Table 1 EP Condition 3.5 (a)(i) - Summary of the document

.	Content	Remarks
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 (a)(i)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; section 3 clause 3.3, section 6, clause 6.1.1, section 10 clause 10.1.2 and section 16 clause 16.2.8
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and (i) and Franchisee Requirements Clause 1.05 item (b)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10 and section 5
5	Contract drawings	**a. Calculation for Capacity of Bunded Area** - PAFF/RJ/02/DWG/G/3015(EX) Revision Q Layout Plan / Block Plan
		b. Oil Buckets - PAFF/RJ/02/DWG/G/3014(EX) Revision Q Layout Plan / Block Plan - PAFF/BA/02/DWG/C/1721 Revision Q3 Tank Farm Bund Wall Details (sheet 1 of 4)
6	Photographs	Photographs of the completed works
7	Justification	The tank farm storage consists of two bunds each designed to have six tanks, of which 4 tanks in each bund (a total of 8 tanks) will be built. The calculation of bund wall containment volume in Drawing PAFF/RJ/02/DWG/G/3015(EX) shows that the current containment capacities of each of the two bunds are 165% and 142% respectively, far greater than 110% of the largest aviation fuel storage tank in the bunded compounds. Moreover, both bunds are interconnected for the overflow so that in normal circumstances, the overall containment capacity is double the size of a single bunded compound, or greater than 300% of the largest tank for the 8 tank facility. This is meeting the I.P. Code Part 19 "Fire Precautions at Petroleum Refineries and Bulk Storage Installations" item 3.4.2.5.5 and the Hong Kong "Code of Practice for Oil Storage Installation" item 4.1.

Table 1 EP Condition 3.5 (a)(ii) - Summary of the document

	Content	Remarks
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 (a)(ii)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; section 3 clause 3.3, section 6, clause 6.1.1, section 10 clause 10.1.2 and section 16 clause 16.2.8
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and (i) and Franchisee Requirements Clause 1.05 item (b)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10 and section 5
5	Contract drawings	**(a) Bunds, wave deflectors, fire retardant joints** - PAFF/BA/02/DWG/C/1721 Revision 3 Tank Farm Bund Wall Details (sheet 1 of 4) - PAFF/BA/02/DWG/C/1722 Revision 3 Tank Farm Bund Wall Details (sheet 2 of 4) - PAFF/BA/02/DWG/C/1723 Revision 3 Tank Farm Bund Wall Details (sheet 3 of 4) - PAFF/BA/02/DWG/C/1724 Revision 3 Tank Farm Bund Wall Details (sheet 4 of 4)
		(b) Internal bunds (intermediate bunds) - PAFF/LC/02/DWG/C/0551 Revision A Tank farm Drainage Layout Plan - PAFF/BA/02/DWG/C/1452 Revision 6 Tank Farm EVA Stormwater Drainage Layout
		(c) Fire retardant joints, stainless steel - PAFF/CON/SK/0670 Revision 0 Stainless Steel Water Stop for Phase la Bundwall - PAFF/HK/02/DWG/C/9835 Revision 0 Stainless Steel Protection Cover for Movement Joint of Bund Wall
6	Technical information	Technical information on the flame retardant sealant
7	Photographs	Photographs of the completed works.
8	Justification	• Drawings PAFF/BA/02/DWG/C/1721-1724 reflect that the bunds had been designed to be partly sunken below ground level outside the bunds in the EVA. • Drawings PAFF/BA/02/DWG/C/1721-1724 reflect that the bunds had been designed with the installation of wave deflectors on the bund walls. • Drawings PAFF/BA/02/DWG/C/1722-1724, PAFF/CON/SK/0670 and PAFF/HK/02/DWG/C/9835 show designed installation of special fire-retardant joints at the bunds. The components consist of Flexcell Compressible Filler and Hilti CP601 S Elastic Firestop Sealant. All visible parts of the joints are covered by stainless steel plates on the inside. • Drawings PAFF/BA/02/DWG/C/1452 & PAFF/LC/02/DWG/C/0551 show the construction of internal bund (intermediate bund) walls within the bunded compounds for each aviation fuel storage tank. It is meeting the I.P. Code Part 19 "Fire Precautions at Petroleum Refineries and Bulk Storage Installations" item 3.4.2.5.4.

香港機場管理局 | AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (a) (ii)
Date of Report:	24 November 2009
Date prepared by ET:	24 November 2009
Date received by IEC:	24 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (a) (ii)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(a) Containment Systems of Aviation Fuel Storage Tank
Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular :

(ii) The bunds shall be partly sunken below the level of ground outside the bunds. Wave deflector and fire retardant joints shall be used at the bunds. Intermediate bund walls shall be designed and constructed within the bunded compounds for each aviation fuel storage tanks;

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 24 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

pp Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. <u>Submissions or Measures during the Construction of Certain Parts of the Project</u>

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

a) <u>Containment Systems of Aviation Fuel Storage Tank Farm</u>

Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular:

ii) The bunds shall be partly sunken below the level of ground outside the bunds. Wave deflector and fire-retardant joints shall be used at the bunds. Intermediate bund walls shall be designed and constructed within the bunded compounds for each aviation fuel storage tanks;

Environmental Impact Assessment Report Requirement

3 DESCRIPTION OF PROJECT AND ASSUMPTIONS

3.2 Tank Farm and Onshore Facilities

3.2.1 About 6.75 ha of land is required to accommodate the aviation fuel tank farm and associated facilities. The proposed site for the tank farm at Tuen Mun Area 38 has been reclaimed by Government and is zoned for special industrial use. The site is situated at Siu Lang Shui just southeast of the Castle Peak Power station and is adjoined on the west by the Shiu Wing Steel Mill and on the south-east by the proposed EcoPark and adjacent to that is land earmarked for industrial use in keeping with the other land uses in the area. Further east is the River Trade Terminal. The allocated plot has a short length of sea frontage of 60m in width which extends inland for about 140m before widening out to a square area of about 217m in length by 278m in width, see Figure 3.2c.

3.2.2 No residential developments are present in the area and the closest substantial development, Melody Garden in Tuen Mun, is at least 3 kilometres from the proposed site. The villages at Lung Kwu Tan are closer at about 2km away but are screened from the site by the Castle Peak topography. However, there is a planned Holiday Camp to the North-East of the site along Lung Man Road which is over 500m away.

3.2.3 It should be noted that the previous EIA study (April 2002) was undertaken based upon the project layout detailed in Figure 3.2a and a tank design capacity of 420,000m^3. However, changes were made to the detailed layout and an application for a variation (Application No. VEP-133/2004) to the then valid Environmental Permit EP-139/2002 was made. However, during the development of the detailed design, FSD placed a restriction on the height of the storage tanks above the emergency access. Thus, in order to comply with FSD's requirement on the tank height (requested in April 2003), the height of the tanks were reduced from 32.0m to 24.7m and the volume of the largest tanks reduced from 39,000m^3 to 35,000m^3. As a result, the ultimate capacity of the facility was reduced to 388,000m^3 from 420,000m^3, resulting in variation to the environmental permit (EP-139/2002/A) which was granted by EPD in February 2004. Details of the revised layout approved by the VEP are provided in Figure 3.2b and details of the improvements made to the tank farm layout are detailed in EP Variation Application No. VEP-133/2004 and summarized in Table 3.2 below. Also, as part of the changes made, and as shown in Figure 3.2b, the whole site has been shifted 10m to the southeast from that proposed in the original EIA of April 2002, to accommodate Lands Department's commitment of a land extension to Shiu Wing Steel Mill.

Table 3.2 Summary of Tank Farm Improvements

Item		Previous EIA Report (April 2002)	Current Design	Improvement / Neutral	Change Initiated By
Dimension					
1	Volume (largest tank)	39,000 cu.m.	35,000 cu.m.	Improvement	FSD
2	Tank height (highest) (total)	32.0 m	24.7 m (23m above ground)	Improvement	FSD
3	Distance from tank to bund	10.0 m	10.0 m	Neutral	--
4	Distance from bund to security wall	8.0 m	8.5 m	Improvement	FSD
5	Distance from bund to boundary	16.5 m (minimum)	18.5 m	Improvement	AA
Bunding					
1	Bund with wave wall	None	Included	Improvement	AA
2	Height of bund wall (average)	4.6 m	4.8 m	Improvement	AA
3	Height of inner security wall	2.0 m	2.0 m	Neutral	--
4	Drainage ditch	Included	Included	Neutral	--
5	Earth bund in landscaped area	None	1.5 m high	Improvement	Planning/EP
6	Outer security fence/wall	Open mesh fence	Impervious wall	Improvement	AA

3.2.4 In addition to these changes, the phasing of the tanks has changed with 8 (eight) to be constructed initially as shown in Figure 3.2c. While Figures 3.2b and 3.2c show the current layout for the site and phasing for the construction of the tanks, indicative cross sections between the tanks and the lot boundaries with Shiu Wing Steel and the EcoPark are provided in Figures 3.2d and 3.2e respectively with the location of the cross-sections shown in Figure 3.2c.

3.2.5 The tank farm will initially house 8 storage tanks, 6 tanks of 43.5m diameter by 24.7m in height, one of 41.5m diameter by 24.7m in height and one of 35m diameter by 24.7m in height. The tank heights refer to the total tank height but it should be noted that part of the tank will be positioned in the ground and as such only 23m will protrude above ground level. The tanks provide a storage capacity of between 22,000m^3 to 35,000m^3. It is intended that the tankage capacity would be increased once the initial capacity of 264,000m^3 has been reached around 2025 to 2030. It is intended that the remaining 4 tanks would be built all together between 2025 and 2030 to increase the tankage capacity to the ultimate design tankage capacity of PAFF i.e. 388,000m^3. The heights of 3 of the remaining tanks would be 24.7m, with one tank of 23m and their capacities would vary accordingly between 35,000m^3 and 19,000m^3. When planning for the 4 remaining tanks in the final phase of the development, latest technology, industrial standards and statutory requirements at that time would be used. Also the EIA would be reviewed if appropriate in view of the latest technology, standards and statutory requirements at that time.

3.2.10 The tank farm would be provided with bundwalls and contained drainage. There are 2 main bunds (designed to contain any spills from the tank or tank piping), each containing 6 tanks in future but 4 tanks initially. The height of the bundwalls has also been increased from previous April 2002 EIA in order to improve the retention of any fuel spillage from the tanks within the PAFF boundary. The initial bund containment with 4 tanks in each bund would amount to at least 180% of the volume of the largest tank (well exceeding the required 110%) and ultimately (2040) this would be at least 150% of the volume of the largest tank with 6 tanks in each bund. Each tank is also separated by intermediate bund walls to hold minor spills. There are also 2 emergency shutdown valves on the pipeline inlet to the tank farm from jetty and another 2 on the pipeline outlet of the tank farm to the Airport. These valves are operated via motorized electric actuators. The tank bunds and the pump platform are contained areas and drain to the interceptor via bund drain valves. Other leakage prevention devices include fuel tank high-high level alarm and leak detection system for the pipeline. The storm water drain will also have a remotely operated block valve to contain any oil spill on site.

Mitigation Measures

6.1.1 Operational Phase

6.1.1.2 Other mitigation measures recommended for the operational phase include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- all tanks shall be bunded to a capacity of at least 150% of the largest individual tank in each compound at the ultimate phase of 2040. For the initial development phase, as only 4 tanks will be present in each bund, a containment capacity of about 175% will be achieved. Tank pits shall be protected by an impermeable bed (e.g. geotextile sheeting) to prevent seepage of aviation fuel to ground. A leak detection system shall be installed beneath the containment membrane;

- there shall be no direct outlet from the bund. A collection sump shall be included in the base. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator;

10 HAZARD TO LIFE ASSESSMENT

10.1.2 Overview of PAFF Hazards

10.1.2.8 The PAFF will be built to internationally recognised standards and best practices for fuel storage. Cylindrical steel storage tanks with conical roofs (to API 650) are used throughout the world for storage of liquid hydrocarbon fuels. The same types of tanks are also used to store more volatile fuels such as gasoline, although internal floating roofs are now standard for gasoline to reduce environmental emissions of vapour. Bund walls, will surround the tanks so that, in the case of leaks, any fuel leak is collected and can be cleaned up. The containment capacities of the bunds at the PAFF greatly exceed international standards. The PAFF design also has two additional impervious security walls as well as the more usual single bund wall and fence. This will further reduce the chance of any spill affecting off-site areas.

10.1.4.7 The tank bund design is such that the total capacity of the bund significantly exceeds the usual 110% of the capacity of the largest tank. The bund containment capacities are 166% and 156% of the capacity of the largest tank for the bunds nearest to the sea and furthest from the sea respectively, with all tanks constructed [12]. Initially, with only four of the tanks in each bund constructed, the bund capacities will be 195% and 188% of the capacity of the largest tank [12].

10.1.5.12 The storage tanks will be located within a bund, which is designed to contain any spills from the tank or tank piping. The bund is designed to hold much more than the required 110% of the contents of the largest tank in the bund. The bund will be provided with a drain, which will be discharged by a manually operated valve to the sea through an oil interceptor. Drainage from unbunded areas onsite will be discharged through the storm water drain to the sea. The storm water drain will be provided with a remotely operated block valve to contain any oil spill on site.

16. SUMMARY OF ENVIRONMENTAL OUTCOMES

<u>Design</u>

16.2.8 All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure, and the resultant leaks/spills, to the lowest practicable extent. Fuel storage tanks will be constructed in a bunded area which will have collection capacity greater than the maximum content of the largest tank, to contain any fuel leaks or spills. There shall be no direct outlet from the bund to ensure retention of any spilled material. A collection sump shall be included in the base. Protection against leaks or spills from the bottom of the tanks will be achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. A spill detection system will be fitted underneath this membrane to provide additional security. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

(i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting
(ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings
(iii) Sampling and product recovery system
(iv) Manifolding to tank farm and existing aviation fuel system simultaneously
(v) Fire protection system
(vi) Power supply and independent standby power generator or second supply
(vii) Buildings including offices, canteen, control room, workshop, stores
(viii) Emergency response facilities
(ix) Storage tanks for fuel, water, chemicals and wastes
(x) Utility and other systems including back-up systems
(xi) Cathodic protection
(xii) Lightning protection
(xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities
(xiv) Electronic tank servo gauges
(xv) Hard standing, roads and parking
(xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services;

EPC – Franchisee’s Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services; and associated fire protection;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed.

Also, in the detail design additional standards may be referenced for specific items.

5. Storage Tank (including BUND Wall and Foundation)

5.1 GENERAL

The main storage tanks will be circular and made of steel plate with diameters of 6 x 43.5m, 1 x 41.5m, 1 x 35m and a height of 24.7 metres and nominal capacities of 35,000, 32,000, 22,000 cubic metres respectively. The tanks will be founded on a reinforced concrete ring beam. The eight storage tanks will be contained within two reinforced concrete bund walls (4 nos. of fuel tank for each bund wall) with a membrane lining to contain any leakage. All bund walls will include a wave wall to assist in containing Jet A1 within the bunded area.

5.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) API 650 Vertical Storage Tanks
(b) BS EN 12285 Horizontal Storage Tanks
(c) British Standard for Concrete Structures
(d) Code of Practice for Oil Storage Installations 1992 – Building Authority Hong Kong
(e) IP Code of Practice Part 15

5.3 SPECIFIC CRITERIA

5.3.4 Bund Walls

1. The bund walls shall be of reinforced concrete.

2. The capacities of the bunded areas will be 57,691 cubic metres for phase 1a & 2 tank farms and a minimum of 50,695 cubic metres for phase 1b & 2 tank farm, which are not less than 38,500 cubic metres (110% of a 35,000 cubic metres tank) for both areas.

3. The construction of the bund walls joints will provide a continuous barrier to any spill within the bunded area.

4. The bund walls shall be designed to retain the bunded area when full of water or the impact load of an instantaneous release from a simple storage tank which ever is greater.

5. A means of access in and out of the bunded area will be provided adjacent to the stairs fitted to the main storage tanks and as directed by the FSD.

6. The bund wall alignment will allow 25% of the circumstance of each tank to be with in 15 metres of the EVA.

5.3.6 Secondary Containment

The security walls adjacent to the bund wall facing public areas will in addition be constructed of reinforced concrete to contain potential overtopping of the bund wall. Gates in the security walls are to be solid and sealed up to the first hinge on the gate.

