3 and 4 which is expected in the first year of construction from September 2010 to August 2011. Case 2 covered the predicted peak consumption at delivery points 1, 3, and 7 which is expected from April 2011 to March 2012.

The results showed consistency with the original assessment. Despite a more conservative frequency being used, the risks from both Case 1 and Case 2 remained within the acceptable region of the HKRG as originally concluded in the WIL 2008 Study. A "Technical Note of Re-examination for WIL HtL" [2] was submitted to EPD in May 2010 and has been accepted (referred to as the WIL Technical Note 2010 hereafter).

Figure 1.1 F-N Curve of the Approved WIL 2008 Study



1.2.3 *Environmental Review for "The Excavation of Construction Access Shaft at KGV Memorial Park by Drill and Blast method", June 2010*

An environmental review (referred to as the WIL Environmental Review 2010 hereafter) was carried out for a proposal to carry out the excavation of King George V Memorial Park (KGV) shaft by drill and blast method, as an alternative, with the intention to shorten the excavation period for the shaft and to further reduce the environmental nuisance to the surroundings. Proposed changes and the key environmental issues associated with them were highlighted; potential impacts on the environment from the proposed changes were assessed and compared to those in the approved WIL EIA (2008) report, and the requirements for environmental mitigation measures in the approved WIL EIA (2008) were reviewed. Also the use of electronic detonators (e-dets) in place of conventional detonators for KGV shaft excavation was also examined. The assessment indicated that no adverse environmental impacts were anticipated from the proposed changes and the environmental performance requirements set out in the WIL EIA (2008) will not be exceeded. With the use of drill and blast method, the excavation period programme for the rock section of the shaft was shortened by about two months and the airborne construction noise levels will be further reduced. Based on the findings of the review, the proposed changes did not constitute a material change to the WIL Project. The assessment also found that the failure frequency for e-dets is generally lower than that for conventional detonators. It has also been concluded that the proposed changes do not pose any requirement for the variation of any conditions in the current EP for the project. MTR has also provided an update in the subsequent Monthly EM&A Report. The shaft blasting activities at KGV are currently underway.

1.3 *OBJECTIVE OF THIS HAZARD TO LIFE ASSESSMENT*

This Hazard to Life Assessment is to assess the risk associated with the proposed change of construction period for WIL Work Contract 703 using the approved WIL EIA (2008) methodology and compare the societal and individual risk levels against the Hong Kong Risk Guidelines (HKRG). The ultimate goal is to determine whether such change constitutes a material change posing an adverse environmental impact within the context of the EIAO Technical Memorandum.

1.4 *STUDY BASIS*

This assessment revisited the transport and the use of explosives aspects of the WIL project pertaining to Contract 703's scope of works, which includes tunnels and adits for the section from Sheung Wan (SHW) to Sai Ying Pun (SYP) tunnels.

There are a number of transport route options from WIL Magazine to KGV. The selected route has been selected considering population density, route length, and explosives quantity to be transported. A preliminary assessment has been undertaken to compare the different route lengths and population densities in the area and determined that the Eastern Street route option is not only the shortest practicable route from WIL magazine to KGV but also has the lowest associated risk. Therefore, the transport route from the WIL Magazine to the KGV shaft via Eastern Street was adopted for further detailed assessment.

The use of the explosives assessment is in principle the same as the approved WIL QRA, except the frequency of accidental blasting in case the contractor requires using e-dets. The e-det system to be optionally used in "SHW to SYP tunnels" is the same as that assessed in WIL Environmental Review Report [3] but with some improved safety features as described in *Annex C1*.

The proposed changes to the HtL Assessment are further described in *Section 1.4.1* and *1.4.2* for the transport and use respectively.

1.4.1 Proposed Changes of Delivery Point 7 and Associated Delivery Route

The original delivery point 7 is proposed to be changed from Sai Woo Lane to KGV Memorial Park. The travel distance from the WIL Magazine to Sai Woo Lane (in the WIL EIA (2008) report) and to the KGV shaft (via the Eastern Street route) is about 5.8 kilometres and 4.5 kilometres respectively as shown in *Figure 1.2*. Since the explosives transport from the Magazine to the delivery points covers around 5.8 kilometres of road with varying characteristics, the delivery route was broken down into sub-sections for the assessment. Route sectionalisation allows a more accurate determination of the population and of the risk. This is consistent with the WIL EIA (2008). The proposed explosives delivery route from the WIL Magazine to the KGV delivery point is listed in *Table 1.1.*

Table 1.1 Delivery Route from WIL Magazine to KGV Delivery Point (Routes 7a)

Section ID	Description
Road 7a1a	Victoria Road (WIL Magazine – Serene Court)
Road 7a 1b	Victoria Road (WIL Magazine – Serene Court) –Part 2
Road 7a1c	Victoria Road (serene Court - Cadogan St.)
Road 7a2	Cadogan Street (Cardogan St. – New Praya Kennedy town – Shing Sai Rd.)
Road 7a3a	Shing Sai Road to Connaught Road West flyover ent. (opp. Wo Fat bldg) – part 1
Road 7a3b	Shing Sai Road to Connaught Road West flyover ent. (opp. Wo Fat bldg) – part 2
Road 7a3c	Shing Sai Road to Connaught Road West (opposite St. Barnabas Society)
Road 7a4a	Connaught Road West to Water Street Junction
Road 7a4b	Connaught Road West to Eastern Street Junction
Road 7a5	Eastern Street to Second Avenue Junction
Road 7a6	Second Avenue –Western Street Junction
Road 7a7	Western Street – High Street to KGV Park

A revised explosives delivery programme for the delivery point at KGV has been adopted. The delivery programme from the WIL Magazine to KGV delivery point, throughout the construction period November 2010 to July 2011, is shown in the *Table 1.2*.

Table 1.2 Delivery Programme from WIL Magazine to KGV Delivery Point

Delivery Period	No. of Morning Delivery Trips	No. of Afternoon Delivery Trips	Explosives load/ delivery
November 2010	18	0	13.20
December 2010	26	13	12.00
January 2011	25	14	18.00*
February 2011	21	20	8.40
March 2011	26	26	9.60
April 2011	22	22	9.60
May 2011	21	21	9.60
June 2011	17	16	14.40
July 2011	24	5	18.00*
Total	200	137	Max : 18.00*

* A maximum explosives load 18 kg was adopted in the assessment.

In the WIL Technical Note 2010 [2] a maximum explosives load of 80kg was considered in comparison to the new maximum explosives load of 18kg. This is based on the use of cast boosters instead of cartridged emulsion. Due to potential constraints for the programme, the afternoon delivery (originally by Mines Division) will also have to be carried out by the contractor, and therefore the corresponding transport risk has been included in this assessment. Overall, the blasting programme is shortened to November 2010 - July 2011 and the risk from the transport of explosives to delivery point 7 (now KGV) is completely contained within the time period of Case 1, as described in *Section 1.1.2*, with no contribution towards Case 2. Two representative cases had previously been considered in order to appropriately capture the variation of explosives consumption during the construction period, however it is now clear that the time period covered by Case 1 (September 2010 to August 2011) is clearly the peak year of explosives consumption.

1.4.2 *Proposed optional use of Electronic Detonators*

The risk associated with e-dets has already been assessed in details during the previous WIL Environmental Review [3]. Such system was assessed with a generally lower risk than conventional detonators. The same assessment has been repeated in this study, taking into account additional safety measures, to estimate the level of risk of using e-dets should the option be required as part of the proposed change of construction programme.

The pertinent tunnel section runs westward from Sheung Wan (SHW) Station of the existing Island Line to the SYP Station under Centre Street/ High Street area. The layout of the tunnels and the associated adits and shaft are shown in *Figure 1.3*

Figure 1.2 Explosives Transport Routes from WIL Magazines to SWL and KGV

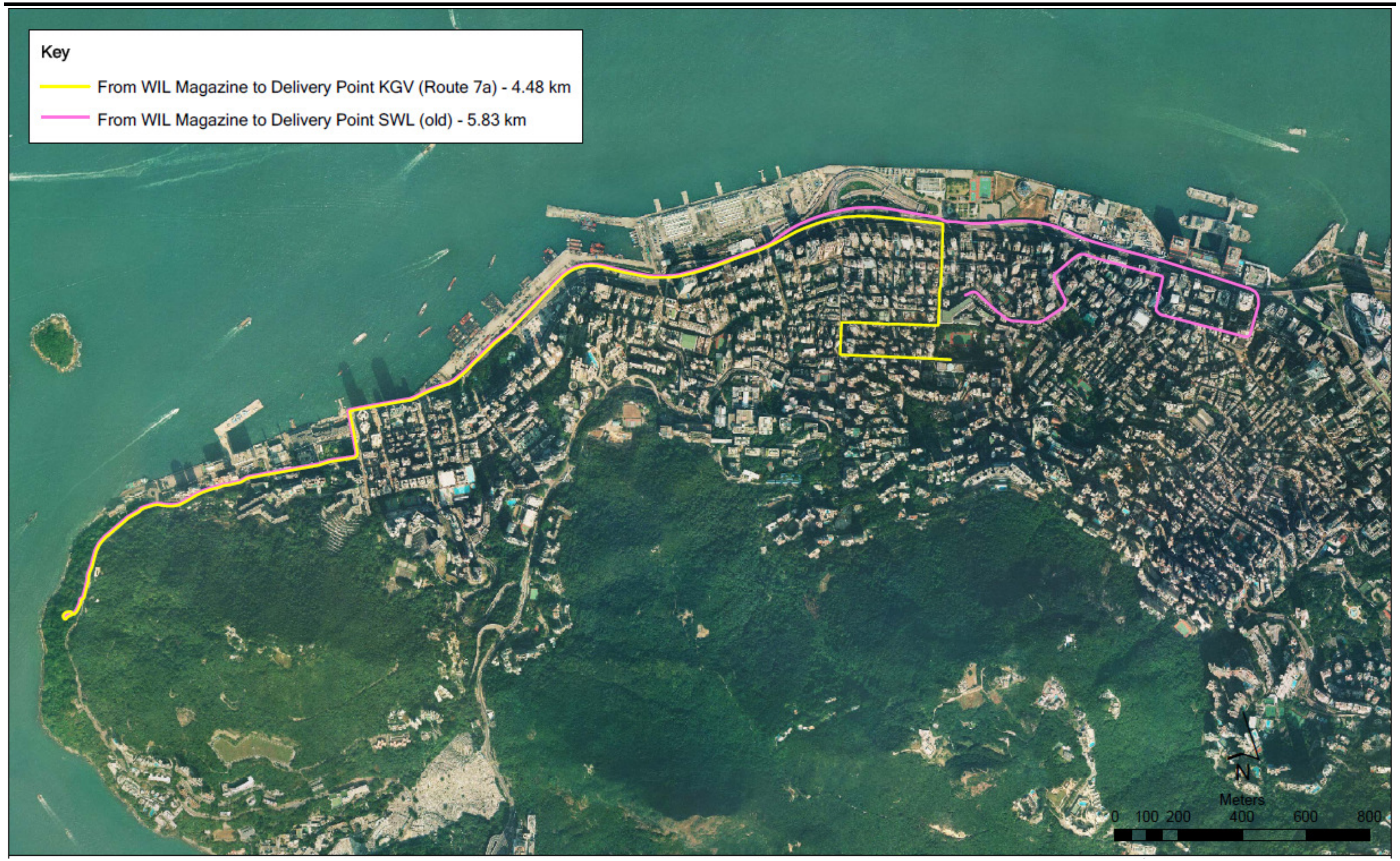
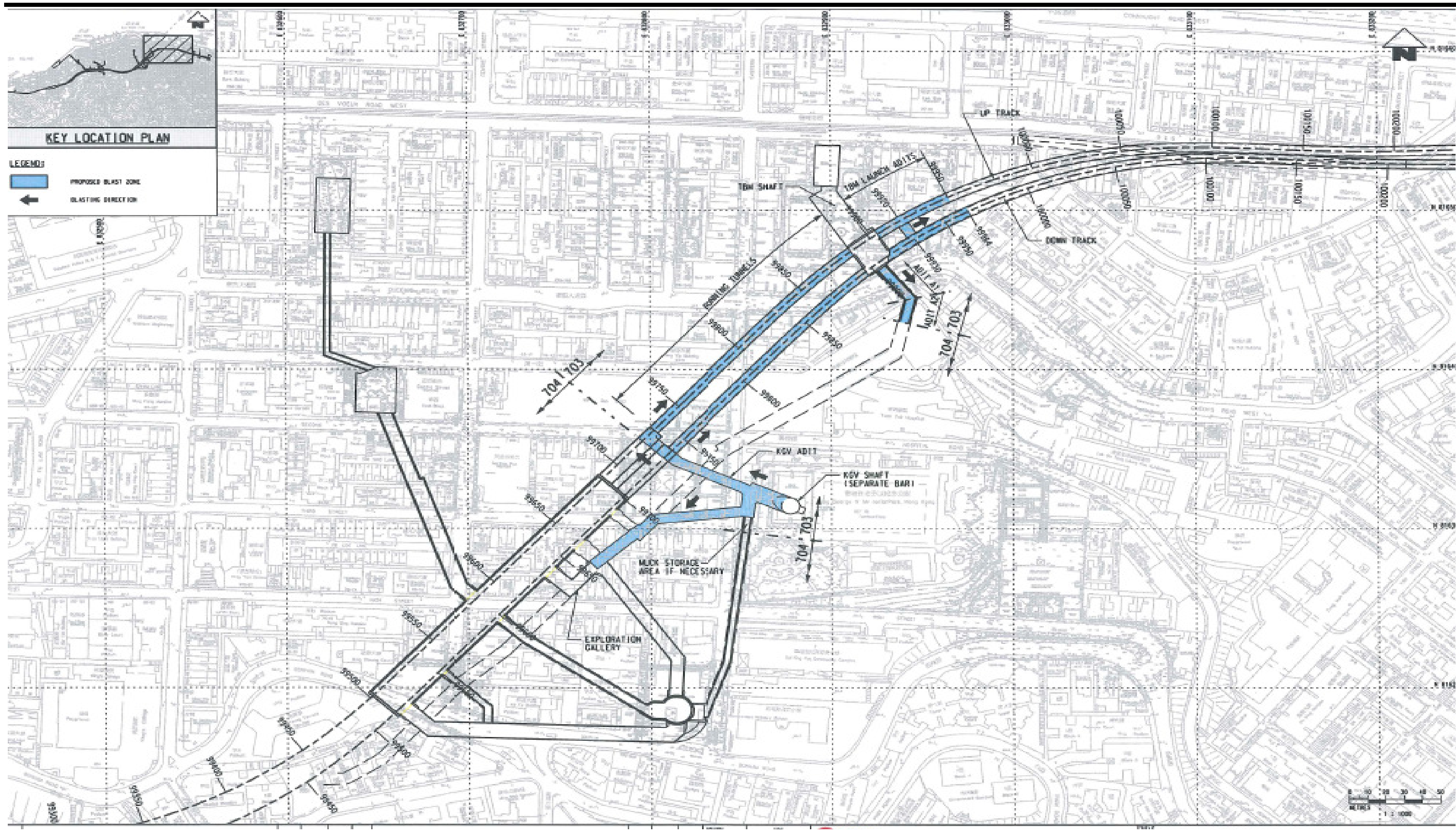


Figure 1.3 Location of Proposed Blast Tunnel Section



1.5 STUDY APPROACH

The assessment methodology for the transport of explosives has followed the methodology detailed in the approved WIL EIA (2008), with the revised explosion frequency related to explosives transportation as approved in the XRL EIA [4].

With regard to the use of explosives assessment, the relevant scenarios within the SHW to SYP tunnels were extracted from the approved WIL EIA (2008). The frequencies associated with these scenarios were then updated to account for the use of e-dets based on the failure rates derived in the previous WIL Environmental Review [3].

1.6 POPULATION ALONG DELIVERY ROUTES

All assumptions as described in detail in the WIL EIA (2008) [1] apply. Three types of population have been considered:

- Pedestrian population on footpaths and pavements next to the delivery routes;
- Road population; and
- Building population.

The populations along the route from WIL Magazine to the KGV delivery point have been measured by survey as appropriate and incorporated into the modeling.

1.7 FREQUENCY ASSESSMENT

1.7.1 *Frequency analysis for Transport of Explosives*

The WIL EIA (2008) has previously been re-examined on the basis of the revised explosives initiation frequencies derived in the XRL Study [4] for the transport of explosives. The revised base frequency for accidental explosion during transport was assessed at 7.69×10^{-10}/km for normal roads as applicable for the transport of explosives for the WIL project.

1.7.2 *Frequency analysis for Use of Explosives – E-dets*

The previous WIL Environmental Review [3] has derived a set of failure rates for concerned e-det system which forms the basis of this analysis. The failure rates presented in the WIL Environmental Review [3] are repeated in *Table 1.3.* It may be noted that the failure frequencies for e-dets are generally lower than those for conventional shock tube non-electric (nonel) detonators.

Table 1.3 *Probability of Occurrence per Face*

Scenarios	Probability of Occurrence Per Face
Higher vibration due to 2 MIC detonated at the same time	5.76×10^{-5}
Higher vibration due to 3 MIC detonated at the same time	5.91×10^{-8}
Higher vibration due to 4 MIC detonated at the same time	7.04×10^{-10}
Higher vibration due to 5 MIC detonated at the same time	7.04×10^{-11}
Higher vibration due to 6 MIC detonated at the same time	7.04×10^{-12}
Higher vibration due to whole string detonating at the same time	1.20×10^{-11}

Since the environmental review for KGV shaft blasting [3], additional safety features have been added into the e-det system for this undertaking. These include:

- disabling the possibility to program a string with a 0 ms increment; and
- at the end of the setup and before blasting, the time delays from the taggers are to be downloaded onto a laptop computer with software to check that no time delay are the same.

Therefore, the values in *Table 1.3* have been further adjusted (refer to *Annex C1* and *C2* for details) to reflect these safety features. *Table 1.4* summarises the frequencies used in this study after the adjustment.

Table 1.4 *Probability of Occurrence per Face Taking into Account the Additional Safety Features*

Scenarios	Probability of Occurrence Per Face
Higher vibration due to 2 MIC detonated at the same time	1.21×10^{-5}
Higher vibration due to 3 MIC detonated at the same time	1.45×10^{-8}
Higher vibration due to 4 MIC detonated at the same time	2.25×10^{-10}
Higher vibration due to 5 MIC detonated at the same time	2.25×10^{-11}
Higher vibration due to 6 MIC detonated at the same time	2.25×10^{-12}
Higher vibration due to whole string detonating at the same time	1.25×10^{-12}

1.8 *CONSEQUENCE ASSESSMENT*

1.8.1 *Consequence Analysis for Transport of Explosives*

To be consistent with the approach adopted in WIL EIA (2008) [1], the consequence models used for assessment of the probability of fatality due to blast and pressure waves are based on the most recent UK Explosive Storage and Transport Committee (ESTC) model defined in the HSC publication (ESTC, 2000).

The distance to probabilities of fatality of 1%, 50% and 90% was estimated. The criteria adopted in this study are consistent with the WIL EIA (2008).

The Consequence results for each transport scenarios are summarized in *Table 1.5*

Table 1.5 ***Summary of Results for Consequence Scenarios***

No.	Scenario	TNT eqv. kg	Fatality Prob.	*Indoor*	*Outdoor*
				Impact distance (m)	Impact distance (m)
Transport of Explosives					
01	Detonation of full load of explosives in one contractor's truck on public roads – from Magazine site to KGV delivery point	25.2	90%	9.11	7.29
			50%	10.53	7.59
			1%	27.09	9.56

1.8.2 Consequence Analysis for Use of Explosives

In the context of QRA, the designed explosives load of a blast face is referred as 1 maximum instant charge (MIC), ie 1 time of the allowance load. For detonation of more explosives at the same time, for instance, if x times of the designed load of explosives get detonated, it is commonly referred as xMICs. The relationship between the quantity of explosive (Q) in kg and the magnitude of ground vibration in terms of peak particular velocity (PPV) in mm/s for underground blasting can be described by the following equation:

$$PPV = 1200 \left(R / Q^{0.5/1.22}\right)^{-1.22}$$

Where
R is the distance between the blasting source and the measurement point.

Table 1.6 presents the criteria adopted for the impact assessment.

Table 1.6 ***Impact Criteria***

PPV (mm/s)	Description
90	0.01% chance of the weakest slope failure. Any slope reaches this level of vibration will be subject to further detailed assessment
100	Object falling threshold. 1% fatality of the persons within the building observing this level of vibration.
229	Building structural element collapse threshold

The relevant scenarios were extracted from the WIL 2008 [1]. The frequencies associated with those scenarios have been updated with the frequencies for e-dets and summarised in *Table 1.7*.

Table 1.7 Features Affected by Higher Vibration Generated by Initiation during the Construction of "SHW to SYP Tunnels"

Scenario/ Chainage	Features Affected	Scenario Frequency (yr)(1)	Expected Fatality (N)(2,3)
4MIC detonated at the same time			
SYPSHW_WB_100013	Building No. 426 (833026 ,816513)	3.51E-09	2
	General Utilities		1
SYPSHW_EB_100010	General Utilities	3.51E-09	1
5MIC detonated at the same time			
SYPSHW_WB_100023	Building No. 426 (833026 ,816513)	3.51E-10	2
SYPSHW_WB_100013	Building No. 426 (833026 ,816513)	3.51E-10	2
	General Utilities		1
SYPSHW_EB_100000	General Utilities	3.51E-10	1
SYPSHW_EB_100010	Building No. 427 (833013 ,816537)	3.51E-10	1
SYPSHW_EB_100020	Building No. 427 (833013 ,816537)	3.51E-10	1
	Building No. 426 (833026 ,816513)		2
	General Utilities		1
	General Utilities		1
6MIC detonated at the same time			
SYPSHW_WB_100023	Building No. 426 (833026 ,816513)	3.51E-11	2
	General Utilities		1
SYPSHW_WB_100013	Building (833013 ,816537)	3.51E-11	1
	Building No. 426 (833026 ,816513)		2
	General Utilities		1
SYPSHW_WB_100003	Building No. 426 (833026 ,816513)	3.51E-11	2
	General Utilities		1
SYPSHW_EB_100000	Building No. 427 (833013 ,816537)	3.51E-11	1
	General Utilities		1
SYPSHW_EB_100010	Building No. 427 (833013 ,816537)	3.51E-11	1
	Building No. 426 (833026 ,816513)		2
	General Utilities		1
SYPSHW_EB_100020	Building No. 427 (833013 ,816537)	3.51E-11	1
	Building No. 426 (833026 ,816513)		2
	General Utilities		1

Note:
(1) This value corresponds to the frequency per 10m section (details refer to Annex C1)
(2) Expected fatality = Population x Fatality rate
(3) 1% fatality threshold reached

As part of the use of explosives assessment, the risk associated with detonation of full load of explosives during transfer to the blast face within the tunnel was assessed. Following the approach adopted in WIL EIA (2008) [1], the consequences of this scenario could involve both overpressure and ground vibration effects.

The overpressure effect has been estimated with the ESTC model for which the results are the same as those listed in *Table 1.5*. these consequence effects do not extend beyond the construction site boundary.

For ground vibration effect, it has been assessed that in the event of detonation of the maximum load of 25.2kg (TNT equivalent) of explosives, no sensitive receivers could experience a vibration level of 90 mms^{-1} or higher and therefore this risk has been considered negligible.

1.9 *RISK SUMMATION*

The ERM's in-house software has been used for risk calculation and summation in accordance with the WIL EIA (2008) methodology. This integrates the risks associated with the transport of explosives to the work sites, including the risks to other road users, nearby buildings and outdoor population.

The two types of risk measures considered are societal and individual risks.

1.9.1 *Societal Risk*

Societal risk is defined as the risk to a group of people due to all hazards arising from a hazardous installation or activity. The simplest measure of societal risk is the Rate of Death or Potential Loss of Life (PLL), which represents the predicted equivalent fatalities per year:

$$\text{PLL} = f_1N_1 + f_2N_2 + f_3N_3 + \ldots + f_nN_n$$

where f_i is the frequency and N_i the number of fatalities for each hazardous outcome event.

Societal risk can also be expressed in the form of an F-N curve, which represents the cumulative frequency (F) of all event outcomes leading to N or more fatalities. This representation of societal risk highlights the potential for accidents involving large numbers of fatalities.

1.9.2 *Potential Loss of Life*

The Potential Loss of Life (PLL) for the transport of explosives to the original delivery point 7 (at SWL) was 5.62E-06 [2]. The PLL for the modified delivery point 7 (at KGV) is 5.59E-06. Therefore the risk from the transport of explosives has been in fact slightly reduced due to the proposed change. As for the use of explosives (excluding the magazine portion which is not relevant in this study), as expected, the risk has been reduced from 1.26E-06 to 1.01E-06 per year, on account of the use of e-dets.

1.9.3 F-N Curves

Figure 1.4 shows a comparison of the F-N curves for the overall risk of the Project due to the storage, transport and use of explosives. The red line represents the original delivery point at SWL as presented in the Technical Note (2010) [2], and the blue line is the new delivery point at KGV.

Figure 1.5 shows the contribution of storage, transport and use of explosives to the overall risk to the Project incorporating the changed delivery point at KGV. The risk from the option of using e-dets is shown separately in dotted line.

The assessed risks to the public due to the construction of WIL, incorporating the change of delivery point from SWL to KGV and the use of e-dets in "SHW to SYP tunnels", as shown in *Figure 1.4* and *Figure 1.5* remain within the acceptable region of the HKRG for societal risk.

Figure 1.4 F-N Curves – Storage, Use and Transport of Explosives from Magazine

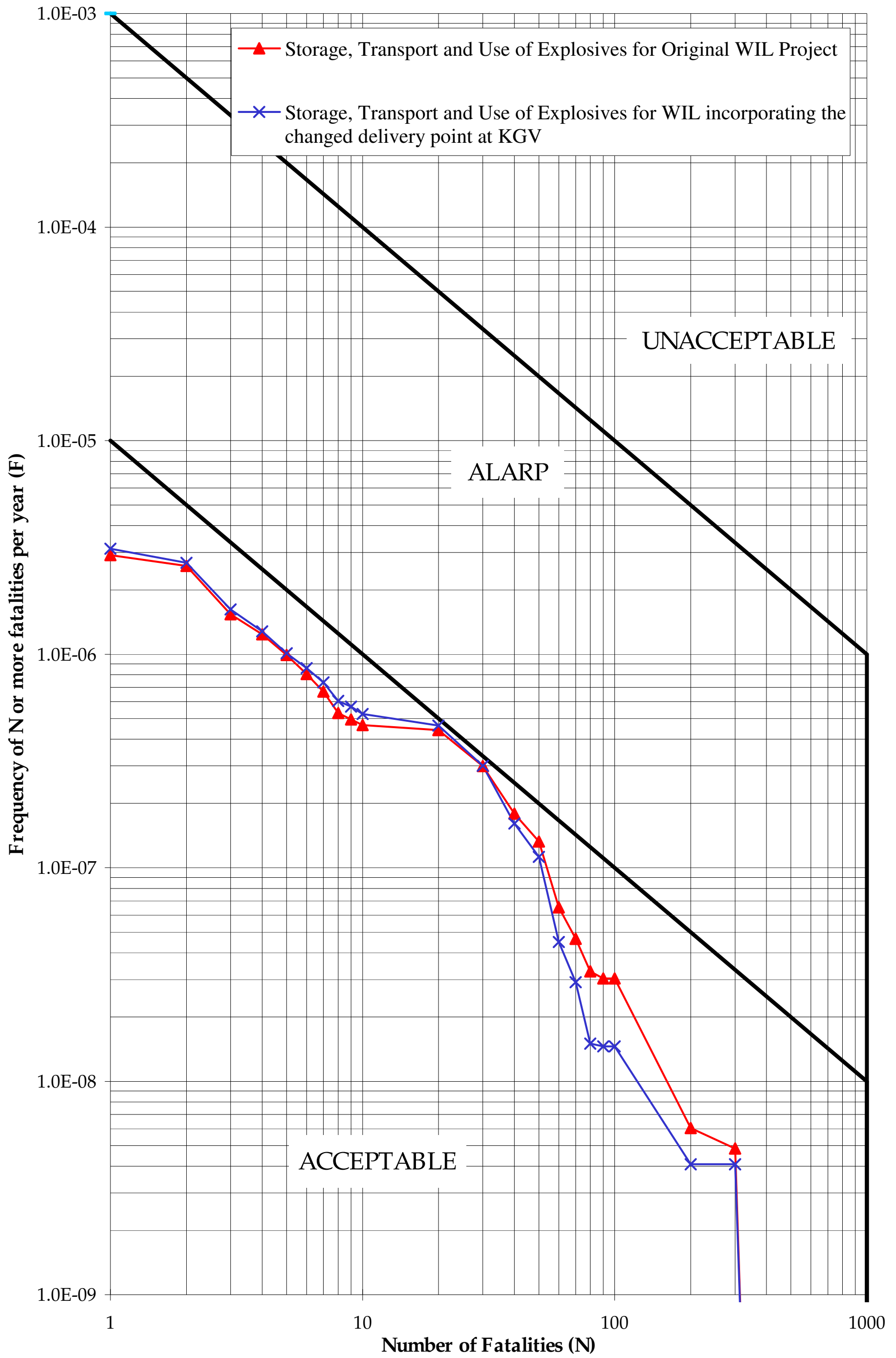
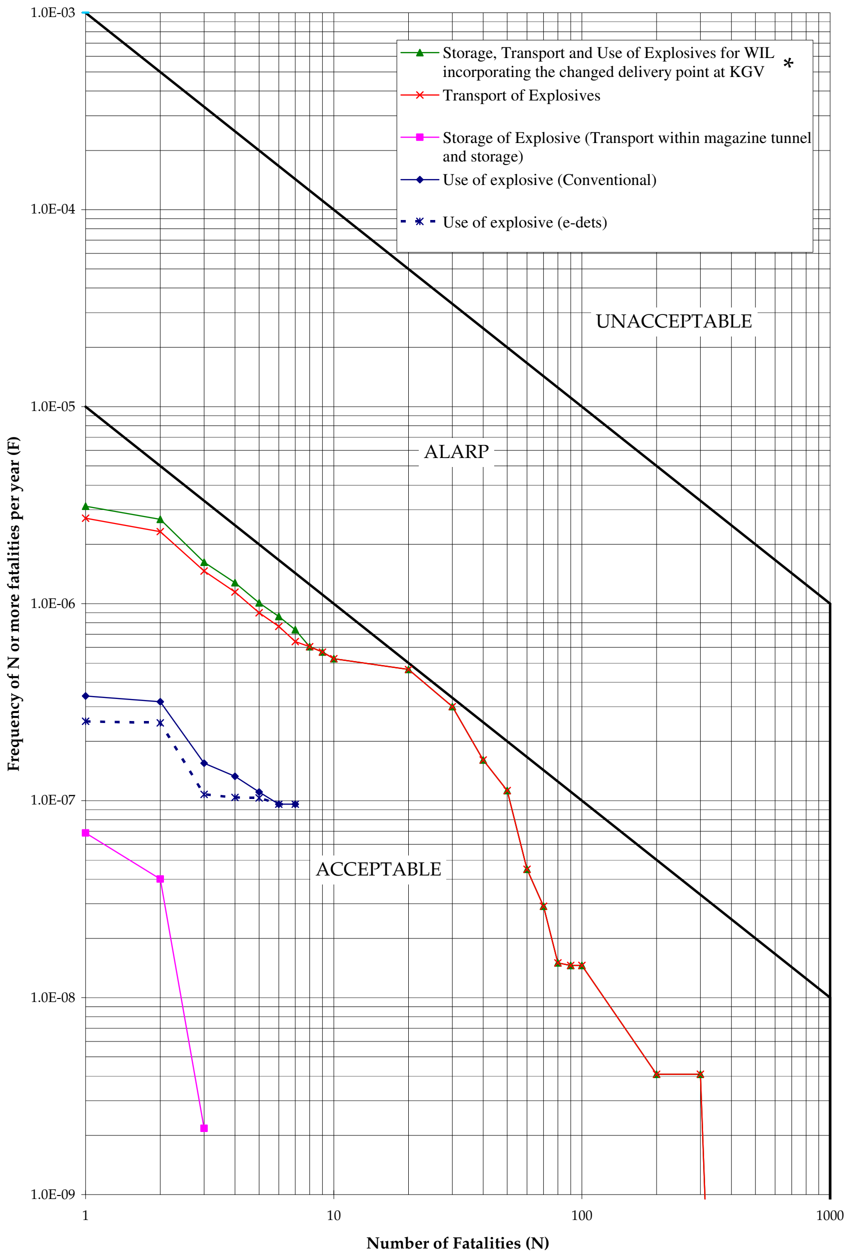


Figure 1.5 *F-N Curves Incorporating the Proposed Changes - Contribution of Storage, Transport and Use of Explosives to the Overall Risk*



*Note: The green line indicating the combined risk (Storage, Transport and Use of Explosives) incorporates the risk contribution from "Use of Explosive (Conventional)" – the solid blue line

1.10 INDIVIDUAL RISK

The assessed individual risk for the transport and use of explosives was expressed in terms of outdoor exposure and indoor exposure. The results are shown in *Figure 1.6* and *Figure 1.7*. The conclusion for individual risk remains the same as the WIL EIA (2008) [1] that no route section has an IR exceeding the criterion of 1E-5 per year.

Figure 1.6 IR for Delivery Route for Indoor Population

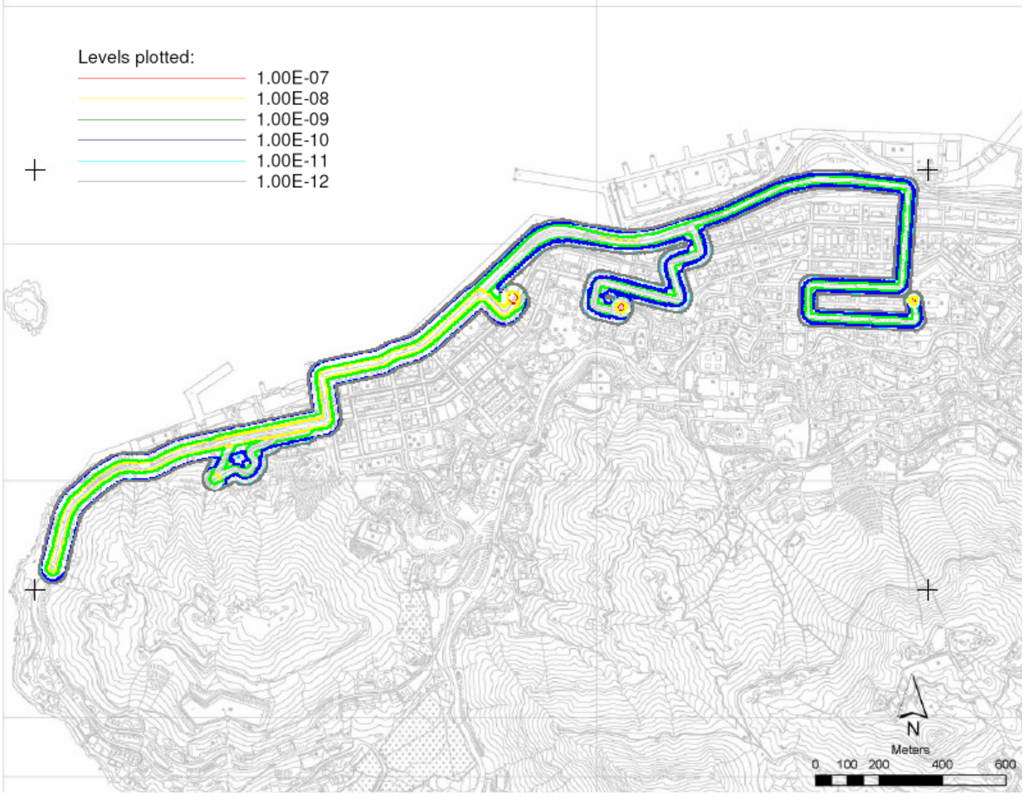
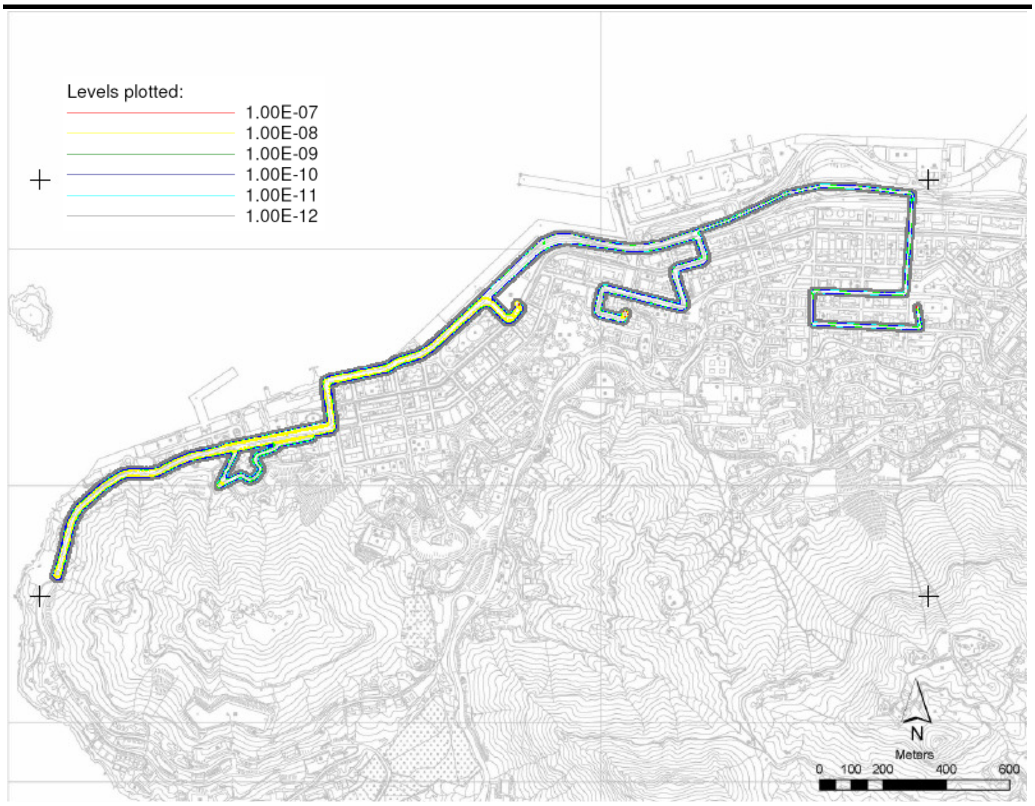


Figure 1.7 IR of Delivery Route for Outdoor Population



1.11 CONSLUSIONS

The risk (societal and individual) arising from the proposed change of construction programme, involving a change of explosives delivery from Sai Woo Lane to King George V for the construction activities within the Contract 703 scope of works, has been assessed following the methodology of the WIL EIA (2008) [1] as well as the subsequent studies [2, 3].

The F-N curves show that the overall risk for WIL remains within the acceptable region according to the HKRG and is of the same order when compared to the curves in WIL 2008 [1]. Yet the overall risk of the project is in fact lower on the basis of PLL. The individual risk levels are essentially the same as WIL 2008 [1] except the change of location of explosives delivery meeting the HKRG criteria. The same conclusion applies whether the contractor uses conventional or electronic detonators.

Therefore, the proposed change will not constitute a material change to the Environment Permit for West Island Line related to Hazard to Life.

2 *REFERENCES*

[1] ERM, West Island Line: Hazard to Life Assessment for the Transport, Storage and Use of Explosives, 2008

[2] ERM, Technical Note of Re-examination for West Island Line Hazard to Life, May 2010

[3] ERM, MTR West Island Line – Excavation of Construction Access Shaft at King George V Memorial Park by Drill and Blast Method: Environmental Review, June 2010

[4] ERM, Environmental Impact Assessment of Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link: Appendix 13 – Hazard to life Assessment, 2009

Annex C1

Use of Explosives - Frequency Assessment Details for Electronic Detonators

CONTENTS

C1-1 FREQUENCY ASSESSMENT OF SCENARIOS LEADING TO HIGHER GROUND VIBRATION AT A BLAST FACE WITH THE USE OF ELECTRONIC DETONATORS

C1-1.1 HIGH-LEVEL FAILURE MODE ANALYSIS FOR USE OF EXPLOSIVES

A high-level failure mode effect analysis was carried out to systematically identify failure scenarios associated with use of explosives for the construction of the tunnel and adits. The analysis focused on those failure modes that could lead to potential increase in ground vibration, given consideration of human errors and other causes. A series of workshops were held with the equipment suppliers and shotfirers specialized with the use of electronic detonators to identify potentially new failure modes. The failure modes, not applicable for the use of electronic detonators, were not considered further.

The following failure scenarios were identified and further investigated in the subsequent sections.

1. Face freeze caused by cut failure

2. Two MIC detonated at the same time at a blast face

3. Multiple MIC detonated at the same time at a blast face

4. More cartridged sticks/ bulk emulsion explosives loaded into a production hole than required

5. Unforeseen ground conditions

6. Sympathetic detonation of all the MICs at the blast face.

Fault tree analysis was then carried out, as described in *Section C1-1.3* to assess the causal relationship amongst the failure modes and causes, and evaluate the probability of occurrence for each failure scenario that could lead to higher ground vibration.

C1-1.2 BASIS FOR FREQUENCY ASSESSMENT

The following forms the basis for assessing the probability of occurrence for the failure scenarios associated with the use of explosives:

- The SmartShot™ electronic detonator system may be used to blast the running tunnels and associated adits and exploration galleries , which includes the following components: SmartShot Electronic Detonators, SmartShot Taggers, SmartShot End Plugs, SmartShot String Starters, SmartShot Bench Boxes, and SmartShot Smart keys. The various components are shown in *Figure 2.1*.

- All SmartShot detonators are the same, and arrive without any pre-programmed delay times. Even if detonators come pre-programmed for any reason, the blasting process will override the pre-programmed data. This is unlike conventional detonators which have preset delays.

- Fixed time, Row and Change pattern Markers (software tags) will be used together with the Tagger to programme the detonator time delays. The process of tagging will require a direct connection in a 4-wire mode.

- No more than one detonator for production holes is allowed to be programmed with the same time delay.

- Perimeter holes will have a dedicated detonator per hole and will not detonate at the same time. They will have a minimum of 1 ms interval from each other.

- No failure modes of detonator will directly result in significant change in time delay with the exception of manufacture scatter out of tolerance.

- Perimeter holes, if used, will be designed such that each of them will be loaded with a charge less than a MIC and multiple perimeter holes may be detonated at small time delay increments.

  In case the perimeter hole are blasted out earlier than expected, due to programming errors or system failure, the effects will be negligible on vibration as the charge load is lower than a MIC. Hence, no significant effect is expected.

  Due to lower MIC for perimeter holes and since there is one detonator per hole, a minimum of two permutations is required to result in 2 MIC detonated at the same time. Perimeter hole detonators require one further level of error or permutation than production hole detonators to cause multiple MIC detonated at the same time, and therefore, perimeter holes were not considered further in the frequency assessment as the frequency is dominated by production holes. The exception is systematic human error or system failure for the whole string which is modeled separately.

It has been further assumed that:

- The Tagger will perform basic diagnostic checks including self checks and alarms

- The Tagger will be subject to functional tests before each blast. This will involve checking that inputs and outputs are the same.

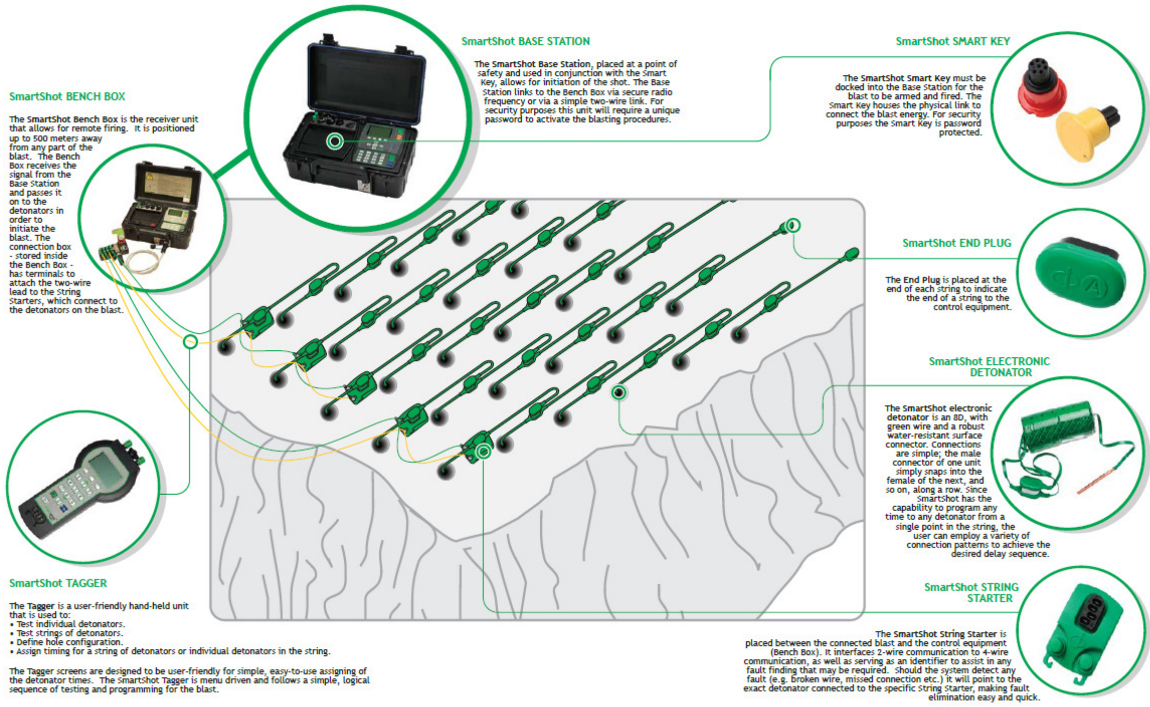
- The function to program a string with 0 ms time delay increment will be disabled.

- After allocating a time delay for each of the detonators, the time delay information stored in the tagger will be downloaded onto a laptop computer with software to check that no time delay are the same.

- Independent checks will be carried out by the Blasting Engineer to ensure the delay set for each detonator is matching the Blasting Plan. During these checks, the Blasting Engineer will used a different Tagger

- Third party checks will be carried out by the Competent Blasting Supervisor to ensure that no more than one MIC is set to detonate at the same time.

Figure 1.1 Electronic Detonator System



C1-1.2.1 Face freeze caused by cut failure due to either wrong hole diameter for relief holes at cut or wrong time delay at cut

This scenario is same as for conventional detonators.

A cut is provided for each blast face to provide a void/ relief before other production holes are blasted, allowing the rock to be blasted out in a ring like sequence. Three relief holes are provided at the centre of the cut to provide relief when the cut holes blast out in sequence.

In case the size or location of relief holes is not correctly drilled to an extent significant enough to hinder sufficient relief, possible freeze of blast face may result. The reason for incorrect size or location of relief holes could be either design or drilling errors.

A minimum of 4 out of 6 cut holes should be blasted out in order to achieve sufficient relief for other production holes. If more than 2 cut holes cannot be blasted out due to design error, installation error, or manufacturer defect, the cut cannot be ejected to provide a void of sufficient relief before the production holes blast out. Possible freeze of blast face will result.

In the event of a face freeze, the vibration will increase by about 30% to 40% beyond the expected vibration for a given MIC with sufficient relief. Since the PPV correlation has considered blast under confined condition, the face freeze caused by cut failure will not contribute to further increase in PPV value.

Since face freeze does not generate excessive vibration to pose a concern to the general population, it is not further considered in this assessment.

C1-1.2.2 Two MIC detonated at the same time at a blast face

More than one MIC detonated at the same time in a face will result in higher vibration than the design limit. A total of 5 failure modes leading to two MIC detonated at the same time were identified in the high-level failure mode analysis. They were further analysed as described below:

a) Wrong design of time delay

This scenario is same as for conventional detonators.

The typical blast plan will contain those information that are applicable for all blast faces of the same layout and dimensions, these include layout and dimension of the blast face, number of production holes, location of cut, type and number of detonators, blast pattern information such as Starter Devices location and IDs and, Marker types and position. The typical blast plan can then be customized to accommodate face-specific details such as the co-ordinates of the holes, loading of each perimeter hole, MIC for holes, and sensitive receiver, to meet the location specific blasting constraints.

The electronic detonators arrive without any default time delay therefore for 2 detonators to initiate at the same time, the same time delay would have to be input to both of them. This could be due to an error in the design such that two detonators are unintentionally given the same time delay during the design process and such time delay are used in the blast resulting in two MIC detonated at the same time. However, as two detonators for production holes are not allowed to be programmed with the same time delay, the team undertaking the blast is likely to detect the situation.

The human error probabilities associated with the wrong design of time delay were calculated in *Annex* C3 and summarized in *Table 1.1* below.

Table 1.1 Human Error Probabilities for Wrong Design of Time Delay

Event/ task no.	Description	Human Error Probability for a face
2.1	**Wrong design of time delay for a face**	
2.1.1	Design error by Blasting Engineer and failure of design check	1.92e-02
2.1.2	Failure to detect and correct error by Shotfirers, Blast Engineer, Competent Blasting Supervisor, and Mines	2.76e-05

b) Human Error during Input of detonator time delays

This scenario is applicable to electronic detonators only.

This can be done in a number of ways, however, it is mainly dependent on human error. The potential causes are:

- Shotfirer keys in a wrong delay with the Tagger which coincides with a delay from another detonator;
- The 2nd Shotfirer and/or Blasting Engineer fail to detect error using a different tagger and no corrective action is taken;
- The Competent Blasting Supervisor fails to detect error using the bench box system or fails to take/ensure corrective actions (which is independent from the Tagger system)

The human error probabilities associated with the Wrong input of time delay by Shotfirer were calculated *in Annex C3*. A summary is given in *Table 1.2*.

Such errors will depend on the number of detonators programmed for production holes. The assessment has been based for a typical blast plan involving typically about 200 production holes. The error probability will also depend on the input method which is either manual or semi-automatic. For the purpose of this assessment, the manual method could theoretically produce an error for each detonator and has been assumed as the worst case. In the case of human error, it has been also conservatively assumed that if the Shotfirer inputs a wrong a time delay for one detonator, such a value will match another one in the face.

Table 1.2 Human Error Probabilities for Wrong input of time delay by Shotfirer using Tagger

Event/ task no.	Description	Human Error Probability for a face
2.3	**Wrong input of time delay by Shotfirer using Tagger**	
2.3.1-1	Shot firer inputs wrong time delay using Tagger	1.86E-01
2.3.1-2	BE fails to detect wrong detonator delay time using Tagger	3.48E-02
2.3.1-3	Shot firer/BE fail to correct wrong time delay using Tagger	3.64E-03
2.7	**Independent Checking Team fails to detect and correct individual errors**	
2.7.1-1	CBS fails to detect some dets in string are programmed incorrectly	3.64E-03
2.7.1-2	SFs/CBS fail to correct incorrectly programmed string dets	3.64E-03

c) Tagger random failure leading to wrong time delay

This scenario is applicable to electronic detonators only.

This could be due to a random hardware or software failure that remains undetected and could impact on the input and checking of the detonator delay times. The main causes are:

- Tagger fails in such a way that it gives an erroneous time delay during the process and the time delay matches another one. A possible error may come from a random communication error originating from the Tagger. This could be due to hardware failure or software error giving a dangerous output and the diagnostic function fails to detect such a failure. In the case of random failure, the tagger may feedback the correct time delay as entered by the shotfirer but the diagnostic function cannot check whether the same time delay has been actually programmed to the detonators;

- The 2nd Shotfirer and/or Blasting Engineer fail to detect error using a different tagger and no corrective action is taken;

- The Competent Blasting Supervisor fails to detect error using the bench box system or fails to take/ensure corrective actions(which is independent from the Tagger system)

The Tagger system follows a robust development process and is classified as a safety related system with Safety Integrity Level 1 (SIL1) in accordance with safety standard IEC61508 [3]. This certification guarantees an average dangerous failure rate of between 10^{-6} and 10^{-5} per hour of operation. Each blast setup will last less than 2 hours, however, since the Tagger will not be used between two consecutive blasts and can be subject to dormant failure, it is conservatively assumed that it could also fail while not in operation. Since blast is roughly every 100 hour, the probability of dangerous failure for a given blast is ranging form 0.0001 to 0.001. The upper value is selected for random failure, as random failure is the most likely outcome compared to systematic failures as the detonator system has been proven in use. In the case of random failure, the probability of giving a dangerous output matching another time delay has been conservatively assumed as 10% as the values may more likely be out of range compared to time delay set in the blast plan.

It should be noted that this failure scenario may result in repeated detonations of 2 MICs.

d) Communication error/failure with detonator devices

This scenario is applicable to electronic detonators only.

Any communication error and failure leading to incorrect programming of the detonators will require a specific failure of the detonator communication system which may lead to the assignment of the same time delay for two detonators. Since the detonators are connected in daisy chain arrangement, it will require multiple failures to lead to more than 2 MICs.

Communication could be influenced by a number of parameters such as Radio Frequency and Induced Current [4]. However, the system has been specifically designed to mitigate such effects. Tests have also been made to check the immunity of the system to induced current. These tests indicate that the system is not sensitive to induced current and requires a significant energy to cause an accidental initiation of the detonators.

Electronic detonator devices and communication system follow a similar design and development process as the tagger and the probability of dangerous failure has been assumed as 0.001 for a random failure. In addition, diagnostic checks are performed within the bench box which will further reduce the probability of dangerous failure to 10^{-4} per blast. However, to account for potential local string failures, this probability has been applied per string. Assuming a maximum of 10 strings, the overall probability for communication failure with detonators has been assessed as 0.001.

Detonators erroneously programmed with wrong time delay can also be independently detected. The human error failures considered for this initiating event are:

- The 2nd Shotfirer and/or Blasting Engineer fail to detect error using a different tagger and no corrective action is taken;
- The Competent Blasting Supervisor fails to detect error using the bench box system or fails to take/ensure corrective actions(which is independent from the Tagger system)

e) Human Error during Starter or Marker Tagging.

This scenario is applicable to electronic detonators only.

Wrong tagging may results in 2 MIC detonated at the same time if the following conditions occur:

- Wrong tagging could occur if a starter or marker is wrongly positioned or the started has been assigned a wrong ID;
- The 2nd Shotfirer and/or Blasting Engineer fail to detect error using a different tagger and no corrective action is taken;
- The Competent Blasting Supervisor fails to detect error using the bench box system or fail to take/ensure corrective actions(which is independent from the Tagger system)

The human error probabilities associated with Wrong Starter or Marker Tagging were calculated in *Annex C3*. A summary is given in *Table 1.3*.

Table 1.3 Human Error Probabilities for Wrong Starter or Marker Tag or Position

Event/ task no.	Description	Human Error Probability for a face
2.4	**Wrong Starter or Marker Tag or Position**	
2.4.1-1	Shot firer wrongly place or tag starter or marker	5.54E-03
2.4.1-2	BE fails to check starter/marker tagging and position is correct	3.64E-03
2.4.1-3	Shot firer/BE fail to correct starter/marker tag or ID	3.64E-03
2.7	**Independent Checking Team fails to detect and correct individual errors**	
2.7.1-1	CBS fails to detect some dets in string are programmed incorrectly	3.64E-03
2.7.1-2	SFs/CBS fail to correct incorrectly programmed string dets	3.64E-03

C1-1.2.3 Multiple MIC detonated at the same time at a blast face

This scenario is applicable to electronic detonators only.

The failure mode analysis considers simply the multiple failures of the same types of failure modes identified for 2 MIC detonated at the same time above, for example, 3 detonators incorrectly programmed with the same time delay.

Common cause failures have been specifically assessed, especially when error repetition is concerned. The following conservative assumptions have been made:

- Independent Check Failure: In case several errors have been made (eg wrong time delay input to detonators) requiring the independent checker (CBS/SF2) to detect and correct errors. It has been conservatively assumed that the probability of failing to detect another mistake is 10%;
- Multiple failures beyond 4 MIC detonated at the same time: It has been conservatively assumed that once 3 errors have been made leading to 4 MIC detonating at the same time, another error is unlikely. However, due to potential common causes it has been conservatively assumed that there would be a 10% probability that another error is made to cause 5 MIC detonated at the same time and another 10% chance to cause 6 MIC detonated at the same time.

Combinations of failure modes leading to multiple MIC detonated at the same time have been modeled using fault tree analysis.

C1-1.2.4 More bulk emulsion explosives loaded into a production hole than required

This scenario is same as for conventional detonators.

There are three causes that will lead to more bulk emulsion explosives loaded into a production hole than required:

- Wrong density check of bulk emulsion
    - Density checks will be carried out by the truck operator, with results verified by Chief Shotfirer and Blasting Engineer, prior to loading of bulk emulsion into holes, in the middle of loading and towards end of loading. In case the results read low density but the density is actually high due to human error or mechanical failure of instruments, more than required bulk emulsion will be loaded into the holes. Considering the MIC profile of WIL, the density of the bulk emulsion and pull length of blasts, the holes will be overloaded with double MIC in worst case.

      The gassing flow meter and scales used for the density checks will be calibrated by certified bodies once every year. The failure rate of erratic output for flow meter is 2.78E-06 per hour based on OREDA [1]. It was assumed that the usage of the truck (which can act as proof tests of the flow meter) is at least once every week. The probability of failure of the flow meter was evaluated to be 2.4E-04 (ie 2.78E-6 x 168 hours/2). No reported failure data for scales are available in generic datasource. The probability of failure of the scales was assumed to be the same as flow meter. This value is considered conservative based on the engineering judgment by the Blast Expert who did not observe such failures in his past experience (ie more than 12,000 blasts).

- Truck operator, Shotfirer, Blasting Engineer do not realise holes are overloaded
    - In case the truck operator inputs incorrect revolutions of bulk emulsion loading pump (note that each revolution of pump will deliver a certain amount of bulk emulsion) into PLC or Shotfirer puts mark on hose in the wrong place, holes overload could be possible. However, a totaliser is provided on the truck to indicate the total amount of bulk emulsion delivered for a blast and the reading will be checked by Truck operator and verified by Blasting Engineer at the end of loading.

- Wrong design of MIC
    - The MIC profile has been defined in the Blast Assessment Reports [2]. The MIC along the alignment varies with respect to the type and maximum design PPV of sensitive receivers and distance to the sensitive receivers from the alignment. Actual site blast trials will be carried out prior to full scale blasts for the whole alignment to obtain site specific details for refining the MIC values.
    - In case there are any errors in the MIC calculation, a higher charge load may be defined upto the maximum MIC specified for the WIL. However, the MIC profile along the alignment basically changes gradually (the change of charge load is generally less than one charge load of the preceding location) and any sudden spike will be obviously

spotted. It was therefore assumed that design error will lead to no more than double charge.

The human error probabilities associated with more bulk emulsion explosives loaded into a production hole than required were calculated in *Annex C3* and summarized in *Table 1.4* below.

Table 1.4 Human Error Probabilities for Excess Emulsion Loaded into a Hole

Event/ task no.	Description	Human Error Probability for a face
3.1	**Excess emulsion is loaded into a hole**	
3.1.1	Excess emulsion is loaded due to wrong density	7.95E-11
3.1.2	Shotfirer does not realise hole is overloaded	1.09E-06
3.2	**Wrong design of MIC**	
3.2.1	Design error by Blasting Engineer	8.52E-05
3.2.2	Failure to detect and correct design error	1.06E-03

C1-1.2.5 Sympathetic Detonation of the Full Face

This scenario is applicable to electronic detonators only.

Only two failure modes have been identified that can theoretically cause sympathetic detonation of all the MICs of the full face. This can be due to the following systematic errors:

- The shotfirer programs the full string with 0 ms increment, despite the 0 ms function being disabled. An upper range probability of 0.01 has been used to account for the chance of this software function failure (refer to probability of tagger dangerous failure in the previous section); or
- A systematic error from the Tagger leads to the full string programmed with 0 ms increment or with the same time delay.

Such errors would normally be detected during the various checks performed during the blast process. Combinations of failures have been modelled using Fault Tree Analysis considering specific Human Factor Assessment.

a) Human Error during Input of detonator time delays leading to full string programmed with same time delay

This scenario is applicable to electronic detonators only.

A series of failures are required to lead to this scenario outcome. The causes considered are::

- The shotfirer can erroneously program the full string of detonators with a 0 ms increment which would lead to all the detonators within the string to be programmed with the same time delay;

- First level of checks: the shot firer will receive an error message to indicate a dangerous action has been conducted. The probability of failure of this first level of checks will mainly depend on the reliability of the Tagger diagnostic function which is conservatively assumed to have a 10% chance of failure;

- Second level of checks:

    - The 2nd Shotfirer and/or Blasting Engineer may fail to detect error using a different tagger and no corrective action is taken. Additionally, tagger information from all the strings are to be uploaded to a computer and time delay are checked for full face to ensure no time delay coincides. This feature of independent software checking will further improve the error detection rate by at least a factor of 10 (a factor of 10 used conservatively) in addition to checking with a different tagger. A gross negligence would be required for failure to spot that all the time delays have been programmed with the same value;

    - The second level of checks can also fail if the Tagger fails and misleads the checking team by displaying time delays which appear to match the blast design. Such Tagger error is unlikely as it requires a Tagger failure (probability of 0.001) and the failure is such the values match the Blast Plan. A 10% probability has been conservatively assumed for each time delay in a short string of 5 MIC (overall 10^{-5} probability);

    - The second level of checks can also fail if the second Tagger used for checking has a systematic fault (as described in point (b) below) such that the second shortfirer and Blasting Engineer think that the correction has been made but the Second Tagger has programmed the detonators with a 0 ms increment. Such failure has been assessed with overall probability of dangerous failure per blast being 10^{-4}.

- Third level of checks:

    - The Competent Blasting Supervisor may fail to detect error using the bench box system at fail to take corrective actions(which is independent from the Tagger system). A gross negligence would be required for failure to spot that all the time delays have been programmed with the same value;

    - The shotfirer may fail to detect error using the bench box system at fail to take corrective actions (which is independent from the Tagger system). However, this final check performed by the same shotfirer who sets up the blast face is conservatively not considered an independent check and therefore not included in human error calculation.

- o The bench box itself may fail and display time delays which appear to be correct. Such failure is very unlikely and assumed as 0.0001 (bottom range from the certified failure rate range). However, such failures will have to pass the various diagnostic checks performed within the Bench Box.

The human errors associated with the Input of detonator time delays leading to full string programmed with same time delay were calculated *in Annex C3*. A summary is given in *Table 1.5*.

Table 1.5 Human Error Probabilities for Wrong input of time delay by Shotfirer using Tagger leading to Sympathetic Detonation of all MIC within the Face

Event/ task no.	Description	Human Error Probability for a face
2.5	**Wrong programming of string pattern by Shotfirer using Tagger**	**9.78E-09**
2.5.1-1	Shot firer programmes string of detonators with incorrect delay time	7.38E-04
2.5.1-2	BE fails to detect string is programmed incorrectly	3.64E-03
2.5.1-3	SF/BE fails to correct incorrectly programmed string	3.64E-03
2.8	**Independent Checking Team fails to detect and correct string pattern errors**	**7.28E-05**
2.8.1-1	CBS fails to detect all dets in string are programmed incorrectly (assumed 1% common cause as compared to 2.7.1)	3.64E-05
2.8.1-2	SFs/CBS fail to correct incorrectly programmed string for all dets (1% common cause as compared to 2.7.1)	3.64E-05

b) Tagger systematic failure leading to wrong time delay

This scenario is applicable to electronic detonators only.

This could be due to a systematic hardware or software failure that remains undetected and would require a series of failures to lead to this scenario outcome. The causes considered are::

- Tagger fails in such a way that it gives the same time delay systematically to all detonator within a string. A possible error may come from a systematic communication error originating from the Tagger. This could be due to hardware failure or software error giving a dangerous output. In the case of random failure, the tagger may feedback the correct time delay as entered by the shotfirer but the diagnostic function cannot check whether the same time delay has been actually programmed to the detonators;

- First level of checks:

    - o The 2nd Shotfirer and/or Blasting Engineer may fail to detect error using a different tagger and no corrective action is taken. A gross negligence would be required for failure to spot that all the time delays have been programmed with the same value;

- The second level of checks can also fail if the Tagger fail and misleads the checking team by displaying time delays which appear to match the blast design. Such Tagger error is unlikely as it requires a Tagger failure (probability of 0.001) and the failure is such that the time delays match the Blast Plan. A 10% probability has been conservatively assumed for each time delay in a short string of 5 MIC (overall 10^{-5} probability).

- The second level of checks can also fail if the second Tagger used for checking has a systematic fault (as described in point b))such that the second shortfirer and Blasting Engineer think that the correction has been made but the Second Tagger has programmed the detonators with a 0 ms increment.

- Second level of checks:

  - The Competent Blasting Supervisor may fail to detect error using the bench box system at fail to take corrective actions (which is independent from the Tagger system). A gross negligence would be required for failure to spot that all the time delays have been programmed with the same value;

  - The bench box itself may fail and display time delays which appear to be correct. Such failure is very unlikely and assumed as 0.0001 (bottom range from the certified failure rate range). However, such failures will have to pass the various diagnostic checks performed within the Bench Box.

C1-1.2.6 Unforeseen ground conditions

This scenario is the same as for conventional detonators.

The MIC values derived in the Blast Assessment Reports [2] are based on site surveys carried out for sensitive receivers and will be refined using the trial blast results prior to the full scale blast process of the WIL project. A 3As (Alert-Alarm-Action) monitoring programme will also be implemented to continuously monitor any potential exceedance of 25 mm/s for every blast. All potential causes leading to increase in ground vibration level (such as deviation of geological condition from the base design) will be investigated and the root cause will be identified. It was assumed that the unforeseen ground conditions between the blast faces and the sensitive receivers will be detected by the 3As programme.

As an additional check on forward ground conditions, the geologist will drill a horizontal forward probe hole to determine rock quality in advance of the blast face (usually up to 20m in length). This will help to determine the geographical condition prior to the actual blast.

C1-1.3 FAULT TREE ANALYSIS

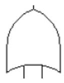
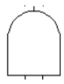
C1-1.3.1 *Overview*

Fault Tree Analysis (FTA) was used to estimate the probability of occurrence for each failure scenario identified in *Section C1-1.1*.

FTA is a technique widely applied to estimate the probability of unwanted events. It is a technique by which the logical relationships between the circumstances, equipment failure and human error are examined. The software package, FaultTree+, was used to construct fault trees for the estimation of probability of occurrence. FaultTree+ calculated the probability of occurrence using cutset to model multiple levels of protections, checking and review process.

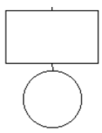
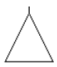
The gate symbols are listed in *Table 1.6* together with their causal relations.

Table 1.6 Gate Symbols for Fault Tree Models

Gate Symbol	Name	Causal Relation	Valid No. of Inputs
	*OR*	Output event occurs if any one of the input events occur	≥ 2
	*AND*	Output event occurs if all input events occur	≥ 2

The event symbols used in fault tree models are illustrated in *Table 1.7* together with their meanings.

Table 1.7 Event Symbols for Fault Tree Models

Event Symbol	Name	Meaning
	*BASIC*	System or component event description Basic event for which failure and repair data is available
	*TRANSFER*	Indicates that this part of the fault tree is developed in a different part of the diagram or on a different page

C1-1.3.2 *Fault Tree Models*

The fault tree models were developed for each of the following failure scenarios associated with the use of explosives.

- Higher vibration due to 2 MIC detonated at the same time
- Higher vibration due to 3 MIC detonated at the same time
- Higher vibration due to 4 MIC detonated at the same time
- Higher vibration due to 5 MIC detonated at the same time

- Higher vibration due to 6 MIC detonated at the same time
- Higher vibration due to whole string detonating at the same time

Modelling of Overcharge of Emulsion more than Required

Fault tree models were developed for the failure scenarios of more bulk emulsion explosives being loaded into a production hole than required. This was considered one of the causes leading to a maximum of 2 MIC detonated at the same time as mentioned in the previous section. The overload could be a maximum of 1 MIC or less.

Configuration of Fault Tree Models

For the construction of the fault tree models, the number of the errors (failure modes) required and their combinations need to be considered, as shown bellow.

- One error leading to 2 MIC detonation at the same time
- Two errors leading to 3 MIC detonation at the same time
- Three errors leading to 4 MIC detonation at the same time
- Four errors leading to 5 MIC detonation at the same time
- Five errors leading to 6 MIC detonation at the same time
- Systematic errors leading to whole face detonation at the same time

Therefore, the trees have been constructed in such a way that:

- For the 3 MIC case, the two errors could be of the same type or different types.
- For the 4 MIC case, the three errors could be 3 of same types, or 2 of same type + 1 different type, or 3 of different types. In addition, it has been assumed that "Overcharge of emulsion more than required" plus 1 error other than overcharge will lead to 4 MIC detonation.

Potential Dependency of Human Errors

Human errors dependencies were specifically modeled in the Fault Trees as discussed in *Section 2.2.2*.

C1-1.3.3 Modelling Results

The modelling results are summarised in *Table 1.8*.

Table 1.8 Probability of Occurrence per Face

Scenarios	Probability of Occurrence Per Face
Higher vibration due to 2 MIC detonated at the same time	1.21×10^{-5}
Higher vibration due to 3 MIC detonated at the same time	1.45×10^{-8}
Higher vibration due to 4 MIC detonated at the same time	2.25×10^{-10}
Higher vibration due to 5 MIC detonated at the same time	2.25×10^{-11}
Higher vibration due to 6 MIC detonated at the same time	2.25×10^{-12}
Higher vibration due to whole string detonating at the same time	1.25×10^{-12}

Table 1.8 shows that the probability of occurrence of multiple MIC being detonated at the same time will generally reduce as additional error is required to result in one more MIC going off together. EIAO-TM criteria have set out a threshold that only hazardous scenarios with a frequency of 10^{-9} per year or above are required to be assessed in QRA. On this basis, assessment for the scenario of whole string detonating at the same time is not required as the total number of blasts involving e-det are well below 800 (ie. 10^{-9} / 1.25×10^{-12}).

To be consistent with the approval WIL EIA, the failure frequencies have been expressed for 10m chainage interval (*Table 1.9*).

Table 1.9 Frequency for failure Scenarios leading to Higher Vibration per 10m

Occurrence Frequency for multiple MIC detonated at the same time for 10 m (occurrence per 10m)				
2MIC	3MIC	4MIC	5MIC	6MIC
3.29E-04	3.49E-07	3.51E-09	3.51E-10	3.51E-11

C1-2 REFERENCES

[1] SINTEF Industrial Management, Offshore Reliability Data, 4th edition, 2002.

[2] MTR, West Island Line, Blasting Assessment Report, SHW to SYP Tunnels, Revision A, July 2010

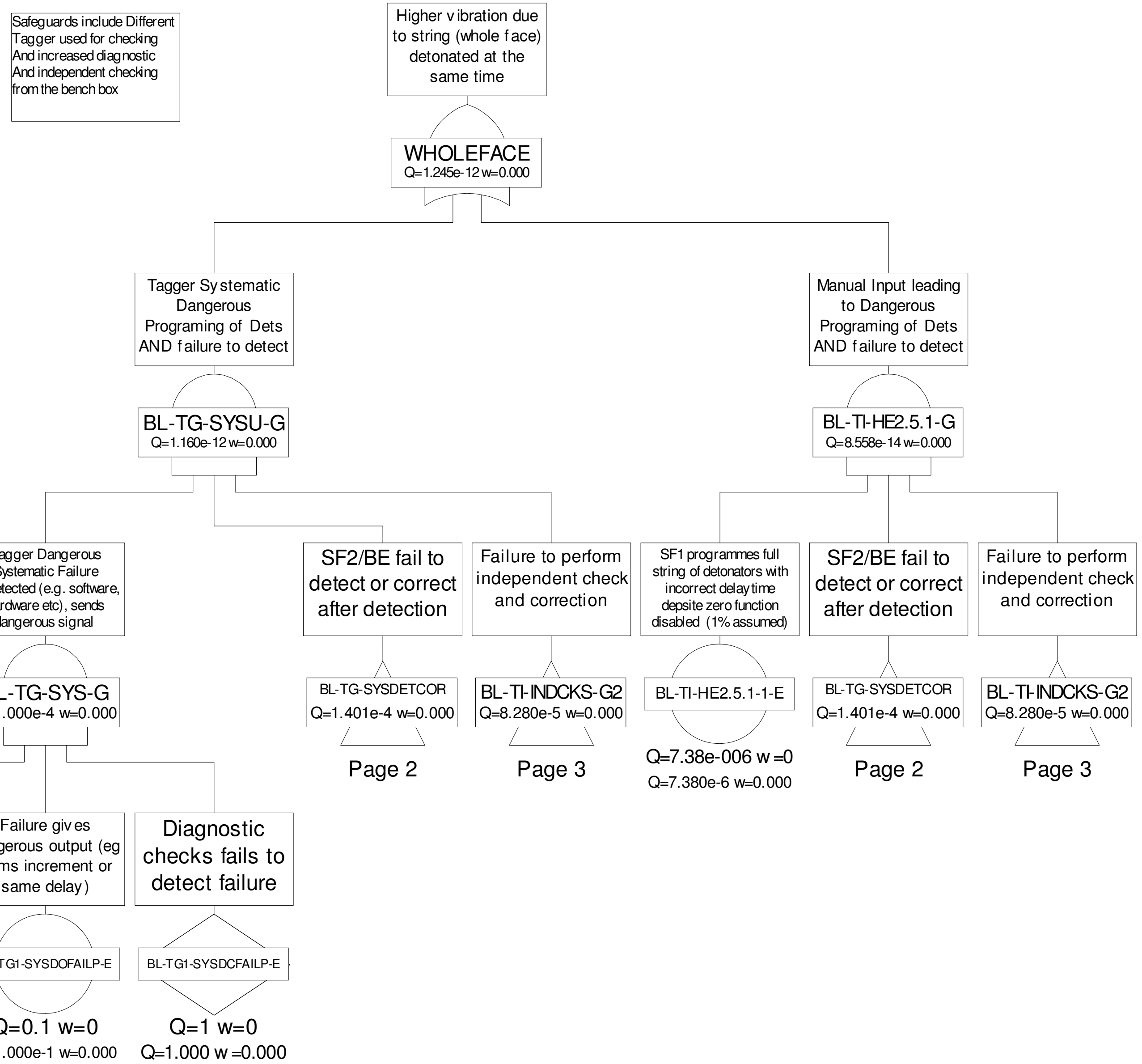
[3] IEC, IEC 61508 Functional Safety of electrical / electronic / programmable electronic safety-related systems

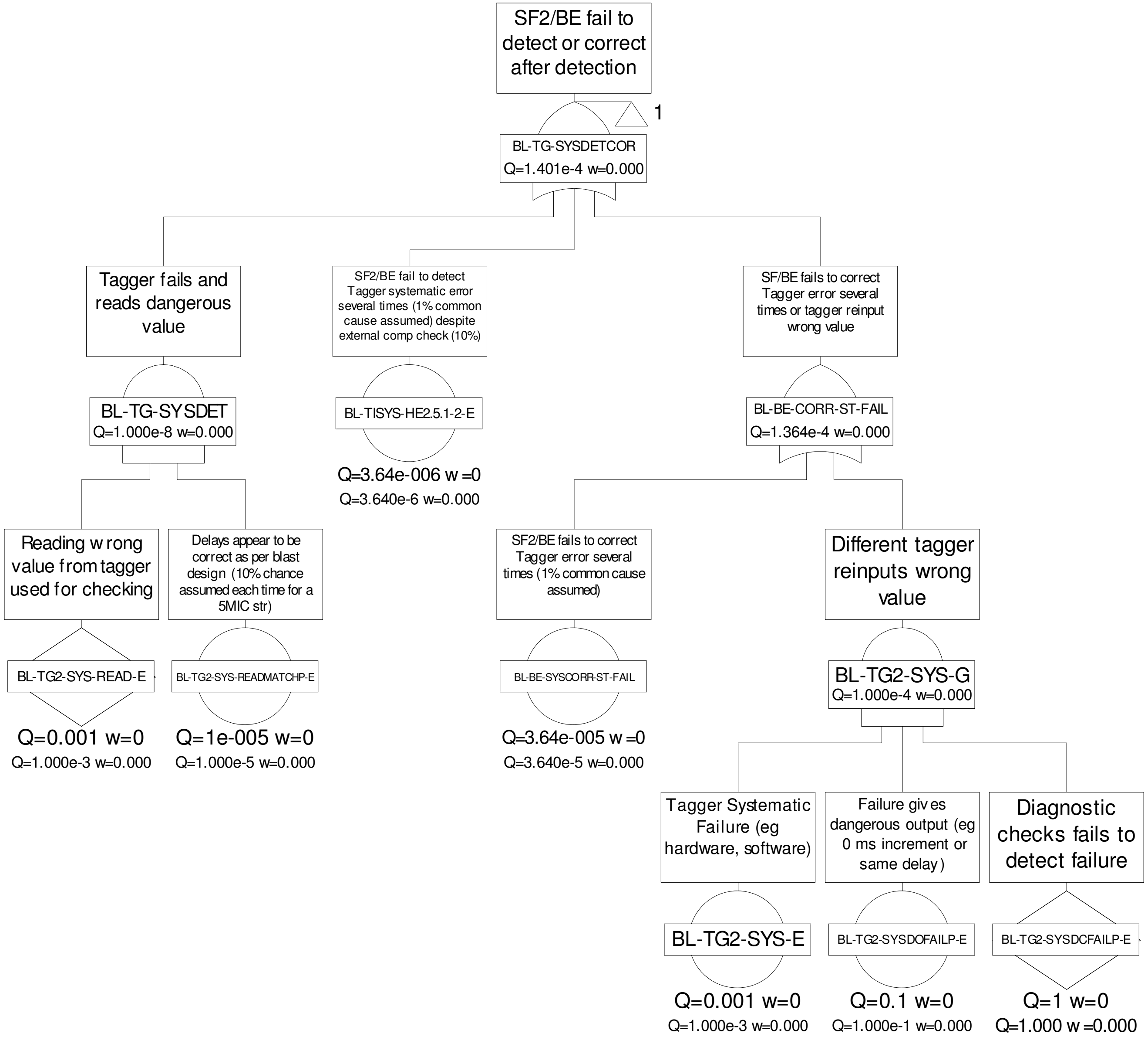
[4] G. Teowee, Firing Reliability of Electronic Detonators, Special Devices, Inc, International Society of Explosives Engineers 2010G Vol.2.