Contract Drawings

Bunds, wave deflectors, fire retardant joints

- **PAFF/BA/02/DWG/C/1721 Revision 3 Tank Farm Bund Wall Details (sheet 1 of 4)**
- **PAFF/BA/02/DWG/C/1722 Revision 3 Tank Farm Bund Wall Details (sheet 1 of 4)**
- **PAFF/BA/02/DWG/C/1723 Revision 3 Tank Farm Bund Wall Details (sheet 1 of 4)**
- **PAFF/BA/02/DWG/C/1724 Revision 3 Tank Farm Bund Wall Details (sheet 1 of 4)**

Internal bunds (intermediate bunds)

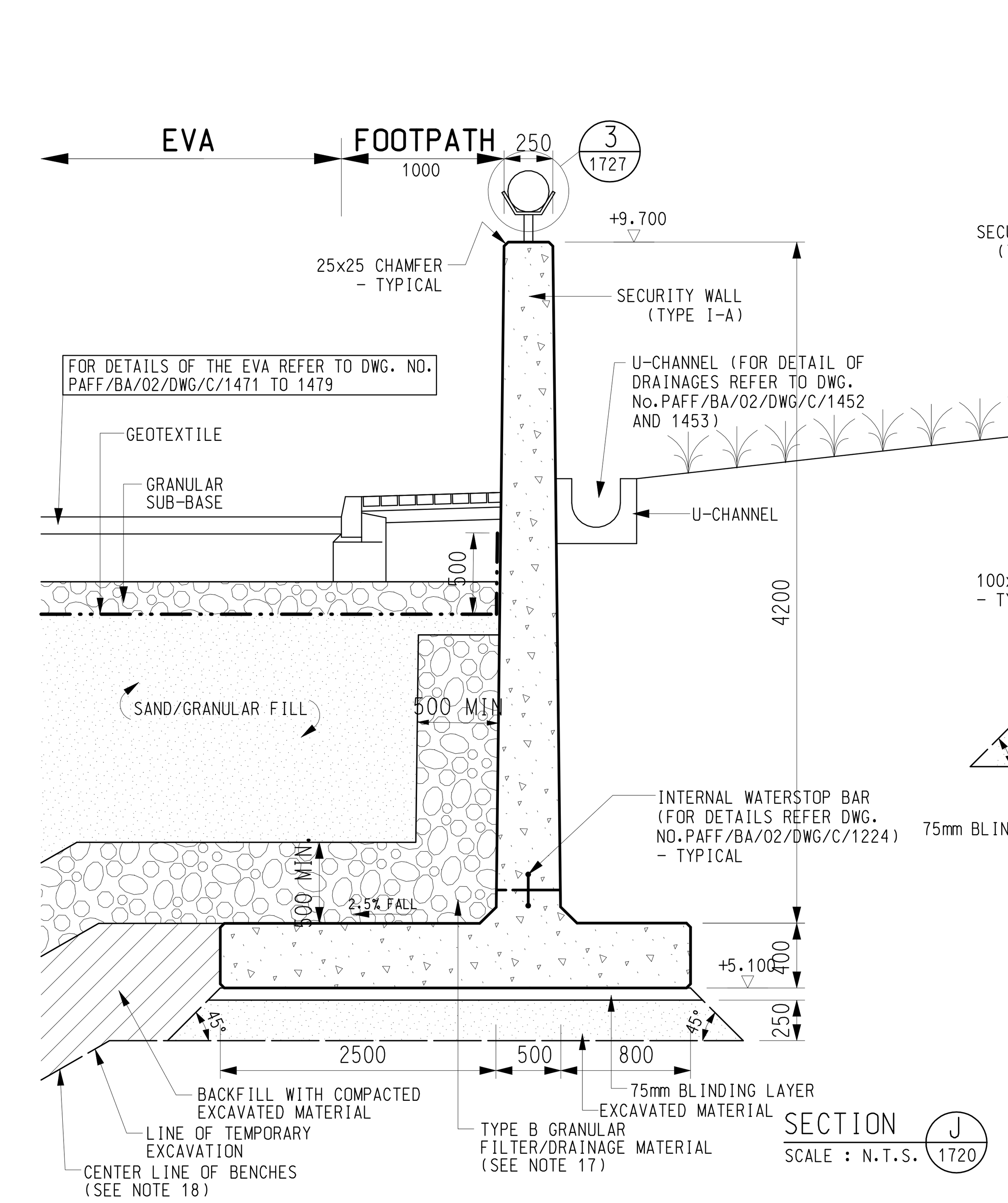
- **PAFF/LC/02/DWG/C/0551 Revision A Tank farm Drainage Layout Plan**
- **PAFF/BA/02/DWG/C/1452 Revision 6 Tank Farm EVA Stormwater Drainage Layout**

Fire retardant joints, stainless steel

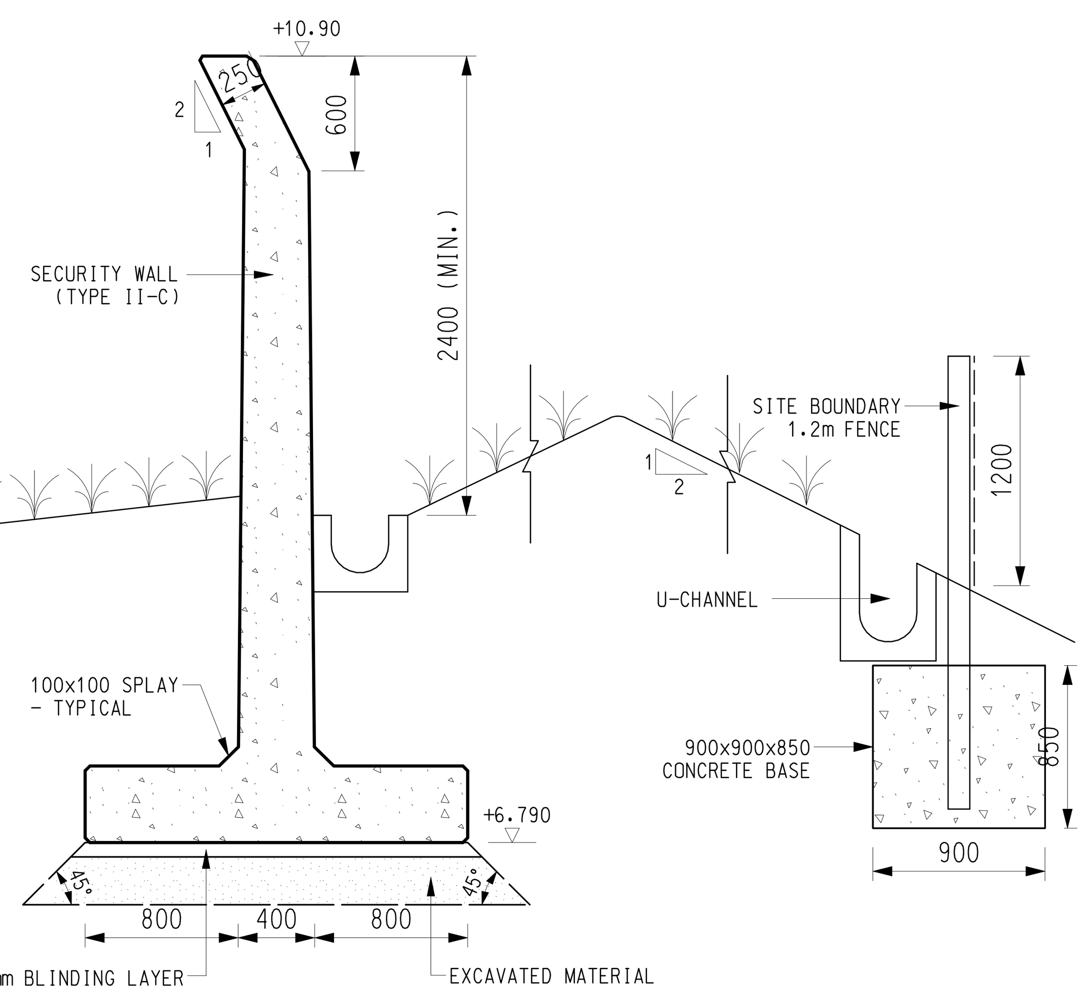
- **PAFF/CON/SK/0670 Revision 0 Stainless Steel Water Stop for Phase 1a Bundwall**
- **PAFF/HK/02/DWG/C/9835 Revision 0 Stainless Steel Protection Cover for Movement Joint of Bund Wall**

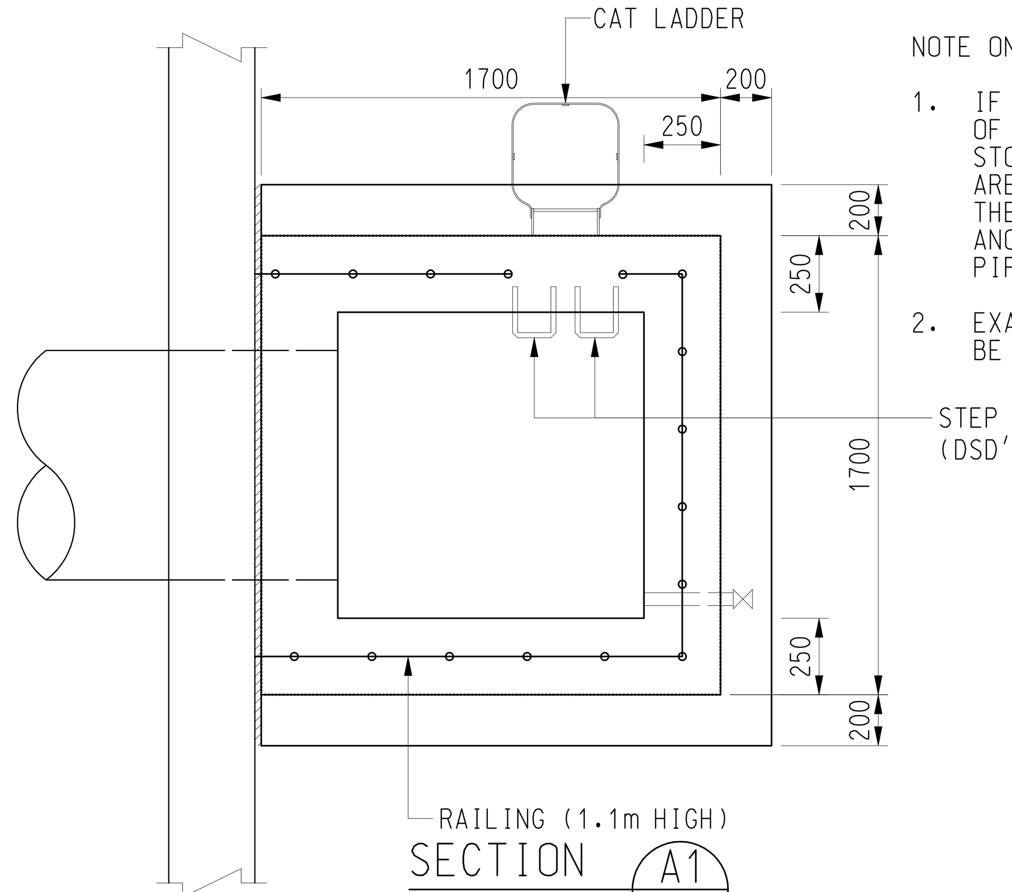
BD REF. NO. 3/0001/02

SECTION A (1720)
SCALE 1 : 25



SECTION J (1720)
SCALE : N.T.S.



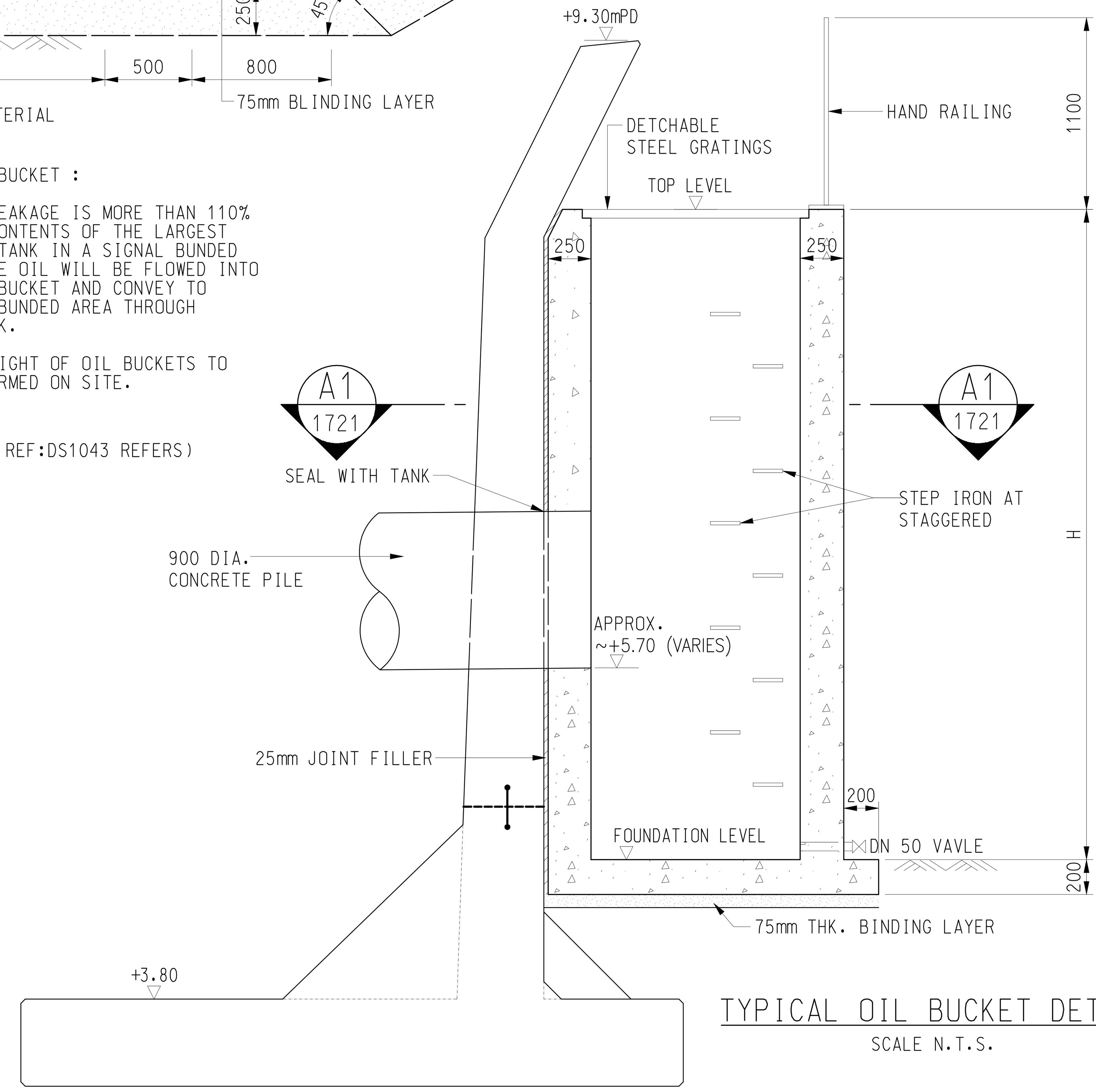


SECTION A1 (1721)
SCALE N.T.S.

NOTE ON OIL BUCKET :

1. IF OIL LEAKAGE IS MORE THAN 110% OF THE CONTENTS OF THE LARGEST STORAGE TANK IN A SIGNAL BUNDED AREA, THE OIL WILL BE FLOWED INTO THE OIL BUCKET AND CONVEY TO ANOTHER BUNDED AREA THROUGH PIPE LINK.
2. EXACT HEIGHT OF OIL BUCKETS TO BE CONFIRMED ON SITE.

	OIL BUCKET	TOP LEVEL (mPD)	FOUNDING LEVEL (APPROX.)	HEIGHT OF OIL BUCKET (H)
PHASE 1A (FOR TANKS 1 TO 6)	A1	7.96	4.54	3.42
	A2		4.57	3.39
	A3		4.61	3.35
PHASE 1B (FOR TANKS 7 TO 12)	B1	8.53	5.10	3.43
	B2		5.00	3.53
	B3		4.45	4.08



TYPICAL OIL BUCKET DETAIL
SCALE N.T.S.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	FEB 2004	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	OCT 2007	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale: AS SHOWN (A1)	Date: JAN 2006	
Designed: BW	Drawn: SKL	Checked: AS
Design Team Leader: AS	Date: JAN 2006	
Approved: LHS	Date: JAN 2006	

ECO

Contractor
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Fax: (852) 2565 5561

Permanent Aviation Fuel Facility

Title
TANK FARM
BUND WALL DETAILS
(SHEET 1 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1721 Revision 3

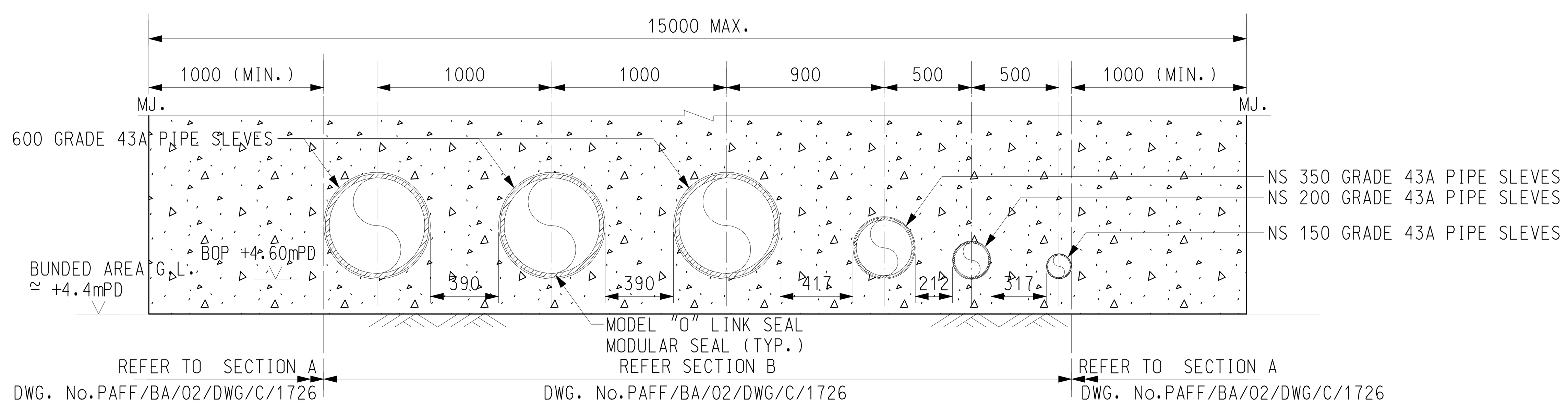
DATE : 3/2/2009
TIME : 10:05:45 AM
PLOT DRV: $PLTDRVL$

FILENAME : S:\Drawings\DGN\Babtie\20090225\1721-3.dgn

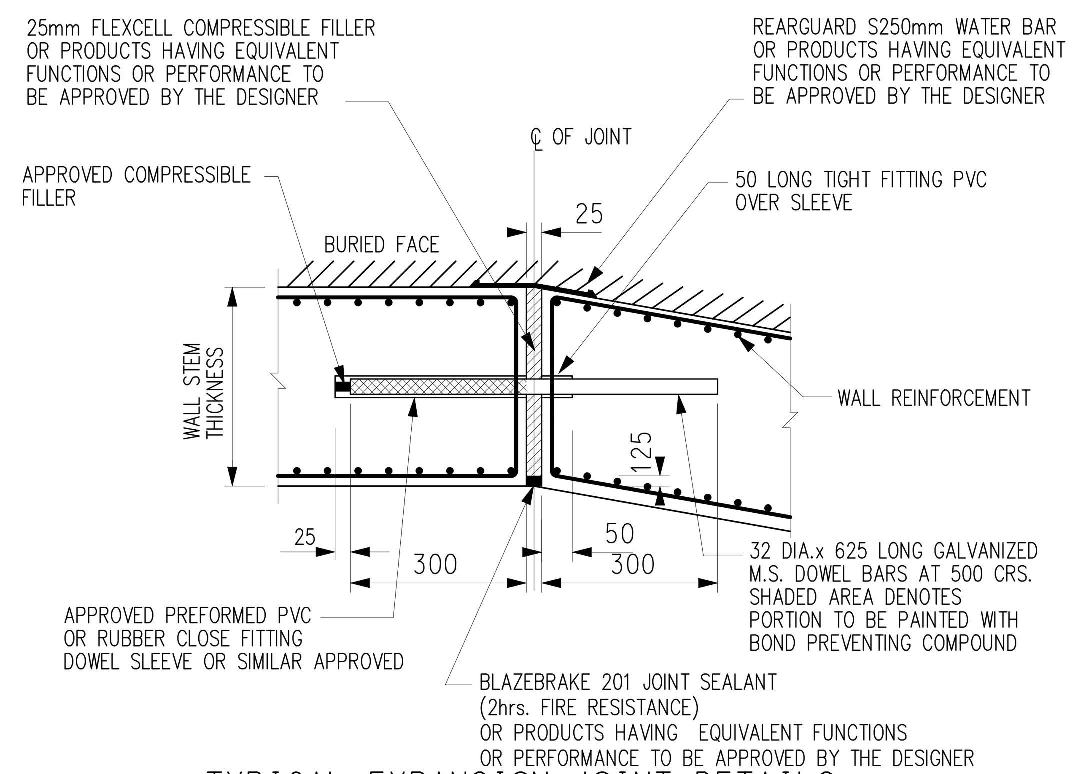
BD REF. NO. 3/0001/02

NOTES :
1. FOR GENERAL NOTES REFER TO DWG. NO. PAFF/BA/02/DWG/C/1721.

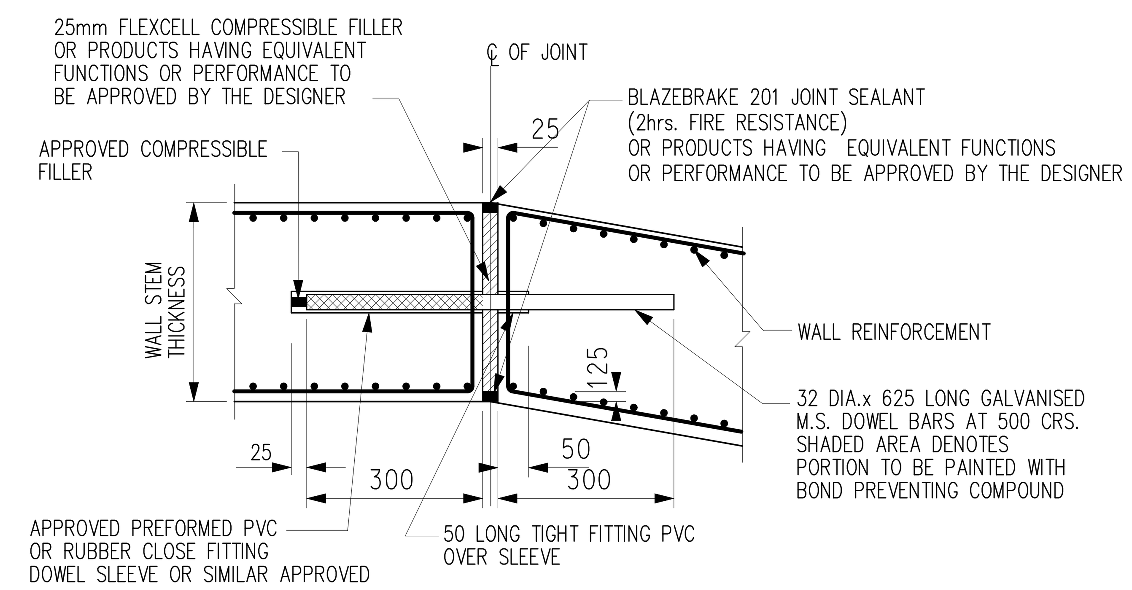
SECTION B (1720)
SCALE 1 : 25



FRONT VIEW OF BUND WALL WITHIN BUNDED AREA (6 / 1720)
SCALE: N.T.S.



TYPICAL EXPANSION JOINT DETAILS FOR SECURITY WALLS & BUND WALL TYPE A AT THE BEND WHERE ONE FACE IS BURIED
SCALE: N.T.S.



TYPICAL EXPANSION JOINT DETAILS FOR SECURITY WALLS & BUND WALL TYPE A AT THE BEND WHERE BOTH FACES ARE EXPOSED
SCALE: N.T.S.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	OCT 2007	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale	Date
1:25 (A1)	OCT 2002

Designed	Drawn	Checked
BW	SKL	AS

Design Team Leader	Date
AS	OCT 2002

Approved	Date
LHS	OCT 2002

ECO

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Permanent Aviation Fuel Facility

Title
TANK FARM
BUND WALL DETAILS
(SHEET 2 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1722
Revision 3

FILENAME : S:\Drawings\DGN\Babtie\20090225\1722-3.dgn

BD REF. NO. 3/0001/02

NOTES :
1. FOR GENERAL NOTES REFER TO DWG. NO. PAFF/BA/02/DWG/C/1721.

Rev.	Date	Description
0	JAN 2006	FOR CONSTRUCTION
1	SEP 2007	FOR CONSTRUCTION
2	SEP 2008	FOR CONSTRUCTION
3	FEB 2009	FOR CONSTRUCTION

Notes:
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Scale	1:25 (A1)
Date	OCT 2002
Designed	BW
Drawn	SKL
Checked	AS
Design Team Leader	AS
Date	OCT 2002
Approved	LHS
Date	OCT 2002

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Permanent Aviation Fuel Facility

TANK FARM
BUND WALL DETAILS
(SHEET 3 OF 4)

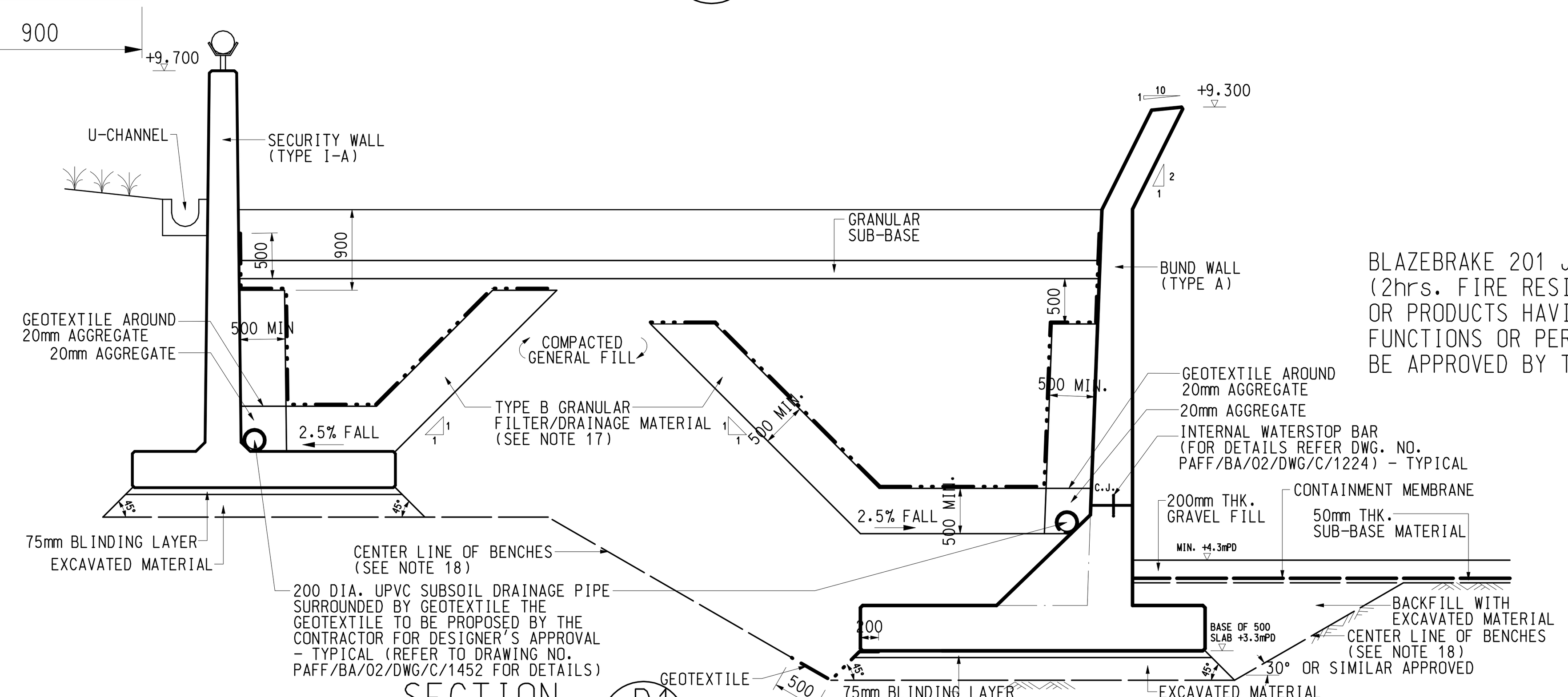
Drawing No. PAFF/BA/02/DWG/C/1723 Revision 3

FILENAME : S:\Drawings\DGN\Babtie\20090225\1723-3.dgn

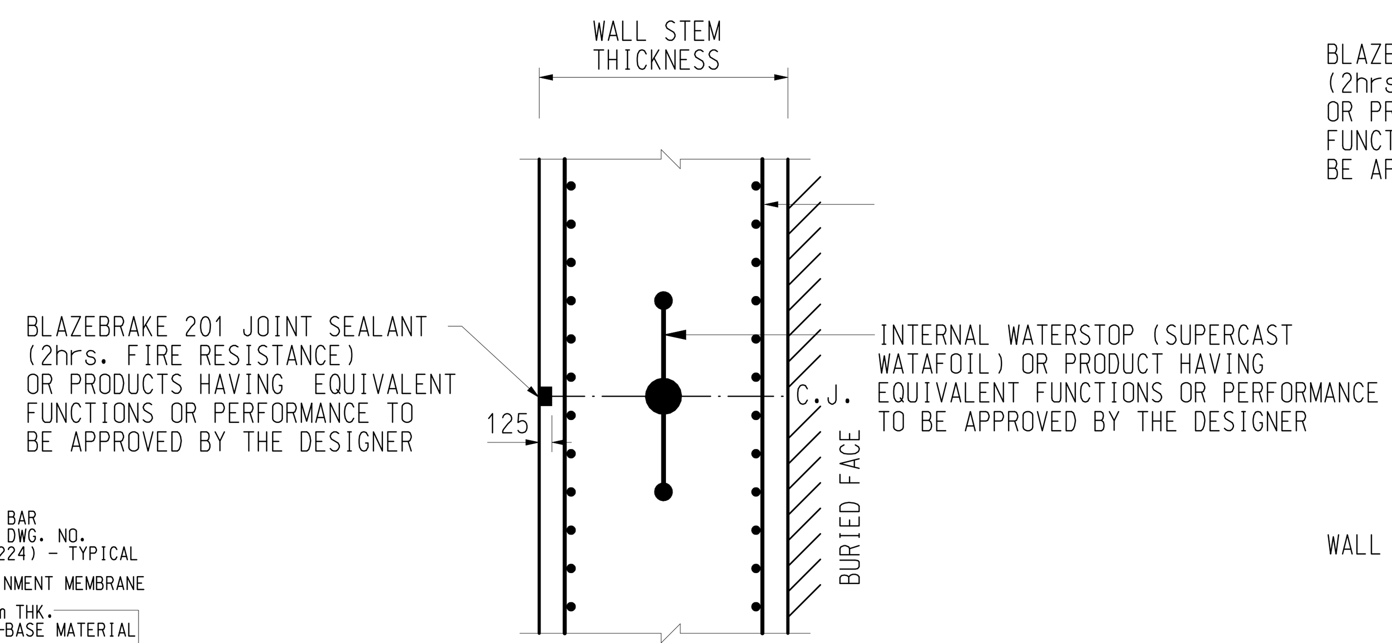
BD REF. NO. 3/0001/02

NOTES :
1. FOR GENERAL NOTES REFER TO DWG. NO. PAFF/BA/02/DWG/C/1721.

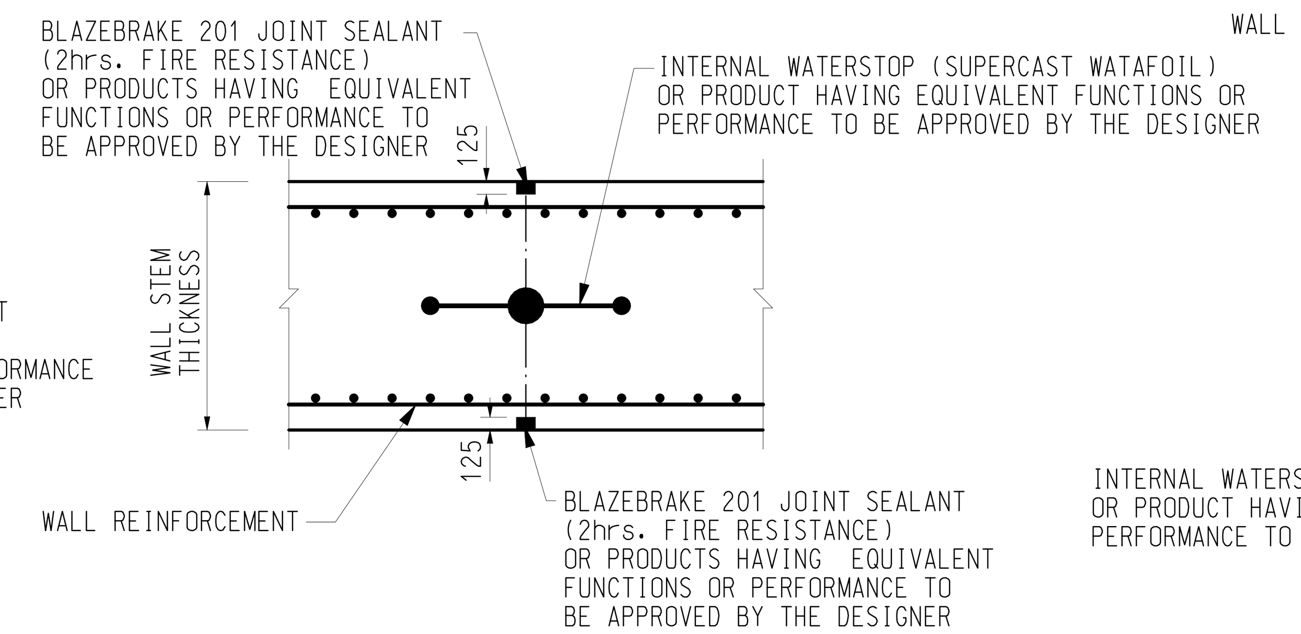
SECTION D
SCALE 1 : 25 (1720)



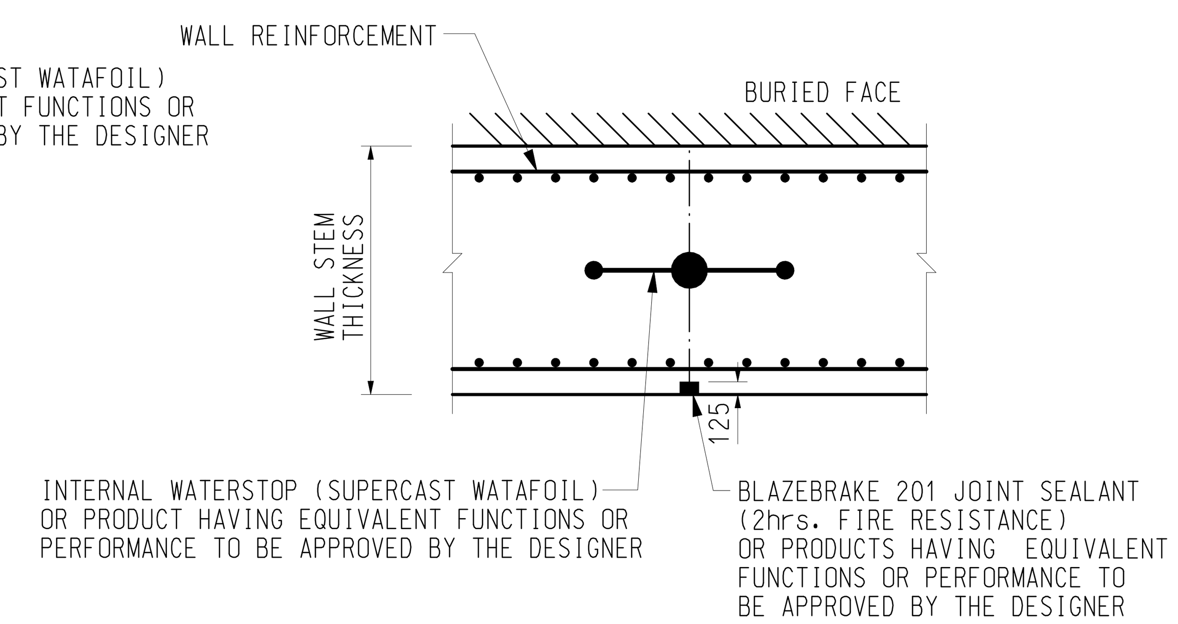
SECTION D1
SCALE 1 : 25 (1720)



TYPICAL CONSTRUCTION JOINT DETAILS
(HORIZONTAL SECTION)
N.T.S.



TYPICAL CONSTRUCTION JOINT DETAILS
WHERE BOTH FACES ARE EXPOSED
(VERTICAL SECTION)
N.T.S.



TYPICAL CONSTRUCTION JOINT DETAILS
WHERE ONE FACE IS EXPOSED
(VERTICAL SECTION)
N.T.S.