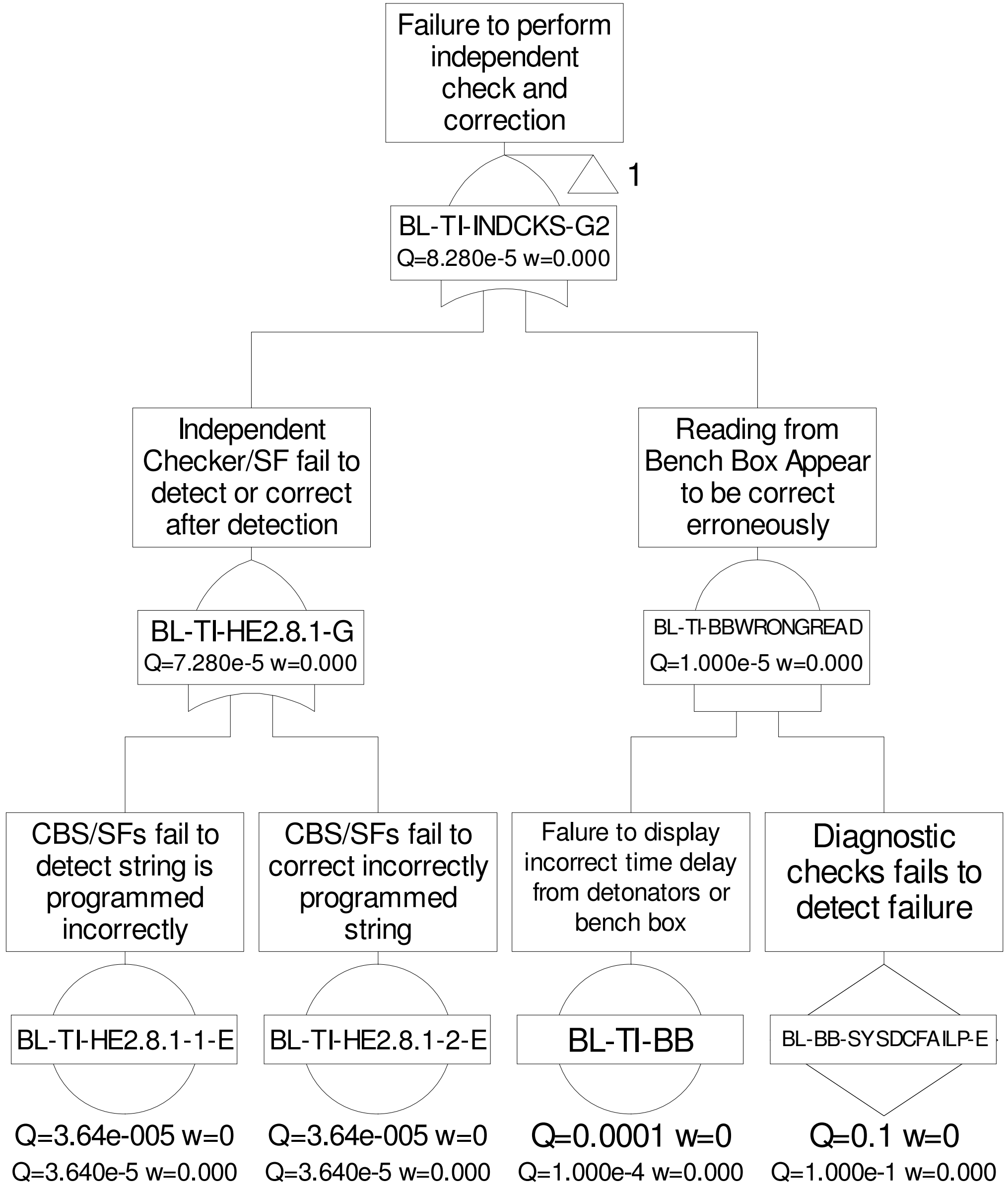
Annex C2

Fault Tree Models for Use of Explosives with Electronic Detonators

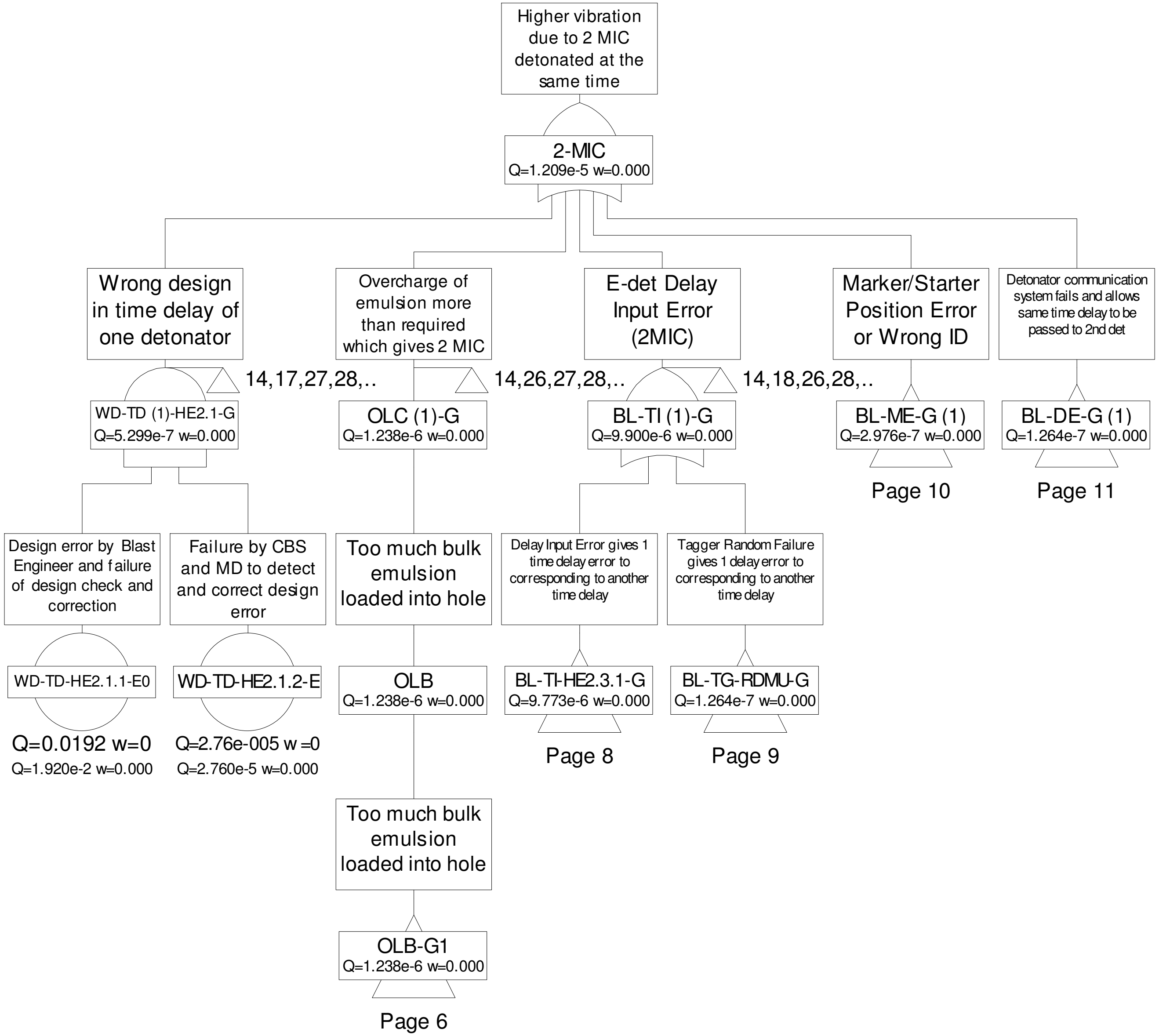
CONTENTS


Safeguards include Different Tagger used for checking And increased diagnostic And independent checking from the bench box
Higher vibration due to string (whole face) detonated at the same time
WHOLEFACE
Q=1.245e-12 w=0.000
Tagger Systematic Dangerous Programing of Dets AND failure to detect
BL-TG-SYSU-G
Q=1.160e-12 w=0.000
Manual Input leading to Dangerous Programing of Dets AND failure to detect
BL-TI-HE2.5.1-G
Q=8.558e-14 w=0.000
Tagger Dangerous Systematic Failure Undetected (e.g. software, hardware etc), sends dangerous signal
BL-TG-SYS-G
Q=1.000e-4 w=0.000
SF2/BE fail to detect or correct after detection
BL-TG-SYSDETCOR
Q=1.401e-4 w=0.000
Page 2
Failure to perform independent check and correction
BL-TI-INDCKS-G2
Q=8.280e-5 w=0.000
Page 3
SF1 programmes full string of detonators with incorrect delay time depsite zero function disabled (1% assumed)
BL-TI-HE2.5.1-1-E
Q=7.38e-006 w=0
Q=7.380e-6 w=0.000
SF2/BE fail to detect or correct after detection
BL-TG-SYSDETCOR
Q=1.401e-4 w=0.000
Page 2
Failure to perform independent check and correction
BL-TI-INDCKS-G2
Q=8.280e-5 w=0.000
Page 3
Tagger Systematic Failure (eg hardware, software)
BL-TG1-SYS-E
Q=0.001 w=0
Q=1.000e-3 w=0.000
Failure gives dangerous output (eg 0 ms increment or same delay)
BL-TG1-SYSDOFAILP-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Diagnostic checks fails to detect failure
BL-TG1-SYSDCFAILP-E
Q=1 w=0
Q=1.000 w=0.000

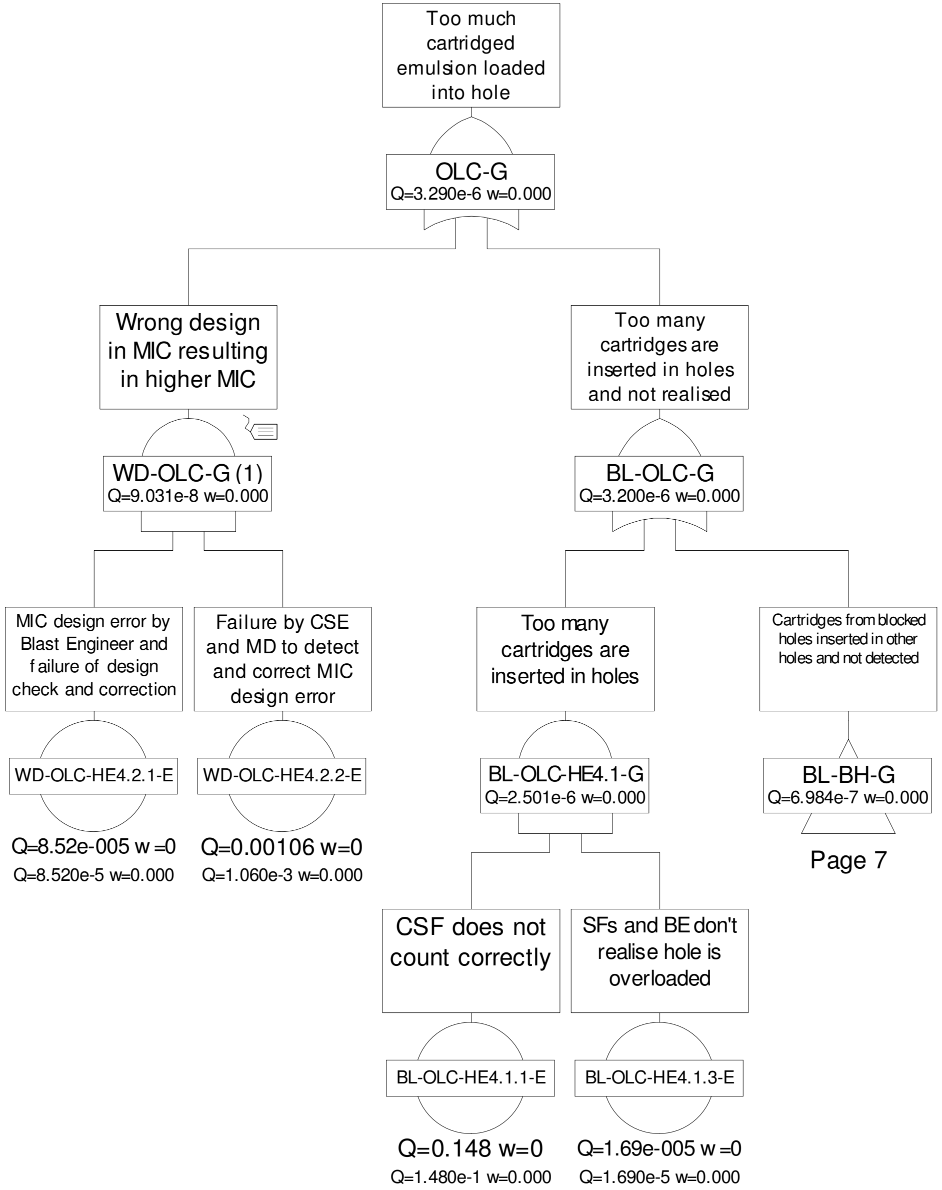

SF2/BE fail to detect or correct after detection
1
BL-TG-SYSDETCOR
Q=1.401e-4 w=0.000
Tagger fails and reads dangerous value
BL-TG-SYSDET
Q=1.000e-8 w=0.000
SF2/BE fail to detect Tagger systematic error several times (1% common cause assumed) despite external comp check (10%)
BL-TISYS-HE2.5.1-2-E
Q=3.64e-006 w=0
Q=3.640e-6 w=0.000
SF/BE fails to correct Tagger error several times or tagger reinput wrong value
BL-BE-CORR-ST-FAIL
Q=1.364e-4 w=0.000
Reading wrong value from tagger used for checking
BL-TG2-SYS-READ-E
Q=0.001 w=0
Q=1.000e-3 w=0.000
Delays appear to be correct as per blast design (10% chance assumed each time for a 5MIC str)
BL-TG2-SYS-READMATCHP-E
Q=1e-005 w=0
Q=1.000e-5 w=0.000
SF2/BE fails to correct Tagger error several times (1% common cause assumed)
BL-BE-SYSCORR-ST-FAIL
Q=3.64e-005 w=0
Q=3.640e-5 w=0.000
Different tagger reinputs wrong value
BL-TG2-SYS-G
Q=1.000e-4 w=0.000
Tagger Systematic Failure (eg hardware, software)
BL-TG2-SYS-E
Q=0.001 w=0
Q=1.000e-3 w=0.000
Failure gives dangerous output (eg 0 ms increment or same delay)
BL-TG2-SYSDOFAILP-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Diagnostic checks fails to detect failure
BL-TG2-SYSDCFAILP-E
Q=1 w=0
Q=1.000 w=0.000

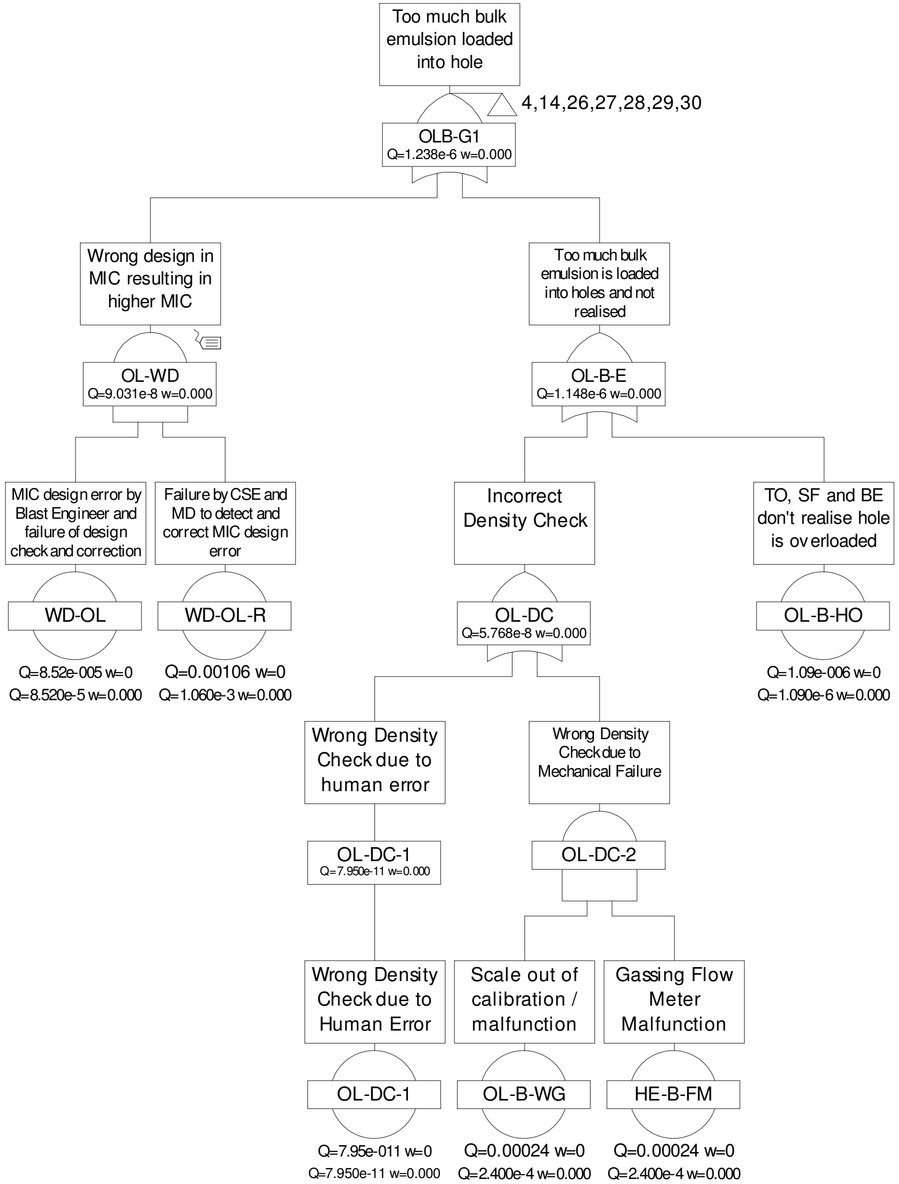


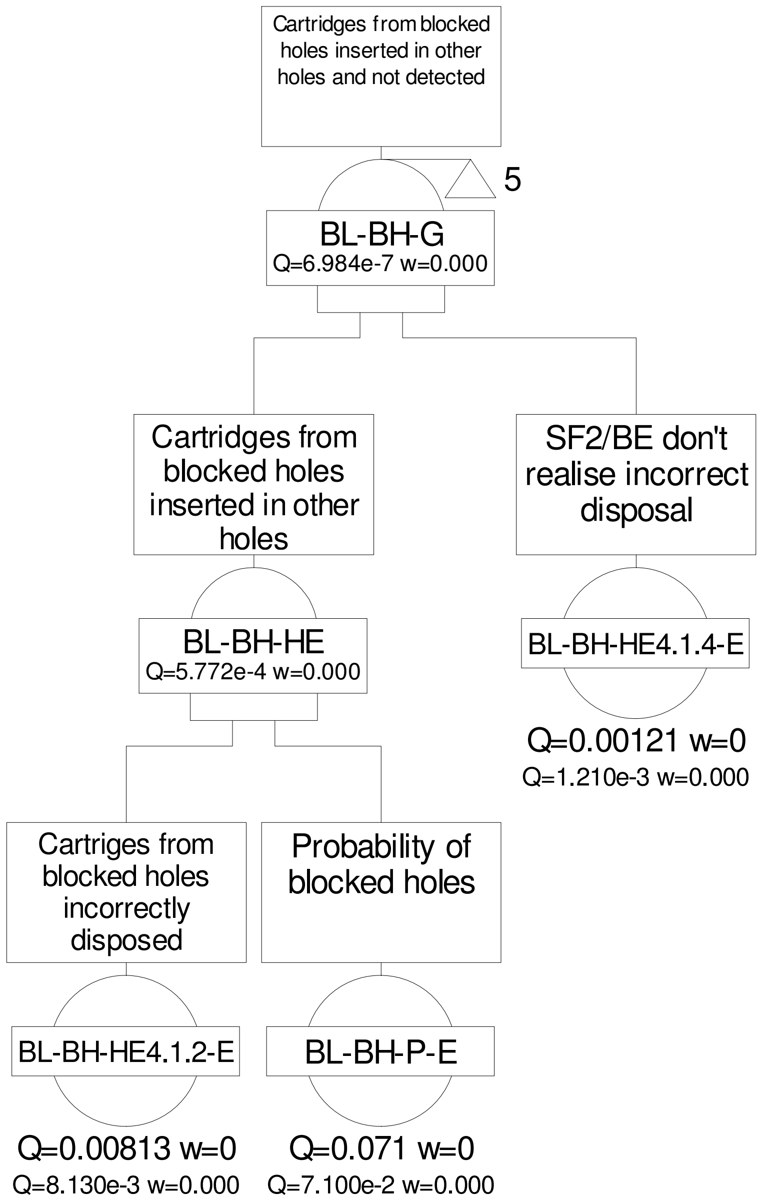
Failure to perform independent check and correction
1
BL-TI-INDCKS-G2
Q=8.280e-5 w=0.000
Independent Checker/SF fail to detect or correct after detection
BL-TI-HE2.8.1-G
Q=7.280e-5 w=0.000
Reading from Bench Box Appear to be correct erroneously
BL-TI-BBWRONGREAD
Q=1.000e-5 w=0.000
CBS/SFs fail to detect string is programmed incorrectly
BL-TI-HE2.8.1-1-E
Q=3.64e-005 w=0
Q=3.640e-5 w=0.000
CBS/SFs fail to correct incorrectly programmed string
BL-TI-HE2.8.1-2-E
Q=3.64e-005 w=0
Q=3.640e-5 w=0.000
Falure to display incorrect time delay from detonators or bench box
BL-TI-BB
Q=0.0001 w=0
Q=1.000e-4 w=0.000
Diagnostic checks fails to detect failure
BL-BB-SYSDCFAILP-E
Q=0.1 w=0
Q=1.000e-1 w=0.000



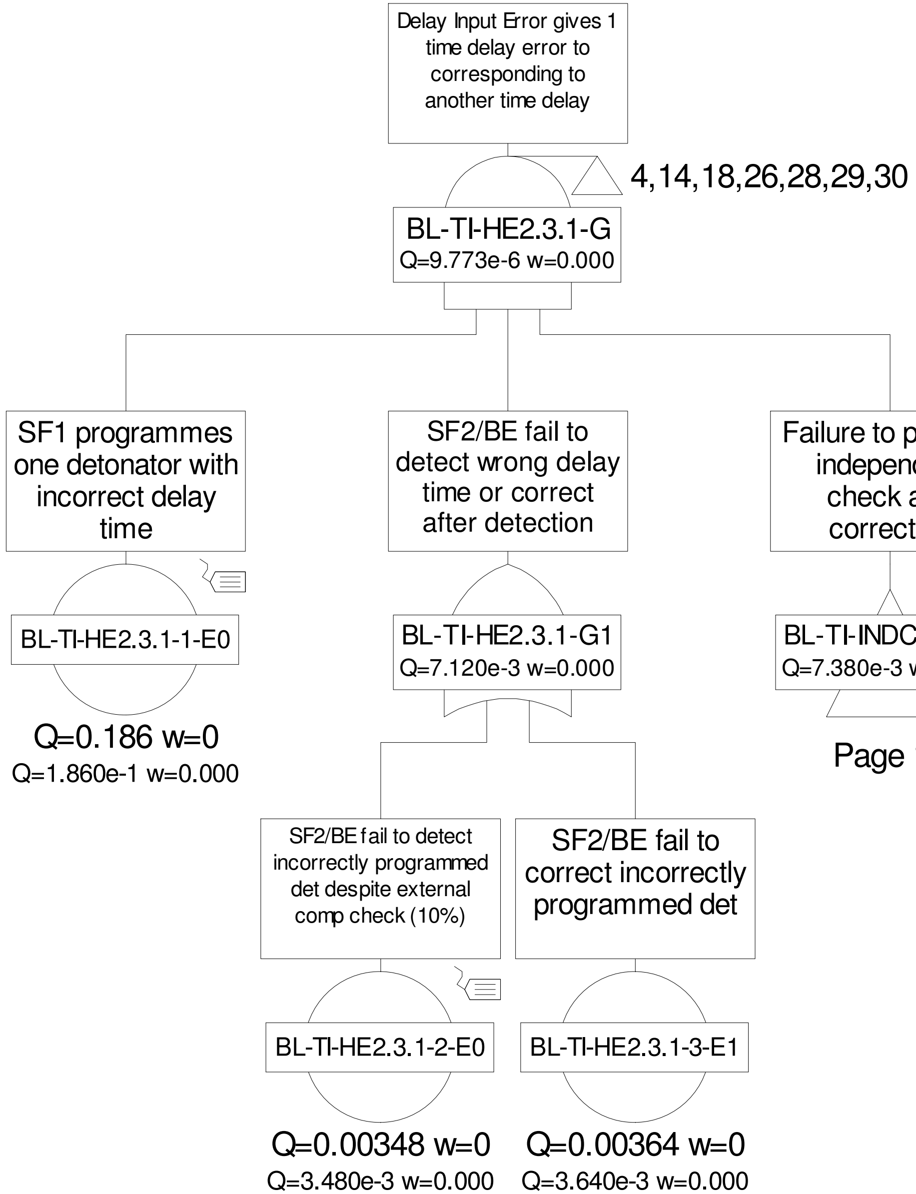
Higher vibration due to 2 MIC detonated at the same time
2-MIC
Q=1.209e-5 w=0.000
Wrong design in time delay of one detonator
14,17,27,28,..
WD-TD (1)-HE2.1-G
Q=5.299e-7 w=0.000
Design error by Blast Engineer and failure of design check and correction
WD-TD-HE2.1.1-E0
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Failure by CBS and MD to detect and correct design error
WD-TD-HE2.1.2-E
Q=2.76e-005 w =0
Q=2.760e-5 w=0.000
Overcharge of emulsion more than required which gives 2 MIC
14,26,27,28,..
OLC (1)-G
Q=1.238e-6 w=0.000
Too much bulk emulsion loaded into hole
OLB
Q=1.238e-6 w=0.000
Too much bulk emulsion loaded into hole
OLB-G1
Q=1.238e-6 w=0.000
Page 6
E-det Delay Input Error (2MIC)
14,18,26,28,..
BL-TI (1)-G
Q=9.900e-6 w=0.000
Delay Input Error gives 1 time delay error to corresponding to another time delay
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
Page 8
Tagger Random Failure gives 1 delay error to corresponding to another time delay
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
Page 9
Marker/Starter Position Error or Wrong ID
BL-ME-G (1)
Q=2.976e-7 w=0.000
Page 10
Detonator communication system fails and allows same time delay to be passed to 2nd det
BL-DE-G (1)
Q=1.264e-7 w=0.000
Page 11


Too much cartridged emulsion loaded into hole
OLC-G
Q=3.290e-6 w=0.000
Wrong design in MIC resulting in higher MIC
WD-OLC-G (1)
Q=9.031e-8 w=0.000
Too many cartridges are inserted in holes and not realised
BL-OLC-G
Q=3.200e-6 w=0.000
MIC design error by Blast Engineer and failure of design check and correction
WD-OLC-HE4.2.1-E
Q=8.52e-005 w=0
Q=8.520e-5 w=0.000
Failure by CSE and MD to detect and correct MIC design error
WD-OLC-HE4.2.2-E
Q=0.00106 w=0
Q=1.060e-3 w=0.000
Too many cartridges are inserted in holes
BL-OLC-HE4.1-G
Q=2.501e-6 w=0.000
Cartridges from blocked holes inserted in other holes and not detected
BL-BH-G
Q=6.984e-7 w=0.000
Page 7
CSF does not count correctly
BL-OLC-HE4.1.1-E
Q=0.148 w=0
Q=1.480e-1 w=0.000
SFs and BE don't realise hole is overloaded
BL-OLC-HE4.1.3-E
Q=1.69e-005 w=0
Q=1.690e-5 w=0.000

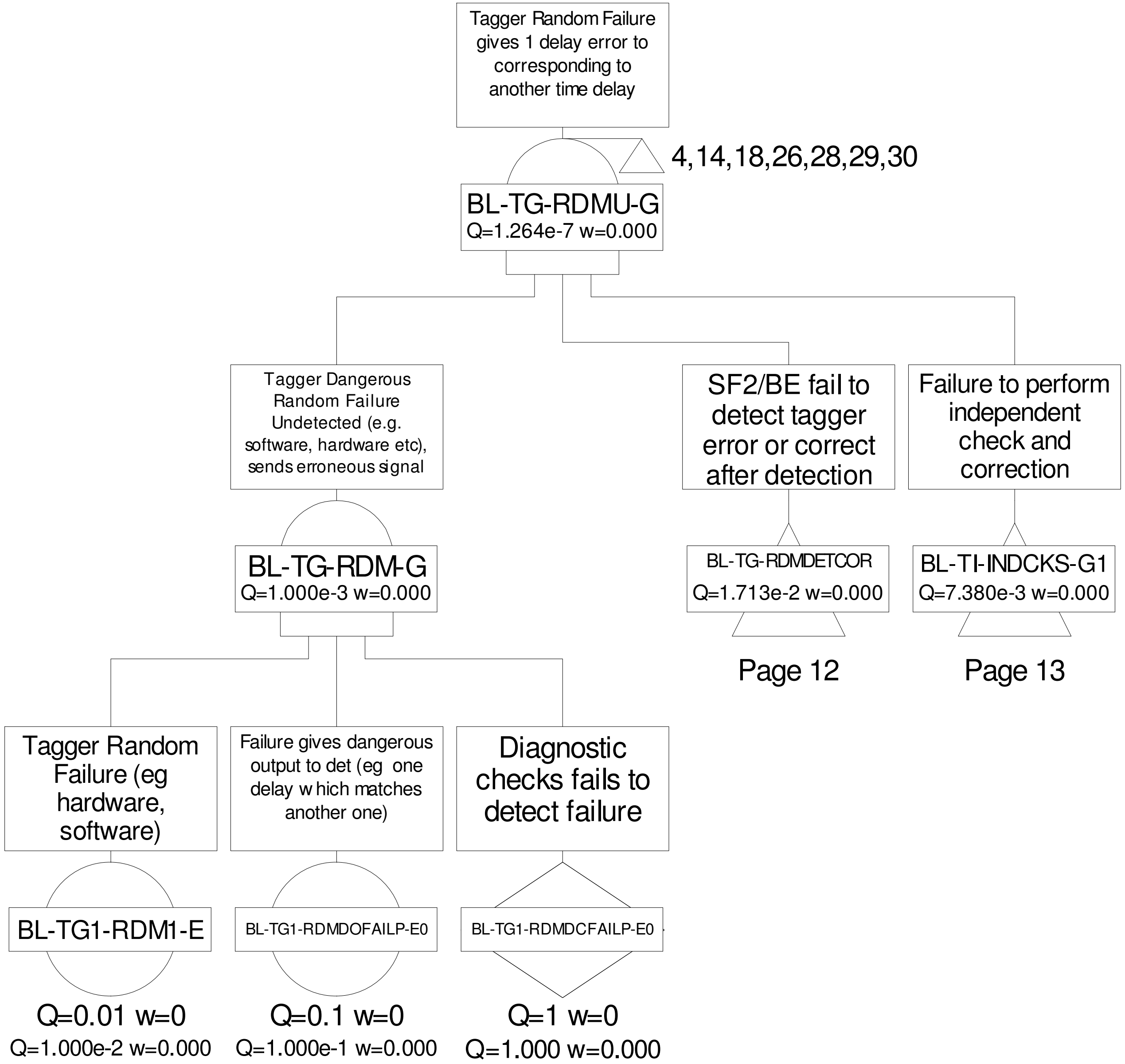

Too much bulk emulsion loaded into hole
4,14,26,27,28,29,30
OLB-G1
Q=1.238e-6 w=0.000
Wrong design in MIC resulting in higher MIC
OL-WD
Q=9.031e-8 w=0.000
Too much bulk emulsion is loaded into holes and not realised
OL-B-E
Q=1.148e-6 w=0.000
MIC design error by Blast Engineer and failure of design check and correction
WD-OL
Q=8.52e-005 w=0
Q=8.520e-5 w=0.000
Failure by CSE and MD to detect and correct MIC design error
WD-OL-R
Q=0.00106 w=0
Q=1.060e-3 w=0.000
Incorrect Density Check
OL-DC
Q=5.768e-8 w=0.000
TO, SF and BE don't realise hole is ov erloaded
OL-B-HO
Q=1.09e-006 w=0
Q=1.090e-6 w=0.000
Wrong Density Check due to human error
OL-DC-1
Q=7.950e-11 w=0.000
Wrong Density Check due to Mechanical Failure
OL-DC-2
Wrong Density Check due to Human Error
OL-DC-1
Q=7.95e-011 w=0
Q=7.950e-11 w=0.000
Scale out of calibration / malfunction
OL-B-WG
Q=0.00024 w=0
Q=2.400e-4 w=0.000
Gassing Flow Meter Malfunction
HE-B-FM
Q=0.00024 w=0
Q=2.400e-4 w=0.000

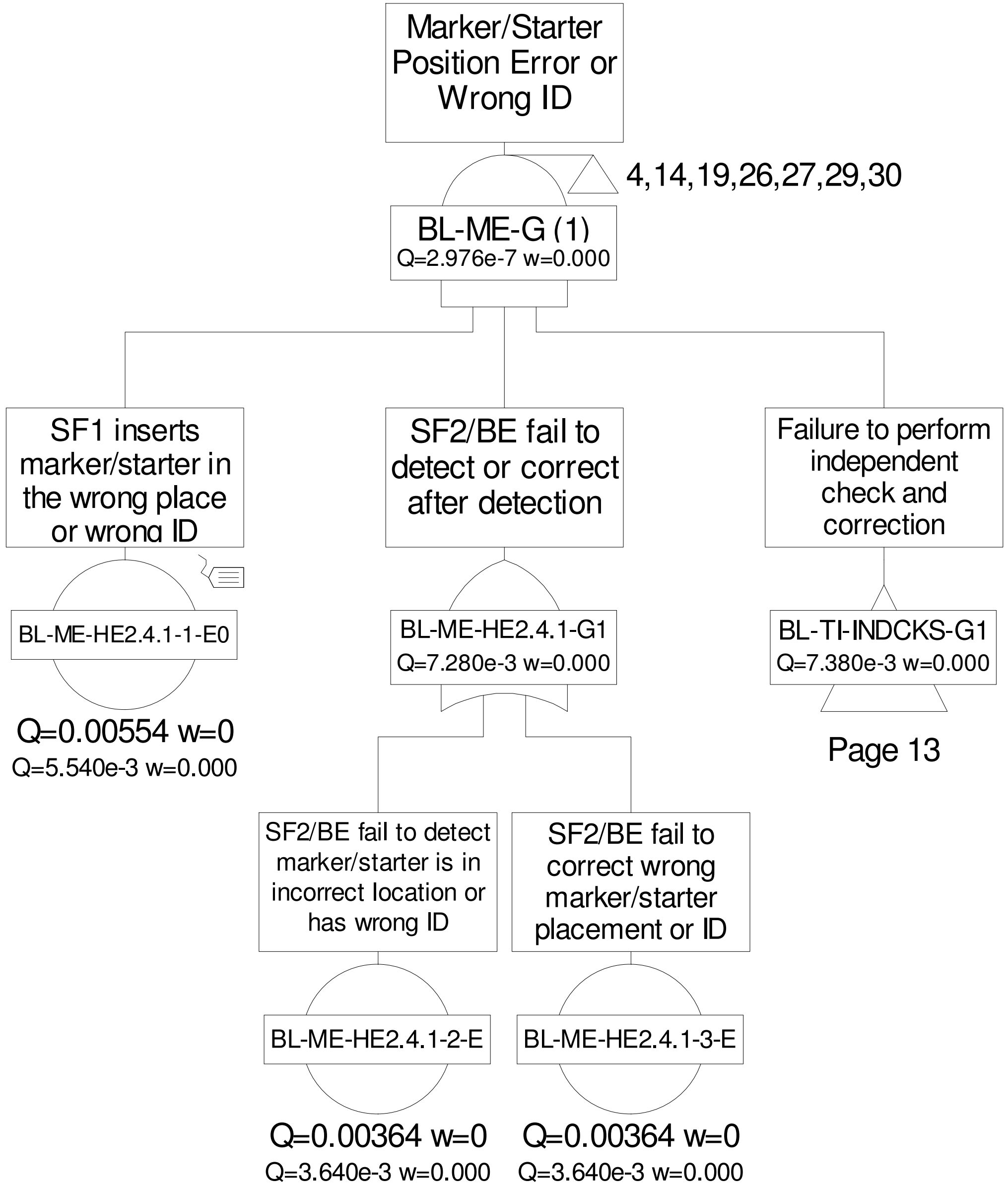


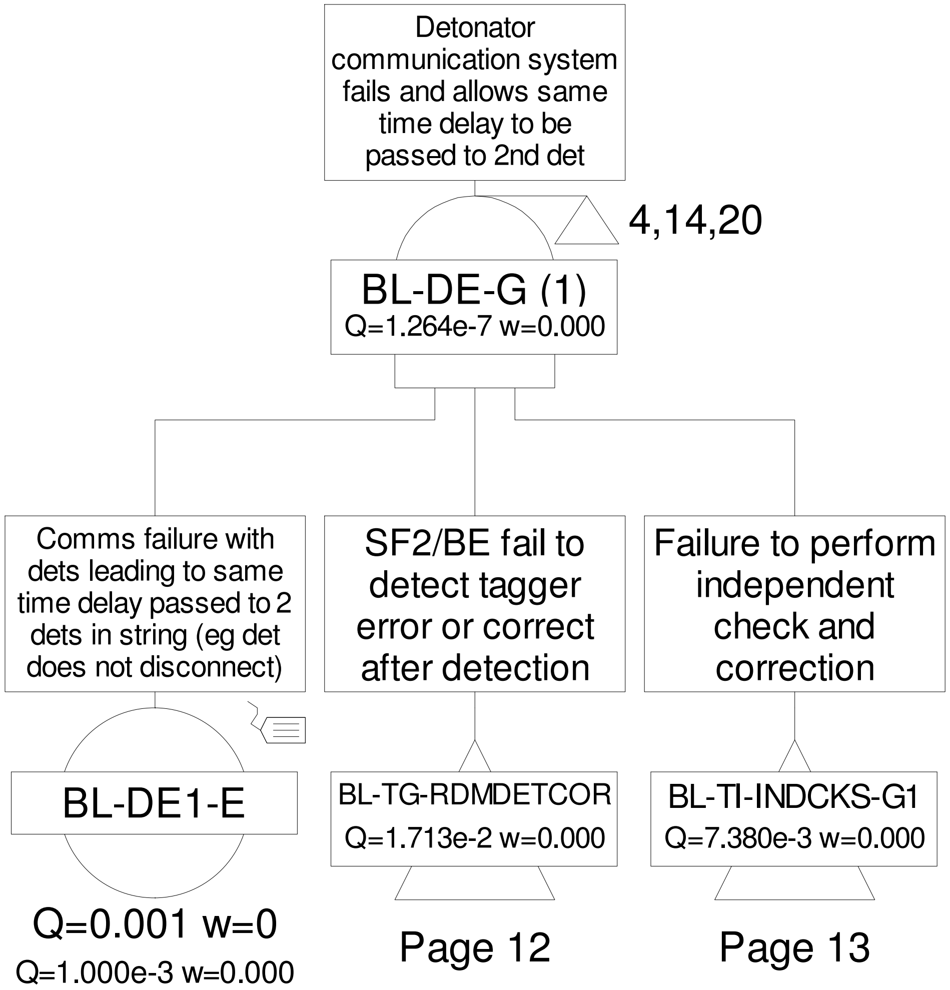
Cartridges from blocked holes inserted in other holes and not detected
5
BL-BH-G
Q=6.984e-7 w=0.000
Cartridges from blocked holes inserted in other holes
SF2/BE don't realise incorrect disposal
BL-BH-HE
Q=5.772e-4 w=0.000
BL-BH-HE4.1.4-E
Q=0.00121 w=0
Q=1.210e-3 w=0.000
Cartriges from blocked holes incorrectly disposed
Probability of blocked holes
BL-BH-HE4.1.2-E
BL-BH-P-E
Q=0.00813 w=0
Q=8.130e-3 w=0.000
Q=0.071 w=0
Q=7.100e-2 w=0.000