Rev.	Date	Description
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3	FEB 2009	FOR CONSTRUCTION

Scale	Date
1:25 (A1)	OCT 2002
Designed: BW / Drawn: SKL	Checked: AS
Design Team Leader: AS	Date: OCT 2002
Approved: LHS	Date: OCT 2002

Contractor: LEIGHTON CONTRACTORS (ASIA) LIMITED

JACOBS

Permanent Aviation Fuel Facility

Title: TANK FARM
BUND WALL DETAILS
(SHEET 4 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1724 Revision 3

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FILENAME : S:\Drawings\DGN\Babtie\20090225\1724-3.dgn

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
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Rev.	Date	Description	Checked
A	18.01.08	ISSUED FOR REVIEW	

Rev.	Date	Description	Checked

Scale	Date	
1:500	18 JAN 2008	
Designed	Drawn	Checked
P. HO	F. CHUNG	D. LAM
Design Team Leader		Date
D. LAM		18 JAN 2008
Approved		Date
B. GILLON		18 JAN 2008

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Permanent Aviation Fuel Facility

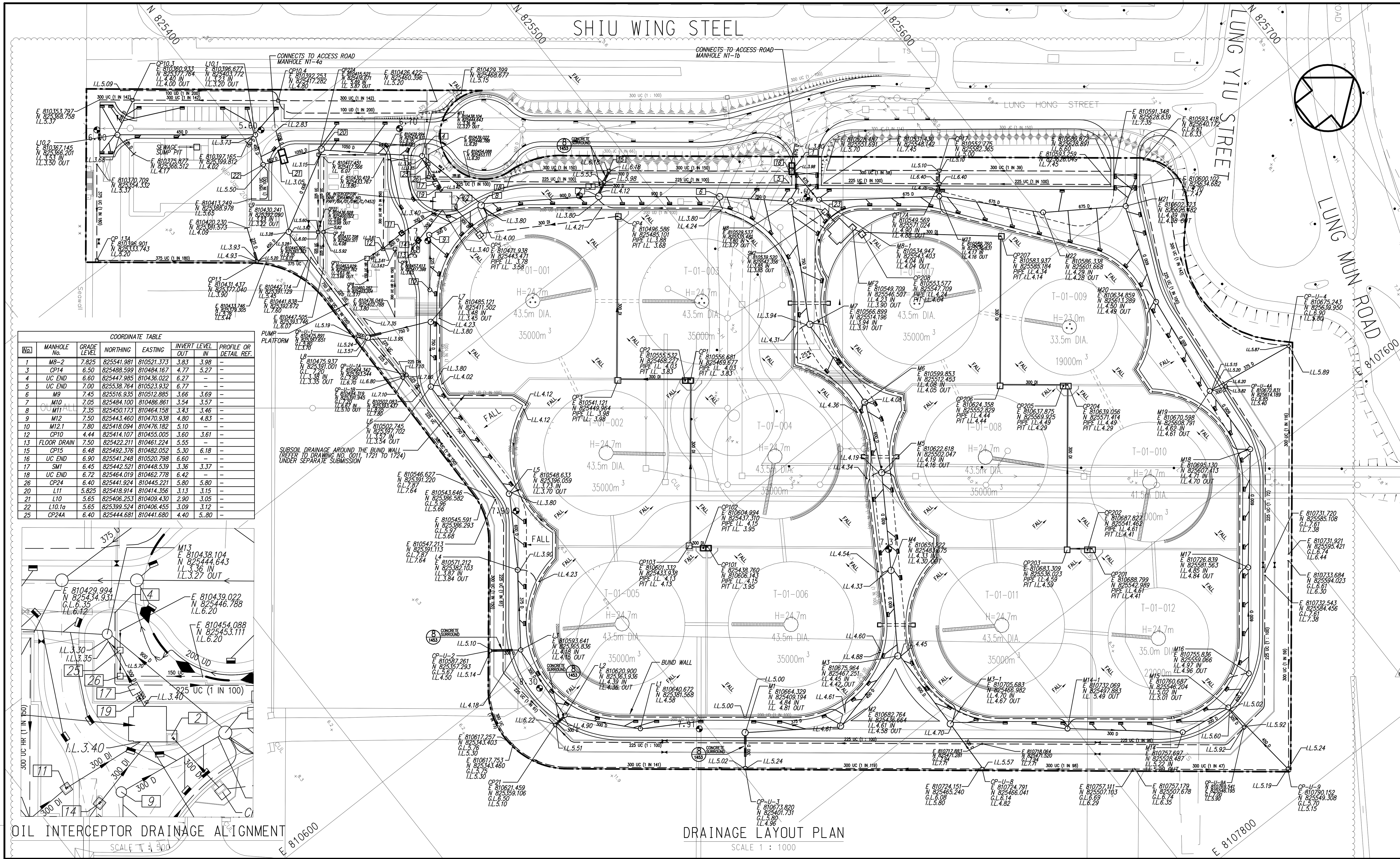
Title
TANK FARM
DRAINAGE LAYOUT PLAN

	Project	Originator	Location	Category	Discipline	Number	Revision
Drawing No.	PAFF	LC	02	DWG	C	0551	A

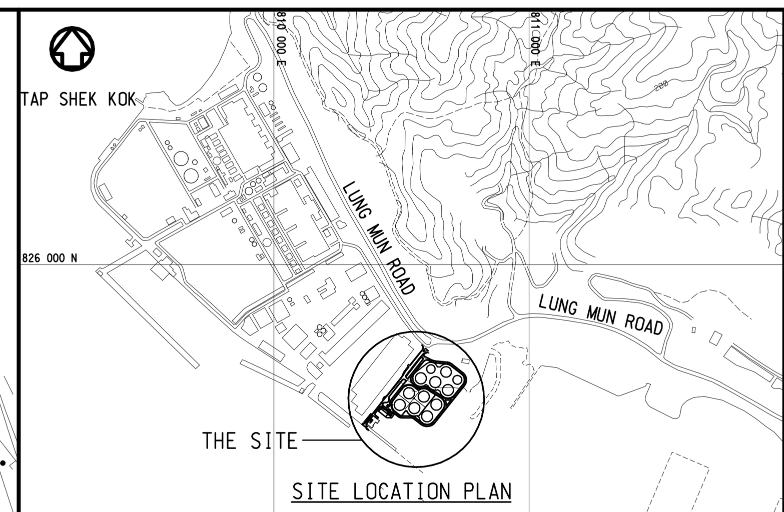
DATE : 1/18/2008
TIME : 2:22:55 PM

FILENAME : J:\Design & Eng (DWGS Specs & Calcs)\Drawings\DGN\LC02DWGC0551_A.dgn

BD REF. NO. 4/0001/02

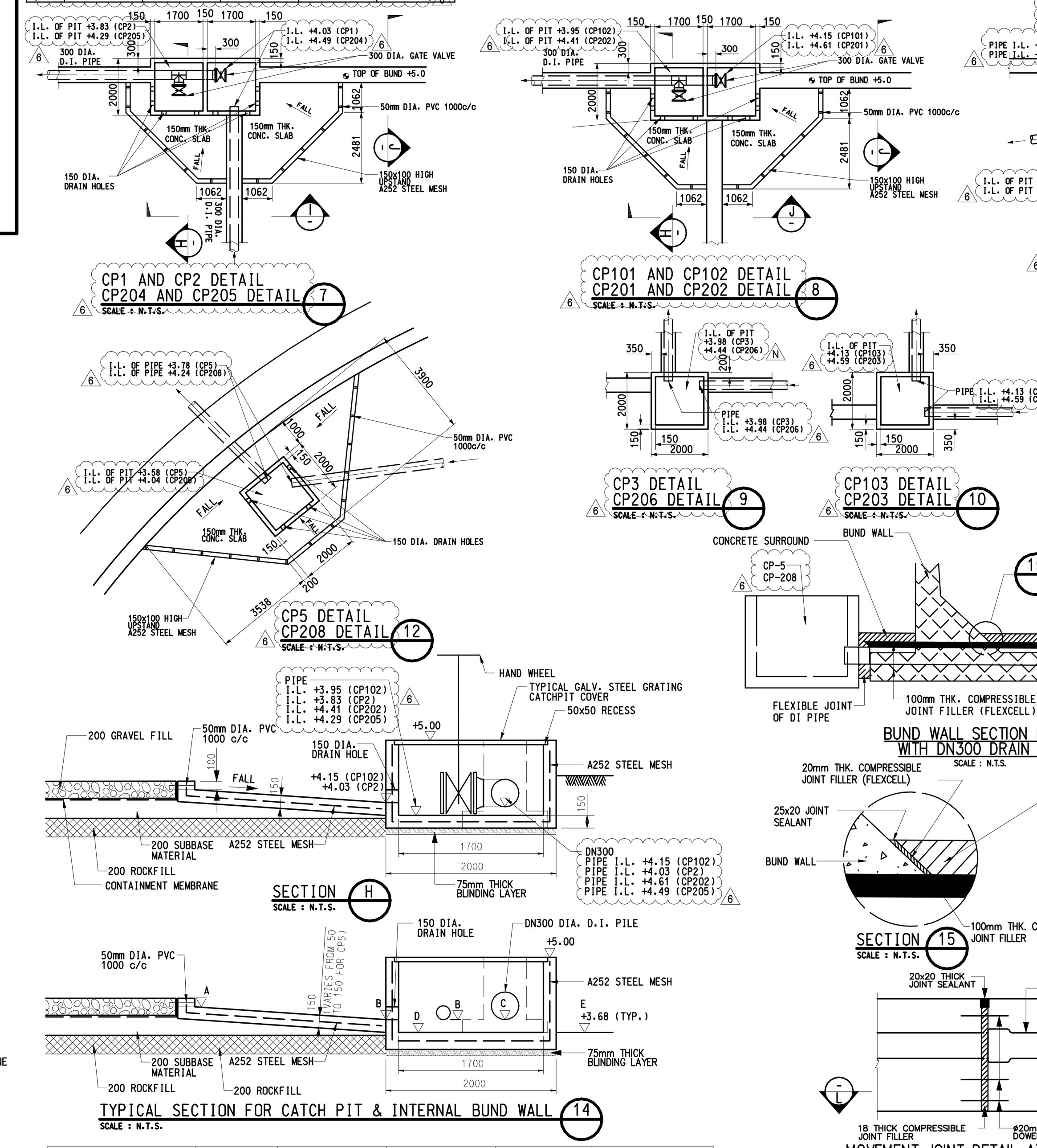


COORDINATE TABLE							
No.	MANHOLE No.	GRADE LEVEL	NORTHING	EASTING	INVERT LEVEL OUT	INVERT LEVEL IN	PROFILE OR DETAIL REF.
1	M8–2	7.825	825541.981	810521.373	3.83	3.98	–
3	CP14	6.50	825488.599	810484.167	4.77	5.27	–
4	UC END	6.60	825447.985	810436.022	6.27	–	–
5	UC END	7.00	825538.764	810523.932	6.77	–	–
6	M9	7.45	825516.935	810512.885	3.66	3.69	–
7	M10	7.05	825484.100	810486.861	3.54	3.57	–
8	M11	7.35	825450.173	810464.158	3.43	3.46	–
9	M12	7.50	825443.460	810470.938	4.80	4.83	–
10	M12.1	7.80	825418.094	810476.182	5.10	–	–
12	CP10	4.44	825414.107	810455.005	3.60	3.61	–
13	FLOOR DRAIN	7.50	825422.211	810461.224	5.55	–	–
15	CP15	6.48	825492.376	810482.052	5.30	6.18	–
16	UC END	6.90	825541.248	810520.798	6.60	–	–
17	SM1	6.45	825442.521	810448.539	3.36	3.37	–
18	UC END	6.72	825464.019	810462.778	6.42	–	–
26	CP24	6.40	825441.924	810445.221	5.80	5.80	–
20	L11	5.825	825418.914	810414.356	3.13	3.15	–
21	L10	5.65	825406.253	810409.430	2.90	3.05	–
22	L10.1a	5.65	825399.524	810406.455	3.09	3.12	–
25	CP24A	6.40	825444.681	810441.680	4.40	5..80	–

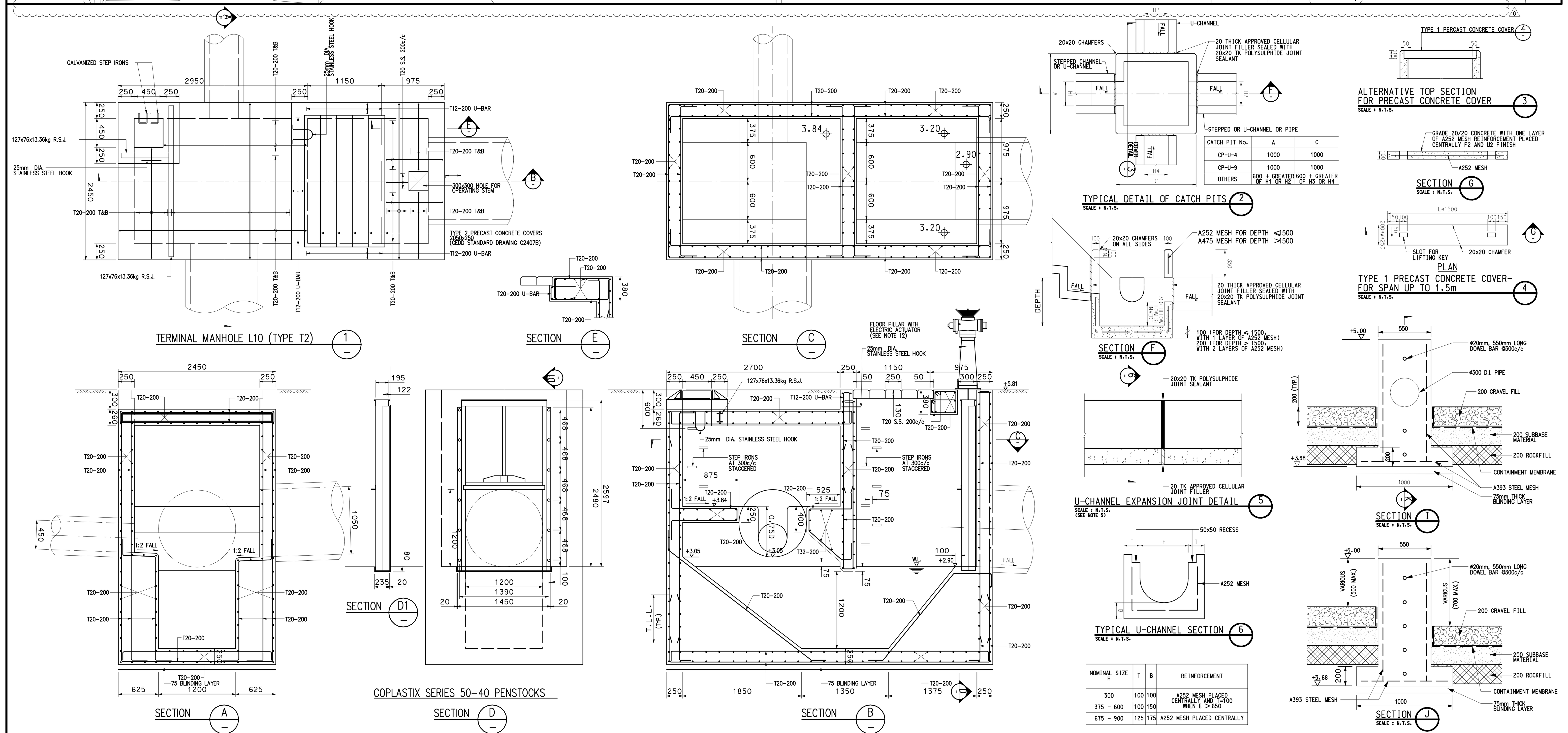


LEGEND :

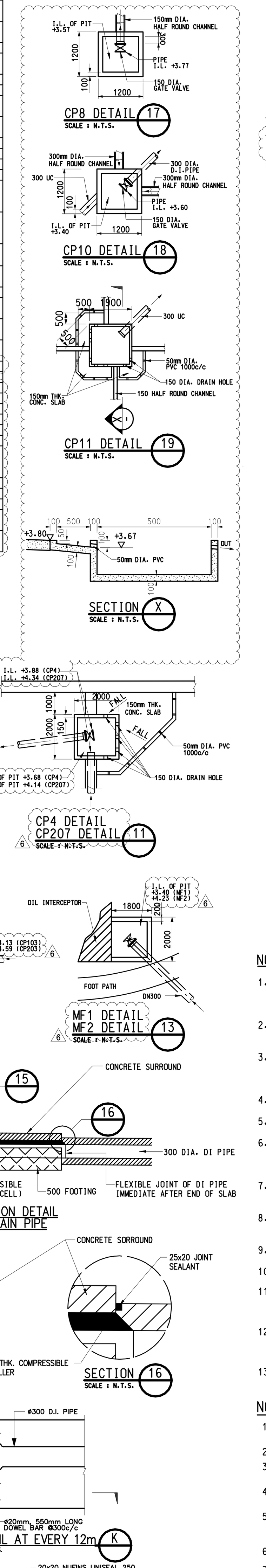
- SITE BOUNDARY
- CATCH PIT
- GULLY
- SEWAGE SUMP PIT
- PROPOSED STORMWATER MANHOLE
- U-CHANNEL
- STORMWATER DRAINAGE PIPES
- EXISTING GROUND LEVEL
- SUB-SOIL DRAIN
- PROPOSED ROAD LEVEL
- EXISTING FOUL WATER DRAIN AND MANHOLE
- EXISTING STORMWATER DRAIN AND MANHOLE
- VALVE
- J-CHANNEL
- SM1 MONITORING AND SAMPLING POINT



	A I.L. OF ø50 PVC	B I.L. OF ø150 DRAIN HOLES	C I.L. OF ø300 D.I. PIPE	D I.L. OF CATCH PIT	E BASE LEVEL OF INTERNAL BUND
CP102 (CP102 TO CP103)	4.20	4.15	4.15	3.95	3.68
CP103 (CP102 TO CP103)	–	–	4.13	4.13	3.68
CP103 (CP103 TO CP1)	–	–	4.13	4.13	3.68
CP1 (CP103 TO CP1)	4.20	4.03	4.03	3.83	3.68
CP2 (CP2 TO CP3)	4.20	4.03	4.03	3.83	3.68
CP3 (CP2 TO CP3)	–	–	3.98	3.98	3.68
CP3 (CP3 TO CP4)	–	–	3.98	3.98	3.68
CP4 (CP3 TO CP4)	4.20	3.88	3.88	3.68	3.68
~~CP5 (CP4 TO CP5)~~	~~4.20~~	~~4.19~~	~~3.78~~	~~3.58~~	~~–~~
CP202 (CP202 TO CP203)	4.66	4.61	4.61	4.41	3.68
CP203 (CP202 TO CP203)	–	–	4.59	4.59	3.68
CP203 (CP203 TO CP204)	–	–	4.59	4.59	3.68
CP204 (CP203 TO CP204)	4.54	4.49	4.49	4.29	3.68
CP205 (CP205 TO CP206)	4.54	4.49	4.49	4.29	3.68
CP206 (CP205 TO CP206)	–	–	4.44	4.44	3.68
CP206 (CP206 TO CP207)	–	–	4.44	4.44	3.68
CP207 (CP206 TO CP207)	4.39	4.34	4.34	4.14	3.68
CP208 (CP207 TO CP208)	4.29	4.24	4.24	4.04	–



NOMINAL SIZE H	T	B	REINFORCEMENT
300	100	100	A252 MESH PLACED CENTRALLY AND T=100 WHEN E > 650
375 – 600	100	150	
675 – 900	125	175	A252 MESH PLACED CENTRALLY



NOTES :

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRG. NO. PAFF/BA/01/DWG/C/1453.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE INDICATED. ALL LEVELS ARE IN METRES ABOVE PRINCIPAL DATUM.
3. ALL PRECAST CONCRETE PIPES AND FITTING SHALL COMPLY WITH BS5911 : PART 100.
4. ALL PRECAST CONCRETE PIPES AND FITTINGS SHALL HAVE FLEXIBLE JOINTS OF SPIGOTS AND SOCKET OR REBATED TYPE. THEY SHALL BE DESIGNED TO INCORPORATE AN ELASTOMETRIC RING COMPLYING WITH TYPE D OF BS2494. THE TEST FOR JOINT SHALL COMPLY WITH BS5911 : PART 100 & GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS.
5. DIRECTION CHANGE OF CONCRETE PIPELINES SHALL BE MADE AT MANHOLE ONLY.
6. MANHOLE COVERS AND FRAMES WITHIN THE CARRIAGEWAY AND PROPOSED FOOTPATH SHALL BE HEAVY DUTY TYPE UNLESS OTHERWISE INDICATED.
7. ALL DI PIPES AND FITTING SHALL COMPLY WITH BS 4772 & GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS. PIPES AND FITTINGS SHALL BE LINED INTERNALLY WITH CEMENT MORTAR AND SHALL BE COATED EXTERNALLY WITH BITUMINOUS COATING.
8. CONCRETE PIPE CLASS (L, M & H) SHOULD REFER TO BS 5911 : PART 100.
9. AREAS WITHIN BUND WALL AND PUMP PLATFORM ARE DESIGNED AS BUNDED AREA.
10. THE JUNCTION OF A SINGLE BRANCH DRAIN WITH ANOTHER DRAIN AT AN ANGLE OF NOT MORE THAT 45° IN THE DIRECTION OF FLOW MAY BE MADE BY MEANS OF A PURPOSED-MADE Y JUNCTION.
11. GROUND SURFACE PAVING SHALL BE LAID TO FALL AT A GRADIENT OF NOT LESS THAN 1 IN 80 TO A GULLY TRAP OR DRAINAGE CHANNELS CONNECTED TO A SURFACE WATER DRAIN.
12. STEEL PENSTOCKS TO BE INSPECTED BY OPERATOR EVERY 60 MINUTES TO ENSURE THEY ARE NOT SHUTTED ACCIDENTALLY.
13. THE ABANDONED DRAINS, SEWERS AND MANHOLES WITHIN THE SITE BOUNDARY SHOULD EITHER BE REMOVED OR FILLED WITH FOAMED CONCRETE IN ACCORDANCE WITH THE REQUIREMENTS AS RECOMMENDED IN DSD'S TECHNICAL CIRCULAR No. 2/2008. 6
14. MINIMUM GRADIENT FOR PIPES

PIPE DIAMETERS (mm)	GRADIENT	PIPE DIAMETERS (mm)	GRADIENT
225	1 IN 100	600	1 IN 324
250	1 IN 100	750	1 IN 396
300	1 IN 150	900	1 IN 468
375	1 IN 180	1050	1 IN 540
450	1 IN 216	1200	1 IN 648
		675	1 IN 324

15. ALL ARISE SHOULD HAVE A MINIMUM 25mm CHAMFER UNLESS STATED OTHERWISE.
16. THE SEE OF OPENING OF MANHOLE M14-1, M14 TO M23, M8-1 AND SM2 ARE 675mmx675mm. 6

NOTES FOR MANHOLE :

1. CONCRETE GRADE :
   40D/20 FOR STRUCTURAL CONCRETE.
   10/20 FOR BLINDING & MASS CONCRETE.
2. ALL GALVANIZED STEEL ITEMS TO BE HOT-DIPPED.
3. MINIMUM COVER TO OUTERMOST REINFORCEMENT TO BE 40mm UNLESS OTHERWISE STATED.
4. RADII AND BENDS FOR REINFORCEMENT TO BE IN ACCORDANCE WITH BS4466.
5. BAR REFERENCING :
   EXAMPLE : 16T32-01-200 ABBRE
   NUMBER OF BARS 16
   TYPE OF STEEL T (REFER TO NOTES 8 & 9)
   DIAMETER OF BARS 32mm
   MARK NO. (IF REQUIRED) 01
   PITCH OF BARS (IF APPLICABLE) 200mm
   ABBREVIATIONS MAY BE ADDED TO THE STRING:
   B BARS IN BOTTOM OF SLAB
   B1 FIRST LAYER OF BOTTOM REINFORCEMENT
   B2 SECOND LAYER OF BOTTOM REINFORCEMENT (ABOVE B1 LAYER)
   T BARS IN TOP OF SLAB
   T1 FIRST LAYER OF TOP REINFORCEMENT
   T2 SECOND LAYER OF TOP REINFORCEMENT (BELOW T1 LAYER)
6. UNLESS OTHERWISE STATED, ANCHORAGE BOND LENGTHS AND LAP LENGTHS OF REINFORCEMENT SHALL AS BE FOLLOWS:-

CONCRETE GRADE	ANCHORAGE BOND LENGTHS & LAP LENGTHS (MULTIPLES OF BAR DIAMETER)
	HIGH YIELD STEEL
40D/20	32

NOTES:-

(A) i) TENSION LAP LENGTHS (DENOTED BY T.L.L.) SHALL BE AT LEAST TO THE ANCHORAGE BOND LENGTH.

ii) WHERE A LAP OCCURS AT THE TOP OF A SECTION AS CAST AND THE MINIMUM COVER IS LESS THAN TWICE THE SIZE OF THE LAPPED REINFORCEMENT. THE REQUIRED LAP LENGTH SHOULD BE MULTIPLIED BY A FACTOR OF 1.4.

iii) WHERE A LAP OCCURS AT THE CORNER OF A SECTION AND THE MINIMUM COVER TO EITHER FACE IS LESS THAN TWICE THE SIZE OF THE LAPPED REINFORCEMENT OR WHERE THE DISTANCE BETWEEN ADJACENT LAPS IS LESS THAN 75mm OR SIX TIMES THE SIZE OF THE LAPPED REINFORCEMENT. WHICHEVER IS THE GREATER, THE REQUIRED LAP LENGTH SHOULD BE MULTIPLIED BY A FACTOR OF 1.4.

iv) IN CASES WHERE BOTH CONDITIONS (ii) AND (iii) APPLY, THE REQUIRED LAP LENGTH SHOULD BE MULTIPLIED BY A FACTOR OF 2.0.

(B) i) NOMINAL LAP FOR DISTRIBUTION BARS SHALL BE 300.

(C) i) LAP LENGTH FOR UNEQUAL SIZE BARS SHALL BE BASED UPON THE SMALLER BAR.

7. ALL CONCRETE WORKS SHALL COMPLY WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS 1990, RECOMMENDATIONS OF BRITISH STANDARD CODE OF PRACTICE BS8110 THE STRUCTURAL USE OF CONCRETE 1987.
8. ALL REINFORCEMENT DENOTED BY MARK R INDICATED PLAIN ROUND BARS TO COMPLY WITH CS2:1995 WITH A CHARACTERISTIC STRENGTH OF $250N/mm^2$.
9. ALL REINFORCEMENT DENOTED BY MARK T INDICATES HOT ROLLED DEFORMED BARS TO COMPLY WITH CS2:1995 WITH A CHARACTERISTIC STRENGTH OF $460N/mm^2$.
10. UNLESS OTHERWISE STATED, ALL CONCRETE SHALL BE DESIGN MIX 40D/20 CONCRETE AND THE GRADE DESIGNATIONS GIVEN ARE THE CHARACTERISTIC CUBE STRENGTH AT 28 DAYS AND THE MAXIMUM AGGREGATE SIZE.
11. THE REACTIVE ALKALI OF CONCRETE EXPRESSED AS THE EQUIVALENT SODIUM OXIDE PER CUBIC METER OF CONCRETE SHOULD NOT EXCEED 3.0 KG WHEN DETERMINED IN ACCORDANCE WITH PNAP 180.

NOTES FOR OIL-WATER INTERCEPTOR

1. THE CONTRACTOR SHALL CHECK ALL DRAWINGS AND VERIFY LEVELS AND DIMENSIONS IN ADVANCE OF THE WORK AND REPORT ANY DISCREPANCIES TO THE PROJECT MANAGER IMMEDIATELY.
2. ALL WORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH THE HONG KONG BUILDING AND CONSTRUCTION REGULATION 1990.
3. ALL CONCRETE WORKS SHALL CONFORM WITH HONG KONG BUILDING CONSTRUCTION REGULATION 1990 AND STRUCTURAL USE OF CONCRETE 1987 AND DESIGN TO BS8110 & BS8007.
4. CONCRETE STRENGTH GRADE SHALL BE 40D/20.
5. NOMINAL COVER TO ALL REINFORCEMENT (INCLUDING LINKS) SHALL BE 40mm.
6. REINFORCEMENT IS TO BE HOT ROLLED HIGH YIELD DEFORMED BARS STRESS=460N/mm FOR BAR ⩽ 16mm ø TO BS4449. STRESS=425N/mm FOR BARS > 16mm ø TO BS4449.
7. WELDING OF REINFORCEMENT SHALL NOT BE PERMITTED WITHOUT THE APPROVAL OF THE DESIGNER.
8. UNLESS NOTED OTHERWISE, THE ANCHORAGE BOND OR LAP LENGTH OF REINFORCEMENT SHALL BE 46D.
9. ALL ARISES SHALL HAVE A MINIMUM 25mm CHAMFER.
10. MINIMUM BEARING CAPACITY OF FOUNDATION SOIL SHALL BE 200 kN/m.
11. THE MATERIAL OF RAILINGS SHALL BE HOT ROLLED STRUCTURAL STEEL WITH HOLLOW SECTION COMPLY WITH BS 4848: PART 2 AND WELDABLE STRUCTURAL STEEL SECTIONS COMPLY WITH BS 4360.
12. ALL STEEL RAILINGS SECTIONS SHALL BE HOT-DIP GALVANIZED IN ACCORDANCE WITH BS 729 TO A COATING THICKNESS OF AT LEAST 500 g/m^2. GALVANIZING TO STEEL SHALL BE APPLIED AFTER WELDING, DRILLING AND CUTTING ARE COMPLETED.
13. GALVANIZED BOLTS, NUTS, SCREWS, WASHERS AND RIVETS SHALL BE USED WITH GALVANIZED RAILINGS.

NOTE FOR INTERNAL BUND AND CATCH PITS WITHIN BUND WALL:

1. A CJ MAY NEED TO INTRODUCE TO THE INTERNAL BUND. ACTUAL LOCATION TO BE DETERMINED ON SITE. (CJ-CONSTRUCTION JOINT)
2. ALL ARISES SHALL HAVE A MINIMUM 25mm CHAMFER.
3. THE MINIMUM SPACING FROM THE CATCH PIT INTERNAL WALL FACE TO THE NEAREST FLANGE END OF GATE VALVE SHOULD BE 300mm.
4. THE ENDS OF DI PIPE SHOULD BE PROTRUDED AT LEAST 50mm FROM THE CATCH PIT INTERNAL WALL FACE.
5. CONCRETE GRADE:
   30D/20 FOR STRUCTURAL CONCRETE
   10/20 FOR BLINDING LAYER
6. NOMINAL COVER TO ALL REINFORCEMENT SHALL BE 40mm.
7. CLASS OF FINISH SHALL BE F2 FOR CATCH PITS, INTERNAL BUND AND U3 FOR CONCRETE SLABS.
8. EXPANSION JOINT TO BE INTRODUCED BETWEEN INTERNAL BUND AND CATCH PIT. DETAIL IS THE SAME AS SECTION J EXCEPT THERE IS NO DOWEL BAR PROVIDED IN THE EXPANSION JOINT.

NOTES FOR U-CHANNELS AND CATCH PITS OUTSIDE BUND WALL:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. ALL CONCRETE SHALL BE GRADE 20/20.
3. CONCRETE SURFACE FINISH SHALL BE CLASS U2 OR F2 AS APPROPRIATE.
4. ALL EXTERNAL EDGES OF THE COVERS SHALL BE 20mm CHAMFERED.
5. EXPANSION JOINTS SHALL BE PROVIDED AT A MAXIMUM INTERVAL OF 10 METRES.
6. STEP IRONS SHALL BE STAGGERED AT EVERY 300mm c/c IN DEPTH WITH A 75mm HORIZONTAL SPACING WITHIN A CATCH PIT. THE FIRST STEP IRON SHALL BE 600mm BELOW THE COVER SLAB.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
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4	AUG 2007	FOR CONSTRUCTION	
5	FEB 2008	FOR CONSTRUCTION	
6	SEP 2008	FOR CONSTRUCTION	

Scale	Date
AS SHOWN (A1)	JAN 2006

Designed	Drawn	Checked
BW	SKL	AS

Design Team Leader: AS — Date: JAN 2006
Approved: LHS — Date: JAN 2006

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Permanent Aviation Fuel Facility

Title
TANK FARM
EVA
STORMWATER DRAINAGE LAYOUT

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/BA/02/DWG/C/1452	6

DATE : 9/23/2008
TIME : 10:36:26 AM

FILENAME : S:\Drawings\DGN\Babtie\20080919\1452-6.dgn

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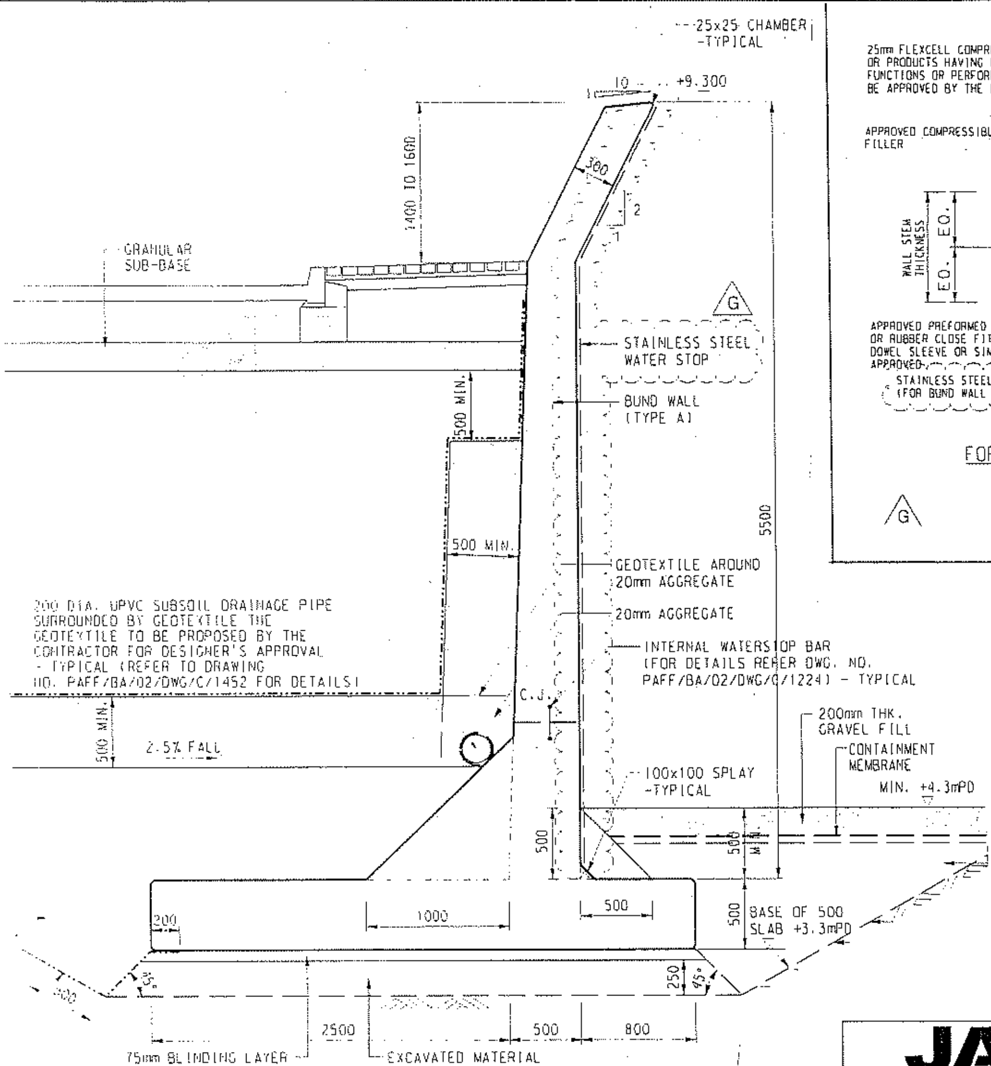
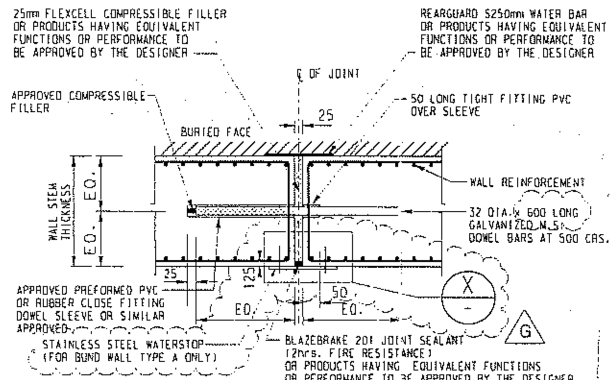
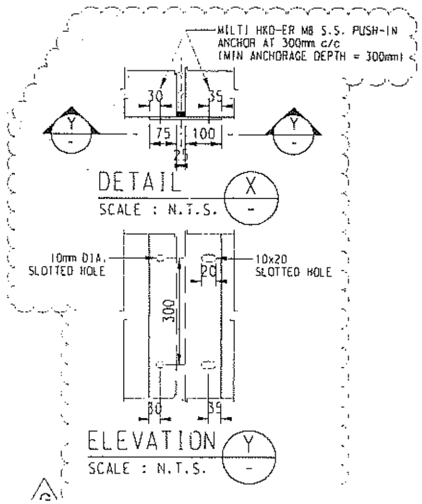


TYP. SECTION – PHASE 1A BUND WALL

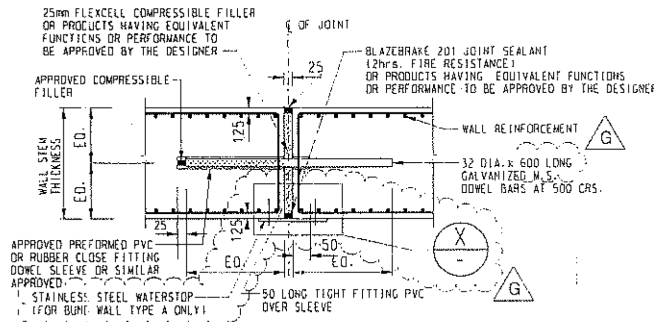


TYPICAL EXPANSION JOINT DETAILS
FOR SECURITY WALLS, BUND WALL TYPE A
WHERE ONE FACE IS BURIED AND
BASE SLAB OF BUND WALL TYPE B
N.T.S.



DETAIL X
SCALE : N.T.S.

ELEVATION Y
SCALE : N.T.S.



TYPICAL EXPANSION JOINT DETALS
FOR SECURITY WALLS AND BUND WALL TYPE A
WHERE BOTH FACES ARE EXPOSED
N.T.S.