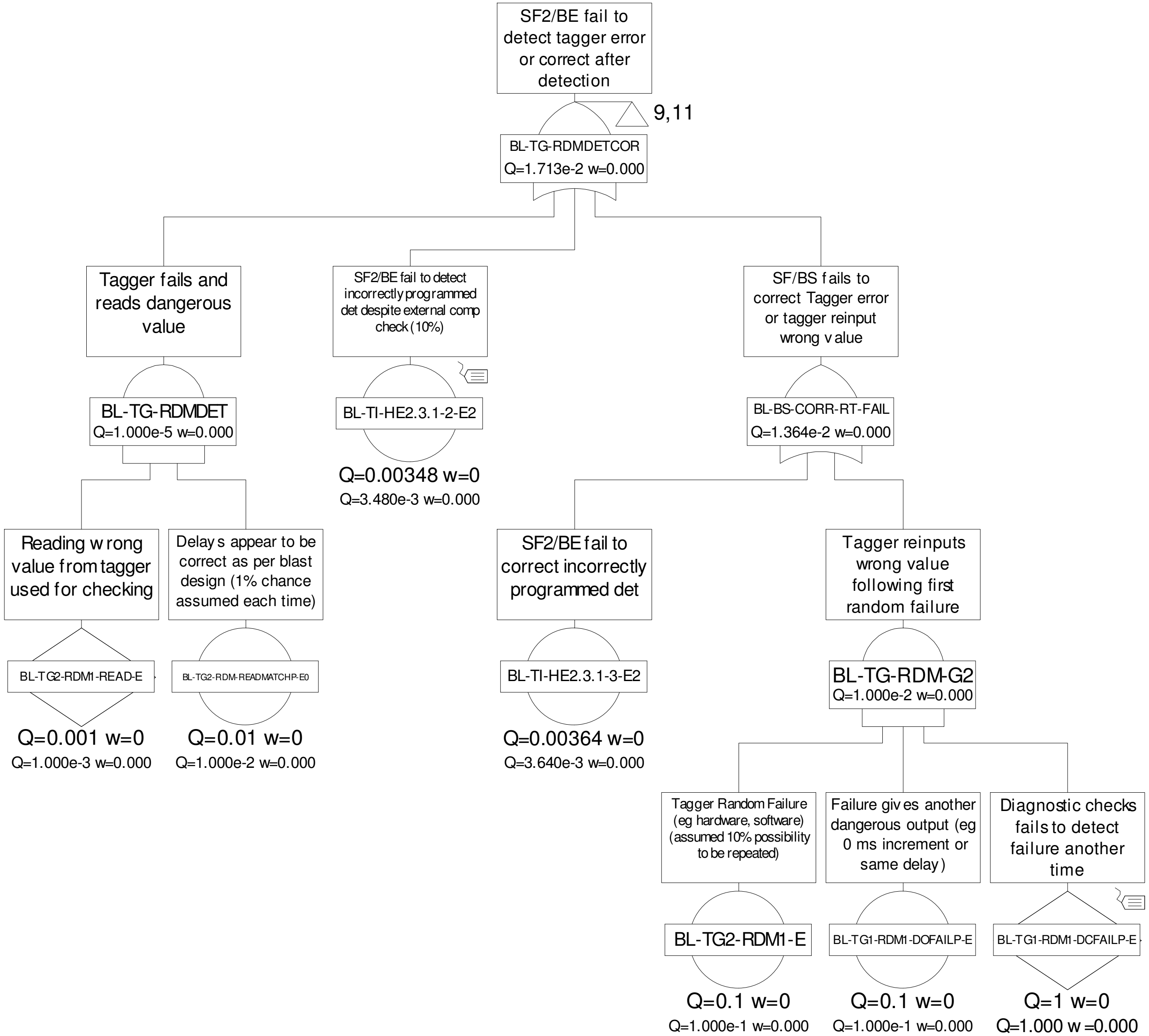


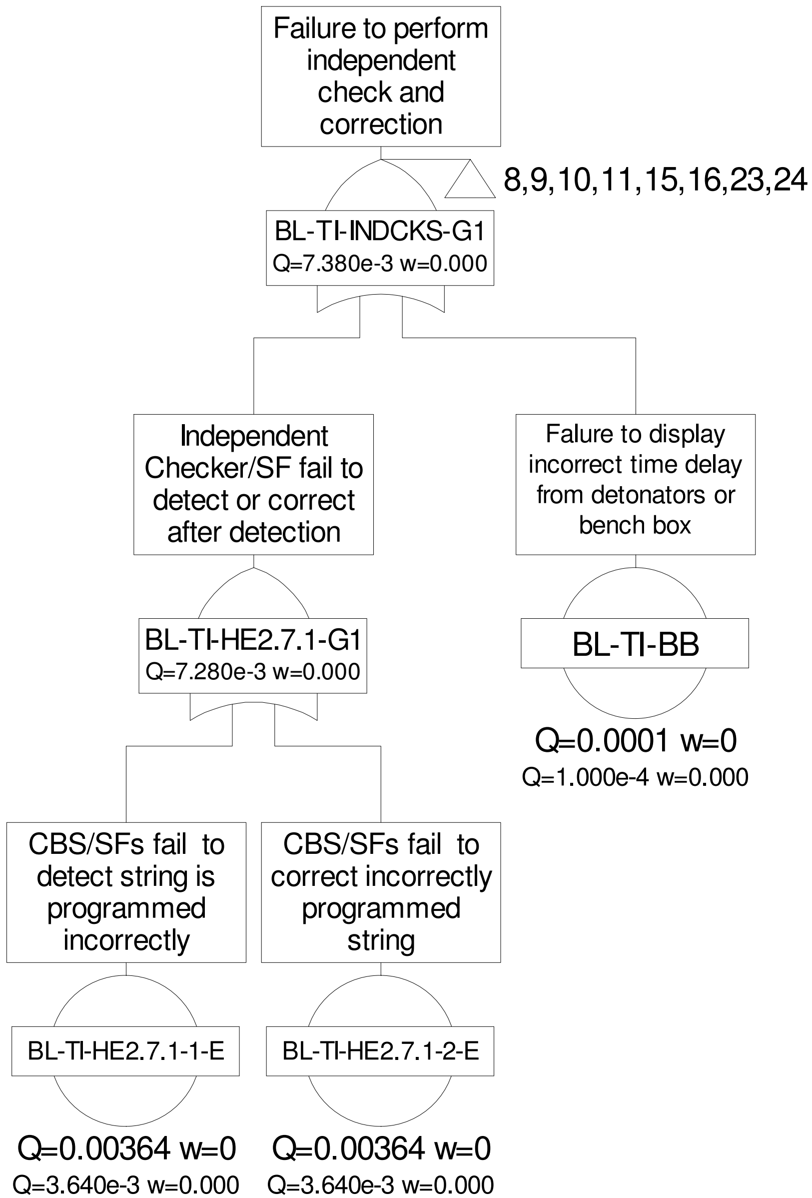
Delay Input Error gives 1 time delay error to corresponding to another time delay
4,14,18,26,28,29,30
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
SF1 programmes one detonator with incorrect delay time
BL-TI-HE2.3.1-1-E0
Q=0.186 w=0
Q=1.860e-1 w=0.000
SF2/BE fail to detect wrong delay time or correct after detection
BL-TI-HE2.3.1-G1
Q=7.120e-3 w=0.000
Failure to perform independent check and correction
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13
SF2/BE fail to detect incorrectly programmed det despite external comp check (10%)
BL-TI-HE2.3.1-2-E0
Q=0.00348 w=0
Q=3.480e-3 w=0.000
SF2/BE fail to correct incorrectly programmed det
BL-TI-HE2.3.1-3-E1
Q=0.00364 w=0
Q=3.640e-3 w=0.000


Tagger Random Failure gives 1 delay error to corresponding to another time delay
4,14,18,26,28,29,30
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
Tagger Dangerous Random Failure Undetected (e.g. software, hardware etc), sends erroneous signal
SF2/BE fail to detect tagger error or correct after detection
Failure to perform independent check and correction
BL-TG-RDM-G
Q=1.000e-3 w=0.000
BL-TG-RDMDETCOR
Q=1.713e-2 w=0.000
Page 12
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13
Tagger Random Failure (eg hardware, software)
Failure gives dangerous output to det (eg one delay which matches another one)
Diagnostic checks fails to detect failure
BL-TG1-RDM1-E
Q=0.01 w=0
Q=1.000e-2 w=0.000
BL-TG1-RDMDOFAILP-E0
Q=0.1 w=0
Q=1.000e-1 w=0.000
BL-TG1-RDMDCFAILP-E0
Q=1 w=0
Q=1.000 w=0.000

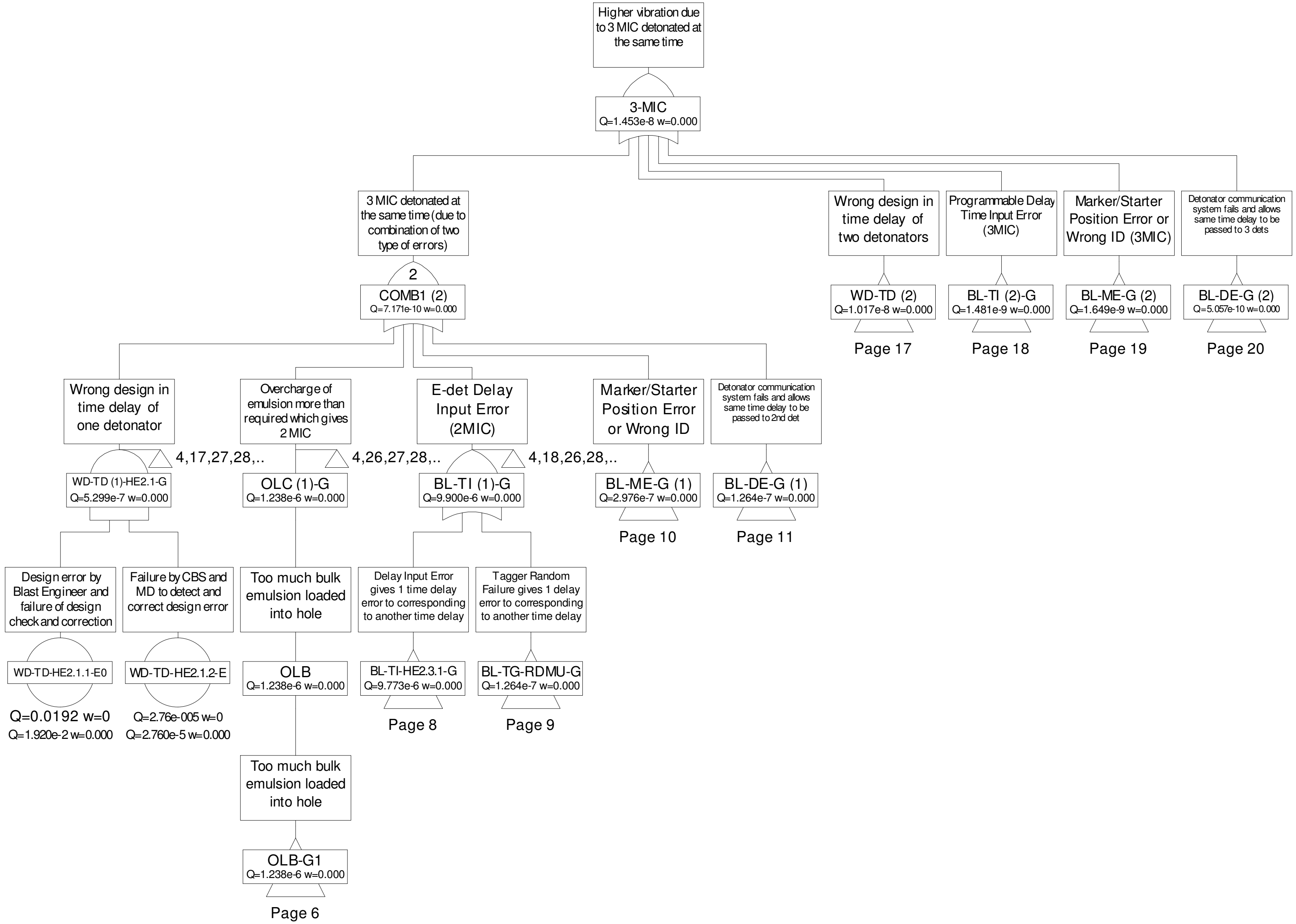

Marker/Starter Position Error or Wrong ID
4,14,19,26,27,29,30
BL-ME-G (1)
Q=2.976e-7 w=0.000
SF1 inserts marker/starter in the wrong place or wrong ID
SF2/BE fail to detect or correct after detection
Failure to perform independent check and correction
BL-ME-HE2.4.1-1-E0
Q=0.00554 w=0
Q=5.540e-3 w=0.000
BL-ME-HE2.4.1-G1
Q=7.280e-3 w=0.000
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13
SF2/BE fail to detect marker/starter is in incorrect location or has wrong ID
SF2/BE fail to correct wrong marker/starter placement or ID
BL-ME-HE2.4.1-2-E
BL-ME-HE2.4.1-3-E
Q=0.00364 w=0
Q=3.640e-3 w=0.000
Q=0.00364 w=0
Q=3.640e-3 w=0.000

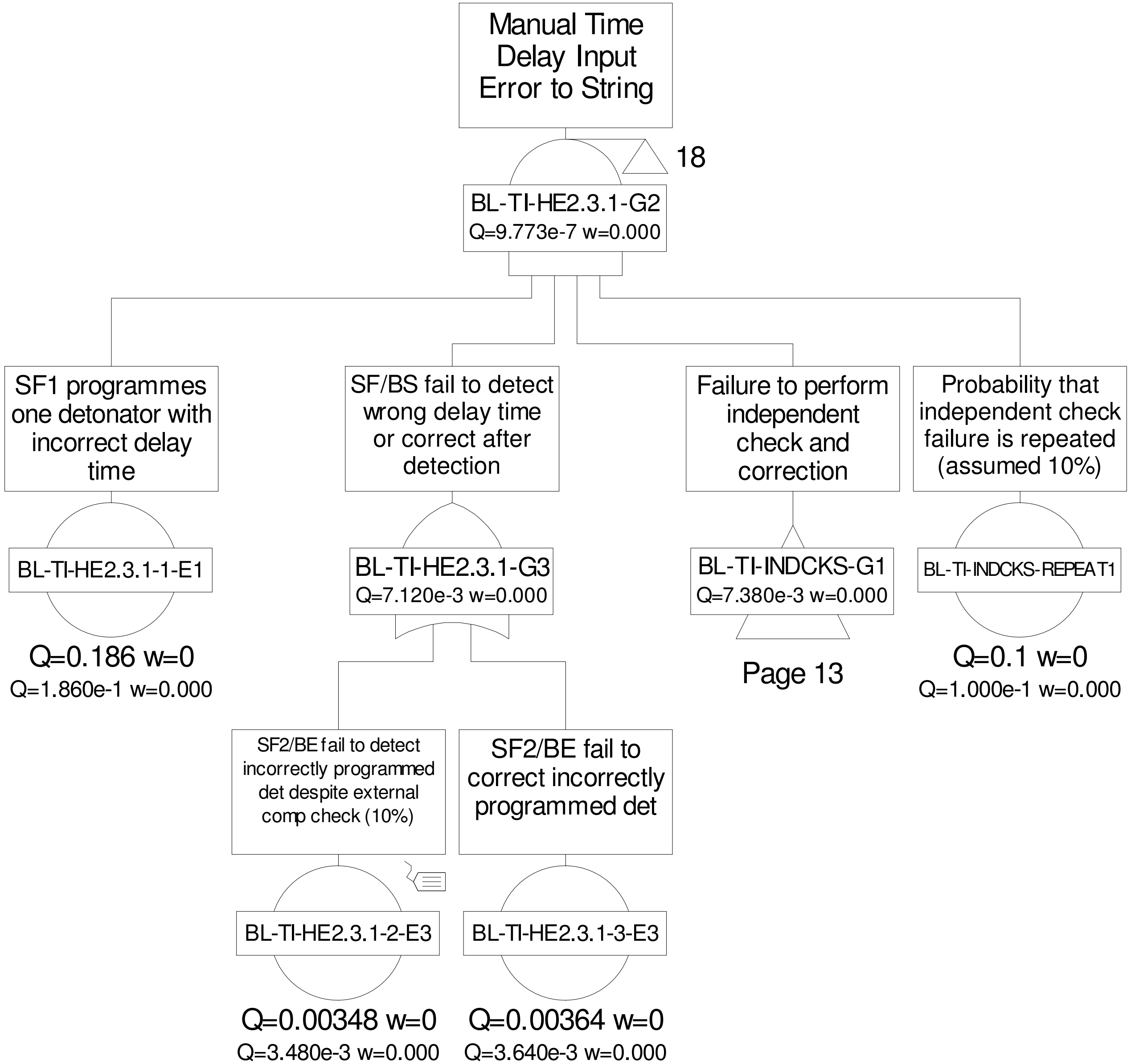

Detonator communication system fails and allows same time delay to be passed to 2nd det
4,14,20
BL-DE-G (1)
Q=1.264e-7 w=0.000
Comms failure with dets leading to same time delay passed to 2 dets in string (eg det does not disconnect)
BL-DE1-E
Q=0.001 w=0
Q=1.000e-3 w=0.000
SF2/BE fail to detect tagger error or correct after detection
BL-TG-RDMDETCOR
Q=1.713e-2 w=0.000
Page 12
Failure to perform independent check and correction
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13

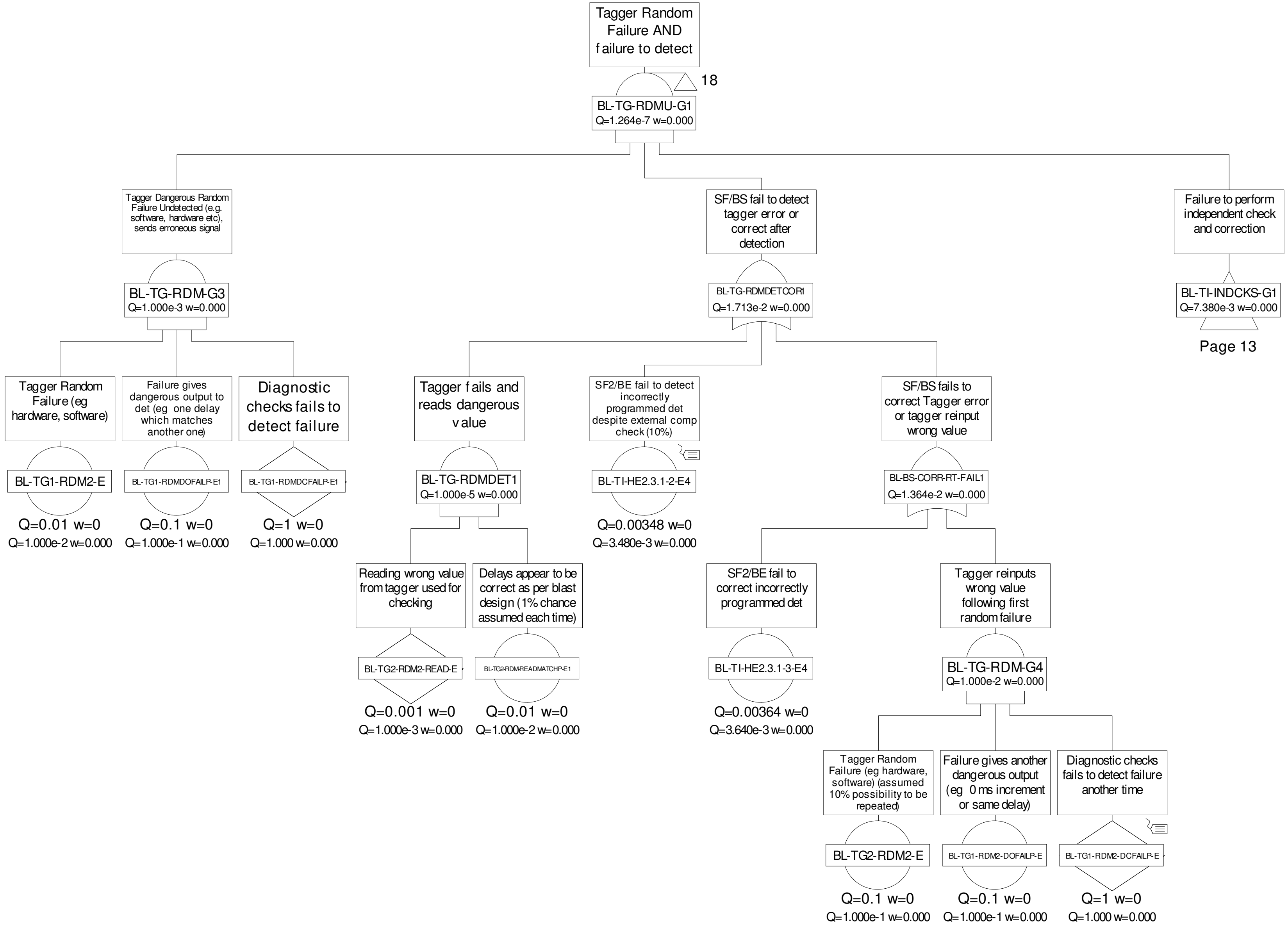

SF2/BE fail to detect tagger error or correct after detection
9,11
BL-TG-RDMDETCOR
Q=1.713e-2 w=0.000
Tagger fails and reads dangerous value
BL-TG-RDMDET
Q=1.000e-5 w=0.000
SF2/BE fail to detect incorrectly programmed det despite external comp check (10%)
BL-TI-HE2.3.1-2-E2
Q=0.00348 w=0
Q=3.480e-3 w=0.000
SF/BS fails to correct Tagger error or tagger reinput wrong value
BL-BS-CORR-RT-FAIL
Q=1.364e-2 w=0.000
Reading wrong value from tagger used for checking
BL-TG2-RDM1-READ-E
Q=0.001 w=0
Q=1.000e-3 w=0.000
Delays appear to be correct as per blast design (1% chance assumed each time)
BL-TG2-RDM-READMATCHP-E0
Q=0.01 w=0
Q=1.000e-2 w=0.000
SF2/BE fail to correct incorrectly programmed det
BL-TI-HE2.3.1-3-E2
Q=0.00364 w=0
Q=3.640e-3 w=0.000
Tagger reinputs wrong value following first random failure
BL-TG-RDM-G2
Q=1.000e-2 w=0.000
Tagger Random Failure (eg hardware, software) (assumed 10% possibility to be repeated)
BL-TG2-RDM1-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Failure gives another dangerous output (eg 0 ms increment or same delay)
BL-TG1-RDM1-DOFAILP-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Diagnostic checks fails to detect failure another time
BL-TG1-RDM1-DCFAILP-E
Q=1 w=0
Q=1.000 w=0.000



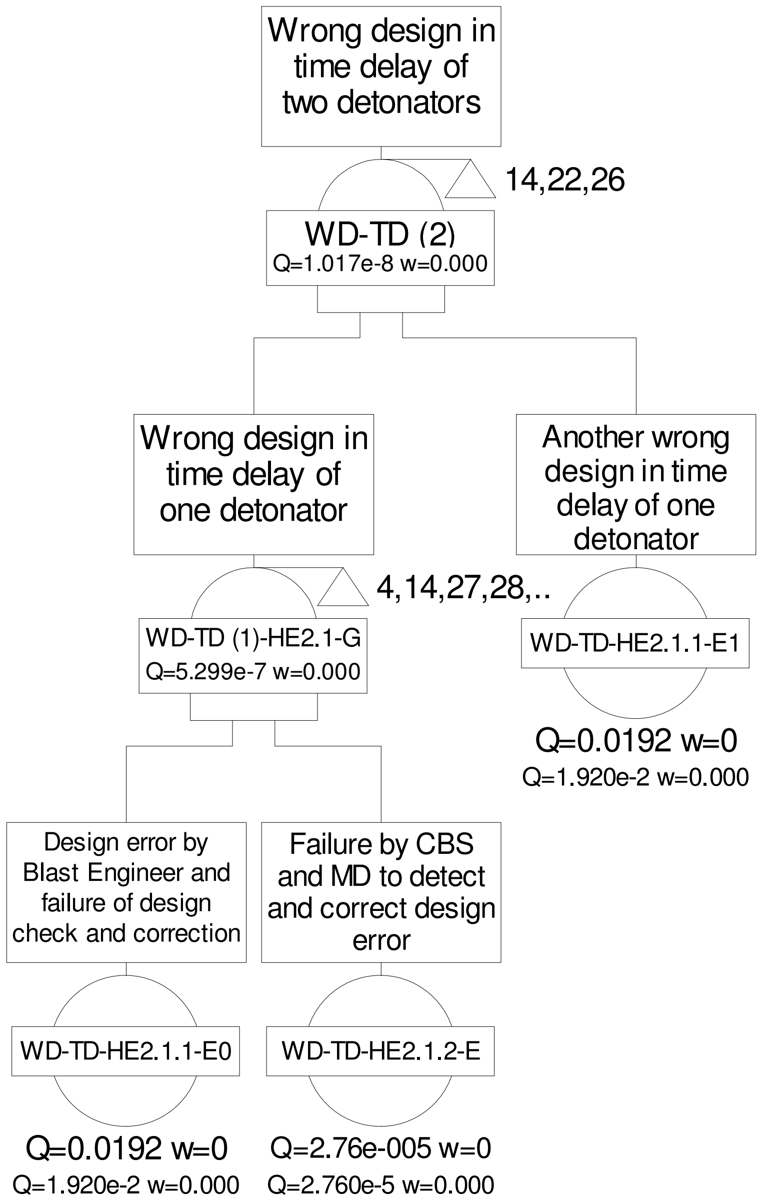
Failure to perform independent check and correction
8,9,10,11,15,16,23,24
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Independent Checker/SF fail to detect or correct after detection
BL-TI-HE2.7.1-G1
Q=7.280e-3 w=0.000
Falure to display incorrect time delay from detonators or bench box
BL-TI-BB
Q=0.0001 w=0
Q=1.000e-4 w=0.000
CBS/SFs fail to detect string is programmed incorrectly
BL-TI-HE2.7.1-1-E
Q=0.00364 w=0
Q=3.640e-3 w=0.000
CBS/SFs fail to correct incorrectly programmed string
BL-TI-HE2.7.1-2-E
Q=0.00364 w=0
Q=3.640e-3 w=0.000

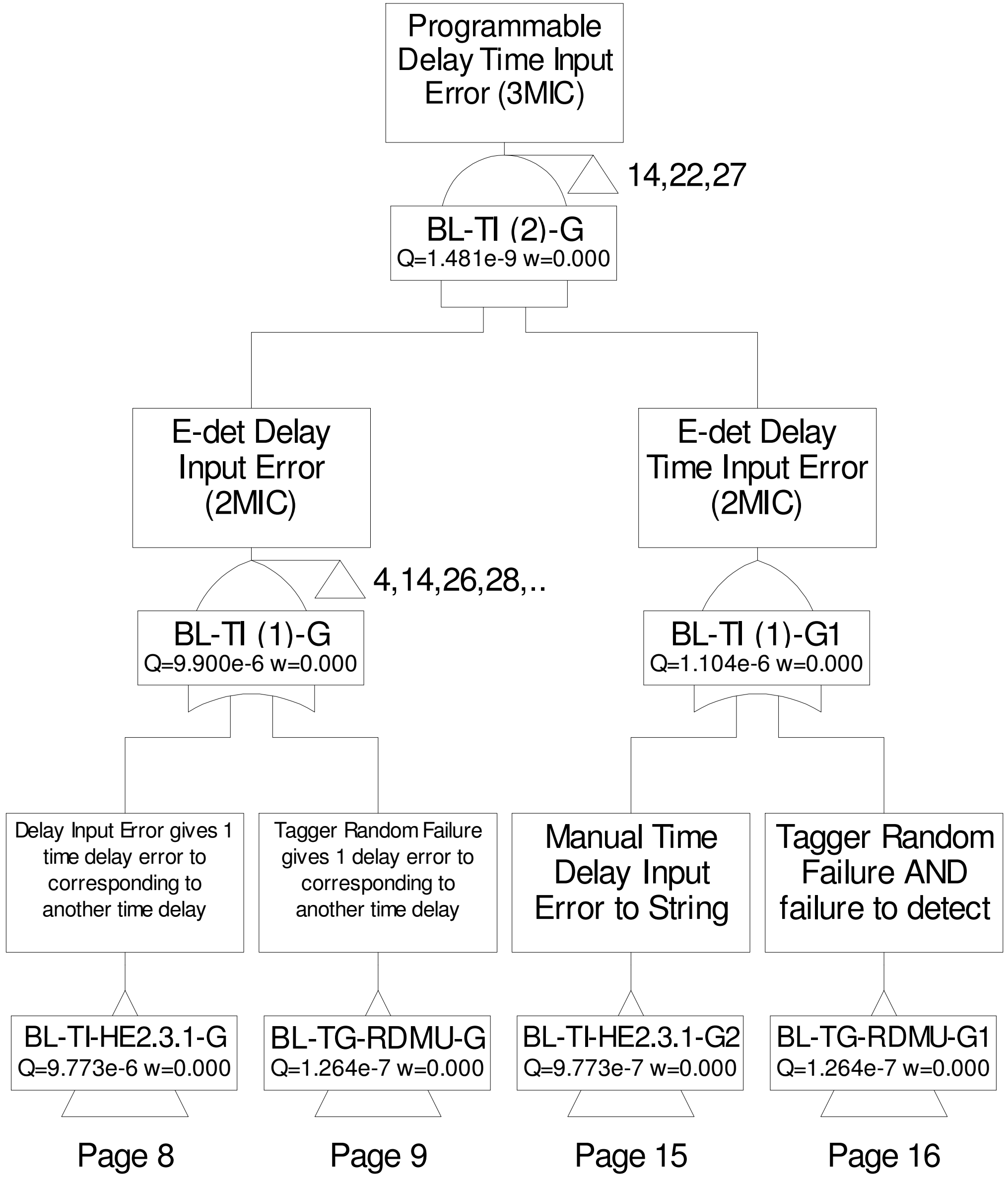

Higher vibration due to 3 MIC detonated at the same time
3-MIC
Q=1.453e-8 w=0.000
3 MIC detonated at the same time (due to combination of two type of errors)
2
COMB1 (2)
Q=7.171e-10 w=0.000
Wrong design in time delay of two detonators
WD-TD (2)
Q=1.017e-8 w=0.000
Page 17
Programmable Delay Time Input Error (3MIC)
BL-TI (2)-G
Q=1.481e-9 w=0.000
Page 18
Marker/Starter Position Error or Wrong ID (3MIC)
BL-ME-G (2)
Q=1.649e-9 w=0.000
Page 19
Detonator communication system fails and allows same time delay to be passed to 3 dets
BL-DE-G (2)
Q=5.057e-10 w=0.000
Page 20
Wrong design in time delay of one detonator
4,17,27,28,..
WD-TD (1)-HE2.1-G
Q=5.299e-7 w=0.000
Overcharge of emulsion more than required which gives 2 MIC
4,26,27,28,..
OLC (1)-G
Q=1.238e-6 w=0.000
E-det Delay Input Error (2MIC)
4,18,26,28,..
BL-TI (1)-G
Q=9.900e-6 w=0.000
Marker/Starter Position Error or Wrong ID
BL-ME-G (1)
Q=2.976e-7 w=0.000
Page 10
Detonator communication system fails and allows same time delay to be passed to 2nd det
BL-DE-G (1)
Q=1.264e-7 w=0.000
Page 11
Design error by Blast Engineer and failure of design check and correction
WD-TD-HE2.1.1-E0
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Failure by CBS and MD to detect and correct design error
WD-TD-HE2.1.2-E
Q=2.76e-005 w=0
Q=2.760e-5 w=0.000
Too much bulk emulsion loaded into hole
OLB
Q=1.238e-6 w=0.000
Too much bulk emulsion loaded into hole
OLB-G1
Q=1.238e-6 w=0.000
Page 6
Delay Input Error gives 1 time delay error to corresponding to another time delay
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
Page 8
Tagger Random Failure gives 1 delay error to corresponding to another time delay
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
Page 9


Manual Time Delay Input Error to String
18
BL-TI-HE2.3.1-G2
Q=9.773e-7 w=0.000
SF1 programmes one detonator with incorrect delay time
BL-TI-HE2.3.1-1-E1
Q=0.186 w=0
Q=1.860e-1 w=0.000
SF/BS fail to detect wrong delay time or correct after detection
BL-TI-HE2.3.1-G3
Q=7.120e-3 w=0.000
Failure to perform independent check and correction
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13
Probability that independent check failure is repeated (assumed 10%)
BL-TI-INDCKS-REPEAT1
Q=0.1 w=0
Q=1.000e-1 w=0.000
SF2/BE fail to detect incorrectly programmed det despite external comp check (10%)
BL-TI-HE2.3.1-2-E3
Q=0.00348 w=0
Q=3.480e-3 w=0.000
SF2/BE fail to correct incorrectly programmed det
BL-TI-HE2.3.1-3-E3
Q=0.00364 w=0
Q=3.640e-3 w=0.000



Tagger Random Failure AND failure to detect
18
BL-TG-RDMU-G1
Q=1.264e-7 w=0.000
Tagger Dangerous Random Failure Undetected (e.g. software, hardware etc), sends erroneous signal
BL-TG-RDM-G3
Q=1.000e-3 w=0.000
SF/BS fail to detect tagger error or correct after detection
BL-TG-RDMDETCORI
Q=1.713e-2 w=0.000
Failure to perform independent check and correction
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13
Tagger Random Failure (eg hardware, software)
BL-TG1-RDM2-E
Q=0.01 w=0
Q=1.000e-2 w=0.000
Failure gives dangerous output to det (eg one delay which matches another one)
BL-TG1-RDMDOFAILP-E1
Q=0.1 w=0
Q=1.000e-1 w=0.000
Diagnostic checks fails to detect failure
BL-TG1-RDMDCFAILP-E1
Q=1 w=0
Q=1.000 w=0.000
Tagger fails and reads dangerous value
BL-TG-RDMDET1
Q=1.000e-5 w=0.000
SF2/BE fail to detect incorrectly programmed det despite external comp check (10%)
BL-TI-HE2.3.1-2-E4
Q=0.00348 w=0
Q=3.480e-3 w=0.000
SF/BS fails to correct Tagger error or tagger reinput wrong value
BL-BS-CORR-RT-FAIL1
Q=1.364e-2 w=0.000
Reading wrong value from tagger used for checking
BL-TG2-RDM2-READ-E
Q=0.001 w=0
Q=1.000e-3 w=0.000
Delays appear to be correct as per blast design (1% chance assumed each time)
BL-TG2-RDMREADMATCHP-E1
Q=0.01 w=0
Q=1.000e-2 w=0.000
SF2/BE fail to correct incorrectly programmed det
BL-TI-HE2.3.1-3-E4
Q=0.00364 w=0
Q=3.640e-3 w=0.000
Tagger reinputs wrong value following first random failure
BL-TG-RDM-G4
Q=1.000e-2 w=0.000
Tagger Random Failure (eg hardware, software) (assumed 10% possibility to be repeated)
BL-TG2-RDM2-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Failure gives another dangerous output (eg 0 ms increment or same delay)
BL-TG1-RDM2-DOFAILP-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Diagnostic checks fails to detect failure another time
BL-TG1-RDM2-DCFAILP-E
Q=1 w=0
Q=1.000 w=0.000


Wrong design in time delay of two detonators
14,22,26
WD-TD (2)
Q=1.017e-8 w=0.000
Wrong design in time delay of one detonator
4,14,27,28,..
WD-TD (1)-HE2.1-G
Q=5.299e-7 w=0.000
Another wrong design in time delay of one detonator
WD-TD-HE2.1.1-E1
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Design error by Blast Engineer and failure of design check and correction
WD-TD-HE2.1.1-E0
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Failure by CBS and MD to detect and correct design error
WD-TD-HE2.1.2-E
Q=2.76e-005 w=0
Q=2.760e-5 w=0.000