Rev	Revision Date	Purpose of revision	Drawn	Checked	Approved
0	26-5-09	FIRST ISSUE	HP		

This drawing is not to be used in whole or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

JACOBS™

15th Floor, Cornwall House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong, China
852.2880.9788 Fax 852.2565.5561
www.jacobschina.com.hk

Client

MASTER RECEIVED
26 MAY 2009

Project

Drawing title: Stainless Steel Water Stop for Phase 1A Bundwall

Drawing status

Scale: N.T.S. (Do not scale)

Job no.: 2511

Client no.

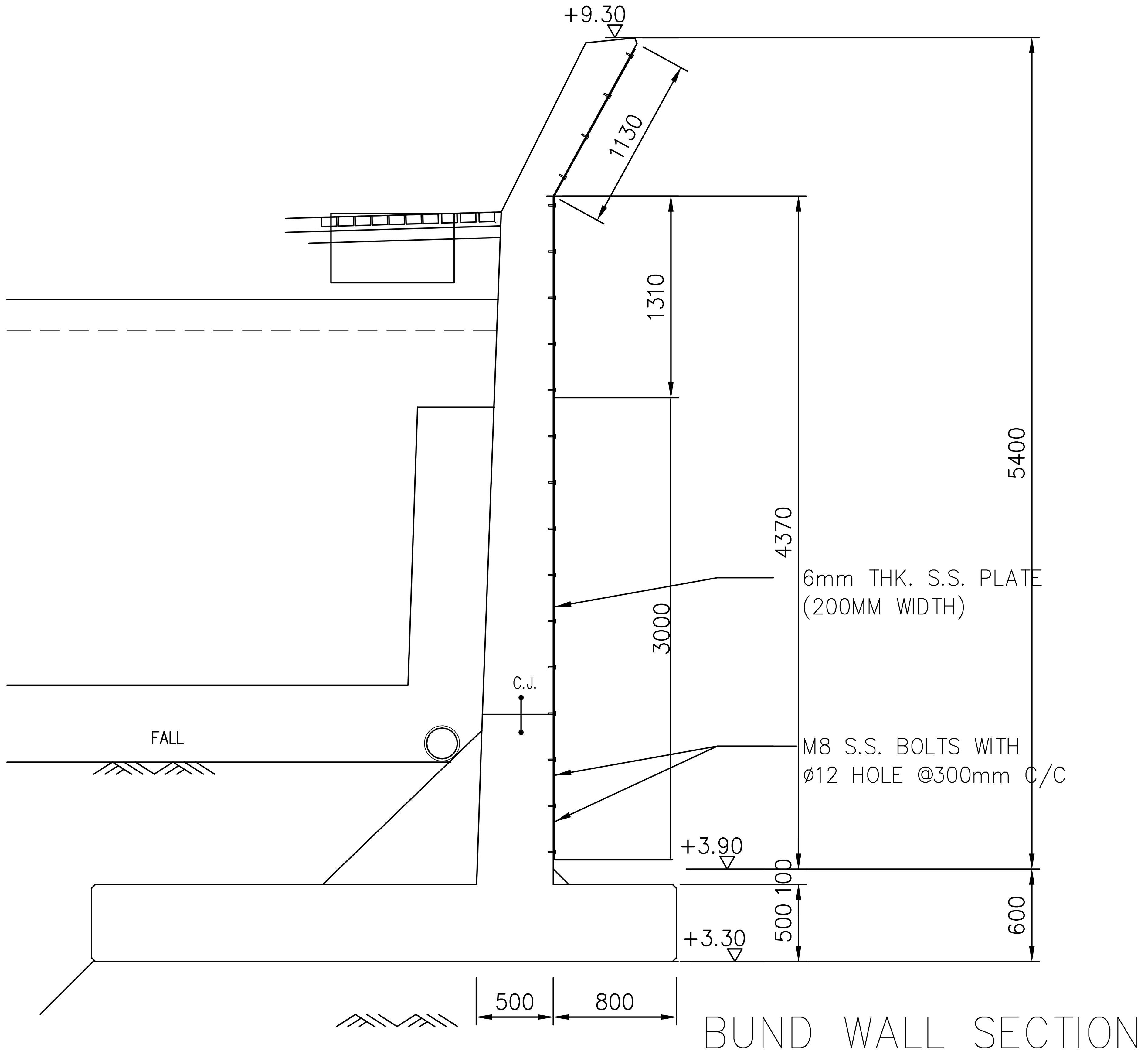
Drawing number: PAFF/CON/SK/0670

Rev: 0

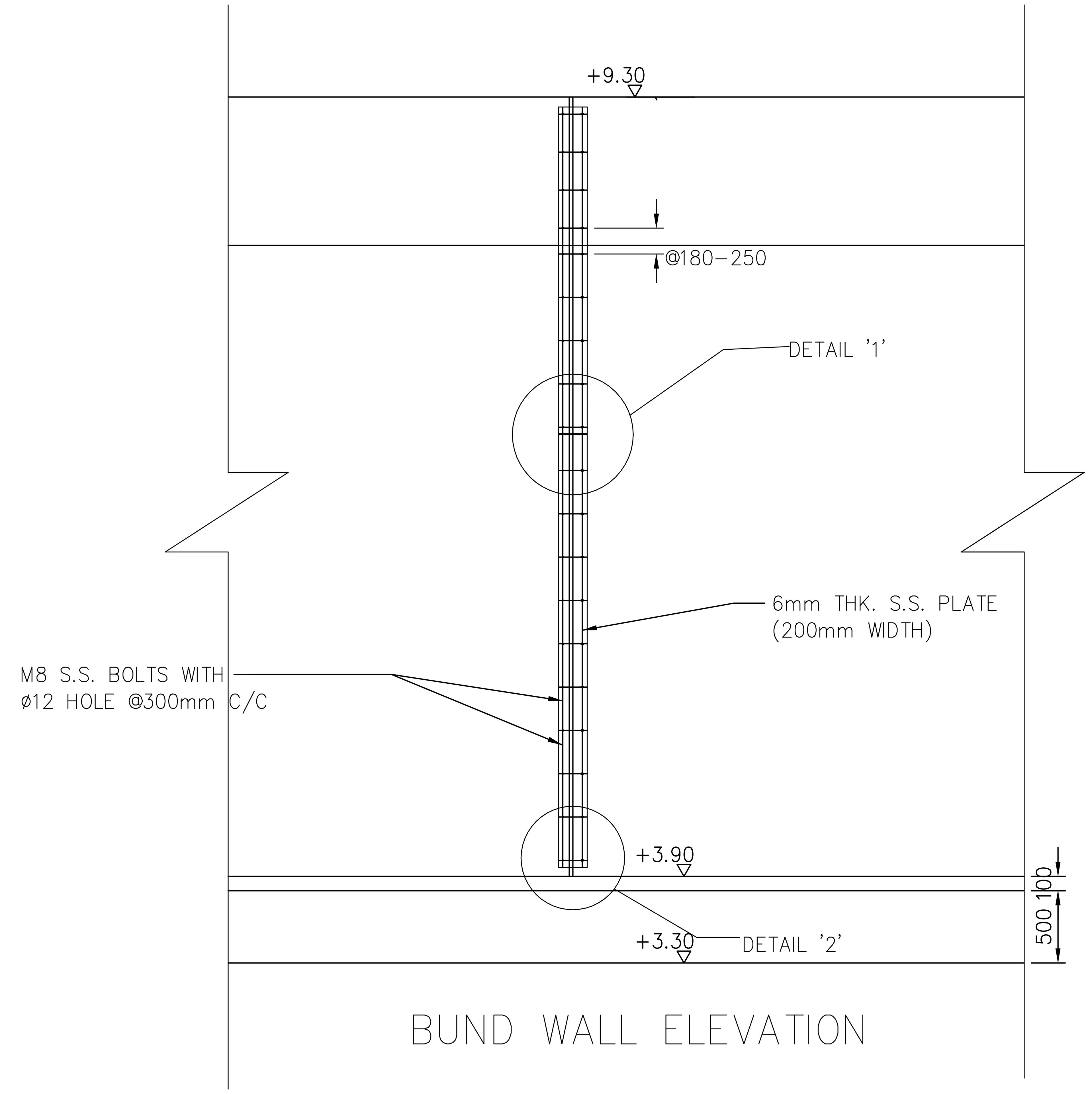
B.D. REF.:

NOTES:

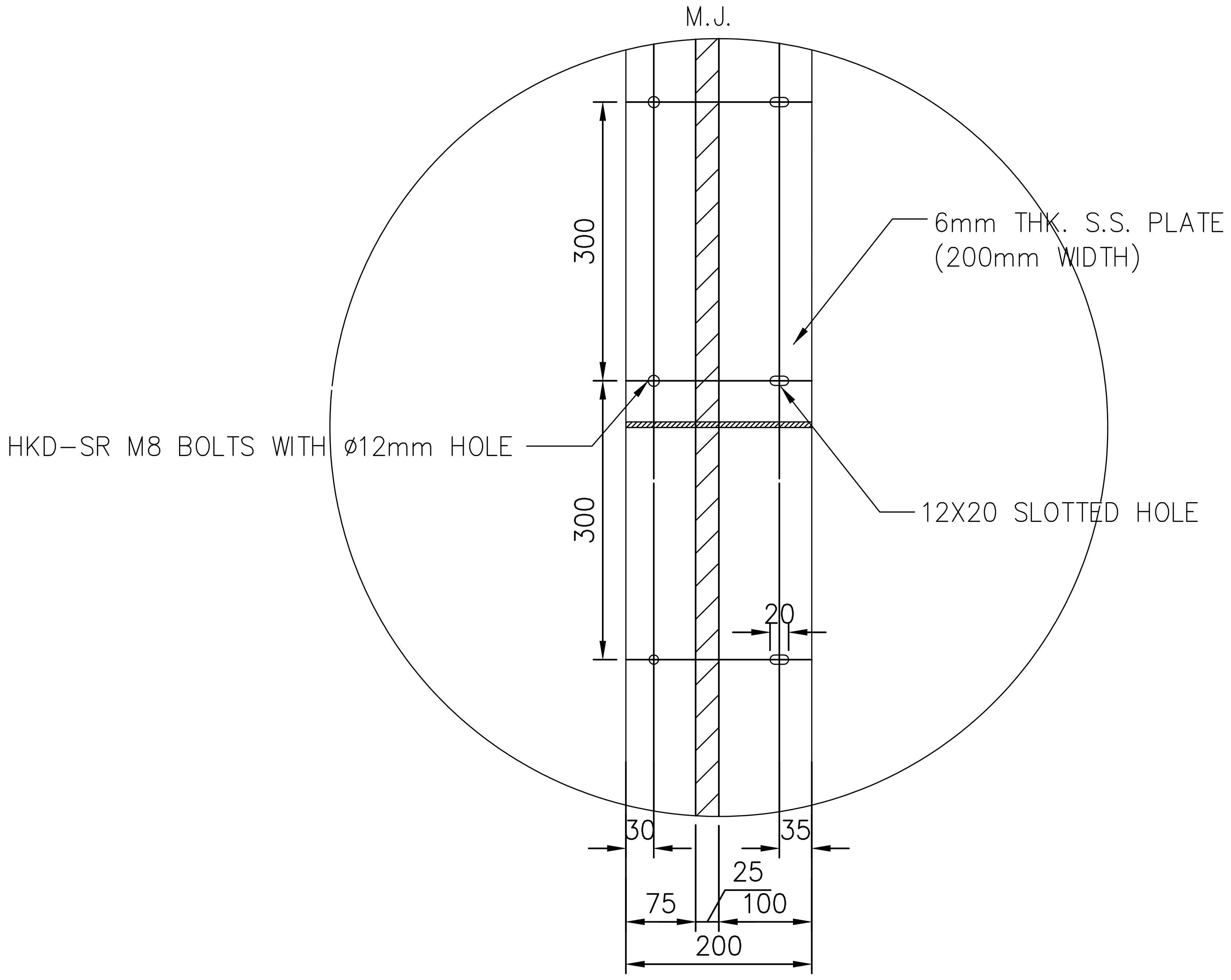
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.



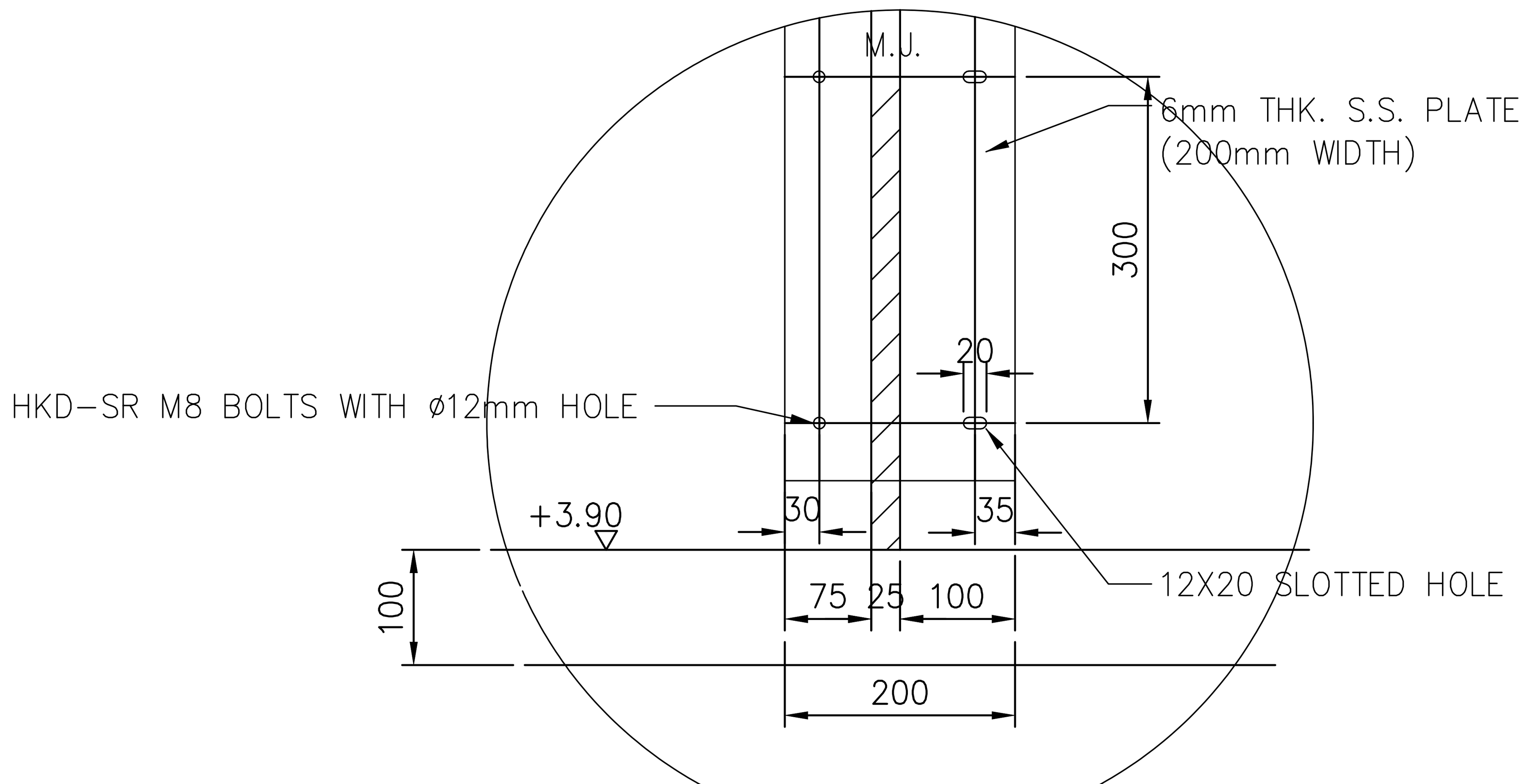
BUND WALL SECTION



BUND WALL ELEVATION



DETAIL '1'
(SCALE 1:10)



DETAIL '2'
(SCALE 1:10)

Notes:
Measurements are based on metric system.
All levels are in metres to Principal Datum (mPD) unless noted otherwise.
Do not scale drawing.
Figure dimensions are to be followed.
Do not use for construction unless expressly permitted.
The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
0	OCT 2008	FOR CONSTRUCTION					

Scale	Date	
1:50	8th– DEC– 2008	
Designed: TMW	Drawn: TWM	Checked: YYC
Design Team Leader		Date
Approved: YYC		Date: JUL 2008

ECO

Contractor
LEIGHTON 禮頓
LEIGHTON CONTRACTORS (ASIA) LIMITED
39th Floor
Sun Hung Kai Centre
30 Harbour Road
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Tel: 2823 1111
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JE JACOBS
15th Floor, Cornwall House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong
Tel: (852) 2880 9788 E-mail: babtie@babtie.com.hk
Fax: (852) 2565 5561

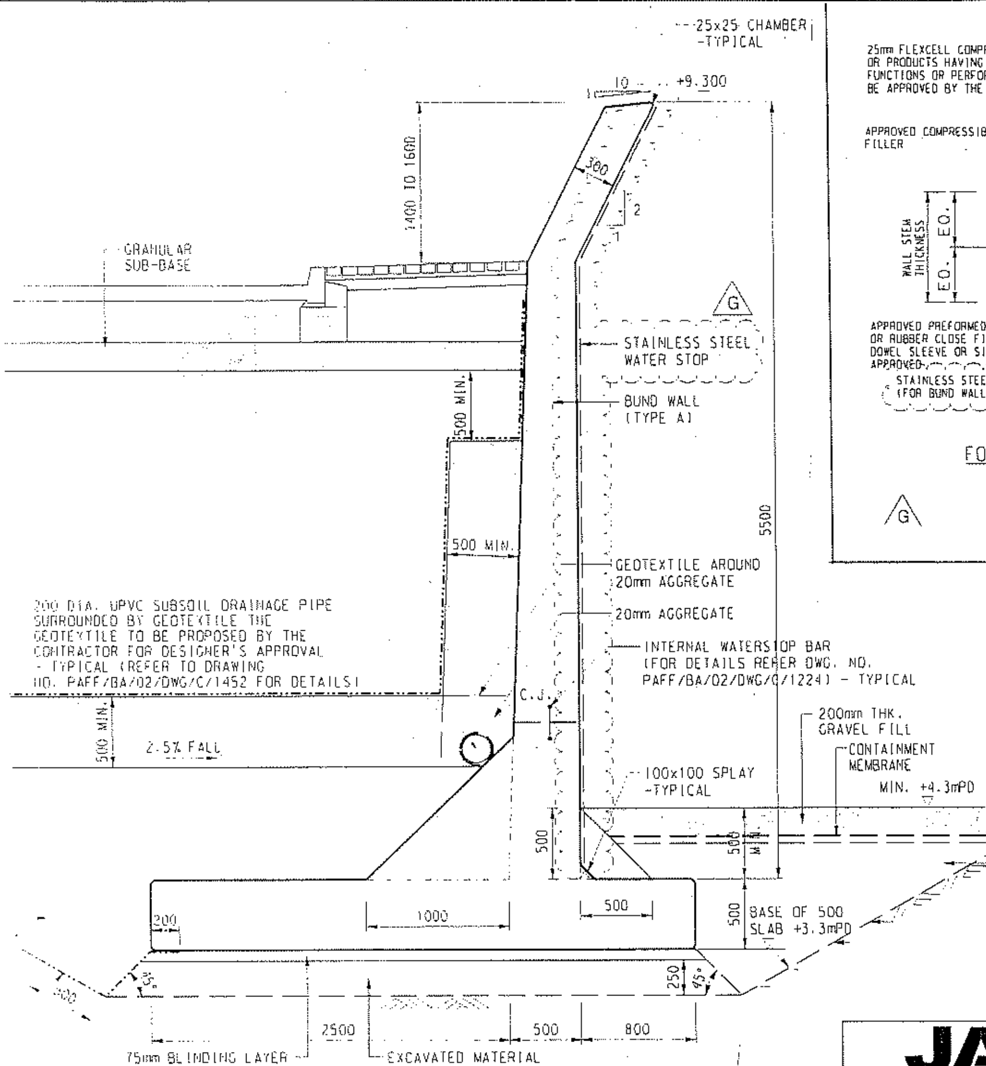
Prepared by
HONG KI ENGINEERING LTD

Project: Permanent Aviation Fuel Facility
Area 38, Tuen Mun, N.T. Hong Kong

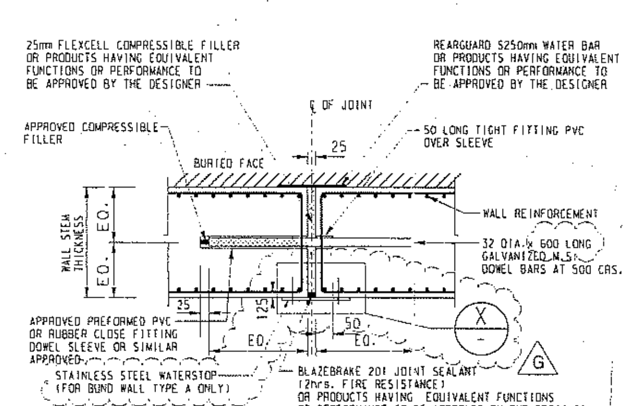
Title: STAINLESS STEEL PROTECTION COVER FOR MOVEMENT JOINT OF BUND WALL

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/HK/02/DWG/C/9835	0

FILENAME :

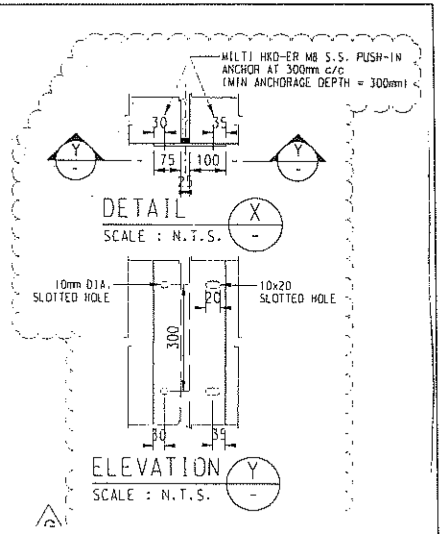


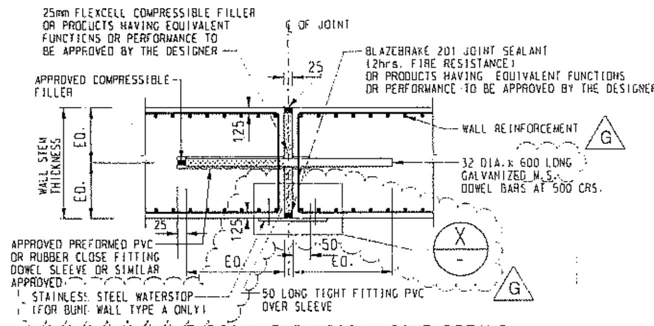
TYP. SECTION - PHASE 1A BUND WALL



TYPICAL EXPANSION JOINT DETAILS FOR SECURITY WALLS, BUND WALL TYPE A WHERE ONE FACE IS BURIED AND BASE SLAB OF BUND WALL TYPE B

N.T.S.





TYPICAL EXPANSION JOINT DETALS FOR SECURITY WALLS AND BUND WALL TYPE A WHERE BOTH FACES ARE EXPOSED

N.T.S.

Rev	Revision Date	Purpose of revision	Drawn	Checked	Approved
0	26-5-09	FIRST ISSUE	HP		

This drawing is not to be used in whole or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

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Client

Project

MASTER RECEIVED

26 MAY 2009

Drawing title: Stainless Steel Water Stop for Phase 1A Bundwall

Drawing status

Scale: N.T.S. (Do not scale)

Job no.: 2511

Client no.

Drawing number: PAFF/CON/SK/0670

Rev: 0

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Technical Data on Fire Retardant Sealant for Bund Walls

Hilti CP601S Elastic Firestop Sealant Submission Folder

Customer Hotline

Hong Kong 8228 8118

Macau (Toll free) 00800- 8228 8118

CP 601S elastic firestop sealant

Smoke | Water Tight | Acoustic | 30 Years Age Tested

British Standard BS 476-20 | pr EN 1366-3 | LPCB | FM APPROVED | c UL us CLASSIFIED

(Macau Local FSD Approved)

Product Description

A silicone based firestop sealant that provides ± 25% movement.

Typical Application Examples

- Movement / Expansion joint
- Metal pipe penetration

Product Features

- Halogen and solvent free
- Weather and UV resistant (ASTM C920 passed)
- Both indoor & outdoor use

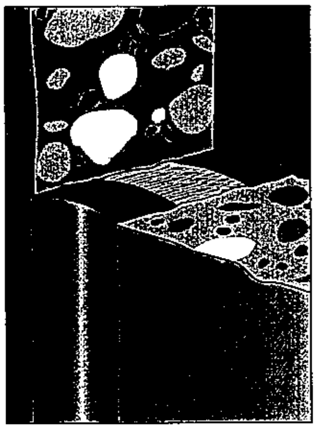
System Advantages/Customer Benefits

- Good adhesion without use of a primer
- Smoke, gas and water tight
- Excellent movement capability
- Unlimited linear length approved

Base materials:	Concrete, masonry, glass, metal,etc.
For use in:	Walls and floors.
Fire rating:	Up to 4 hours.

Technical Data (at 23°C and 50% relative air humidity)

Application temperature:	+5°C to +40°C
Skin-forming time:	approx. 15 min.
Curing rate:	approx. 2 mm in 3 days
Volume shrinkage:	0 – 5%
Movement capability:	±25%
Temperature resistance:	-30°C to + 150°C
Material class as per DIN 4102, P.1:	B1
Shelf-life after production:	12 months (at 20°C in a dry place)



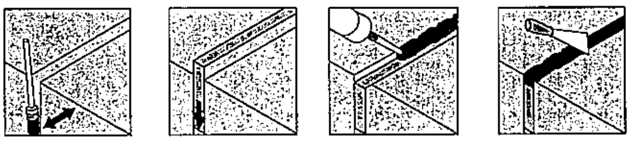
Application Criteria*

- Wall and floor thickness ≥ 100 mm
- Joint widths from 6-100mm with mineral wool backing
- Joint widths up to 50mm with PE rod or CF125-50 foam

* For installation criteria according to ASTM standard (UL / FM approval), please contact Hilti Fire Protection Specialist at (852) 8228 8118 for advice.

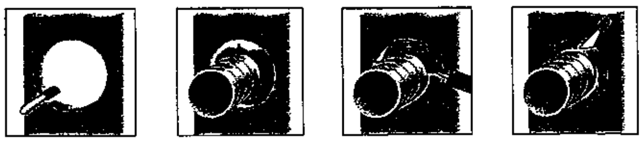
Application Procedure

Joint installation



1. Clean opening 2. Insert backing material 3. Apply CP 601S 4. Smooth CP 601S

Pipe installation



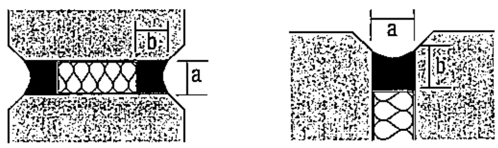
1. Clean opening 2. Insert backing material 3. Apply CP 601S 4. Smooth CP 601S

Consumption Guide

Cartridge volume = 310 ml (CP 601S)
a = Joint width in cm
b = product depth in cm

$$\text{Linear metre per cartridge} = \frac{\text{Cartridge volume in ml}}{a \times b}$$

e.g a floor 20 mm wide with product depth of 10 mm; with 310 ml cartridge:
Therefore linear metres per cartridge = 310/(1 x 2) = 1.55 metre per cartridge for one side of the floor



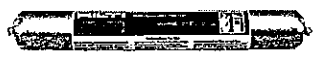
Joint width (mm)	0-15	16-100
Joint depth (mm)	6	15

CP 601S elastic firestop sealant

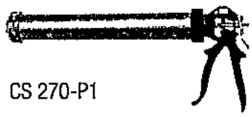
	Packaging contents (pcs)	Ordering designation	Item no.
Firestop sealant, white	20 (310ml)	CP 601S	310633
Firestop sealant, white	20 (600ml)	CP 601S	310637 ★
Firestop sealant, grey	20 (310ml)	CP 601S	310635
Firestop sealant, anthracite	20 (310ml)	CP 601S	310634 ★
Manual dispenser	1 (310ml)	CB 200-P1	055205
580ml Manual dispenser	1 (600ml)	CS 270-P1	024669 ★

310ml cartridge

600ml



CB 200-P1



CS 270-P1

★ Special Request

Warrington FIRE research

FACSIMILE MESSAGE

Holmesfield Road, Warrington, WA1 2DS.

To Reply: Tel : +44 (0) 1925-655116
Fax : +44 (0) 1925-655419
Email :- danny.forshaw@wfrc.co.uk

Company	:	Hilti Entwicklungsgesellschaft GmbH
Attention	:	Harold Bock
Fax No	:	00 49 8191 90 6330
From	:	D. Forshaw
Date	:	16 October 2002

No of Pages (Total) : 1

Dear Mr. Bock,

Re: Warres No. 71151/B

Further to your recent communication regarding the above referenced test report we can confirm that the product reference given as 'CP 6015' shown on page 2 of that report is incorrect.

The correct product reference should actually read 'CP 601S'. The correct reference is given the summary table on the same page and also later in the report under Annex A.

Please accept this fax as confirmation of the correct product reference for specimens H2, H3 and H4 reported under the reference Warres No. 71151/B

Yours faithfully,

Technical Officer
Testing Department

Doc: DF021016Fax 1

Warrington FIRE research

FACSIMILE MESSAGE

Holmesfield Road, Warrington, WA1 2DS.

To Reply: Tel : +44 (0) 1925-655116
Fax : +44 (0) 1925-655419
Email : danny.forshaw@wfrc.co.uk

Company	:	Hilti Entwicklungsgesellschaft GmbH
Attention	:	Dave Williams
Fax No	:	0049 8191906330
From	:	D. Forshaw
Date	:	10 October 2002

No of Pages (Total) : 1

Dear Mr. Williams,

Re: Warres No. 71151/B

Further to your recent communication regarding the above referenced test report we can confirm that the issue date shown on page 2 of that report is incorrect.

The issue date is shown as 16th April 1997, this should actually read 16th July 1997. The correct issue date is given on page 7 of the report.

Please accept this fax as confirmation of the correct date of issue for Warres No. 71151/B

Yours faithfully,

D. Forshaw

Technical Officer
Testing Department

TEST REPORT

FIRE RESISTANCE TEST ON FOUR SPECIMENS OF PROPRIETARY GAP SEALING SYSTEMS INCORPORATED BETWEEN AERATED CONCRETE FLOORS

THE PROFESSIONALS IN FIRE SAFETY •

Warrington FIRE research

CONSULTANCY • TESTING

Holmesfield Road, Warrington, UK WAI 2DS • Tel: 0925 55116 • Telex: 628743 WARRES G • Fax: 0925 55419

THE PROFESSIONALS IN FIRE SAFETY •

Warrington FIRE research
CONSULTANCY•TESTING

TEST REPORT

TEST SPONSOR : HILTI GmbH, Postfact 86915, Kaufering, Germany.

SUMMARY : A fire resistance test has been conducted to assess the ability of four different specimens of a proprietary linear gap sealing system to reinstate the fire resistance, with respect to the integrity and insulation (maximum temperature rise) performance criteria as defined in BS 476: Part 20: 1987, of a simulated floor construction at positions where various structures abut. Since there are currently no standardised British test procedures for this purpose the test utilised the general principles of BS 476: Part 20: 1987, in conjunction with additional guidelines from the draft document CEN/TC127 N579.

The test was performed on four different specimens of gap sealing systems referenced H1 to H4 for the purposes of the test. The specimens were incorporated between aerated concrete gap faces. The gaps were of nominal length 900 mm, and were sealed using Hilti CP606 or CP601S in conjunction with a rockfibre backing material.

Another specimen was incorporated within the test. At the sponsors request this is the subject of a separate report referenced WARRES No. 71151/A

If the performance of each specimen were assessed against the integrity and insulation (maximum temperature rise) criteria of BS 476: Part 20: 1987, the results obtained could be expressed as follows:

Specimen Ref.	Gap Width (mm)	Mastic Ref.	Mastic Depth (mm)	Backing Material	Integrity (mins)	Insulation (mins)
H1	15	CP606	6	Rockfibre	242	242
H2	15	CP601S	6	Rockfibre	242	242
H3	30	CP601S	15	Rockfibre	242	242
H4	100	CP601S	15	Rockfibre	242	242

The test was discontinued after a period of 242 minutes.

DATE OF TEST : 25th April 1997

REPORT ISSUED : 16th ~~April~~ July 1997

JMP(1556)

CONTENTS

1. PURPOSE OF THE TEST

1.1 To investigate the ability of four specimens of a proprietary gap sealing system to reinstate the integrity and insulation (maximum temperature rise) performance, as defined within BS 476: Part 20: 1987, of aerated concrete floors at positions where adjacent sections abut. The test utilised the heating conditions and performance criteria of BS 476: Part 20: 1987, 'Methods for determination of the fire resistance of elements of construction (general principles)' in conjunction with additional guidelines from the draft document CEN/TC127 N579 relating to the testing of linear gap sealing systems.

2. INTRODUCTION

2.1 Walls and floors often incorporate gaps to accommodate either expansion, contraction or other movement of the structure. The fire resistance of such elements is only as good as their weakest point and it is, therefore, important that any gaps are adequately sealed, such that weaknesses are not created at these positions.

2.2 There is not, as yet, any specified British Standard fire test method for evaluating gap seals which are designed to act as an effective barrier to the penetration of fire and to reinstate the necessary fire resistance performance of the separating element. However, the fire resistance of walls and floors is determined by tests utilising the general principles given in BS 476: Part 20: 1987, and it would appear appropriate to use the principles of that Standard to evaluate the performance of gap sealing systems. Additional guidelines were adopted from the latest draft European documents referenced CEN/TC127 N579 relating to the testing of linear gap sealing systems.

2.3 In BS 476: Part 20: 1987, the performance criteria appropriate to separating elements are integrity and insulation. In accordance with the requirements of the draft CEN document only the maximum temperature criterion was used as a basis for assessment with respect to insulation.

2.4 Certain aspects of some fire test specifications are open to different interpretations. The Fire Test Study Group has identified a number of such areas and has agreed Resolutions which define common agreement of interpretations between fire test laboratories which are members of the Group. Where such Resolutions are applicable to this test they have been followed.

2.5 The test was conducted on the 25th April 1997, at the request of Hilti GmbH, the sponsor of the test.

2.6 The test was witnessed by Mr A. Brockett and Mr C. Eberhard, representatives of the test sponsor.

2.7 Another specimen was incorporated within the test. At the sponsors request this is the subject of a separate report referenced WARRES No. 71151/A.

3. TEST SPECIMEN CONSTRUCTION

3.1 A comprehensive description of the test construction is given in Annex A. The description is based on a detailed survey of the specimens and information supplied by the sponsor.

3.2 The construction containing the apertures was supplied by Warrington Fire Research Centre. The gap sealing systems were provided and installed by representatives of the sponsor on 17th to 22nd April 1997.

3.3 Warrington Fire Research Centre was not involved in any selection or sampling procedures of the sealing system components.

4. INSTRUMENTATION AND MEASURING EQUIPMENT

4.1 The instrumentation and measuring equipment was provided in accordance with BS 476: Part 20: 1987, where appropriate.

4.2 Four thermocouples distributed over a plane 100 mm from the face of the wall construction were provided to monitor the temperature of the furnace atmosphere.

4.3 Pressure sensors were provided within the furnace chamber to monitor the furnace atmospheric pressure.

4.4 Thermocouples were provided to monitor the temperature of the unexposed face of the specimen as follows:

4.4.1 At one position at approximately mid-length on the surface of each specimen. (Thermocouples 13, 18, 23 and 27)

4.4.2 At one position on the surface of the separating element adjacent to each seal at approximately mid-length. (Thermocouples 14, 19, 24 and 28)

4.4.3 At one position on the surface of each specimen approximately 100 mm from one end junction. (Thermocouples 11, 16, 21 and 25)

4.4.4 At one position on the surface of the separating element adjacent to each seal approximately 100 mm from the upper end junction. (Thermocouples 12, 17, 22 and 26)

4.4.5 At one position on the surface of specimens H1 to H3, coincident with the junction between the seal and the separating element. (Thermocouples 10, 15 and 20)

4.4.6 The locations and reference numbers of the thermocouples are shown in Figure 1 of Annex A.

4.5 A roving thermocouple was available to measure temperatures on the unexposed surface at positions which might appear to be hotter than temperatures indicated by the fixed thermocouples.

4.6 Cotton pads and gap gauges were available to evaluate the impermeability of the specimens to hot gases.

5. TEST PROCEDURE

5.1 The test utilised the general principles given in BS 476: Part 20: 1987 in conjunction with additional guidelines given CEN/TC127 N579.

5.2 The furnace was controlled so that its mean temperature complied with the requirements of BS 476: Part 20: 1987, paragraph 3.1.