Programmable Delay Time Input Error (3MIC)
14,22,27
BL-TI (2)-G
Q=1.481e-9 w=0.000
E-det Delay Input Error (2MIC)
4,14,26,28,..
E-det Delay Time Input Error (2MIC)
BL-TI (1)-G
Q=9.900e-6 w=0.000
BL-TI (1)-G1
Q=1.104e-6 w=0.000
Delay Input Error gives 1 time delay error to corresponding to another time delay
Tagger Random Failure gives 1 delay error to corresponding to another time delay
Manual Time Delay Input Error to String
Tagger Random Failure AND failure to detect
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
BL-TI-HE2.3.1-G2
Q=9.773e-7 w=0.000
BL-TG-RDMU-G1
Q=1.264e-7 w=0.000
Page 8
Page 9
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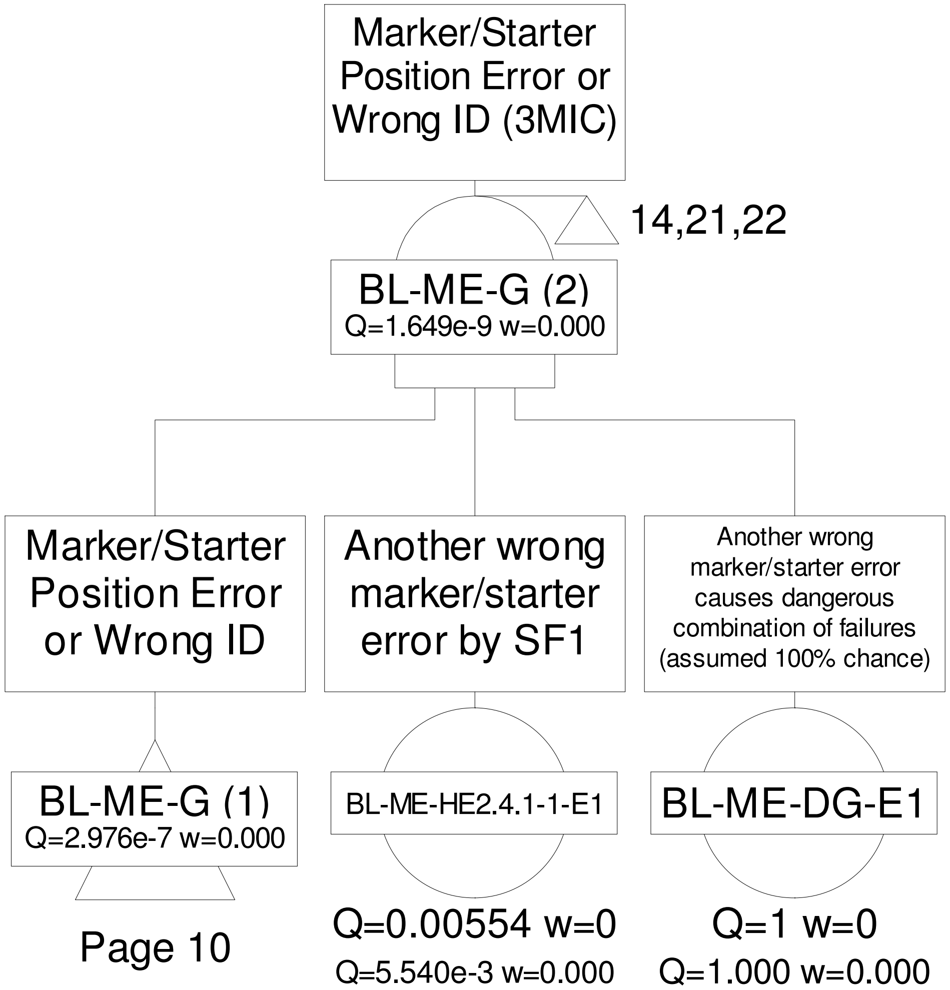
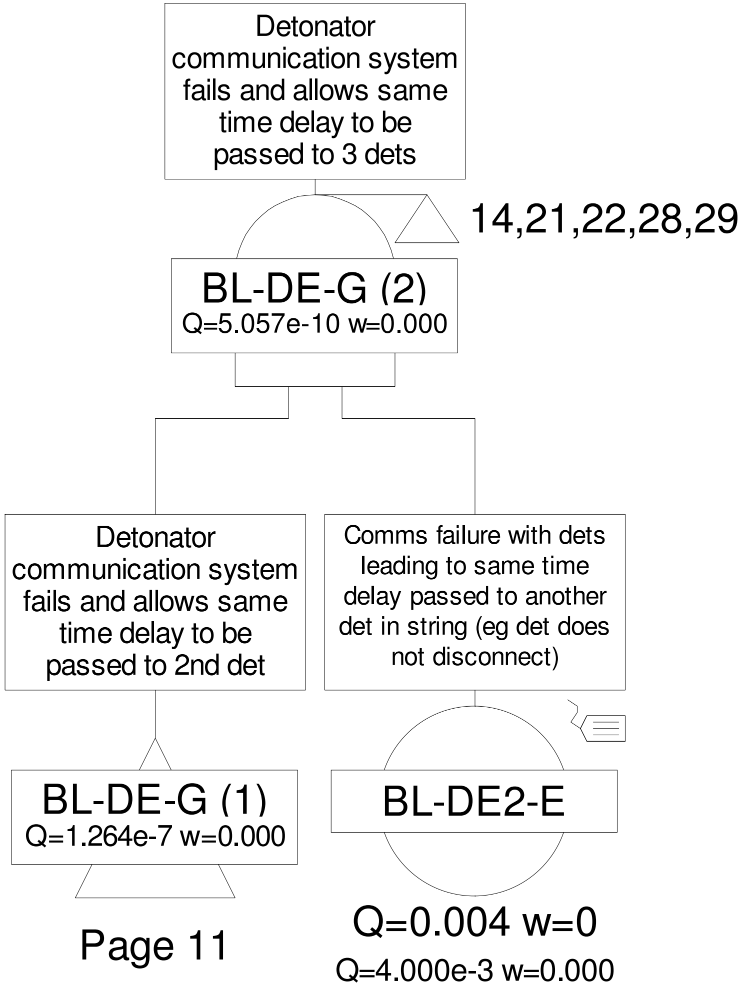
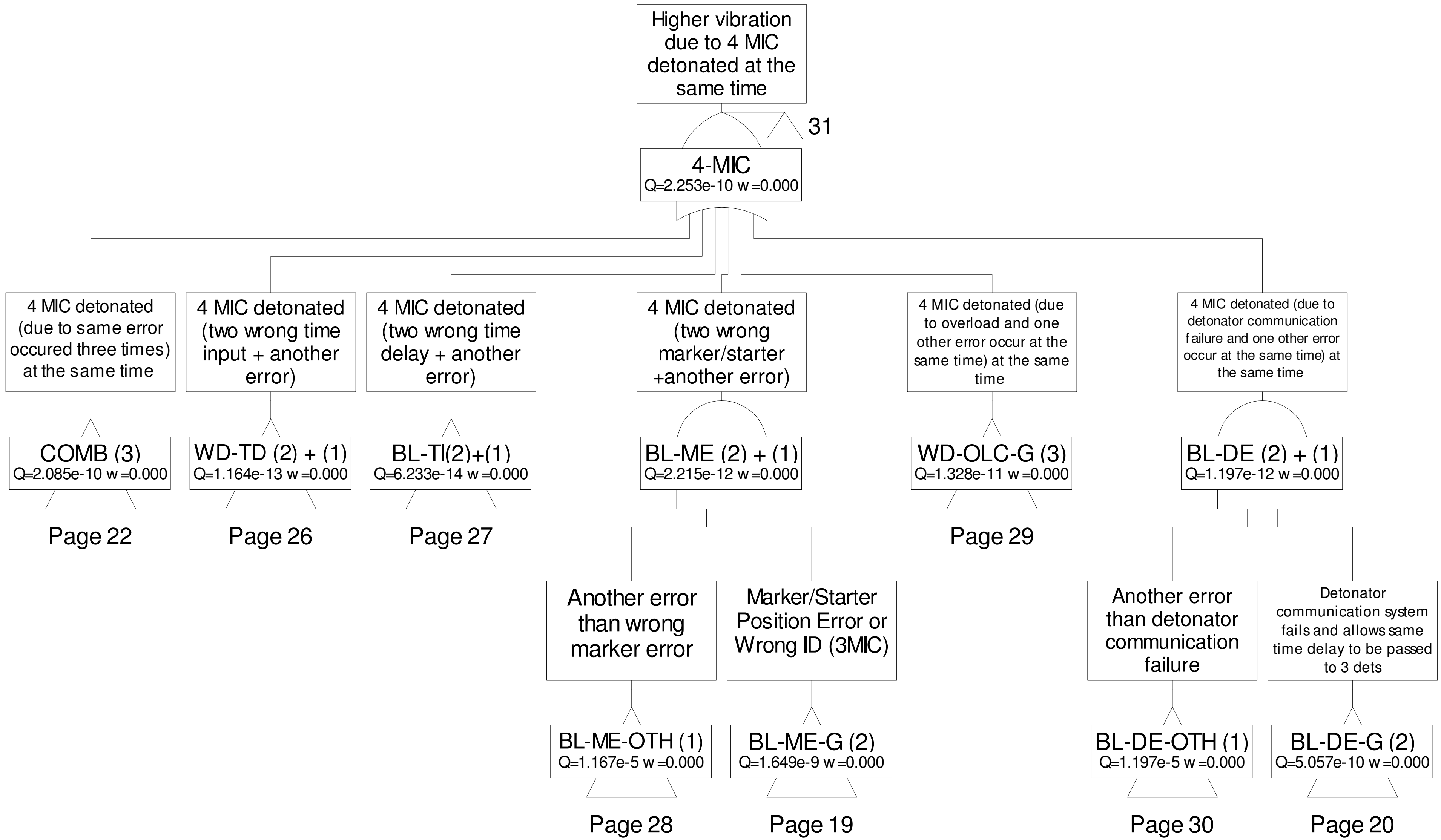
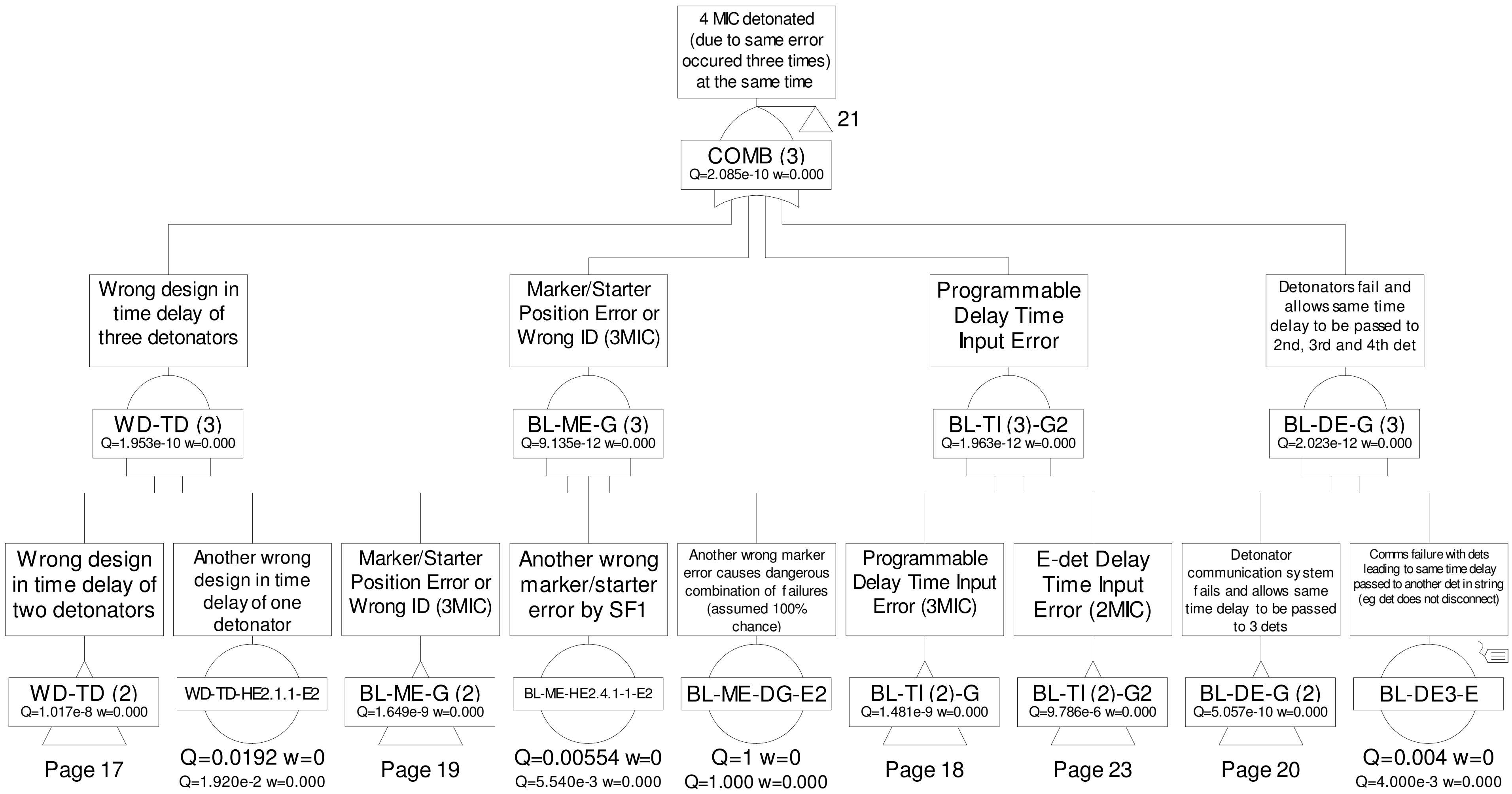
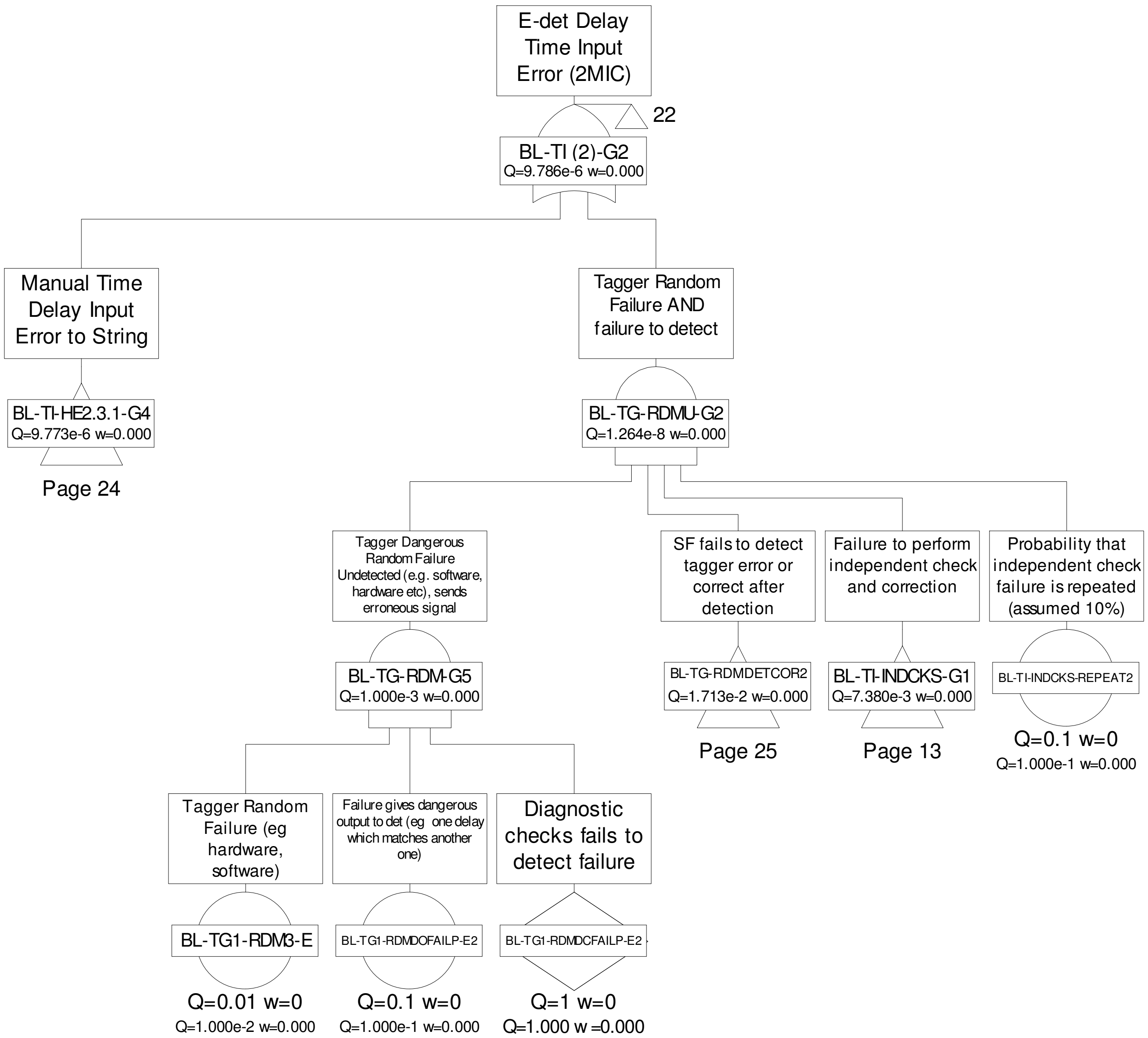


Marker/Starter Position Error or Wrong ID (3MIC)
14,21,22
BL-ME-G (2)
Q=1.649e-9 w=0.000
Marker/Starter Position Error or Wrong ID
Another wrong marker/starter error by SF1
Another wrong marker/starter error causes dangerous combination of failures (assumed 100% chance)
BL-ME-G (1)
Q=2.976e-7 w=0.000
BL-ME-HE2.4.1-1-E1
BL-ME-DG-E1
Page 10
Q=0.00554 w=0
Q=5.540e-3 w=0.000
Q=1 w=0
Q=1.000 w=0.000

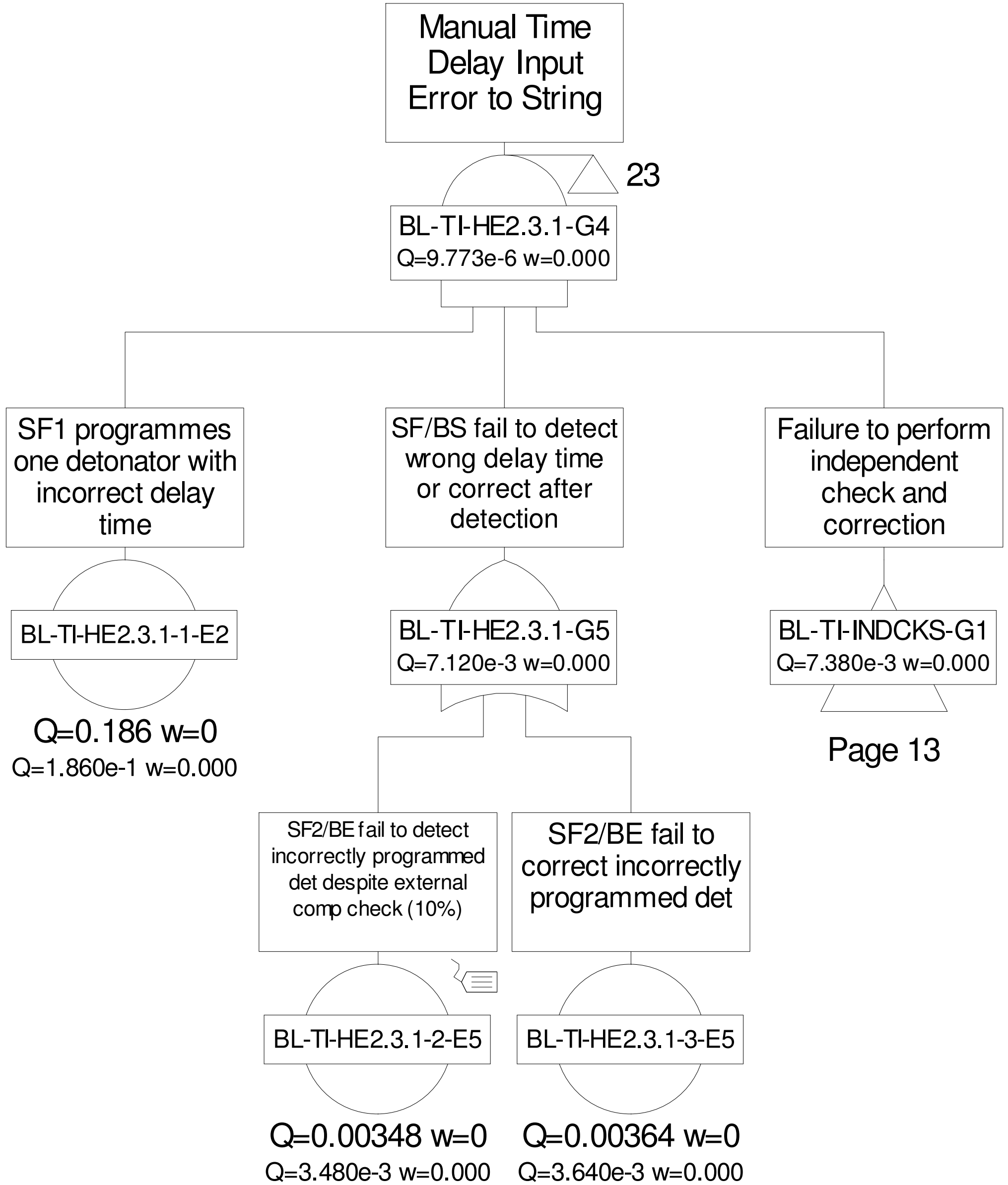

Detonator communication system fails and allows same time delay to be passed to 3 dets
14,21,22,28,29
BL-DE-G (2)
Q=5.057e-10 w=0.000
Detonator communication system fails and allows same time delay to be passed to 2nd det
Comms failure with dets leading to same time delay passed to another det in string (eg det does not disconnect)
BL-DE-G (1)
Q=1.264e-7 w=0.000
BL-DE2-E
Page 11
Q=0.004 w=0
Q=4.000e-3 w=0.000

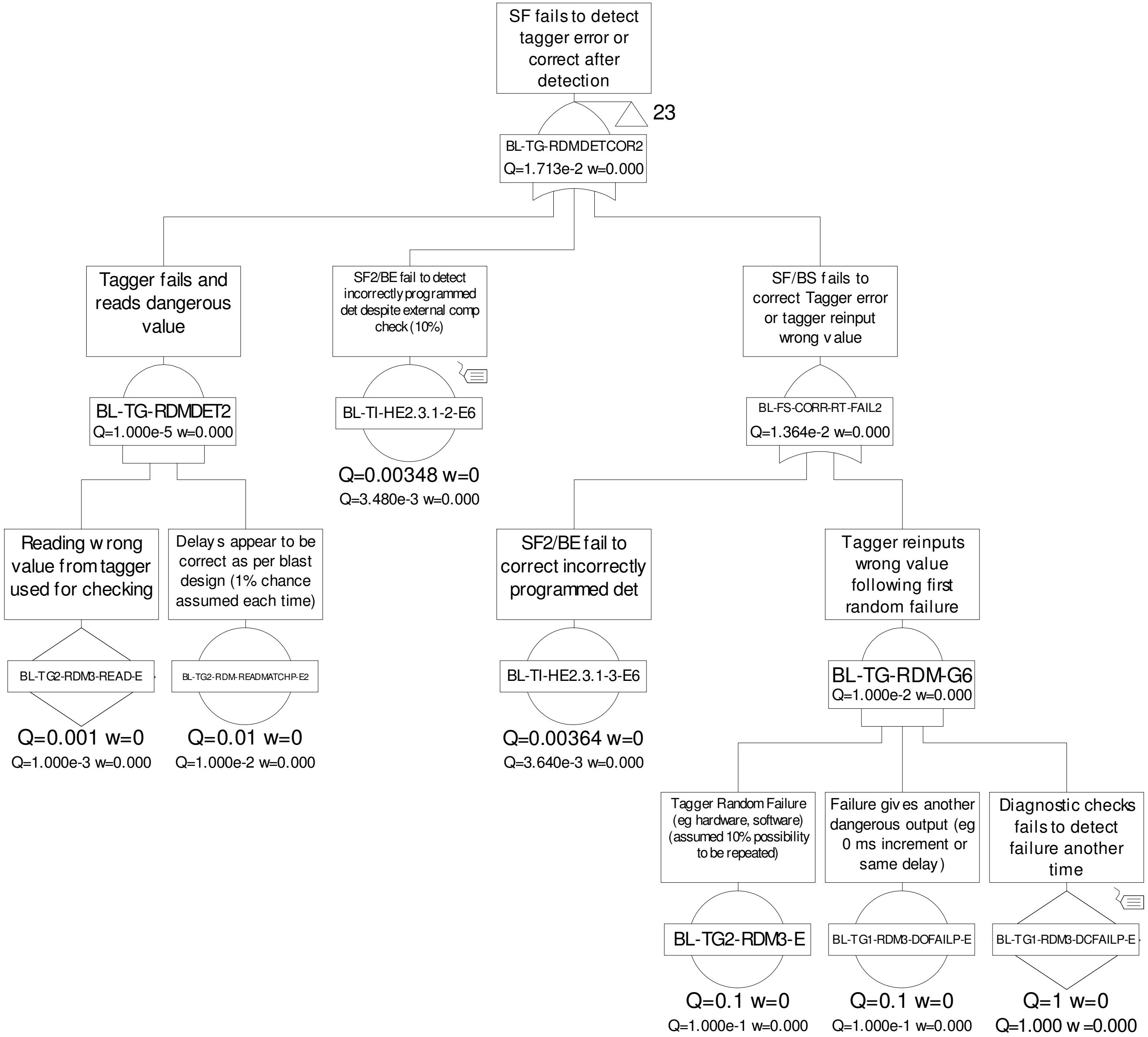

Higher vibration due to 4 MIC detonated at the same time
31
4-MIC
Q=2.253e-10 w=0.000
4 MIC detonated (due to same error occured three times) at the same time
4 MIC detonated (two wrong time input + another error)
4 MIC detonated (two wrong time delay + another error)
4 MIC detonated (two wrong marker/starter +another error)
4 MIC detonated (due to overload and one other error occur at the same time) at the same time
4 MIC detonated (due to detonator communication failure and one other error occur at the same time) at the same time
COMB (3)
Q=2.085e-10 w=0.000
WD-TD (2) + (1)
Q=1.164e-13 w=0.000
BL-TI(2)+(1)
Q=6.233e-14 w=0.000
BL-ME (2) + (1)
Q=2.215e-12 w=0.000
WD-OLC-G (3)
Q=1.328e-11 w=0.000
BL-DE (2) + (1)
Q=1.197e-12 w=0.000
Page 22
Page 26
Page 27
Page 29
Another error than wrong marker error
Marker/Starter Position Error or Wrong ID (3MIC)
Another error than detonator communication failure
Detonator communication system fails and allows same time delay to be passed to 3 dets
BL-ME-OTH (1)
Q=1.167e-5 w=0.000
BL-ME-G (2)
Q=1.649e-9 w=0.000
BL-DE-OTH (1)
Q=1.197e-5 w=0.000
BL-DE-G (2)
Q=5.057e-10 w=0.000
Page 28
Page 19
Page 30
Page 20


4 MIC detonated (due to same error occured three times) at the same time
21
COMB (3)
Q=2.085e-10 w=0.000
Wrong design in time delay of three detonators
WD-TD (3)
Q=1.953e-10 w=0.000
Marker/Starter Position Error or Wrong ID (3MIC)
BL-ME-G (3)
Q=9.135e-12 w=0.000
Programmable Delay Time Input Error
BL-TI (3)-G2
Q=1.963e-12 w=0.000
Detonators fail and allows same time delay to be passed to 2nd, 3rd and 4th det
BL-DE-G (3)
Q=2.023e-12 w=0.000
Wrong design in time delay of two detonators
WD-TD (2)
Q=1.017e-8 w=0.000
Page 17
Another wrong design in time delay of one detonator
WD-TD-HE2.1.1-E2
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Marker/Starter Position Error or Wrong ID (3MIC)
BL-ME-G (2)
Q=1.649e-9 w=0.000
Page 19
Another wrong marker/starter error by SF1
BL-ME-HE2.4.1-1-E2
Q=0.00554 w=0
Q=5.540e-3 w=0.000
Another wrong marker error causes dangerous combination of failures (assumed 100% chance)
BL-ME-DG-E2
Q=1 w=0
Q=1.000 w=0.000
Programmable Delay Time Input Error (3MIC)
BL-TI (2)-G
Q=1.481e-9 w=0.000
Page 18
E-det Delay Time Input Error (2MIC)
BL-TI (2)-G2
Q=9.786e-6 w=0.000
Page 23
Detonator communication system fails and allows same time delay to be passed to 3 dets
BL-DE-G (2)
Q=5.057e-10 w=0.000
Page 20
Comms failure with dets leading to same time delay passed to another det in string (eg det does not disconnect)
BL-DE3-E
Q=0.004 w=0
Q=4.000e-3 w=0.000

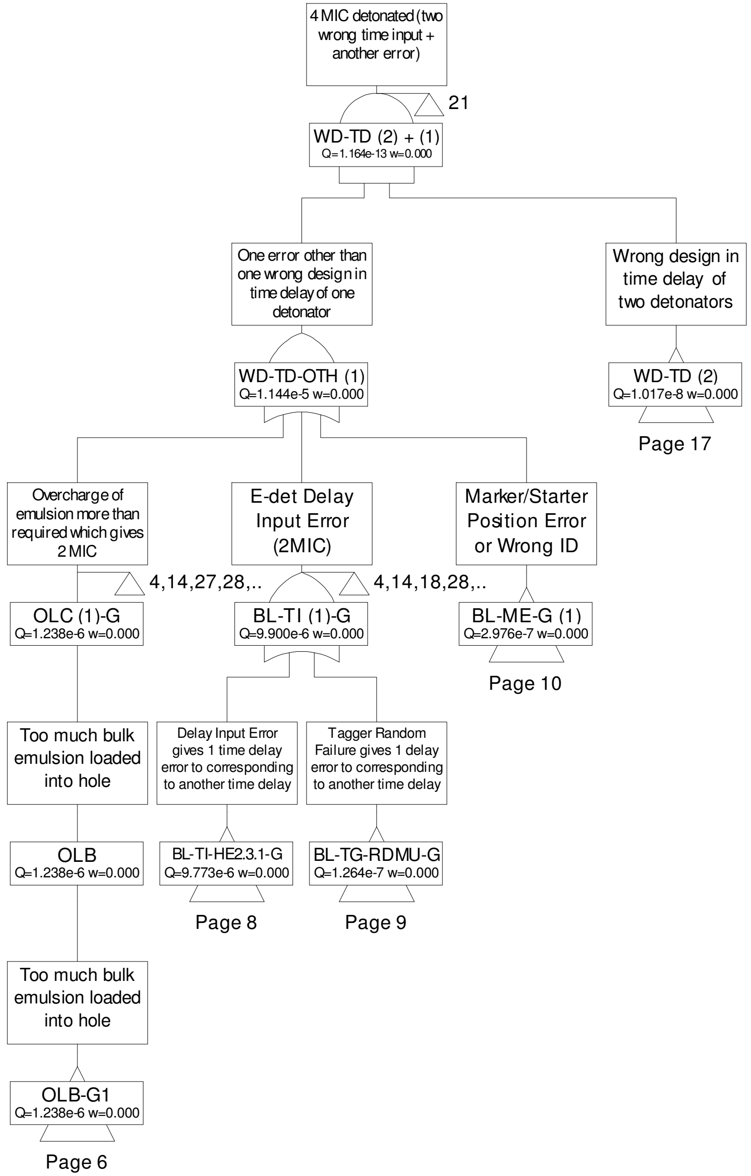


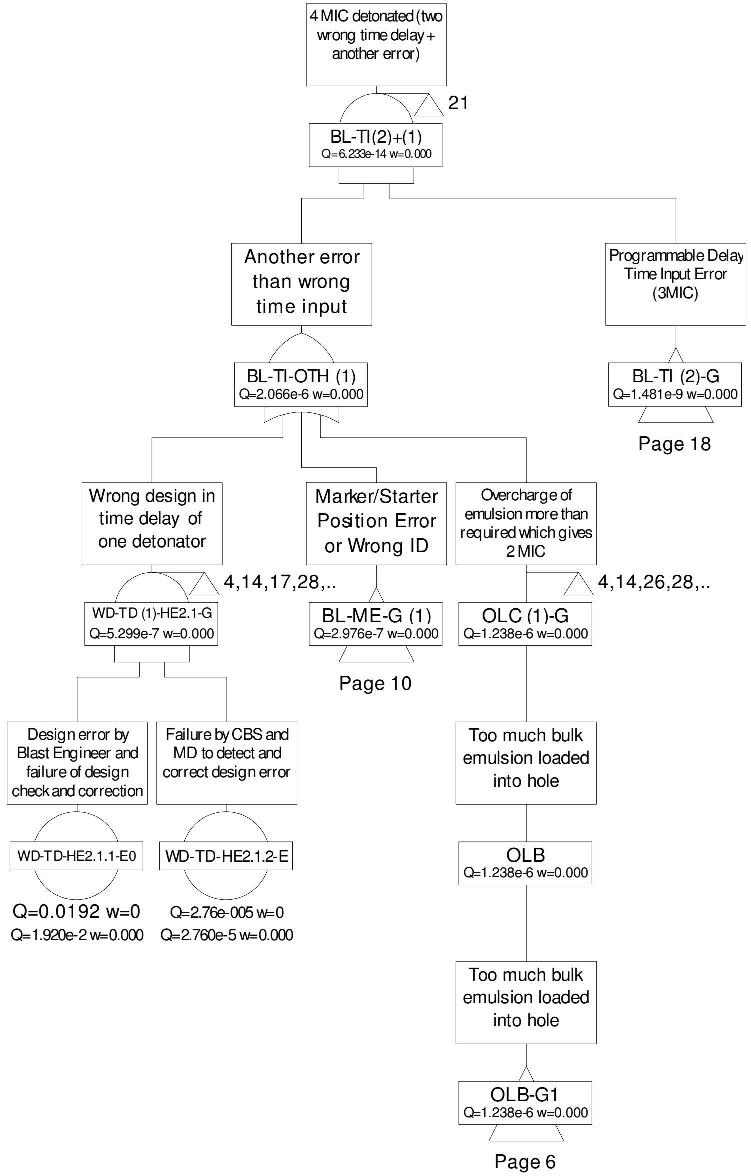
E-det Delay Time Input Error (2MIC)
22
BL-TI (2)-G2
Q=9.786e-6 w=0.000
Manual Time Delay Input Error to String
BL-TI-HE2.3.1-G4
Q=9.773e-6 w=0.000
Page 24
Tagger Random Failure AND failure to detect
BL-TG-RDMU-G2
Q=1.264e-8 w=0.000
Tagger Dangerous Random Failure Undetected (e.g. software, hardware etc), sends erroneous signal
BL-TG-RDM-G5
Q=1.000e-3 w=0.000
SF fails to detect tagger error or correct after detection
BL-TG-RDMDETCOR2
Q=1.713e-2 w=0.000
Page 25
Failure to perform independent check and correction
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13
Probability that independent check failure is repeated (assumed 10%)
BL-TI-INDCKS-REPEAT2
Q=0.1 w=0
Q=1.000e-1 w=0.000
Tagger Random Failure (eg hardware, software)
BL-TG1-RDM3-E
Q=0.01 w=0
Q=1.000e-2 w=0.000
Failure gives dangerous output to det (eg one delay which matches another one)
BL-TG1-RDMDOFAILP-E2
Q=0.1 w=0
Q=1.000e-1 w=0.000
Diagnostic checks fails to detect failure
BL-TG1-RDMDCFAILP-E2
Q=1 w=0
Q=1.000 w =0.000


Manual Time Delay Input Error to String
23
BL-TI-HE2.3.1-G4
Q=9.773e-6 w=0.000
SF1 programmes one detonator with incorrect delay time
BL-TI-HE2.3.1-1-E2
Q=0.186 w=0
Q=1.860e-1 w=0.000
SF/BS fail to detect wrong delay time or correct after detection
BL-TI-HE2.3.1-G5
Q=7.120e-3 w=0.000
Failure to perform independent check and correction
BL-TI-INDCKS-G1
Q=7.380e-3 w=0.000
Page 13
SF2/BE fail to detect incorrectly programmed det despite external comp check (10%)
BL-TI-HE2.3.1-2-E5
Q=0.00348 w=0
Q=3.480e-3 w=0.000
SF2/BE fail to correct incorrectly programmed det
BL-TI-HE2.3.1-3-E5
Q=0.00364 w=0
Q=3.640e-3 w=0.000

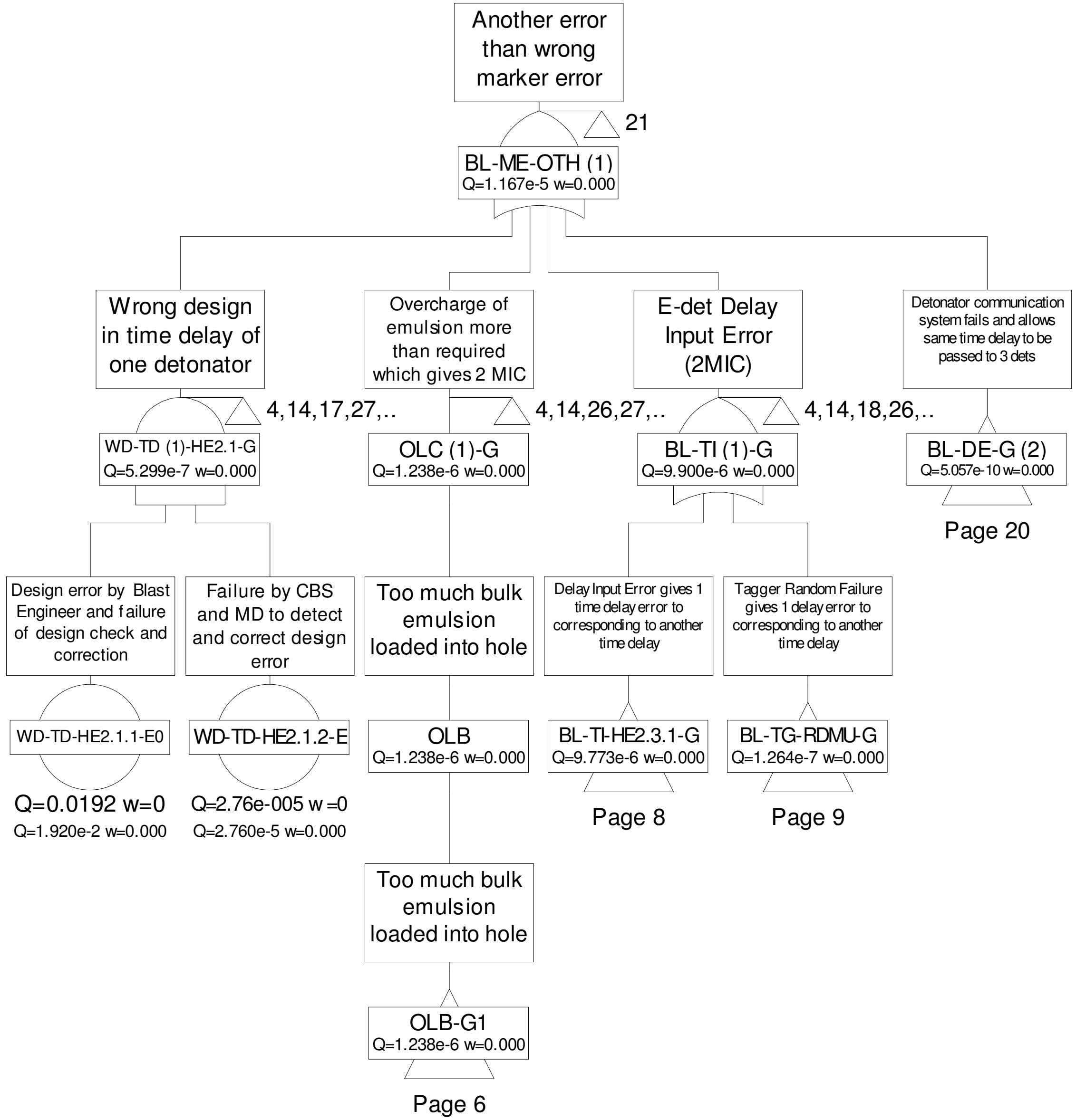


SF fails to detect tagger error or correct after detection
23
BL-TG-RDMDETCOR2
Q=1.713e-2 w=0.000
Tagger fails and reads dangerous value
BL-TG-RDMDET2
Q=1.000e-5 w=0.000
SF2/BE fail to detect incorrectly programmed det despite external comp check (10%)
BL-TI-HE2.3.1-2-E6
Q=0.00348 w=0
Q=3.480e-3 w=0.000
SF/BS fails to correct Tagger error or tagger reinput wrong value
BL-FS-CORR-RT-FAIL2
Q=1.364e-2 w=0.000
Reading wrong value from tagger used for checking
BL-TG2-RDM3-READ-E
Q=0.001 w=0
Q=1.000e-3 w=0.000
Delays appear to be correct as per blast design (1% chance assumed each time)
BL-TG2-RDM-READMATCHP-E2
Q=0.01 w=0
Q=1.000e-2 w=0.000
SF2/BE fail to correct incorrectly programmed det
BL-TI-HE2.3.1-3-E6
Q=0.00364 w=0
Q=3.640e-3 w=0.000
Tagger reinputs wrong value following first random failure
BL-TG-RDM-G6
Q=1.000e-2 w=0.000
Tagger Random Failure (eg hardware, software) (assumed 10% possibility to be repeated)
BL-TG2-RDM3-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Failure gives another dangerous output (eg 0 ms increment or same delay)
BL-TG1-RDM3-DOFAILP-E
Q=0.1 w=0
Q=1.000e-1 w=0.000
Diagnostic checks fails to detect failure another time
BL-TG1-RDM3-DCFAILP-E
Q=1 w=0
Q=1.000 w=0.000

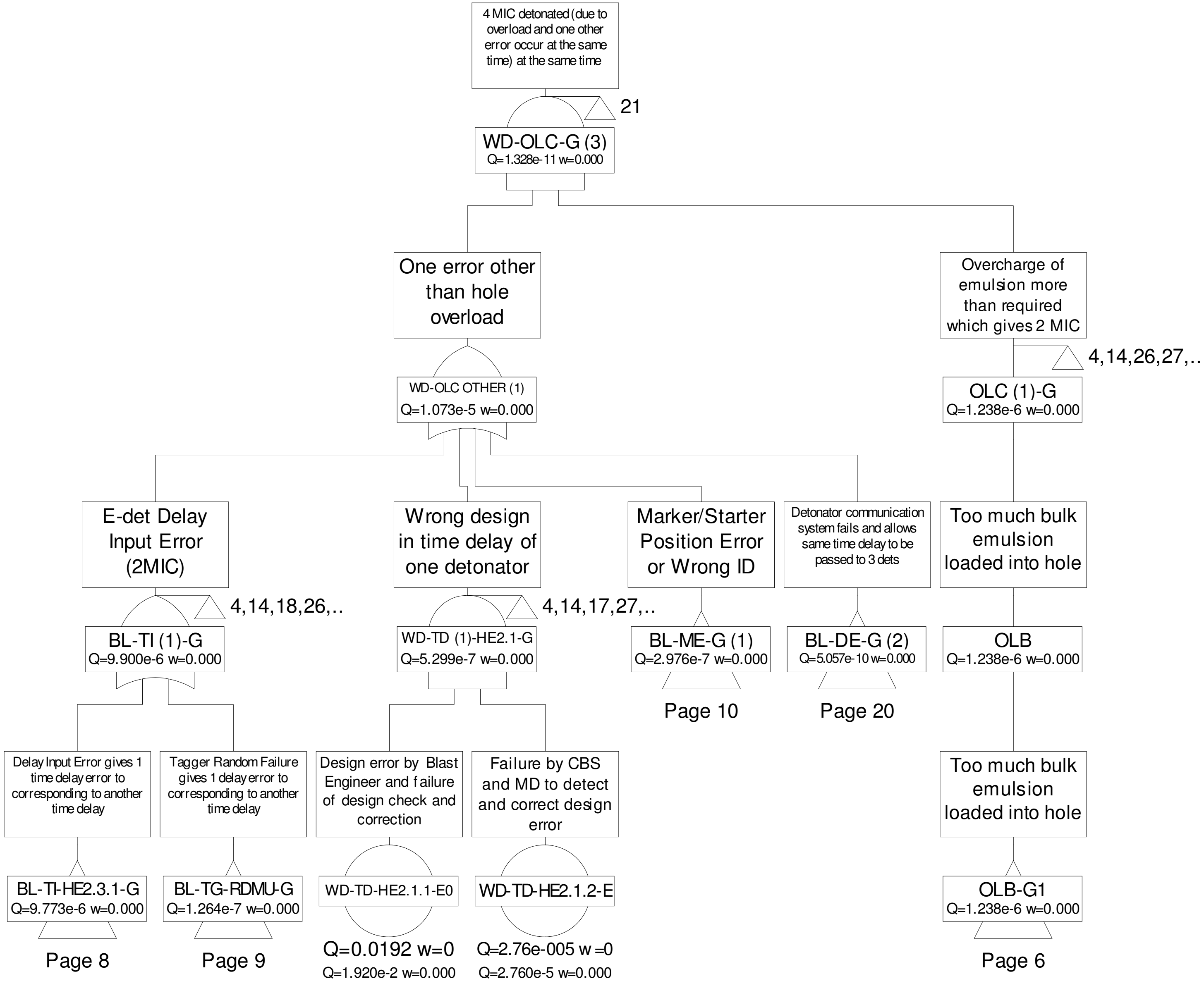

4 MIC detonated (two wrong time input + another error)
21
WD-TD (2) + (1)
Q=1.164e-13 w=0.000
One error other than one wrong design in time delay of one detonator
Wrong design in time delay of two detonators
WD-TD-OTH (1)
Q=1.144e-5 w=0.000
WD-TD (2)
Q=1.017e-8 w=0.000
Page 17
Overcharge of emulsion more than required which gives 2 MIC
E-det Delay Input Error (2MIC)
Marker/Starter Position Error or Wrong ID
4,14,27,28,..
4,14,18,28,..
OLC (1)-G
Q=1.238e-6 w=0.000
BL-TI (1)-G
Q=9.900e-6 w=0.000
BL-ME-G (1)
Q=2.976e-7 w=0.000
Page 10
Too much bulk emulsion loaded into hole
Delay Input Error gives 1 time delay error to corresponding to another time delay
Tagger Random Failure gives 1 delay error to corresponding to another time delay
OLB
Q=1.238e-6 w=0.000
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
Page 8
Page 9
Too much bulk emulsion loaded into hole
OLB-G1
Q=1.238e-6 w=0.000
Page 6

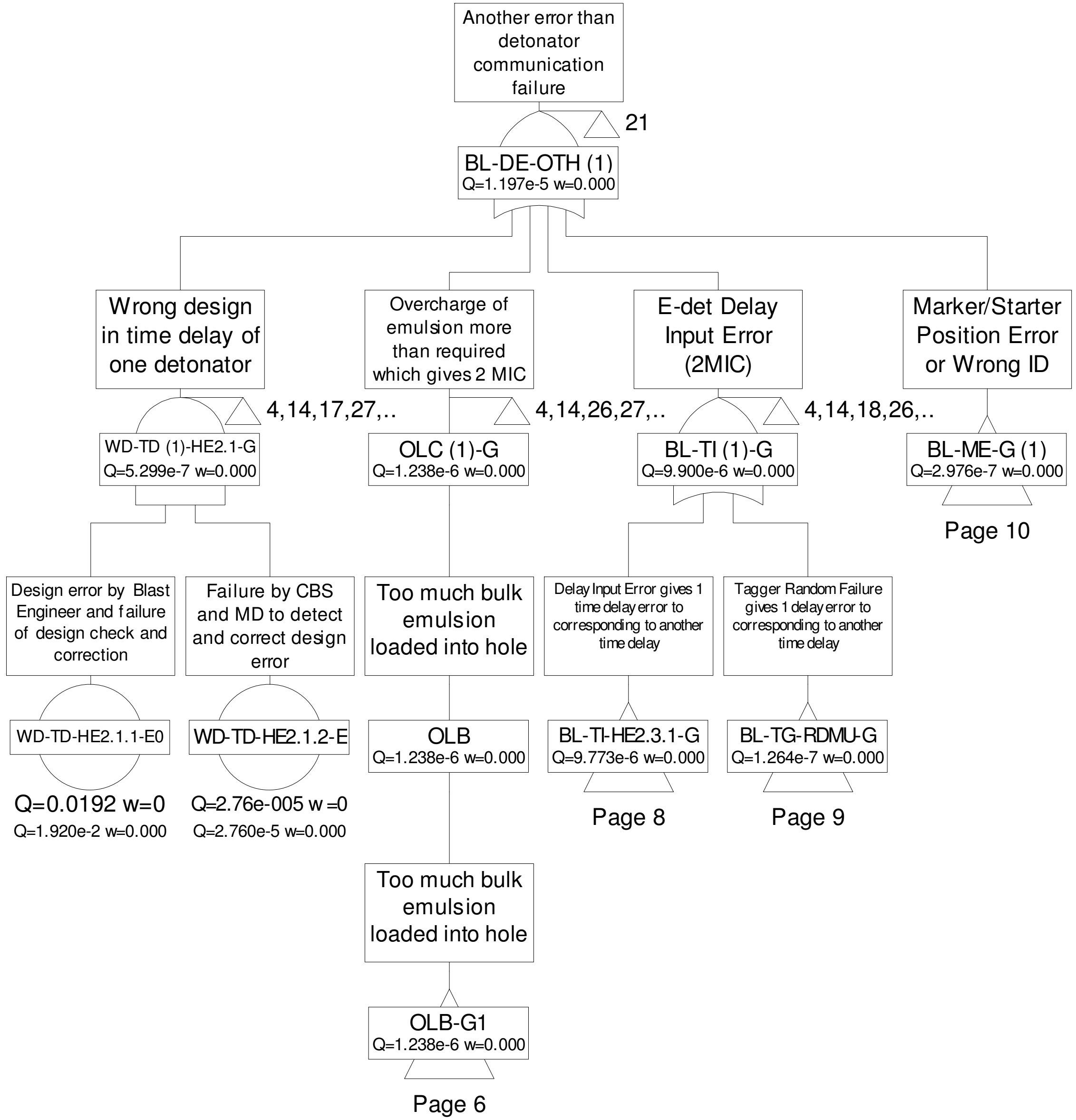


4 MIC detonated (two wrong time delay + another error)
21
BL-TI(2)+(1)
Q=6.233e-14 w=0.000
Another error than wrong time input
BL-TI-OTH (1)
Q=2.066e-6 w=0.000
Programmable Delay Time Input Error (3MIC)
BL-TI (2)-G
Q=1.481e-9 w=0.000
Page 18
Wrong design in time delay of one detonator
4,14,17,28,..
WD-TD (1)-HE2.1-G
Q=5.299e-7 w=0.000
Marker/Starter Position Error or Wrong ID
BL-ME-G (1)
Q=2.976e-7 w=0.000
Page 10
Overcharge of emulsion more than required which gives 2 MIC
4,14,26,28,..
OLC (1)-G
Q=1.238e-6 w=0.000
Design error by Blast Engineer and failure of design check and correction
WD-TD-HE2.1.1-E0
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Failure by CBS and MD to detect and correct design error
WD-TD-HE2.1.2-E
Q=2.76e-005 w=0
Q=2.760e-5 w=0.000
Too much bulk emulsion loaded into hole
OLB
Q=1.238e-6 w=0.000
Too much bulk emulsion loaded into hole
OLB-G1
Q=1.238e-6 w=0.000
Page 6

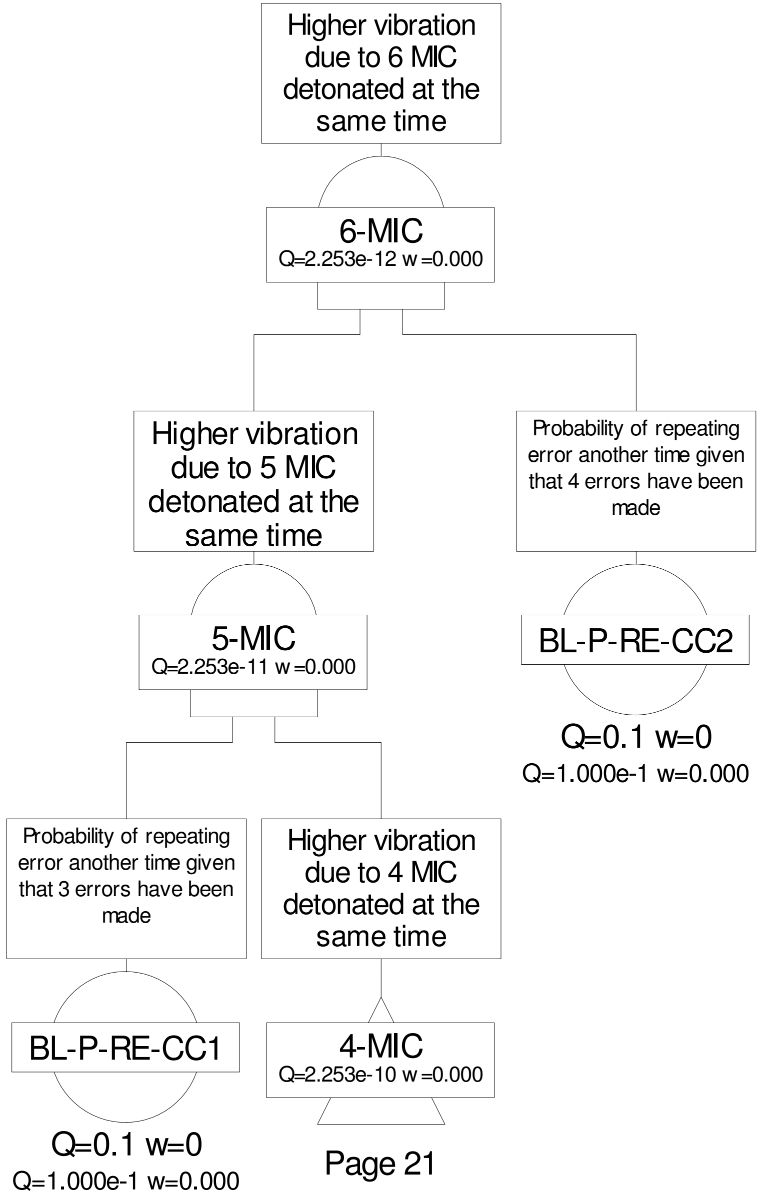


Another error than wrong marker error
21
BL-ME-OTH (1)
Q=1.167e-5 w=0.000
Wrong design in time delay of one detonator
4,14,17,27,..
WD-TD (1)-HE2.1-G
Q=5.299e-7 w=0.000
Overcharge of emulsion more than required which gives 2 MIC
4,14,26,27,..
OLC (1)-G
Q=1.238e-6 w=0.000
E-det Delay Input Error (2MIC)
4,14,18,26,..
BL-TI (1)-G
Q=9.900e-6 w=0.000
Detonator communication system fails and allows same time delay to be passed to 3 dets
BL-DE-G (2)
Q=5.057e-10 w=0.000
Page 20
Design error by Blast Engineer and failure of design check and correction
WD-TD-HE2.1.1-E0
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Failure by CBS and MD to detect and correct design error
WD-TD-HE2.1.2-E
Q=2.76e-005 w =0
Q=2.760e-5 w=0.000
Too much bulk emulsion loaded into hole
OLB
Q=1.238e-6 w=0.000
Too much bulk emulsion loaded into hole
OLB-G1
Q=1.238e-6 w=0.000
Page 6
Delay Input Error gives 1 time delay error to corresponding to another time delay
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
Page 8
Tagger Random Failure gives 1 delay error to corresponding to another time delay
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
Page 9


4 MIC detonated (due to overload and one other error occur at the same time) at the same time
21
WD-OLC-G (3)
Q=1.328e-11 w=0.000
One error other than hole overload
WD-OLC OTHER (1)
Q=1.073e-5 w=0.000
Overcharge of emulsion more than required which gives 2 MIC
4,14,26,27,..
OLC (1)-G
Q=1.238e-6 w=0.000
E-det Delay Input Error (2MIC)
4,14,18,26,..
BL-TI (1)-G
Q=9.900e-6 w=0.000
Wrong design in time delay of one detonator
4,14,17,27,..
WD-TD (1)-HE2.1-G
Q=5.299e-7 w=0.000
Marker/Starter Position Error or Wrong ID
BL-ME-G (1)
Q=2.976e-7 w=0.000
Page 10
Detonator communication system fails and allows same time delay to be passed to 3 dets
BL-DE-G (2)
Q=5.057e-10 w=0.000
Page 20
Too much bulk emulsion loaded into hole
OLB
Q=1.238e-6 w=0.000
Delay Input Error gives 1 time delay error to corresponding to another time delay
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
Page 8
Tagger Random Failure gives 1 delay error to corresponding to another time delay
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
Page 9
Design error by Blast Engineer and failure of design check and correction
WD-TD-HE2.1.1-E0
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Failure by CBS and MD to detect and correct design error
WD-TD-HE2.1.2-E
Q=2.76e-005 w=0
Q=2.760e-5 w=0.000
Too much bulk emulsion loaded into hole
OLB-G1
Q=1.238e-6 w=0.000
Page 6



Another error than detonator communication failure
21
BL-DE-OTH (1)
Q=1.197e-5 w=0.000
Wrong design in time delay of one detonator
4,14,17,27,..
WD-TD (1)-HE2.1-G
Q=5.299e-7 w=0.000
Design error by Blast Engineer and failure of design check and correction
WD-TD-HE2.1.1-E0
Q=0.0192 w=0
Q=1.920e-2 w=0.000
Failure by CBS and MD to detect and correct design error
WD-TD-HE2.1.2-E
Q=2.76e-005 w =0
Q=2.760e-5 w=0.000
Overcharge of emulsion more than required which gives 2 MIC
4,14,26,27,..
OLC (1)-G
Q=1.238e-6 w=0.000
Too much bulk emulsion loaded into hole
OLB
Q=1.238e-6 w=0.000
Too much bulk emulsion loaded into hole
OLB-G1
Q=1.238e-6 w=0.000
Page 6
E-det Delay Input Error (2MIC)
4,14,18,26,..
BL-TI (1)-G
Q=9.900e-6 w=0.000
Delay Input Error gives 1 time delay error to corresponding to another time delay
BL-TI-HE2.3.1-G
Q=9.773e-6 w=0.000
Page 8
Tagger Random Failure gives 1 delay error to corresponding to another time delay
BL-TG-RDMU-G
Q=1.264e-7 w=0.000
Page 9
Marker/Starter Position Error or Wrong ID
BL-ME-G (1)
Q=2.976e-7 w=0.000
Page 10



Higher vibration due to 6 MIC detonated at the same time
6-MIC
Q=2.253e-12 w=0.000
Higher vibration due to 5 MIC detonated at the same time
Probability of repeating error another time given that 4 errors have been made
5-MIC
Q=2.253e-11 w=0.000
BL-P-RE-CC2
Q=0.1 w=0
Q=1.000e-1 w=0.000
Probability of repeating error another time given that 3 errors have been made
Higher vibration due to 4 MIC detonated at the same time
BL-P-RE-CC1
4-MIC
Q=2.253e-10 w=0.000
Q=0.1 w=0
Q=1.000e-1 w=0.000
Page 21

Annex C3

Human Factor Assessment for the Use of Electronic Detonators

CONTENTS

C3-1 HUMAN ERROR ASSESSMENT & REDUCTION TECHNIQUE (HEART)

C3-1.1 OVERVIEW

Note that this part of the analysis was not revisited in the present study. This annex is repeated from the *Environmental Review Report* for completeness.

In order to assess how likely it is that a process will fail based on the potential for human error, a human reliability assessment (HRA) has been undertaken. HRA addresses the following questions:

- Which types of human error may occur (e.g. action error, information retrieval error, communication error, violation)?
- What is estimated probability of such errors being made?
- What factors may influence this probability (e.g. time pressure, stress, poor working environment, low morale)
- How can the identified human errors be prevented in the design or how can their impact be reduced by additional mitigating controls?

The Human Error Assessment and Reduction Technique (HEART) is a HRA method based on human performance literature; it has been used in this assessment to quantify human error probabilities. HEART assesses the interactions between humans, their specific tasks and performance shaping/human factors (error producing conditions).

C3-1.2 METHODOLOGY

The blasting process is inherently complex and is composed of numerous subtasks, carried out by different individuals. It is therefore important to identify these subtasks, the roles and responsibilities associated with these tasks and to assess the risks arising from human performance failure.

In consultation with an experienced Blast Engineer/Shot-firer, fault trees were constructed to identify possible sources of human error during three critical blasting subtasks:

1) More than 1 MIC detonated at the same time (this scenario includes All MIC detonated at the same time);
2) Excessive loading of cartridge emulsion; and
3) Excessive loading of bulk emulsion.

Fault Tree Analysis examines the logical relationship between the circumstances, failures events, and human/management errors which must occur in order for these specified undesired events to occur.

A human factors specialist reviewed the assumptions made by the project team (including relevant personnel from MTR, the contractor and the electronic detonator supplier) and adapted the fault trees where necessary before undertaking the HEART assessment. Analyses were undertaken for each scenario to identify the base human error probability. To ensure all potential human errors were identified and taken into account in the risk assessment, errors were quantified for the entire blasting life cycle, from the design of the blast plan to the initiation of the explosives. Manufacture errors were not taken into account in this assessment as they have been accounted in the equipment and system failure probabilities.

C3-1.2.1 HEART methodology

The HEART technique was developed by Williams (1986) and is based on human performance literature. The human factors specialist must undertake the steps summarised in *Table 1.1* in order to estimate the probability of failure for a specific task.

Table 1.1 HEART methodology

Step	Task	Output
1	Classify the task in terms of its generic human unreliability into one of the 8 generic HEART task types	Nominal human unreliability probability
2	Identify relevant error producing conditions (EPCs) which may negatively influence performance	Maximum predicted nominal amount by which unreliability may increase (multiplier)
3	Estimate the impact of each EPC on the task	Value between 0 and 1
4	Calculate the 'assessed impact' for each EPC according to the formula: (EPC multiplier -1) x Impact	Assessed impact value
5	Calculate overall probability of failure of task based on the formula: Nominal human unreliability x assessed effects 1 x assessed effects 2… etc	Overall probability of failure

Each scenario has been analysed separately in *Sections C5-3 to C5-4* to determine the overall probability of human failure. Hence for each contributing error, the following sections present and discuss the generic HEART task type and the EPCs and their impacts, culminating in an overall probability of failure. It should be noted that the overall probabilities of failures are probabilities *per occasion the task is undertaken*.

C3-1.2.2 General Assumptions

- Where a task is undertaken by more than one individual at a time e.g. two representatives from the Mines Division, a reduction in the *assessed proportion of* effect of 1/3 has been calculated to reflect the presence of two individuals. The value of 1/3 is thought to be appropriate due to the potential distraction introduced when more than one individual is present.
- The Shotfirers, Blast Engineers and Competent Blasting Supervisor are experienced and competent to perform their tasks.
- The working environment in the tunnel is not optimal for human performance. It is understood that it is wet, dusty (due to poor ventilation), hot, poorly lit for the tasks to be carried out and noisy.

Therefore for all tasks taking place within the tunnel, the maximum weighting for the EPC *hostile environment* has been used.

- For all tasks apart from design checking and error correction, a disruption to sleep has been assumed. Shotfirers work a forward-rotating shift pattern, and the Blast Engineer must also be present. The Competent Blasting Supervisor and Mines Division will have to be present at the magazine during the early hours of the morning; therefore they too will also experience some degree of sleep disruption.

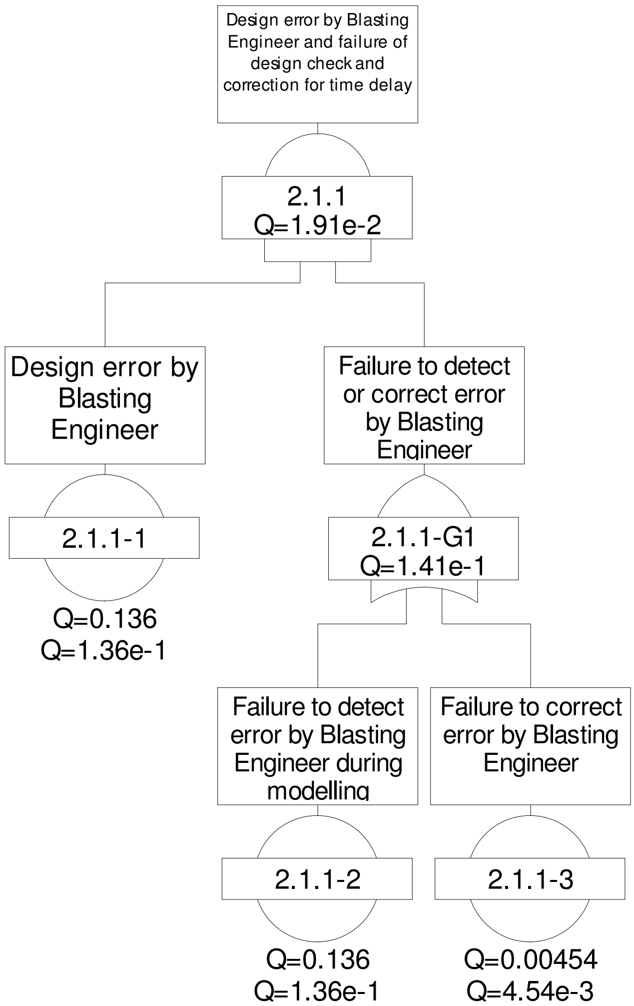
C3-2 SCENARIO ONE: MORE THAN 1 MIC DETONATED AT THE SAME TIME

C3-2.1 EVENT 2.1: WRONG DESIGN OF TIME DELAY

The overall probability of the wrong design being released to the project team is **5.29 E-7**, based on the failure of some or all of the tasks analysed below.

C3-2.1.1 Event 2.1.1: Design error by Blast Engineer and failure of design check and correction

The overall probability of a wrong blast plan submitted to the Competent Blasting Supervisor and Mines Division for review is **1.92 E-2,** based on the failure of all of the tasks analysed below.



2.1.1-1 - Design error by Blast Engineer

As before, if an error is made by the Blast Engineer during the design process and the incorrect drawings are distributed to the blasting team, they will utilise the plans believing them to be correct when in fact they are incorrect. The generic HEART task type taken to represent this checking task, utilising a modelling system is *"Fairly simple task performed rapidly or given scant attention"* for which the nominal human unreliability is *0.09.* The EPCs and their impacts are shown in *Table 2.1*.

Table 2.1 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Design error by Blast Engineer	0.09	Shortage of time available for error detection & correction	11	0.01	1.1	1.36 E-1
		Disruption of normal work-sleep cycles	1.1	0.1	1.01	
		High level of emotional stress	1.3	0.3	1.09	
		Channel capacity overload	6	0.05	1.25	

Based on the above estimates, the likelihood of producing an error is **1.36 E-1**.

Event 2.1.1-2/3 - Failure to detect and correct error by Blast Engineer during modelling

Following any possible calculation error, the Blast Engineer should detect the error during the checking phase, and subsequently correct the error. However, due to time pressure, stress, lack of sleep and workload, it is possible that design errors may slip through.

Event 2.1.1-2 Failure to detect the error

The Blast Engineer utilises a modelling programme which will highlight any inconsistencies or mistakes. However, it is possible that the Blast Engineer does not detect the errors highlighted by the modelling programme, or simply does not utilise the software to check the design. The generic HEART task type taken to represent this checking task, utilising a modelling system is *"Fairly simple task performed rapidly or given scant attention"* for which the nominal human unreliability is *0.09.* The EPCs and their impacts are shown in *Table 2.2*.

Table 2.2 ***HEART calculation***

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Failure to detect error by Blast Engineer during modelling	0.09	Shortage of time available for error detection & correction	11	0.01	1.1	1.36 E-1
		Disruption of normal work-sleep cycles	1.1	0.1	1.01	
		Channel capacity overload	6	0.05	1.25	
		High level of emotional stress	1.3	0.3	1.09	

Based on the above estimates, the likelihood of producing an error is **1.36 E-1**.

Event 2.1.1-3 Failure to correct the error

If the Blast Engineer identifies a problem with the design, there is potential that he may not act upon this information and fail to rectify the mistake. The generic HEART task type taken to represent this action task is *"Restore or shift a system to original or new state following procedures, with some checking"* for which the nominal human unreliability is *0.003.* The EPCs and their impacts are shown in *Table 2.3*.

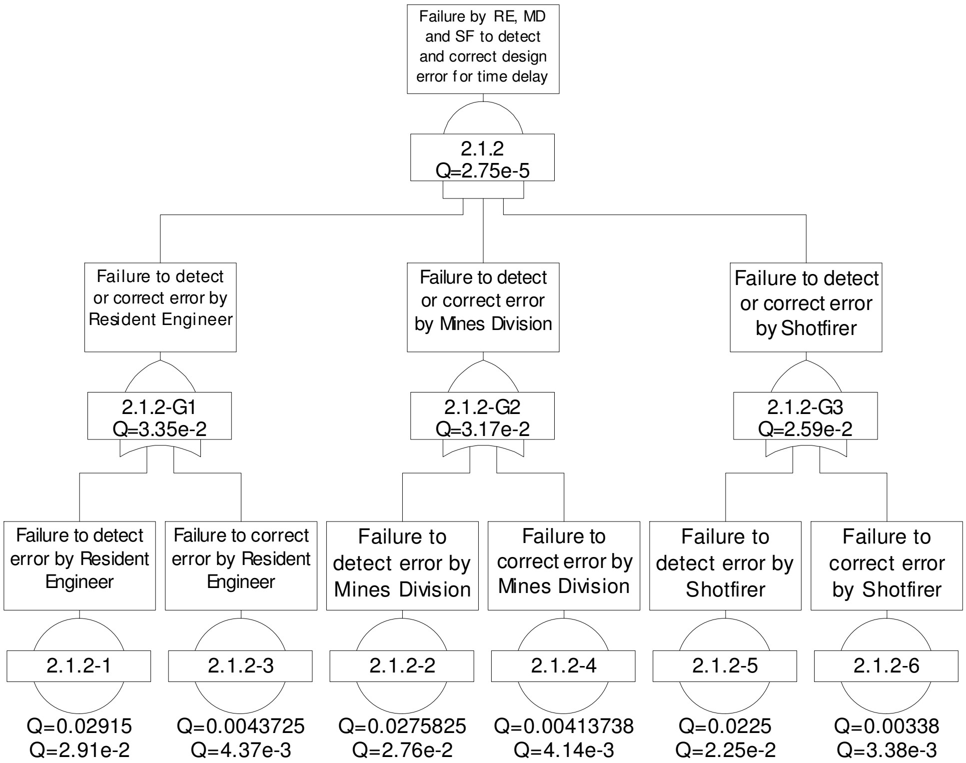
Table 2.3 ***HEART calculation***

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Failure to correct error by Blast Engineer	0.003	Shortage of time available for error detection & correction	11	0.01	1.1	4.54 E-3
		Disruption of normal work-sleep cycles	1.1	0.1	1.01	
		Channel capacity overload	6	0.05	1.25	
		High level of emotional stress	1.3	0.3	1.09	

Based on the above estimates, the likelihood of producing an error is **4.54 E-3**.

Event 2.1.2: Failure to detect and correct error by Competent Blasting Supervisor, Mines Division and Shotfirers

The overall probability of Failure to detect and correct error by Competent Blasting Supervisor, Mines Division and by the Shotfirers is **2.76 E-5,** based on the failure of all of the tasks analysed below.



Event 2.1.2-1 - Failure to detect error by the Competent Blasting Supervisor

Once the Blast Engineer has finalised the design, it is passed to the Competent Blasting Supervisor and to the Mines Division. The Competent Blasting Supervisor should check the design before giving his endorsement to the Mines Division. It has been assumed that the Competent Blasting Supervisor is not as competent or experienced as the Blast Engineer as this is not his sole task within the project. The generic HEART task type taken to represent this manual checking task is *"Routine, highly practised, rapid tasks involving relatively low level of skill"* for which the nominal human unreliability is *0.02.* The EPCs and their impacts are shown in *Table 2.4*.

Table 2.4 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Failure to detect error by Competent Blasting Supervisor	0.02	Shortage of time available for error detection & correction	11	0.01	1.1	2.92 E-2
		High level of emotional stress	1.3	0.2	1.06	
		Channel capacity overload	6	0.05	1.25	

Based on the above estimates, the likelihood of producing an error is **2.92 E-2**.

Event 2.1.2.-2 - Failure to detect error by Mines Division

As specified earlier, Mines Division will also check the design for errors, although it is possible that errors may be made during the check which allows the incorrect design to go unnoticed. The generic HEART task type taken to represent this manual checking task is *"Routine, highly practised, rapid tasks involving relatively low level of skill"* for which the nominal human unreliability is *0.02.* The EPCs and their impacts are shown in *Table 2.5*.

Table 2.5 ***HEART calculation***

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Failure to detect error by Mines Division	0.02	Shortage of time available for error detection & correction	11	0.01	1.1	2.76 E-2
		High level of emotional stress	1.3	0.01	1.003	
		Channel capacity overload	6	0.05	1.25	

Based on the above estimates, the likelihood of producing an error is **2.76 E-2**.

Event 2.1.2-3 - Failure to correct error by the Competent Blasting Supervisor

As above, the Competent Blasting Supervisor may detect the error, but then fail to act on this to correct the design error. The generic HEART task type taken to represent this action task is *"Restore or shift a system to original or new state following procedures, with some checking"* for which the nominal human unreliability is *0.003.* The EPCs and their impacts are shown in *Table 2.6*.

Table 2.6 ***HEART calculation***

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Failure to correct error by Competent Blasting Supervisor	0.003	Shortage of time available for error detection & correction	11	0.01	1.1	4.37 E-3
		Channel capacity overload	6	0.05	1.25	
		High level of emotional stress	1.3	0.2	1.06	

Based on the above estimates, the likelihood of producing an error is **4.37 E-3**.

Event 2.1.2-4 – Failure to correct error by Mines Division

As above, the Mines Division may fail to correct the error in the design. The generic HEART task type taken to represent this action task is *"Restore or shift a system to original or new state following procedures, with some checking"* for which the nominal human unreliability is *0.003.* The EPCs and their impacts are shown in *Table 2.7*.

Table 2.7 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Failure to correct error by Mines Division	0.003	Shortage of time available for error detection & correction	11	0.01	1.1	4.14 E-3
		Channel capacity overload	6	0.05	1.25	
		High level of emotional stress	1.3	0.01	1.003	

Based on the above estimates, the likelihood of producing an error is **4.14 E-3**.

Event 2.1.2-5 – Failure to detect error by Shot-firer

The Shot-firer will review the blast plan before blasting commences. The generic HEART task type taken to represent this manual checking task is *"Routine, highly practised, rapid task involving relatively low level of skill"* for which the nominal human unreliability is *0.02.* The EPCs and their impacts are shown in *Table 2.8*.

Table 2.8 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Shot-firer fails to detect error	0.02	Shortage of time available for error detection & correction	11	0.003	1.03	2.25 E-2
		High level of emotional stress	1.3	0.015	1.075	
		Channel capacity overload	6	0.06	1.018	

Based on the above estimates, the likelihood of producing an error is **2.25 E-2**.

Event 2.1.2-6 – Failure to correct error by Shot-firer

If the Shot-firer identifies an error in the blast plan, he must act to correct the error before the blast commences. The generic HEART task type taken to represent this manual checking task is *"Routine, highly practised, rapid task involving relatively low level of skill"* for which the nominal human unreliability is *0.02.* The EPCs and their impacts are shown in *Table 2.9*.

Table 2.9 ***HEART calculation***

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Shotfirer fails to correct error	0.02	Shortage of time available for error detection & correction	11	0.003	1.03	3.38 E-3
		High level of emotional stress	1.3	0.015	1.075	
		Channel capacity overload	6	0.06	1.018	

Based on the above estimates, the likelihood of producing an error is **3.38 E-3**.

C3-2.2 *EVENT 2.3.1 – SHOTFIRER INPUTS WRONG TIME DELAY AND FAILURE TO DETECT AND CORRECT ERROR*

To model specific human error dependencies, the overall error probability has been modelled in the main Fault Tree.

Event 2.3.1-1 Shotfirer inputs incorrect delay time using Tagger

As all detonators are supplied without any pre-entered time delay, the shotfirer must programme each individual detonator using the Tagger. Information communication errors can be made when reading from the blast plan and inputting the information into the tagger, with a simple lapse resulting in the wrong delay time being inputted. The generic HEART task type taken to represent this action task is *"Routine, highly practised, rapid task involving relatively low level of skill"* for which the nominal human unreliability is *0.02.* This assessment accounts for a typical number of production holes which is about 200 for a shaft. The EPCs and their impacts are shown in *Table 2.10.*

Table 2.10 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Shotfirer inputs incorrect delay time using Tagger	0.02	Shortage of time available for error detection & correction	11	0.01	1.1	1.86E-1
		Disruption of normal work-sleep cycles	1.1	0.1	1.01	
		High level of emotional stress	1.3	0.2	1.06	
		Poor/hostile environment	1.15	1	1.15	
		Low signal-noise ratio	10	0.5	5.5	
		Channel capacity overload	6	0.05	1.25	

Based on the above estimates, the likelihood of producing an error is **1.86E-1.**

Event 2.3.1-2 – Blasting Engineer fails to detect incorrect detonator delay time

The Blasting Engineer should check the programmed detonator delay time against a checklist to ensure it corresponds with the blast plan. However, it is possible that due to time pressure, poor lighting etc that the check is omitted due to a long list being presented, especially when there are few detonators with the same time delay in a long list. The generic HEART task type taken to represent this action task is *"Routine, highly practised, rapid task involving relatively low level of skill"* for which the nominal human unreliability is *0.02.* The EPCs and their impacts are shown in *Table 2.11.*

Table 2.11 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Blasting Engineer fails to detect wrong detonator delay time.	0.02	Shortage of time available for error detection & correction	11	0.01	1.1	3.48E-02
		Disruption of normal work-sleep cycles	1.1	0.1	1.01	
		High level of emotional stress	1.3	0.2	1.06	
		Poor/hostile environment	1.15	1	1.15	

		Low signal-noise ratio	10	0.003	1.027	
		Channel capacity overload	6	0.05	1.25	

Based on the above estimates, the likelihood of producing an error is **3.48E-2.**

It should be noted that a second shotfirer may perform this task instead of or in addition to the Blasting Engineer.

Event 2.3.1-3 – Blasting Engineer/Shot firer fail to correct incorrect detonator delay time

If an error is detected during the checking process, the Blasting Engineer should notify the Shotfirer and the Shotfirer should correct the error by re-entering the time delay. However, it is possible that due to time pressure, poor lighting, noise etc that either the error is not communicated effectively by the person who finds the error, or that the error is not corrected because the person forgets or mishears. The generic HEART task type taken to represent this manual checking task is *"Restore or shift a system to original or new state following procedures, with some checking"* for which the nominal human unreliability is *0.003.* The EPCs and their impacts are shown in *Table 2.12.*

Table 2.12 HEART calculation

Task	**Generic task unreliability**	**EPCs**	**Multiplier**	**Assessed Proportion of Effect**	**Assessed Effect**	**Human Error Probability**
Blasting Engineer/ Shotfirer fails to correct incorrect detonator delay time	0.003	Shortage of time available for error detection & correction	11	0.003	1.03	3.64E-3
		Disruption of normal work-sleep cycles	1.1	0.03	1.01	
		High level of emotional stress	6	0.06	1.25	
		Poor/hostile environment	1.3	0.3	1.06	
		Low signal-noise ratio	10	0.003	1.09	
		Channel capacity overload	1.15	0.015	1.15	

Based on the above estimates, the likelihood of producing an error is **3.64E-3**

C3-2.3 EVENT 2.4.1 – SHOTFIRER WRONGLY DEFINE A STRING WITH STARTER AND MARKERS AND FAILURE TO DETECT AND CORRECT ERROR

To model specific human error dependencies, the overall error probability has been modelled in the main Fault Tree.

Event 2.4.1-1 Shotfirer wrongly place or tag starter or marker

The Shot-firer may elect to programme a string of detonators by inserting starters and markers (change row or change pattern markers) which delineate the start and end of the semi-automatic programming sequence for a string. This will result in part of the string being wrongly defined.

During this task, the Shotfirer may wrongly define a string by physically placing the starter device at the wrong location or, using the Tagger, marking the starter with the wrong ID or marking the wrong detonator with the "change row" or "change pattern tag. An error may be made defining the string at the blast face resulting in the string being too long or too short compared to the blast plan. The generic HEART task type taken to represent this manual checking task is "Restore or shift a system to original or new state following procedures, with some checking" for which the nominal human unreliability is 0.003. The EPCs and their impacts are shown in *Table 2.13*.

Table 2.13 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Shot firer fails to correct incorrect detonator delay time	0.003	Shortage of time available for error detection & correction	11	0.01	1.1	5.54E-3
		Disruption of normal work-sleep cycles	1.1	0.1	1.01	
		High level of emotional stress	1.3	0.2	1.06	
		Low signal-noise ratio	10	0.01	1.09	
		Channel capacity overload	6	0.05	1.25	
		Poor/hostile environment	1.15	1	1.15	

Based on the above estimates, the likelihood of producing an error is **5.54E-3**

Event 2.4.1-2 Blasting Engineer fails to detect starter/marker tagging and position is correct

The Blasting Engineer should check the placement of the starters and markers against the blast plan as well as the correct starter ID, highlighting any deviations. However, the check may not take place, or may be incomplete. The generic HEART task type taken to represent this manual checking task is

"Restore or shift a system to original or new state following procedures, with some checking" for which the nominal human unreliability is 0.003. The EPCs and their impacts are shown in *Table 2.14*.

Table 2.14 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Blasting Engineer fails to detect starter/marker tagging and position is correct	0.003	Shortage of time available for error detection & correction	11	0.003	1.03	3.64E-03
		Disruption of normal work-sleep cycles	1.1	0.03	1.003	
		High level of emotional stress	1.3	0.06	1.018	
		Low signal-noise ratio	10	0.003	1.027	
		Channel capacity overload	6	0.015	1.075	
		Poor/hostile environment	1.15	0.3	1.045	

Based on the above estimates, the likelihood of producing an error is **3.64E-3**

It should be noted that a second shotfirer may perform this task instead of or in addition to the Blasting Engineer.

Event 2.4.1-3 Blasting Engineer/Shotfirer fail to correct starter/marker tagging and position

If an error is detected during the checking process, the Blasting Engineer should notify the Shotfirer and the Shotfirer should correct the error by re-entering the time delay for that part of the string. However, it is possible that due to time pressure, poor lighting, noise etc that either the error is not communicated effectively by the person who finds the error, or that the error is not corrected because the person forgets or mishears. The generic HEART task type taken to represent this manual checking task is "Restore or shift a system to original or new state following procedures, with some checking" for which the nominal human unreliability is 0.003. The EPCs and their impacts are shown in *Table 2.15*.

Table 2.15 *HEART calculation*

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Blasting Engineer/ Shotfirer fail to detect starter/marker tagging and position	0.003	Shortage of time available for error detection & correction	11	0.003	1.03	3.64E-3
		Disruption of normal work-sleep cycles	1.1	0.03	1.01	
		High level of emotional stress	6	0.06	1.25	
		Poor/hostile environment	1.3	0.3	1.06	
		Low signal-noise ratio	10	0.003	1.09	
		Channel capacity overload	1.15	0.015	1.15	

Based on the above estimates, the likelihood of producing an error is **3.64E-3**

C3-2.4 EVENT 2.5.1 – SHOTFIRER INPUTS SAME DELAY FOR PART OF STRING AND FAILURE TO DETECT AND CORRECT ERROR

To model specific human error dependencies, the overall error probability has been modelled in the main Fault Tree.

Event 2.5.1-1 Shotfirer inputs same delay for part of string using Tagger

If semi-automatic programming of the string is utilised, there is potential for the entire string to be programmed with an incorrect time delay ie 0 ms. The generic HEART task type taken to represent this action task is *"Completely familiar, well designed, highly practised, routine task occurring several times per hour, performed to highest possible standards by highly motivated and experienced person, totally aware of the implications of failure, with time to correct potential error, but without the benefit of significant job aids"* for which the nominal human unreliability is *0.0004.* The EPCs and their impacts are shown in *Table 2.16.*

Table 2.16 *HEART calculation*

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Shot firer input same delay to part of the string	0.0004	Shortage of time available for error detection & correction	11	0.01	1.1	7.38E-04
		Disruption of normal work-sleep cycles	1.1	0.1	1.01	
		High level of emotional stress	1.3	0.2	1.06	

		Channel capacity overload	6	0.05	1.25	
		Low signal-noise ratio	10	0.01	1.09	
		Poor/hostile environment	1.15	1	1.15	

Based on the above estimates, the likelihood of producing an error is **7.38E-4**

Event 2.5.1-2 – Blasting Engineer fails to detect incorrect detonator delay for part of string

The Blasting Engineer must check the string delay time against the blasting plan. There is potential for him to make an error when carrying out the check, hence not detecting part of the string has 0 ms delay increment. The generic HEART task type taken to represent this action task is *"Restore or shift a system to original or new state following procedures, with some checking"* for which the nominal human unreliability is *0.003.*

The EPCs and their impacts are shown in *Table 2.17.*

Table 2.17 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Blasting engineer fails to detect incorrect detonator delay for part of string	0.003	Shortage of time available for error detection & correction	11	0.003	1.03	3.64E-03
		Disruption of normal work-sleep cycles	1.1	0.03	1.003	
		High level of emotional stress	1.3	0.06	1.018	
		Channel capacity overload	6	0.015	1.075	
		Low signal-noise ratio	10	0.003	1.027	
		Poor/hostile environment	1.15	0.3	1.045	

Based on the above estimates, the likelihood of producing an error is **3.64E-3**

It should be noted that a second shotfirer may perform this task instead of or in addition to the Blasting Engineer.

It should be noted that such failure to detect is unlikely compared to 2.3.1 given the high number of detonators with wrong time delay. A possibility of common cause error of 1% has been conservatively assumed for independent checks from the check box (event 2.8.1-1) but not for independent checks from the Tagger (event 2.5.1-2) to specifically model human error dependencies.

Event 2.5.1-3 – Blasting Engineer/Shotfirer fail to correct wrong detonator delay for part of string

Upon discovering an error, the Shot Firer and/or the Blasting Engineer must correct the time delay error. The generic HEART task type taken to represent this action task is *"Restore or shift a system to original or new state following procedures, with some checking"* for which the nominal human unreliability is *0.003.* The EPCs and their impacts are shown in *Table 2.18.*

Table 2.18 HEART calculation

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Blasting Engineer/ Shotfirer fail to correct wrong detonator delay for part of string	0.003	Shortage of time available for error detection & correction	11	0.003	1.03	3.64E-03
		Disruption of normal work-sleep cycles	1.1	0.03	1.003	
		High level of emotional stress	1.3	0.06	1.018	
		Channel capacity overload	6	0.015	1.075	
		Low signal-noise ratio	10	0.003	1.027	
		Poor/hostile environment	1.15	0.3	1.045	

Based on the above estimates, the likelihood of producing an error is **3.64E-3**

C3-2.5 EVENT 2.7.1 – FAILURE OF INDEPENDENT CHECKS PERFORMED FROM THE BENCH BOX AND FAILURE TO CORRECT

Event 2.7.1-1 – Competent Blasting Supervisor fail to detect more than 1 MIC are set to detonate at the same time

The Competent Blasting Supervisor should check the programmed detonator delay time as displayed on the bench box against a checklist to ensure it corresponds with the blast plan and specifically that there is no MIC to detonate within the same time delay. However, the check may not take place, or may be incomplete. The generic HEART task type taken to represent this manual checking task is "Restore or shift a system to original or new state following procedures, with some checking" for which the nominal human unreliability is 0.003. The EPCs and their impacts are shown in *Table 2.19.*

Table 2.19 *HEART calculation*

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Competent Blasting Supervisor fail to detect more than 1 MIC are set to detonate at the same time	0.003	Shortage of time available for error detection & correction	11	0.003	1.03	3.64E-03
		Disruption of normal work-sleep cycles	1.1	0.03	1.003	
		High level of emotional stress	1.3	0.06	1.018	
		Low signal-noise ratio	10	0.003	1.027	
		Channel capacity overload	6	0.015	1.075	
		Poor/hostile environment	1.15	0.3	1.045	

Based on the above estimates, the likelihood of producing an error is **3.64E-3.**

Event 2.7.1-2 – Competent Blasting Supervisor /Shot firer fail to correct incorrect detonator delay time

If an error is detected during the checking process, the Competent Blasting Supervisor should notify the Shotfirer and the Shotfirer should correct the error by re-entering the time delay. However, it is possible that due to time pressure, poor lighting, noise etc that either the error is not communicated effectively by the person who finds the error, or that the error is not corrected because the person forgets or mishears. The generic HEART task type taken to represent this manual checking task is *"Restore or shift a system to original or new state following procedures, with some checking"* for which the nominal human unreliability is *0.003.* The EPCs and their impacts are shown in *Table 2.20.*

Table 2.20 *HEART calculation*

Task	Generic task unreliability	EPCs	Multiplier	Assessed Proportion of Effect	Assessed Effect	Human Error Probability
Competent Blasting Supervisor / Shotfirer fails to correct incorrect detonator delay time	0.003	Shortage of time available for error detection & correction	11	0.003	1.03	3.64E-3
		Disruption of normal work-sleep cycles	1.1	0.03	1.01	
		High level of emotional stress	6	0.06	1.25	
		Poor/hostile environment	1.3	0.3	1.06	
		Low signal-noise ratio	10	0.003	1.09	

	Channel capacity overload	1.15	0.015	1.15

Based on the above estimates, the likelihood of producing an error is **3.64E-3**

C3-2.6 EVENT 2.8.1 – FAILURE OF INDEPENDENT CHECKS PERFORMED FROM THE BENCH BOX TO DETECT SYSTEMATIC FAILURES AND FAILURE TO CORRECT

Event 2.8.1-1 – Competent Blasting Supervisor fails to detect all detonator in all string or string segment has more than 1 MIC set to detonate at the same time

It should be noted that such failure to detect is unlikely compared to 2.7.1 given that the failure will appear to follow a certain pattern and would require a number of detection failures to be undetected. A possibility of common cause error of 1% has been conservatively assumed for independent checks from the check box (event 2.8.1-1) when compared to event 2.7.1-1. Based on the above estimates, the likelihood of producing an error is **3.64E-5.**

Event 2.8.1-2 – Competent Blasting Supervisor /Shot firer fail to correct incorrect detonator delay time

For such a severe failure, the level of correction and subsequent checks would be equivalent to starting a new blast. However, to model human error dependency a common cause error of 1% has been conservatively assumed for independent checks from the check box (event 2.8.1-1) when compared to event 2.7.1-1.

Based on the above estimates, the likelihood of producing an error is **3.64E-5**

C3-3 SCENARIO TWO: MIC EXCEEDED (BULK EMULSION)

Such scenario is independent of the type of detonators used and therefore identical to the scenario assessed for non electric detonators. The relevant events have been modelled directly in the main Fault Tree.

C3-4 SCENARIO THREE: MIC EXCEEDED (CARTRIDGE EMULSION)

Such scenario is independent of the type of detonators used and therefore identical to the scenario assessed for non electric detonators. The relevant events have been modelled directly in the main Fault Tree. In any case, cartridge emulsion will not be used for “SHW to SYP tunnels”.

Annex D

Dust Control Measures in accordance with the WIL ER Report

risk assessments contained in the approved WIL EIA. Only the risk from the 'use of explosives' is assessed for this report.

The risk arising from the proposed blasting activities at King George V have been assessed following the methodology of the approved WIL EIA. The frequency assessment particularly assessed all the possible failure scenarios which could lead to 2 or more Maximum Instantaneous Charge (MIC) detonated at the same time and in particular the scenario of the sympathetic detonation of all MIC at the blast face. The frequency assessment shows that from the proposed blasting activities, equipment, systems, work procedures and qualification of personnel involved in preparing and undertaking the blast, there will not be any significant incremental risk (less than 10^{-9} per year) caused by the blasting activities of King George V shaft. Therefore, this new blasting activity for King George V Shaft will not constitute a material change to the Environment Permit for West Island Line related to Hazard to Life.

The Quantitative Risk Assessment Report is given in *Annex I*.

3.9 AIR QUALITY IMPACT

All construction dust, fumes and smoke associated with the drill and blast works activities at the KGV construction shaft in rock will be confined by a blast cover (blast screen) and a full noise enclosure above the shaft. Ventilation system with sprinkler system will also be provided to mitigate the fumes and dust. Details of the above-mentioned mitigation measures are given below:

Blast Cover (Blast Screen)

As mentioned in *Section 3.1.6*, an approved blast cover (blast screen) will be mounted on top of the KGV construction shaft to mitigate the effects of air overpressure and to protect against the ejection of fly rock. The design of the blast cover (blast screen) will be certified by an Independent Checking Engineer and a Blasting Competent Person, and will be checked by Mines Division prior to the commencement of blasting activities. Details of the blast cover (blast screen), including location and specification, are presented in *Annex J*.

Noise Enclosure

As mentioned in *Section 3.1.6*, the KGV construction shaft will be fully enclosed by a noise enclosure. This noise enclosure will also serve to mitigate the construction dust, fumes and smoke associated with the drill and blast works activities.

Ventilation System

A ventilation system comprising an inlet ventilator fan and dust collector assembly will be installed and operated on site to minimise the fumes and dust generated from the excavation of the shaft.

Air inside the shaft is extracted via a ventilation pipe for treatment in the dust collector. A row of sprinklers inside the dust collector create a fine water mist for damping the dust-laden air. The dampened air is then passed through a centrifugal turbine inside the dust collector, where the wetted dust particles are separated from the air stream by centrifugal force, collected in the bottom of the dust collector and drained to a decanter. The treated air is discharged through a vertical vent pipe and the effluent from the dust collector will be suitably treated before discharge to the drainage system.

In addition, a sprinkler system will be installed near the top of the shaft under the blast cover (blast screen) (Drawing No. 703/W/305/DMB/T01/069 given in *Annex K*). The effluent collected at the bottom of the shaft will also be suitably treated before discharge to the drainage system.

The operation of the ventilation system will be closely monitored by site staff and the proper functioning of the dust collector will be checked from time to time on a daily basis.

The operation of the ventilation system and sprinkler system will follow the regime presented as follows:

- When no blasting is carried out, the inlet ventilator fan and the dust collector will both be operated;
- Immediately before a blast, the blast cover will be mounted on top of the shaft. The inlet ventilator fan and the dust collector will be stopped and the sprinkler system will be switched on;
- Immediately after the blast, the dust collector will be started and operated for 15 minutes to extract the air inside the shaft (the inlet ventilator will remain switched off and the blast cover mounted); and
- After 15 minutes from the blast, the sprinkler system will be turned off and the ventilation system will be turned on. The blast cover (blast screen) will then be removed upon confirmation by the Registered Shotfirer and the Electronic Registered Shotfirer that there are no misfires for the blast.

Based on the dimensions of the KGV shaft, and the air flow rate of the dust collector, the time required for extracting all the air within the shaft is estimated as follows:

Shaft length = 70m

Shaft section = 80m^2

Total volume of the KGV shaft = 70 x 80 = 5,600 m^3

Air flow rate of dust collector = 15 m^{3}s^{-1}

Time required to extract all air within the shaft

$= 5{,}600\ m^3 / 15\ m^3s^{-1}$

$= 373$ s, ie about 6.2 min

Under the operating regime to be followed for the ventilation system on site, the dust collector [1] and the sprinklers will be operated for 15 minutes to extract and treat the air within the shaft before the removal of the blast cover (blast screen). Based on the calculations above, the duration of the operation of the dust extraction/treatment in this regime has already allowed a generous margin over the 6.2 minutes estimated to be required for the complete removal and treatment of the air in the shaft.

With the implementation of the above-mentioned ventilation design and operating regime, dust generated from the blasting activities will be confined within the construction shaft and removed via the dust collector. Dust emissions to the surroundings after the removal of the blast cover (blast screen) will be negligible.

The outlet of the exhaust will be arranged such that it will not point towards any air sensitive uses. This will be checked during regular site inspection as per the Environmental Monitoring & Audit (EM&A) Manual.

Details of the ventilation system, including a graphical illustration of the dust collector with sprinklers and centrifugal turbine, technical specification and test record for the proposed dust collector system, are provided in *Annex K*.

The Air Quality Impact Assessment in the approved EIA Report has been comprehensively examined as part of the ER. In the approved EIA Report, the construction shaft at Works Area M falls under the group of construction areas for Sai Ying Pun Station. The construction shaft at Works Area M was not identified as a source of construction dust emission or potential impacts in Sections 11.21 to 11.23 of the approved EIA Report (these sections are part of the "Identification of Emission Sources and Potential Impacts" of the Air Quality Impact Assessment in the approved EIA Report). This is also reinforced by the information presented in Appendix 11.1 of the approved EIA Report. Under Section 11.31 of the approved EIA Report, it was further evaluated that "no adverse dust impact at nearby sensitive receivers would be expected for the area being considered owing to the fact that the excavation works "would all be undertaken within enclosed structure".

The shaft excavation works at Works Area M under the current proposal will still be undertaken within enclosed structure (ie the blast cover and the full noise enclosure). Based on these arrangements, the conditions that allowed the Air Quality Impact Assessment in the approved EIA Report to come to the view that no adverse dust impact would arise from this Works Area have not been changed. With the above-mentioned conditions remaining unchanged, the evaluation presented in the approved EIA Report regarding the lack of adverse dust impact from this Works Area remain valid and a new assessment

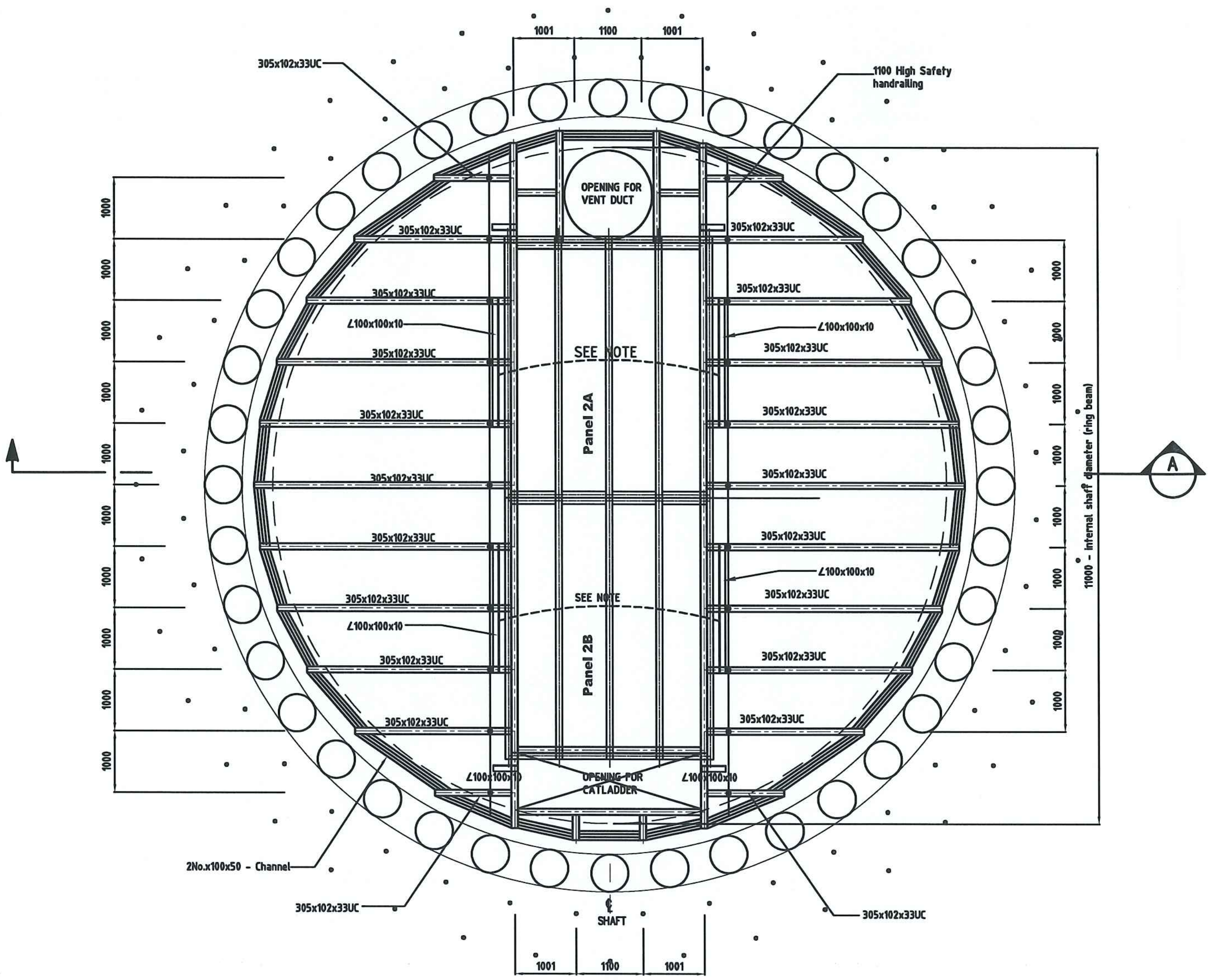
(1) Dust removal efficiency = 95%

for the purpose of providing a comparison with the evaluation in the approved EIA Report is considered not warranted.

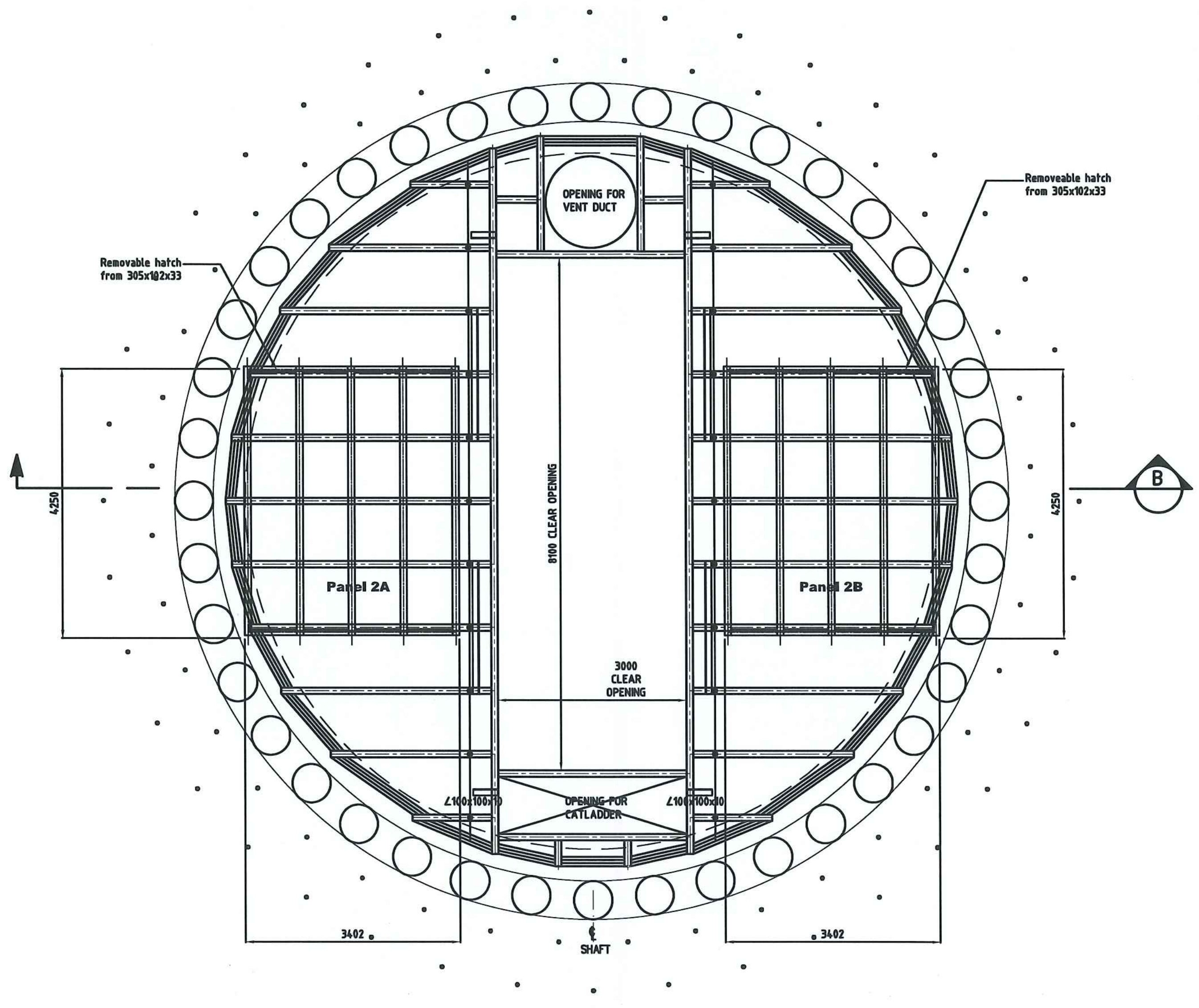
MTR/ DMBJV will conduct a 1-hour TSP measurement at HKSPC Thomas Tam Day Nursery before the commencement of the programme for blasting works to establish the existing condition with respect to dust in the vicinity of the site. Another 1-hour TSP measurement at the same location will be taken after the commencement of the blasting works to demonstrate that no adverse construction dust impacts are caused by the blasting activities. A letter report will be provided to EPD on the findings of these two measurements.

Annex D1

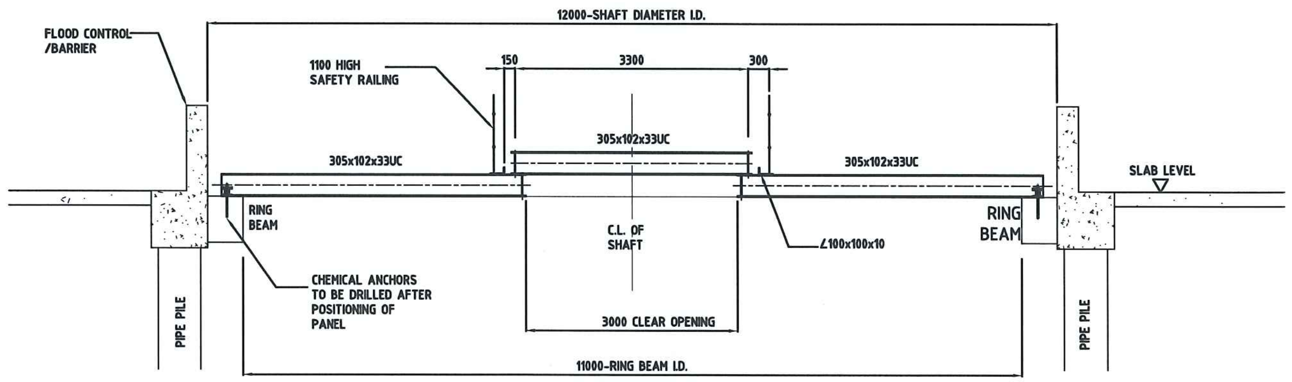
Annex J of WIL ER Report - Details of Blast Cover (Blast Screen)



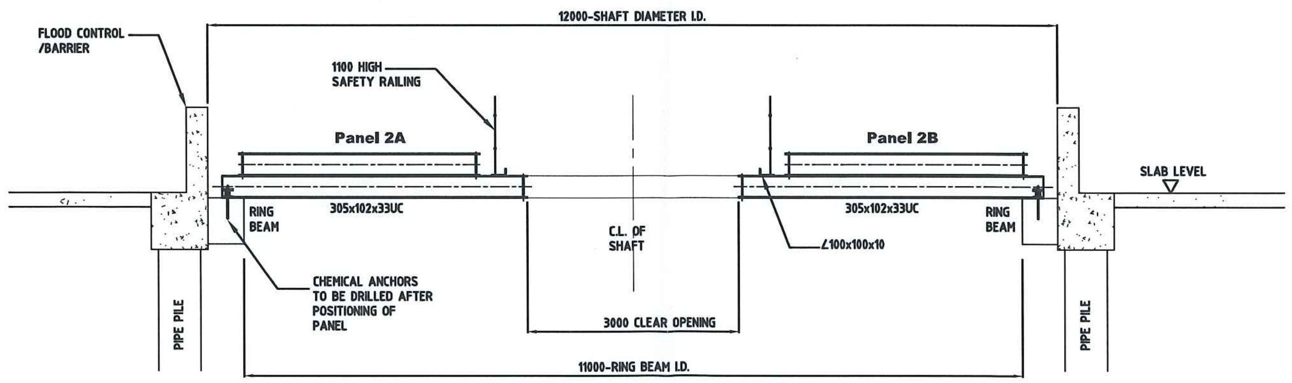
PLAN – DURING BLASTING



PLAN – HATCH OPEN



SECTION A



SECTION B

Maps reproduced with permission of the Director of Lands, © Hong Kong Government

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DRAWN	DAI
DESIGNED	PKV
CHECKED	SPo
APPROVED	SPo
DATE	10/DEC/2009

MTR

WEST ISLAND LINE

ORIGINATOR

BACHY SOLETANCHE

CADD REF. 703-W-305-DMB-T01-067 A1

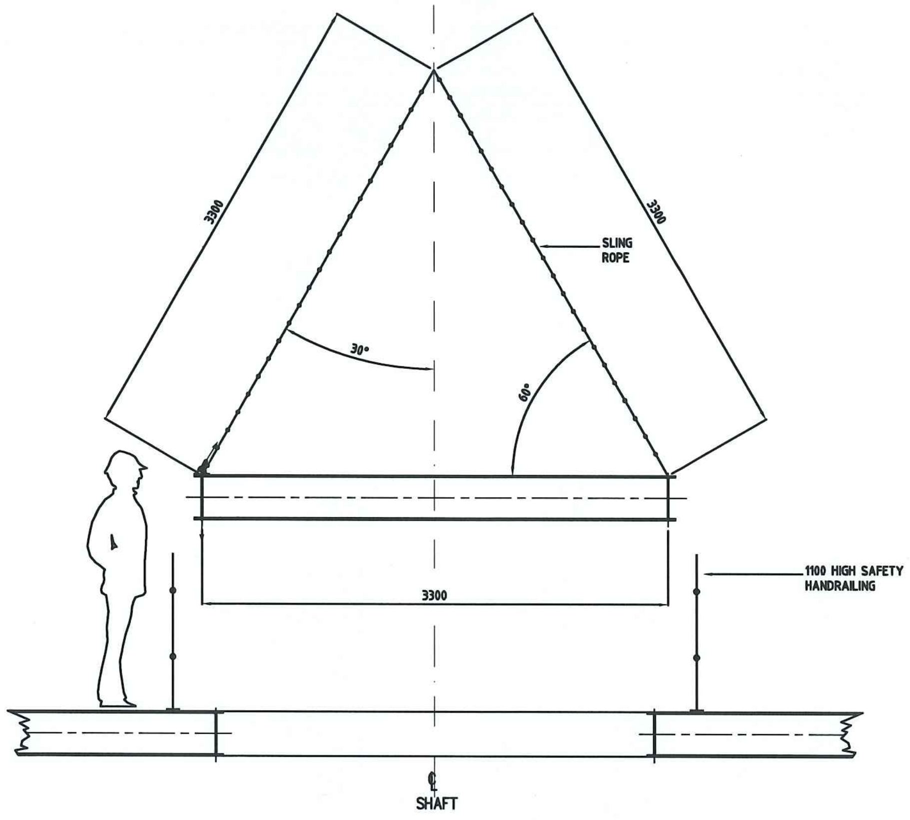
TITLE

CONTRACT 703
SHW TO SYP TUNNELS
KING GEORGE V
BLASTING COVER PRINCIPLE
SHEET 1 OF 2

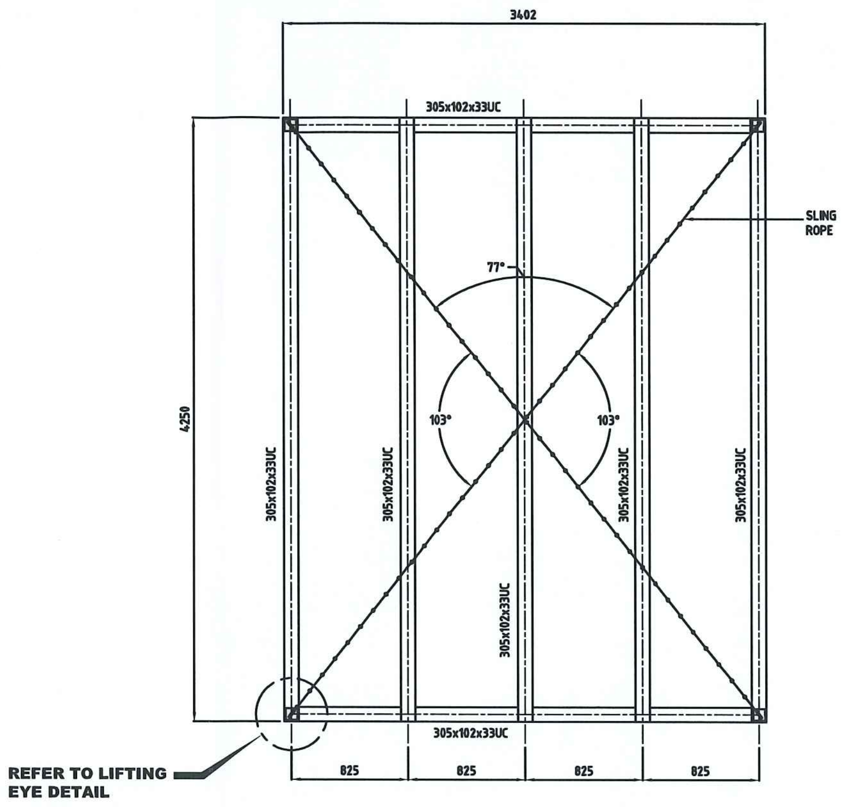
SCALE 1:50 (A1)

DRAWING NO. 703/W/305/DMB/T01/067

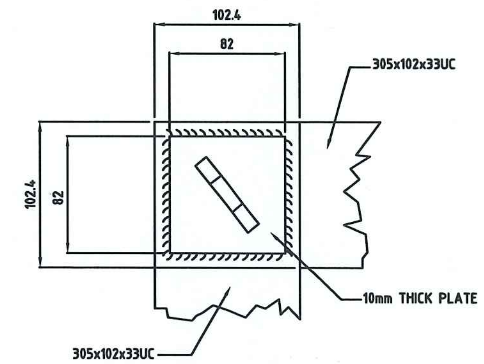
REV. A1



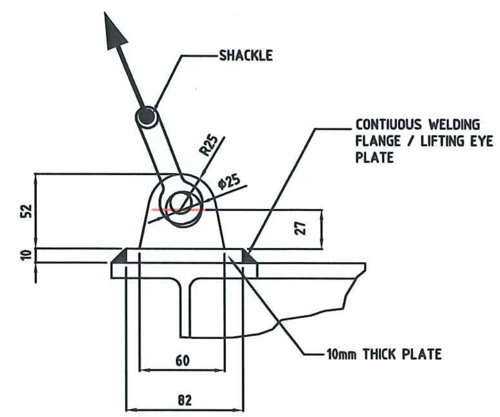
ELEVATION – SLINGING DETAIL



PANEL 2A & 2B DETAIL

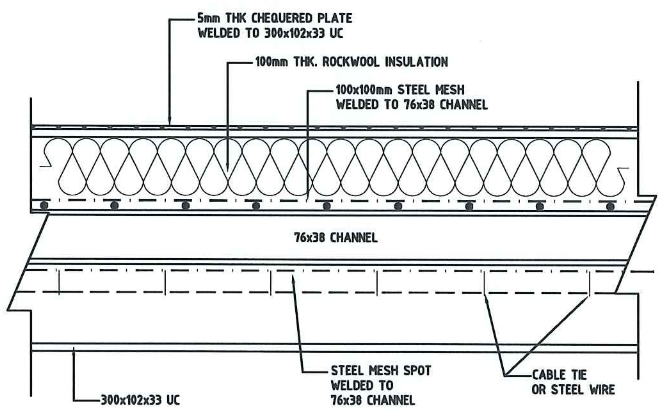


Plan View

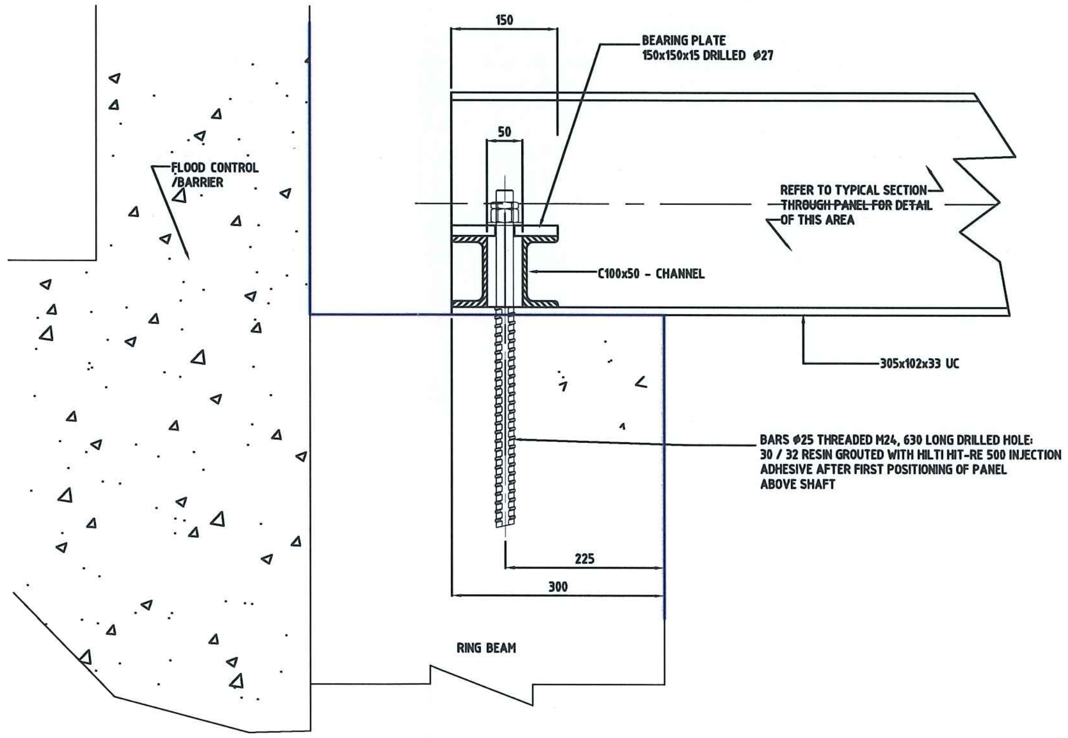


Elevation

LIFTING EYE DETAIL



TYPICAL SECTION THROUGH PANEL



TYPICAL BOLT DOWN DETAIL

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DRAWN	DAI
DESIGNED	PKV
CHECKED	SPo
APPROVED	SPo
DATE	10/DEC/2009

MTR

WEST ISLAND LINE

ORIGINATOR

MAUNSELL

BACHY SOLETANCHE

CADD REF. 703-W-305-DMB-T01-067 A1

TITLE

CONTRACT 703
SHW TO SYP TUNNELS
KING GEORGE V
BLASTING COVER PRINCIPLE
SHEET 2 OF 2

SCALE 1:25:5:2.5 (A1)

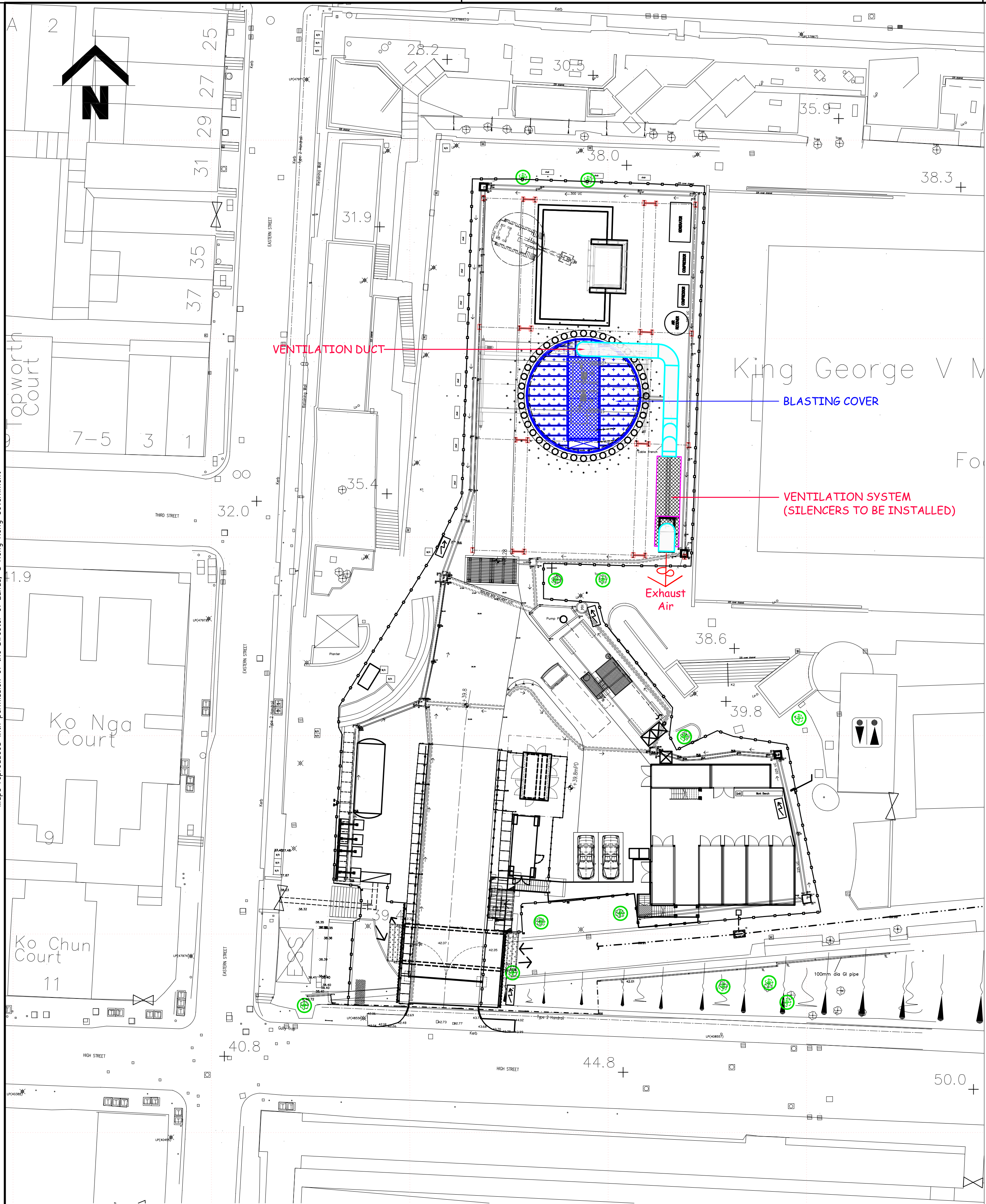
DRAWING NO. 703/W/305/DMB/T01/067

REV. A1

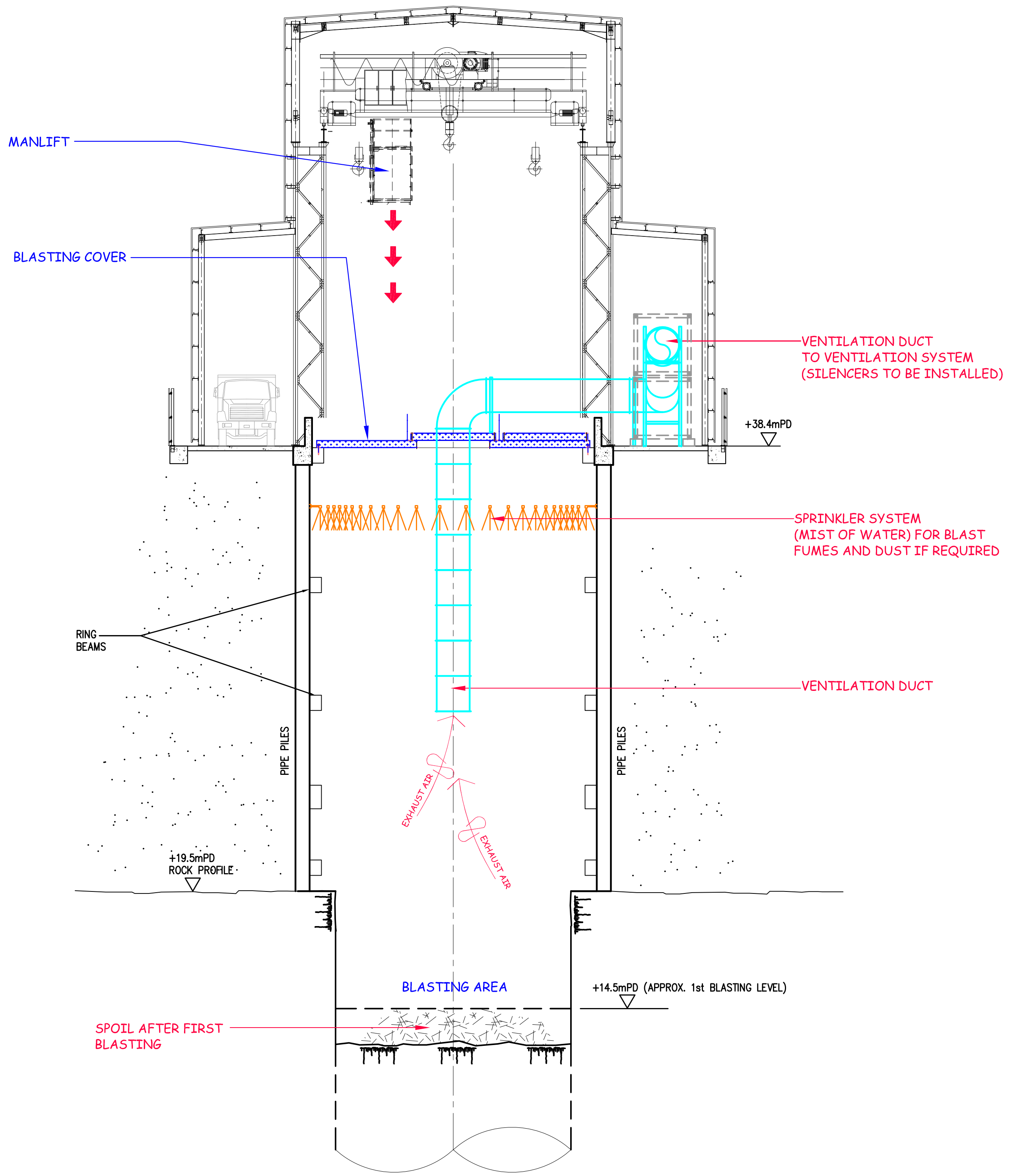
PLOTTED BY: $USER$ $DATE$ $TIME$
PLOT DRV: $PLTDRVL$
MODELNAME: $MODEL$
FILENAME: $FILE$

Annex D2

Annex K of WIL ER Report - Details of Ventilation system



PLAN VIEW



SHAFT SECTION

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A1	FIRST SUBMISSION	FHo	14DEC09	SPo

DRAWN	DAI
DESIGNED	PKV
CHECKED	FHo
APPROVED	SPo
DATE	14/DEC/2009

MTR

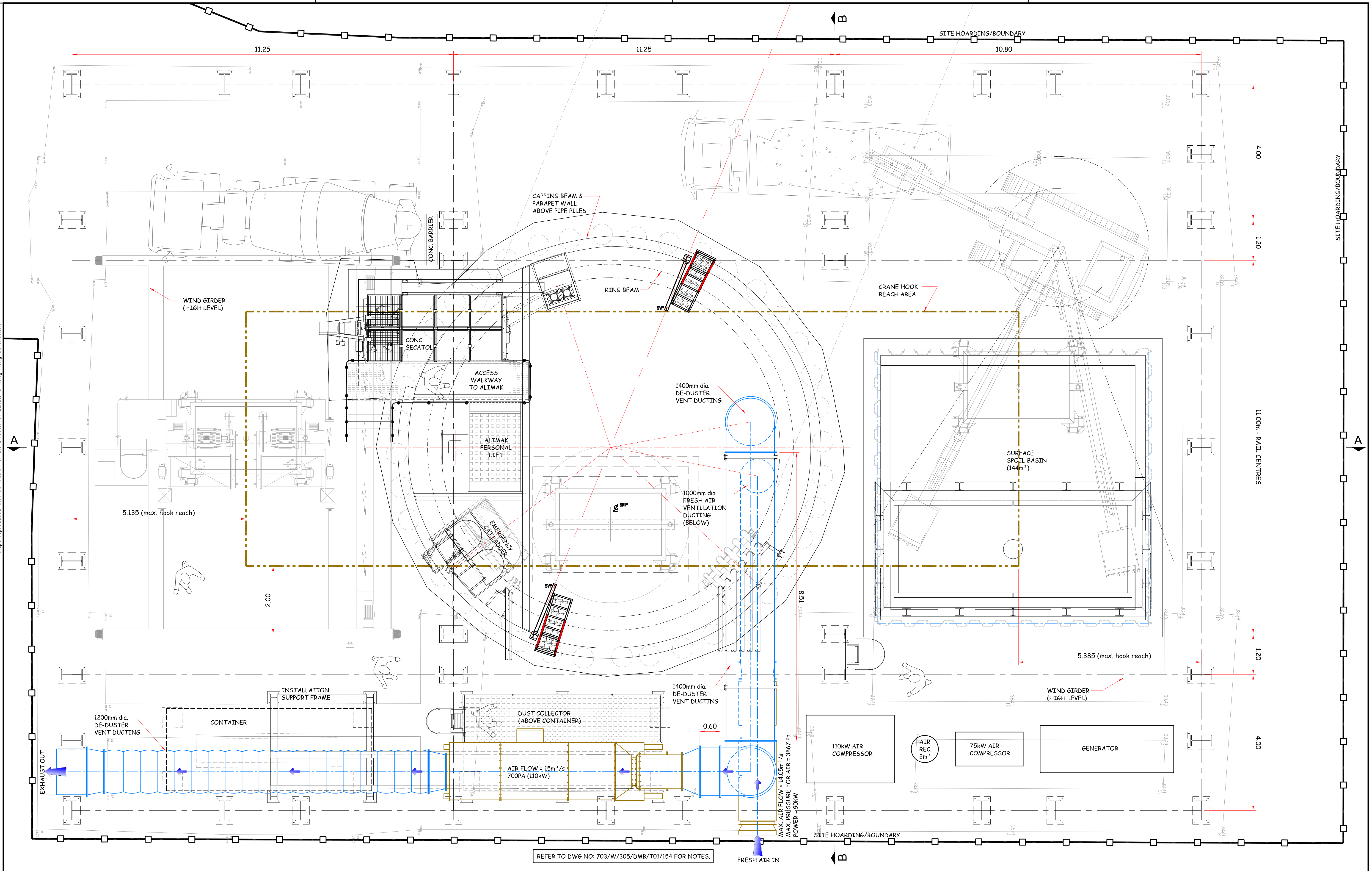
WEST ISLAND LINE

ORIGINATOR

CADD REF. 703-W-305-DMB-T01-069 A2

TITLE
CONTRACT 703
SHW TO SYP TUNNELS
KING GEORGE V
BLASTING VENTILATION
PRINCIPLE

SCALE 1:250:125 (A1) | DRAWING NO. 703/W/305/DMB/T01/069 | REV. A2



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DRAWN	MGo
DESIGNED	MGo
CHECKED	SPo
APPROVED	SPo
DATE	09/JUN/2010

MTR

WEST ISLAND LINE

ORIGINATOR

CADD REF. 703_W_305_DMB_T01_190A1

TITLE
CONTRACT 703
SHW TO SYP TUNNELS
KING GEORGE V

SHAFT VENTILATION DUCTING DURING BLASTING WORKS PRINCIPLE (SHEET 1 OF 3)

SCALE 1 : 50 (A1)

DRAWING NO. 703/W/305/DMB/T01/190

REV. A1

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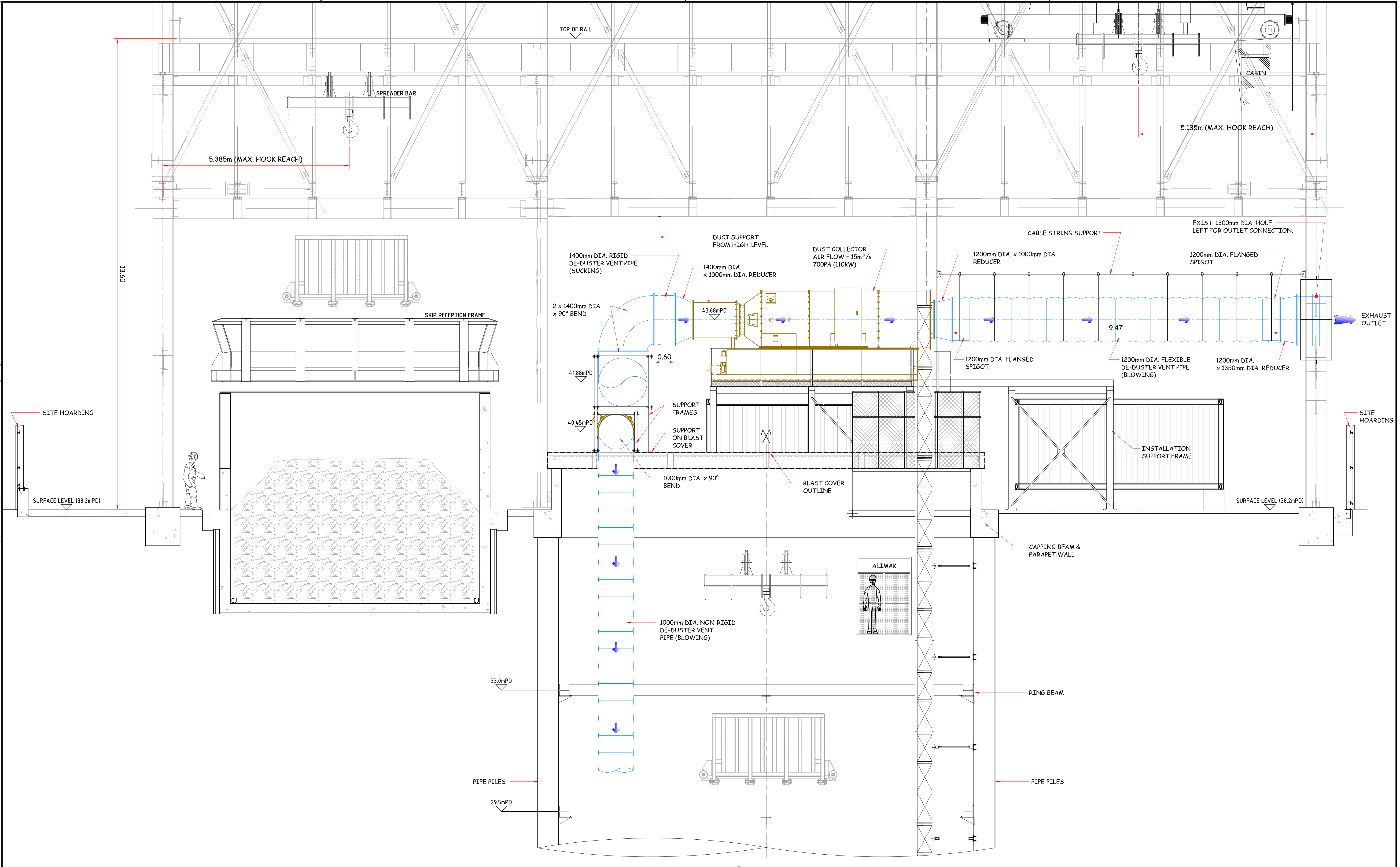
PRINTED BY: $USER$ $DATE$ $TIME$



SECTION A-A

SCALE 1:50 (A1)

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FILENAME: $FILE$

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A1	FIRST ISSUE	MGo	09JUN10	SPo

DRAWN	MGo
DESIGNED	MGo
CHECKED	SPo
APPROVED	SPo
DATE	09/JUN/2010

MTR

WEST ISLAND LINE

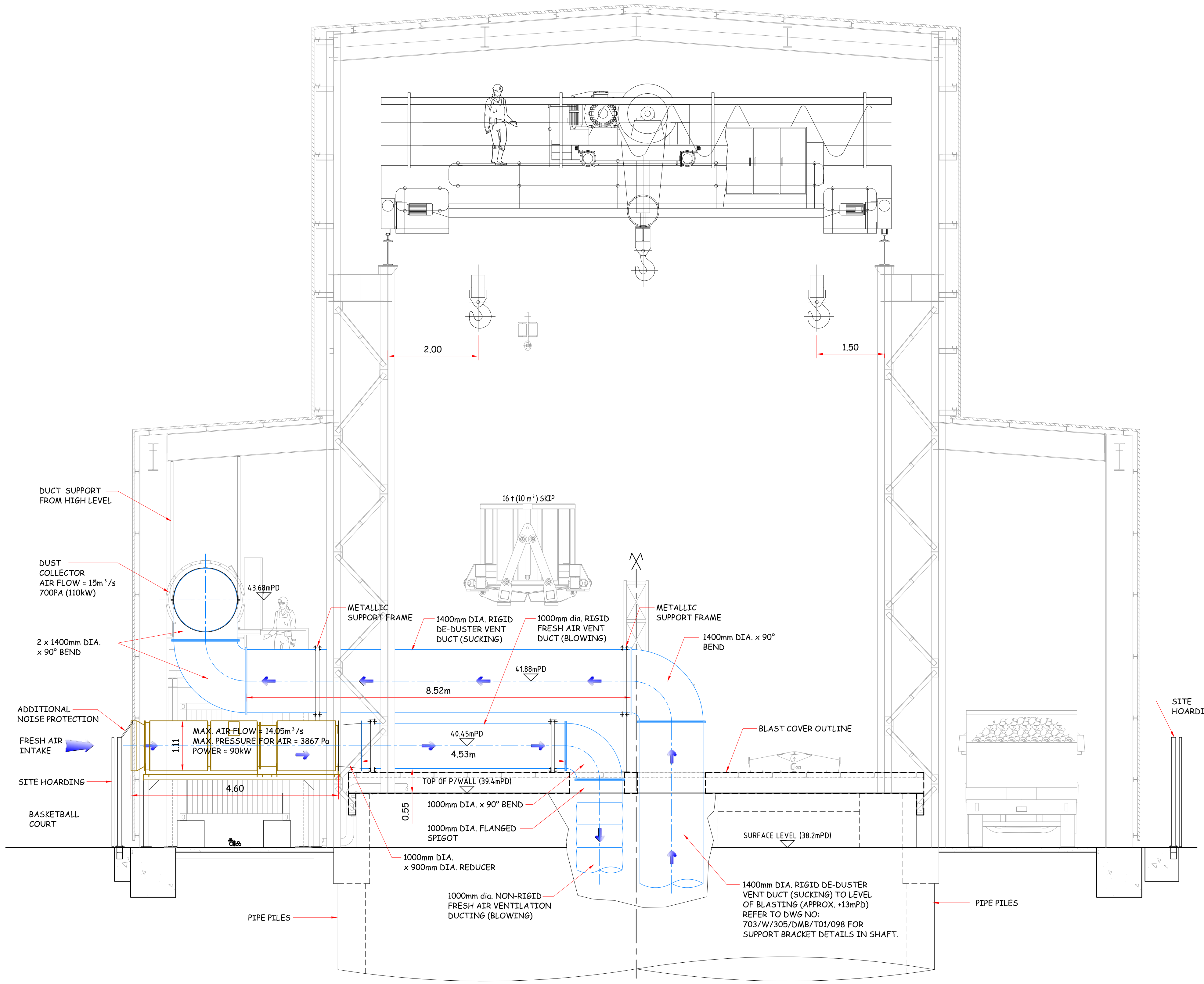
ORIGINATOR

Dragages Hong Kong — MAEDA — BACHY SOLETANCHE 法國地基建築有限公司

CADD REF.
703_W_305_DMB_T01_191A1

TITLE
CONTRACT 703
SHW TO SYP TUNNELS
KING GEORGE V
SHAFT VENTILATION DUCTING DURING BLASTING WORKS
PRINCIPLE (SHEET 2 OF 3)

SCALE	DRAWING NO.	REV.
AS SHOWN	703/W/305/DMB/T01/191	A1



SECTION B-B
SCALE 1:50 (A1)

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DRAWN	MGo
DESIGNED	MGo
CHECKED	SPo
APPROVED	SPo
DATE	09/JUN/2010

DO NOT SCALE DRAWINGS. ALL DIMENSIONS SHALL BE VERIFIED ON SITE.

MTR

WEST ISLAND LINE

ORIGINATOR

CADD REF. 703_W_305_DMB_T01_192A1

TITLE
CONTRACT 703
SHW TO SYP TUNNELS
KING GEORGE V
SHAFT VENTILATION DUCTING DURING BLASTING WORKS PRINCIPLE (SHEET 3 OF 3)

SCALE: AS SHOWN
DRAWING NO. 703/W/305/DMB/T01/192
REV. A1

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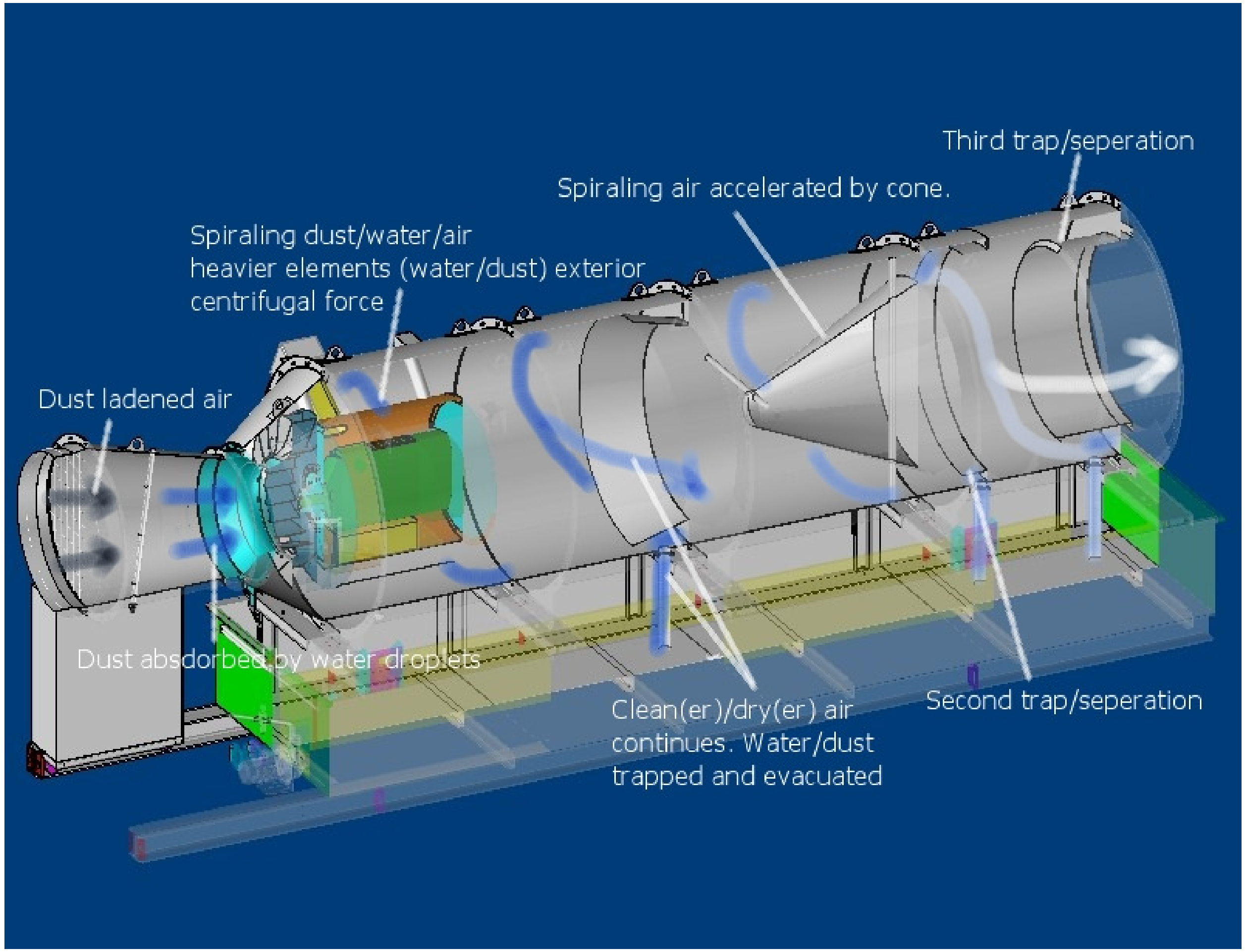


A Sketch showing the operation principle of the Dust Collector

ECE S.A. COGEMACOUSTIC®
42 route du palais
87022 LIMOGES - FRANCE
Tel. : (33) 05 55 43 06 39 / Fax. : (33) 05 55 03 75 53

PO/ - 1
24/05/2010

DUST COLLECTOR TYPE DVH 15

TECHNICAL SPECIFICATION

I) CHARACTERISTICS:

	UNITS	VALUES
Atmospheric pressure	Mhg	760
Temperature	°C	20
Density	Kg/m^3	1.2
Exhausted airflow	m^3/s	15
Admitted dusts quantity per m^3	gr/m^3	5
Maximum dusts quantity per m^3 at air output	mg/m^3	5
Efficiency : Dusts : - Global	%	95
Available pressure differential	Pa	500
Turbine power	kW	110
Rotation speed	tr/mn	1500
Injection pump pressure	kW	5,5
Output	l/sec	2 to 3
Pressure	Bars	Between 1 and 4
Sound level at 3 meters in free field	dB(A)	85

2) PRINCIPLE:

The dusts laden air will be exhausted in a Venturi type air nozzle. The air will, this way be accelerated in the admission convergent fitted with, as the case may be, one or several sprayers aiming at creating a thin droplets curtain to wet the particles.

The average relative speed between dust particles and droplets being very high in order to overcome, by method of collision, the droplets surface tension, the consequence will be the coating of all particles.

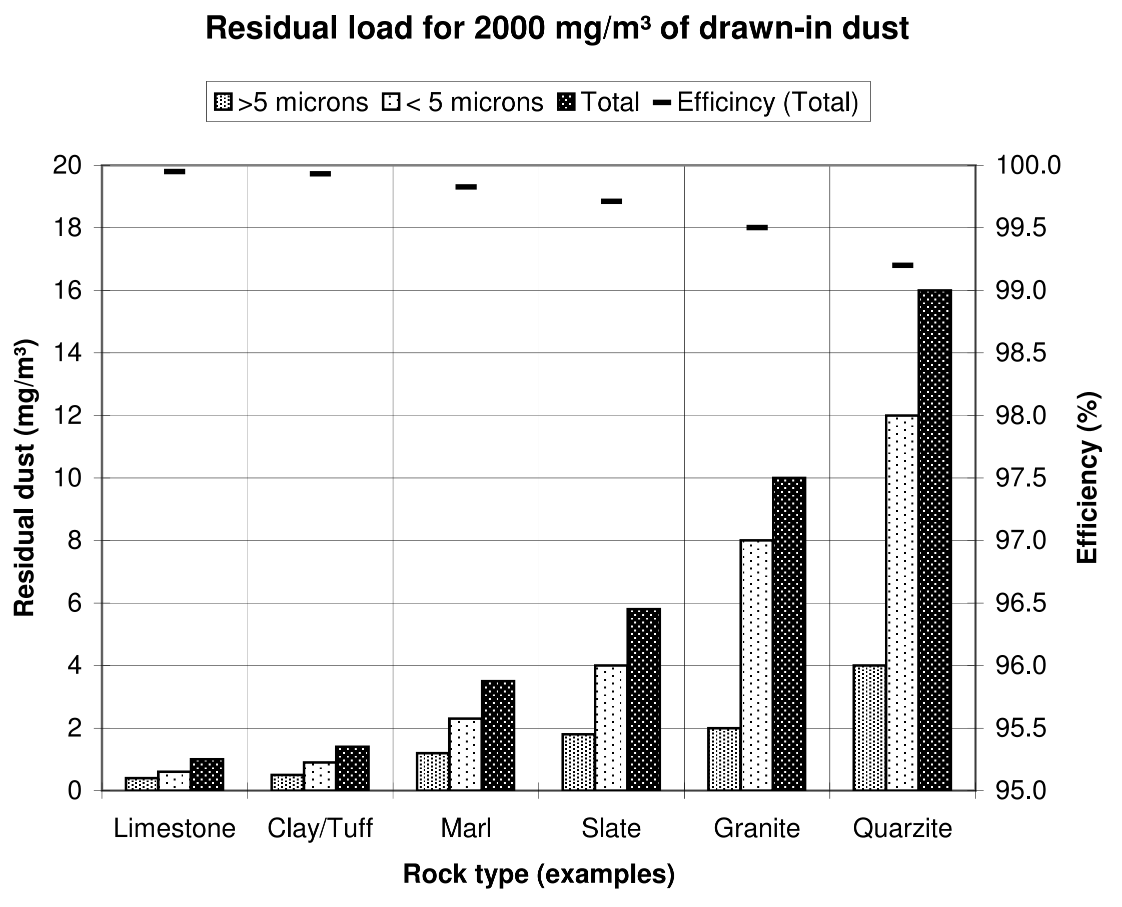
WET TYPE DUST COLLECTOR

The dust collector's capacity to separate dust is directly proportional to the hydrphilic nature of the rock and, to a lesser extent, the pH of the water

The grading of the drawn-in dust depends on the thrust of the drilling face and on the quality of the rock.

It is therefore difficult to predict the exact efficiency of a wet type dust scrubber without the geological and geotechnical specifications of the worksite.

Nevertheless, experience of more than 100 sites gives the following table:



We consider that a guaranty of efficiency based on laboratory results using unrepresentative dust samples and which do not reflect the nature and constraints of a working site is pure theory.

Annex E

TSP Monitoring Results for Shaft Blasting at KGV

FUGRO TECHNICAL SERVICES LIMITED
MateriaLab Division,
Fugro Development Centre,
5 Lok Yi Street, 17 M.S. Castle Peak Road,
Tai Lam, Tuen Mun, N.T., Hong Kong.

Tel : +852-2450 8233
Fax : +852-2450 6138
E-mail : matlab@fugro.com.hk
Website : www.materialab.com.hk

MateriaLab

TEST REPORT ON DUST MONITORING

Client	:	Dragages Maeda Bachy J.V.
Project	:	Contract No. 703 – West Island Line – SHW to SYP Tunnels
Report No.	:	102383EN100678
		July & August, 2010

Note : This report refers only to the sample(s) tested.

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E-mail : matlab@fugro.com.hk
Website : www.materialab.com.hk

Report No. : 102383EN100678

I. Introduction

MateriaLab was requested by the client to provide monitoring services on total suspended particulates (TSP) measurement at a selected location, H.K.S.P.C. Thomas Tam Nursery School at Sai Ying Pun. This report presents the TSP monitoring results for the work undertaken in July and August 2010.

II. Monitoring Methodology & Work Undertaken

One 1-hour TSP average concentration is measured by a hand-held direct reading aerosol monitor at the monitoring location (refer to layout plan in the Appendix). Calibration certificate of the measurement equipment is attached in the Appendix.

The fieldwork was carried out at the monitoring location from 26/07/2010 to 18/08/2010 on five different occasions. As requested, three 1-hour TSP levels were measured on 30/07/2010. The monitoring exercise was conducted and summarised as follows:

Test	Date	Time	Remarks
1	26/07/2010	08:36 – 09:36	Baseline monitoring
2	30/07/2010	08:32 – 09:32 09:32 – 10:32 10:32 – 11:32	Baseline monitoring
3	04/08/2010	07:00 – 08:00	Impact monitoring (blasting at 07:00)
4	10/08/2010	07:05 – 08:05	Impact monitoring (blasting at 07:00)
5	18/08/2010	07:00 – 08:00	Impact monitoring (blasting at 07:00)

Note : This report refers only to the sample(s) tested.

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Tel : +852-2450 8233
Fax : +852-2450 6138
E-mail : matlab@fugro.com.hk
Website : www.materialab.com.hk

Report No. : 102383EN100678

III. Results

The air monitoring results are summarized as follows:

Test	Date	Time	Total Suspended Particulates Content ($\mu g/m^3$)
1	26/07/2010	08:36 – 09:36	85
2	30/07/2010	08:32 – 09:32 09:32 – 10:32 10:32 – 11:32	31 22 28
3	04/08/2010	07:00 – 08:00	22
4	10/08/2010	07:05 – 08:05	76
5	18/08/2010	07:00 – 08:00	54

Prepared by : K.F. Wong

Certified by :
Approved Signatory: HO Kin Man, John
Manager – Chemical & Environmental

Date : 28/9/2010

Note : This report refers only to the sample(s) tested.

FUGRO TECHNICAL SERVICES LIMITED
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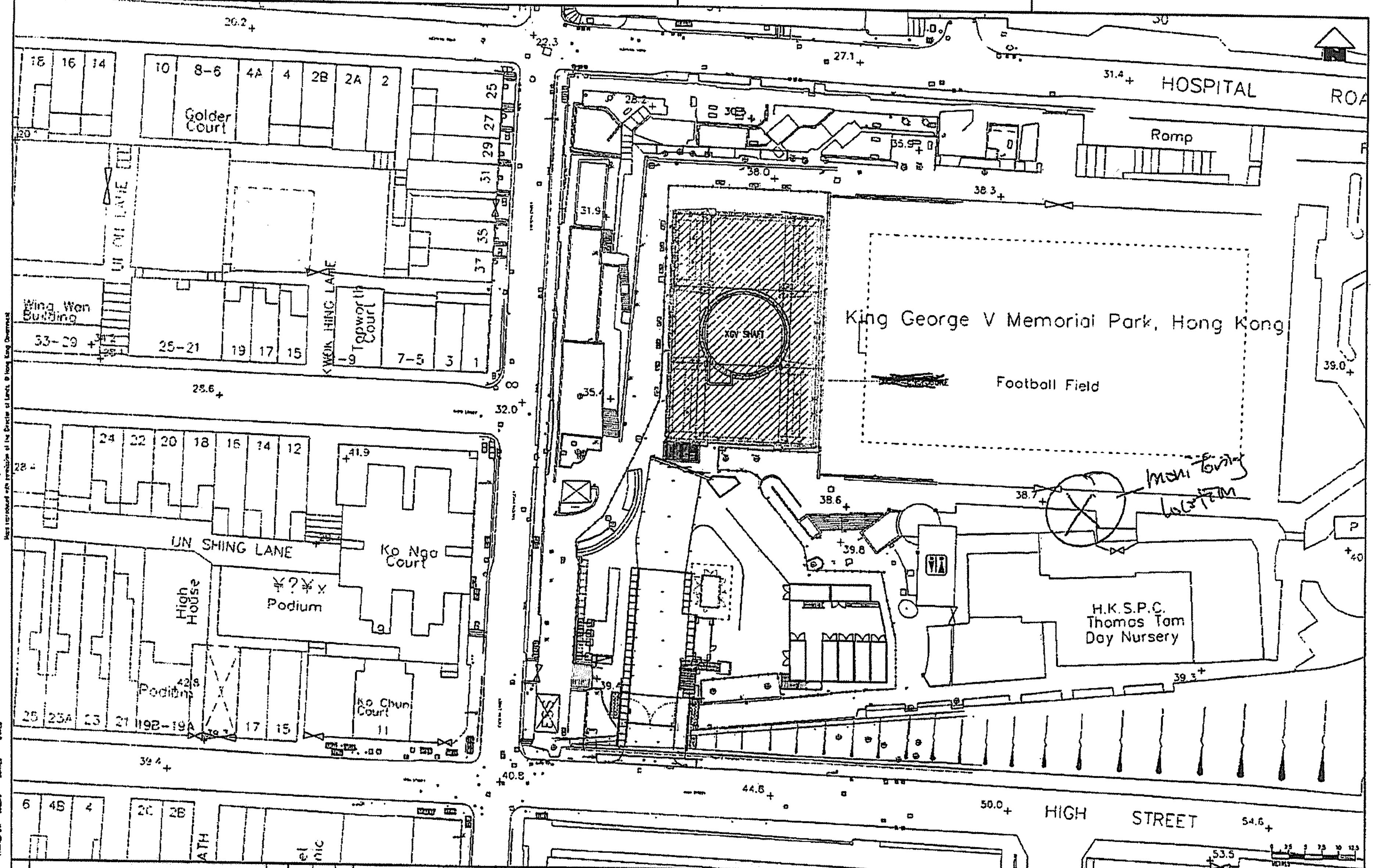
Tai Lam, Tuen Mun, N.T., Hong Kong.
Tel : +852-2450 8233
Fax : +852-2450 6138
E-mail : matlab@fugro.com.hk
Website : www.materialab.com.hk

Appendix

- Layout plan of monitoring location

Note : This report refers only to the sample(s) tested.



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DESIGNED	CCh
CHECKED	PKV
APPROVED	SPe
DATE	12/MAY/2010

A1 FIRST ISSUE

MTR

WEST ISLAND LINE

CADD REF. 703_W_305_DMB_T01_156 A1

CONTRACT 703
SHW TO SYP TUNNELS
KING GEORGE V
LOCATION PLAN

SCALE 1:250 (A1)

DRAWING NO. 703/W/305/DMB/T01/156

REV. A1

FUGRO TECHNICAL SERVICES LIMITED
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Fugro Development Centre,
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Fax : +852-2450 6138
E-mail : matlab@fugro.com.hk
Website : www.materialab.com.hk

Appendix

– Equipment calibration certificate

Note : This report refers only to the sample(s) tested.

7-08-2

CERTIFICATE OF CALIBRATION AND TESTING

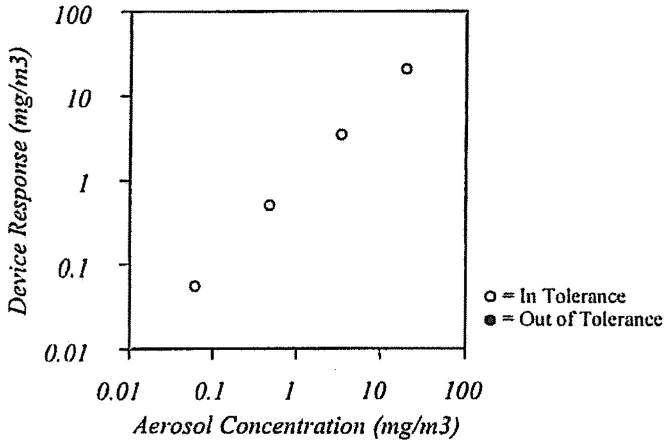
TSI Incorporated, 500 Cardigan Road, Shoreview, MN 55126 USA
Tel: 1-800-874-2811 1-651-490-2811 Fax: 1-651-490-3824 http://www.tsi.com

Environment Condition		
Temperature	77.5 (25.3)	°F (°C)
Relative Humidity	13	%RH
Barometric Pressure	29.19 (988.5)	inHg (hPa)

Model	8520
Serial Number	22398

☒ As Left ☒ In Tolerance
☐ As Found ☐ Out of Tolerance

Concentration Linearity Plot



System ID: DTH01-02

Zero Stability Results			
Average: 0.000 :mg/m^3	Minimum: 0.000 :mg/m^3	Maximum: 0.001 :mg/m^3	Time: 4:00 :hrs.

TSI Incorporated does hereby certify that all materials, components, and workmanship used in the manufacture of this equipment are in strict accordance with the applicable specifications agreed upon by TSI and the customer and with all published specifications. All performance and acceptance tests required under this contract were successfully conducted according to required specifications. There is no NIST standard for optical mass measurements. Calibration of this instrument performed by TSI has been done using emery oil and has been nominally adusted to respirable mass of standard ISO 12103-1, A1 test dust (Arizona dust). Our calibration ratio is greater than 1.2:1

Measurement Variable	System ID	Last Cal.	Cal. Due
Barometric Pressure	E001329	04-23-09	04-23-10
Humidity	E002873	02-24-09	02-24-10
DC Voltage	E003315	01-06-09	07-06-10
Microbalance	E003403	01-07-10	01-07-11
Pressure	E003511	11-12-09	11-12-10

Measurement Variable	System ID	Last Cal.	Cal. Due
Temperature	E002873	02-24-09	02-24-10
DC Voltage	E003314	01-06-09	07-06-10
Photometer	E003319	12-30-09	06-30-10
Flow and Temperature	E003512	02-16-09	02-16-10

Tom [signature]
Calibrated

☒ Final Function Check

January 15, 2010
Date