5.3 After the first five minutes of testing the furnace was controlled to maintain a slightly positive pressure relative to the pressure of the laboratory. The furnace atmospheric pressure was measured and controlled such that at a point 100 mm below the soffit of the floor the calculated differential was between 18 Pa and 20 Pa.

5.4 Throughout the test the temperatures indicated by all thermocouples provided to monitor the furnace and the specimens were continuously monitored and recorded at one minute intervals.

5.5 The thermocouples referred to in 4.4.1 to 4.4.5 were used to assess the ability of each specimen to satisfy the maximum temperature criterion, as specified within the draft CEN document. The roving thermocouple was also used, if considered appropriate, to determine compliance with this criterion.

5.6 The cotton pads and gap gauges were used, if considered appropriate, to determine compliance with the integrity criterion of the Standard. The occurrence of any sustained flaming on the unexposed surface was also recorded to determine compliance with this criterion.

6. TEST DATA AND INFORMATION

6.1 The following data, which was recorded during the test, is given in Annex B:

6.1.1 Mean furnace temperature, together with a comparison with the specified temperature/time relationship specified in the Standard.

6.1.2 The individual temperatures recorded by the thermocouples fixed to the unexposed surfaces of the specimens.

6.2 A summary of the observations made on the general behaviour of the specimens during the test is given in Annex C.

6.3 The ambient air temperature in the vicinity of the test construction was 17^{0}C at the start of the test with no variation during the test.

6.4 The test was discontinued after a period of 242 minutes.

7. EVALUATION AGAINST THE PERFORMANCE CRITERIA

7.1 The performance of each specimen was judged against the following criteria:

7.1.1 **Integrity** - It is required that there is no collapse of the specimen, no sustained flaming on the unexposed surface and no loss of impermeability. These requirements were satisfied for each specimen for the full 242 minutes test duration.

7.1.2 **Insulation** - The highest mean and maximum individual temperature rises allowable by BS 476: Part 20: 1987 are 140 ^{0} C and 180 ^{0} C respectively. In accordance with the requirements of the draft CEN document, only the maximum temperature criterion was used as a basis for assessment. This requirement was satisfied for the full 242 minute test duration for each specimen.

8. CONCLUSIONS

8.1 A fire test which utilised the heating conditions and performance criteria specified in BS 476: Part 20: 1987 in conjunction with additional guidelines adopted from CEN/TC127 N579 has been conducted to assess the ability of four different specimens of proprietary gap sealing systems to reinstate the fire resistance performance with respect to the integrity and insulation (maximum temperature rise) criteria of BS 476: Part 20: 1987 at positions where aerated concrete floor structures abut.

8.2 If the performance of each seal were assessed against the integrity and insulation (maximum temperature rise) requirements of the Standard the results obtained could be expressed as follows:

Specimen Ref.	Gap Width (mm)	Mastic Ref.	Mastic Depth (mm)	Backing Material	Integrity (mins)	Insulation (mins)
H1	15	CP606	6	Rockfibre	242	242
H2	15	CP601S	6	Rockfibre	242	242
H3	30	CP601S	15	Rockfibre	242	242
H4	100	CP601S	15	Rockfibre	242	242

9. LIMITATIONS

9.1 The results relate only to the behaviour of the specimens of the proprietary gap sealing system under the particular conditions of test. They are not intended to be the sole criteria for assessing the potential performance of the seals in use, nor do they reflect the actual behaviour in fires.

9.2 The results may not be applicable to situations where the gap widths and seal depths vary from those which were tested.

10. REVIEW

10.1 This report covers a test which was conducted to a procedure which is not the subject of any British Standard specification, but the test utilised the general principles of fire resistance testing given in BS 476: Part 20: 1987 and the draft document CEN/TC127 N579. Since fire tests are the subject of a continuing standardisation process, and because existing standards are the subject to review and possible amendment and new interpretations, it is recommended that the report be referred back to the test laboratory after a period of two years to ensure that the methodology adopted and the results obtained remain valid in the light of the situation prevailing at that time.

Responsible Officer

S. Hankey.

S. HANKEY
Technical Officer
Structural Fire Protection

Approved

C. W. MILES
Senior Technical Officer
For and on behalf of
WARRINGTON FIRE RESEARCH CENTRE

16th July 1997

JMP(1556)

Warrington FIRE research
CONSULTANCY•TESTING

ANNEX A

SCHEDULE OF COMPONENTS
(Refer to Figure 1)
(All values are nominal unless stated otherwise)
(All references are as stated by the sponsor)

Item	Description		
1.	**Floor Slab**		
	Type	:	Steel reinforced precast concrete.
	Material	:	Autoclaved aerated concrete.
	Density	:	670 Kg/m^3.
	Thickness	:	150 mm.
2.	**Concrete Beams**		
	Material	:	Autoclaved aerated precast concrete.
	Density	:	670 Kg/m^3.
	Section size	:	150 mm by 150 mm.
3.	**Gap Seal**		
	Specimen Reference	:	'H1'.
	Aperture size		
	i) depth	:	150 mm.
	ii) width	:	15 mm.
	iii) length	:	900 mm.
	Aperture faces	:	Autoclaved aerated concrete.
	Intumescent mastic		
	i) manufacturer	:	Hilti.
	ii) reference	:	CP606.
	iii) depth of mastic	:	6 mm.
	Backing		
	i) manufacturer	:	Rockwool.
	ii) material	:	Rock fibre.
	iii) density	:	100 Kg/m^3 uncompressed (stated).
4.	**Gap Seal**		
	Specimen Reference	:	'H2'.
	Aperture size		
	i) depth	:	150 mm.
	ii) width	:	15 mm.
	iii) length	:	900 mm.
	Aperture faces	:	Autoclaved aerated concrete.
	Intumescent mastic		
	i) manufacturer	:	Hilti.
	ii) reference	:	CP601S.
	iii)depth of mastic	:	6 mm.

Annex A (Continued)

4. continued

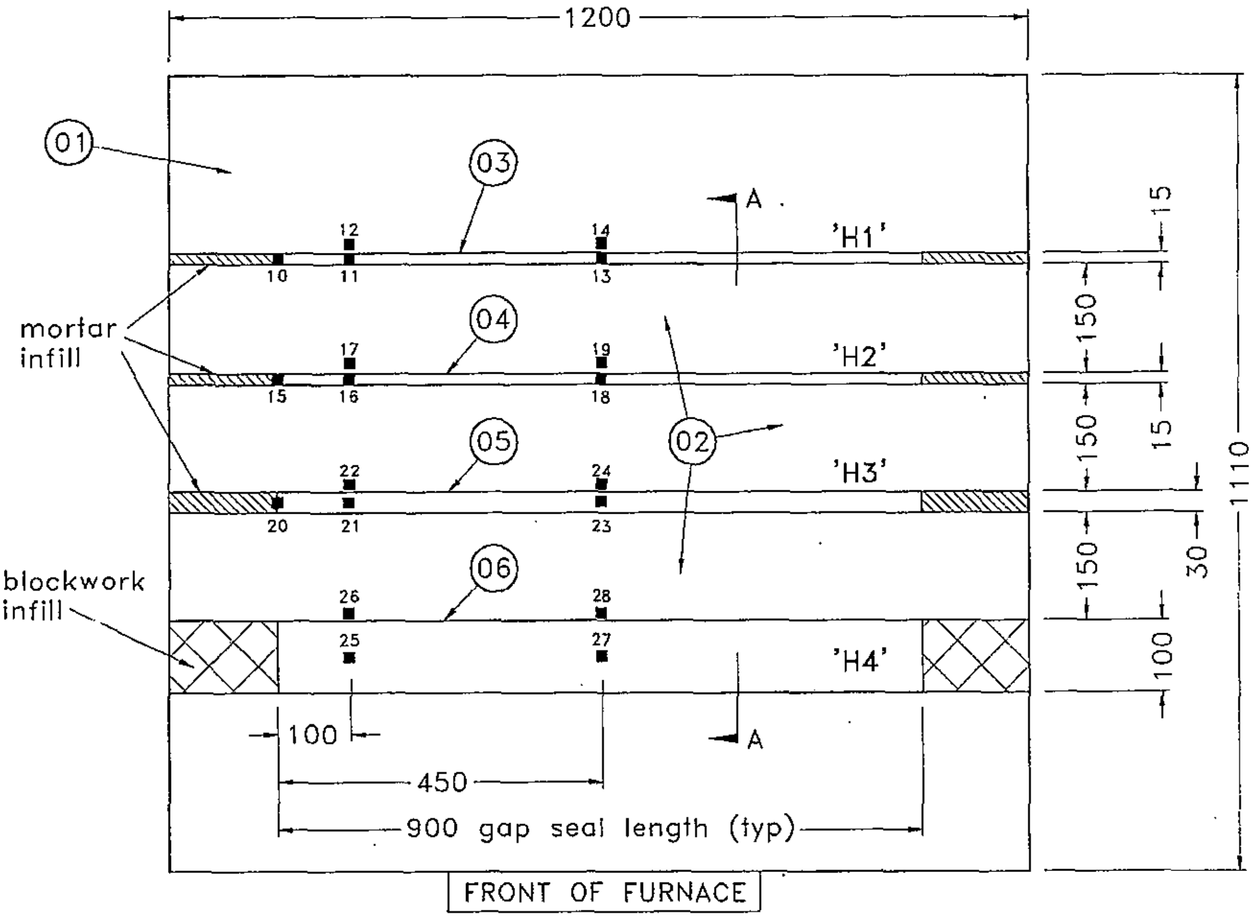
Backing		
i) manufacturer	:	Rockwool.
ii) material	:	Rock fibre.
iii) density	:	100 Kg/m^3 uncompressed (stated).

5. **Gap Seal**

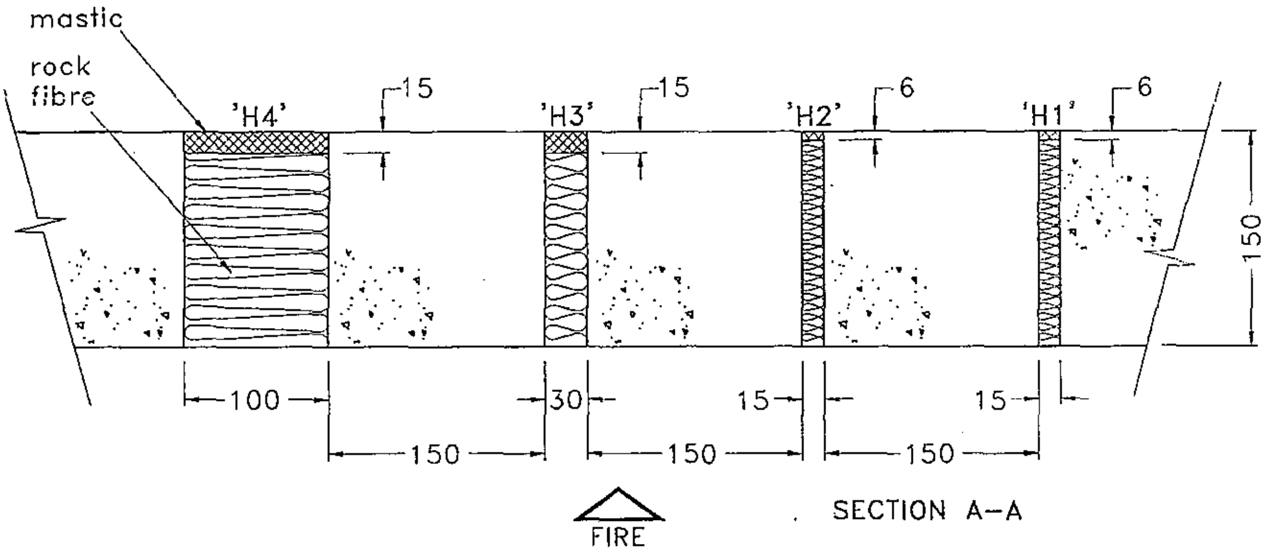
Specimen Reference	:	'H3'.
Aperture size		
i) depth	:	150 mm.
ii) width	:	30 mm.
iii) length	:	900 mm.
Aperture faces	:	Autoclaved aerated concrete.
Intumescent mastic		
i) manufacturer	:	Hilti.
ii) reference	:	CP601S.
iii) depth of mastic	:	15 mm.
Backing		
i) manufacturer	:	Rockwool.
ii) material	:	Rock fibre.
iii) density	:	100 Kg/m^3 uncompressed (stated).

6. **Gap Seal**

Specimen Reference	:	'H4'.
Aperture size		
i) depth	:	150 mm.
ii) width	:	100 mm.
iii) length	:	900 mm.
Aperture faces	:	Autoclaved aerated concrete.
Intumescent mastic		
i) manufacturer	:	Hilti.
ii) reference	:	CP601S.
iii) depth of mastic	:	15 mm.
Backing		
i) manufacturer	:	Rockwool.
ii) material	:	Rock fibre.
iii) density	:	100 Kg/m^3 uncompressed (stated).



GENERAL PLAN VIEW OF FLOOR SPECIMEN
(VIEWED FROM NON-FIRE SIDE FACE)



SECTION A–A

■ Positions of thermocouples.

All dimensions are in mm.
See Annex A for schedule.
Do not scale

Warrington FIRE research CONSULTANCY • TESTING

FIGURE 1

ANNEX B

DATA RECORDED DURING THE TEST

TABLE 1

SPECIFIED AND RECORDED FURNACE TEMPERATURES AND PERCENTAGE TOLERANCES

Time: Mins	STANDARD FURNACE TEMP. Deg C	ACTUAL FURNACE TEMP. Deg C	AREA UNDER STANDARD CURVE Deg C.min	AREA UNDER ACTUAL CURVE Deg C.min	PERCENT DIFF.	PERCENT TOLERANCE + or -
0	20	18				
1	349	398				
2	445	493				
3	502	532				
4	544	564				
5	576	580				
6	603	608				
7	626	626				
8	645	642				
9	663	671				
10	678	681	5302	5463	3.0	15
15	739	728				
20	781	768				
25	815	808				
30	842	837	15493	15335	-1	10
40	885	881				
50	918	919				
60	945	945				
70	968	964				
80	988	986				
90	1006	1009				
100	1022	1024				
110	1036	1043				
120	1049	1048				
130	1061	1064				
140	1072	1077				
150	1082	1087				
160	1092	1091				
170	1101	1102				
180	1110	1116				
190	1118	1126				
200	1126	1131				
210	1133	1133				
220	1140	1137				
230	1146	1144				
240	1153	1149				
242	1154	1152	222298	222604	.1	5

Annex B (Continued)

TABLE 2

INDIVIDUAL TEMPERATURES RECORDED ON THE UNEXPOSED SURFACE OF SPECIMEN H1

Time: Mins	T/C 10 Deg C	T/C 11 Deg C	T/C 12 Deg C	T/C 13 Deg C	T/C 14 Deg C
0	18	18	17	17	17
10	18	18	17	17	17
20	18	18	17	17	17
30	18	18	17	17	17
40	19	18	17	17	17
50	24	20	19	19	18
60	34	26	24	25	23
70	46	36	31	35	31
80	58	47	39	48	40
90	69	60	49	60	51
100	76	70	57	67	58
110	80	75	64	71	62
120	82	78	67	72	64
130	82	79	69	74	66
140	82	78	69	74	66
150	82	81	70	75	67
160	82	81	70	76	67
170	82	82	71	76	68
180	82	83	72	77	69
190	80	83	72	78	70
200	85	82	72	79	70
210	88	82	72	79	70
220	89	81	72	79	70
230	88	80	71	79	70
240	88	80	72	79	70
242	88	80	72	79	70

Annex B (Continued)

TABLE 3

INDIVIDUAL TEMPERATURES RECORDED ON THE UNEXPOSED SURFACE OF SPECIMEN H2

Time Mins	T/C 15 Deg C	T/C 16 Deg C	T/C 17 Deg C	T/C 18 Deg C	T/C 19 Deg C
0	17	18	18	18	18
10	17	18	18	18	18
20	17	18	18	18	18
30	17	18	18	18	18
40	17	18	18	18	18
50	19	20	19	19	19
60	23	23	21	21	21
70	30	30	25	25	24
80	40	37	30	30	29
90	51	46	37	37	35
100	60	53	44	44	41
110	67	60	50	51	48
120	71	64	55	56	53
130	74	67	59	60	58
140	74	68	60	62	61
150	76	70	62	64	63
160	77	71	62	65	65
170	78	72	66	65	65
180	79	77	81	66	66
190	79	78	82	67	67
200	79	78	81	67	68
210	78	78	81	67	68
220	78	78	81	66	68
230	78	77	80	66	69
240	77	77	80	66	69
242	78	77	80	67	70

Annex B (Continued)

TABLE 4

INDIVIDUAL TEMPERATURES RECORDED ON THE UNEXPOSED SURFACE OF SPECIMEN H3

Time: Mins:	T/C 20 Deg C	T/C 21 Deg C	T/C 22 Deg C	T/C 23 Deg C	T/C 24 Deg C
0:	18	18	18	18	21
10:	18	18	18	18	21
20:	18	18	18	18	21
30:	19	18	18	18	21
40:	22	18	18	18	21
50:	27	19	19	19	21
60:	36	22	21	23	21
70:	57	28	24	28	23
80:	69	37	29	34	28
90:	75	45	36	41	35
100:	77	51	44	47	42
110:	78	56	51	52	48
120:	80	58	57	55	54
130:	79	61	61	57	60
140:	78	61	64	59	63
150:	80	63	66	61	66
160:	80	64	67	62	68
170:	80	63	68	62	69
180:	81	64	68	62	70
190:	82	64	69	63	71
200:	83	64	69	64	72
210:	82	64	69	63	71
220:	81	64	70	63	71
230:	80	64	70	62	71
240:	79	63	70	62	72
242:	79	64	71	63	72

Annex B (Continued)

TABLE 5

INDIVIDUAL TEMPERATURES RECORDED ON THE UNEXPOSED SURFACE OF SPECIMEN H4

Time: Mins	T/C 25 Deg C	T/C 26 Deg C	T/C 27 Deg C	T/C 28 Deg C
0	20	20	20	18
10	20	20	20	18
20	20	20	20	18
30	20	20	20	18
40	21	20	23	19
50	25	20	28	24
60	31	26	35	33
70	37	35	41	43
80	42	44	45	50
90	47	52	50	56
100	50	57	52	60
110	52	60	55	62
120	54	63	56	63
130	54	77	58	64
140	55	78	58	64
150	57	78	58	65
160	59	77	59	66
170	61	76	60	67
180	65	76	63	67
190	69	76	66	68
200	74	76	71	70
210	78	75	75	71
220	83	74	79	72
230	87	74	83	73
240	78	74	86	74
242	53	74	88	74

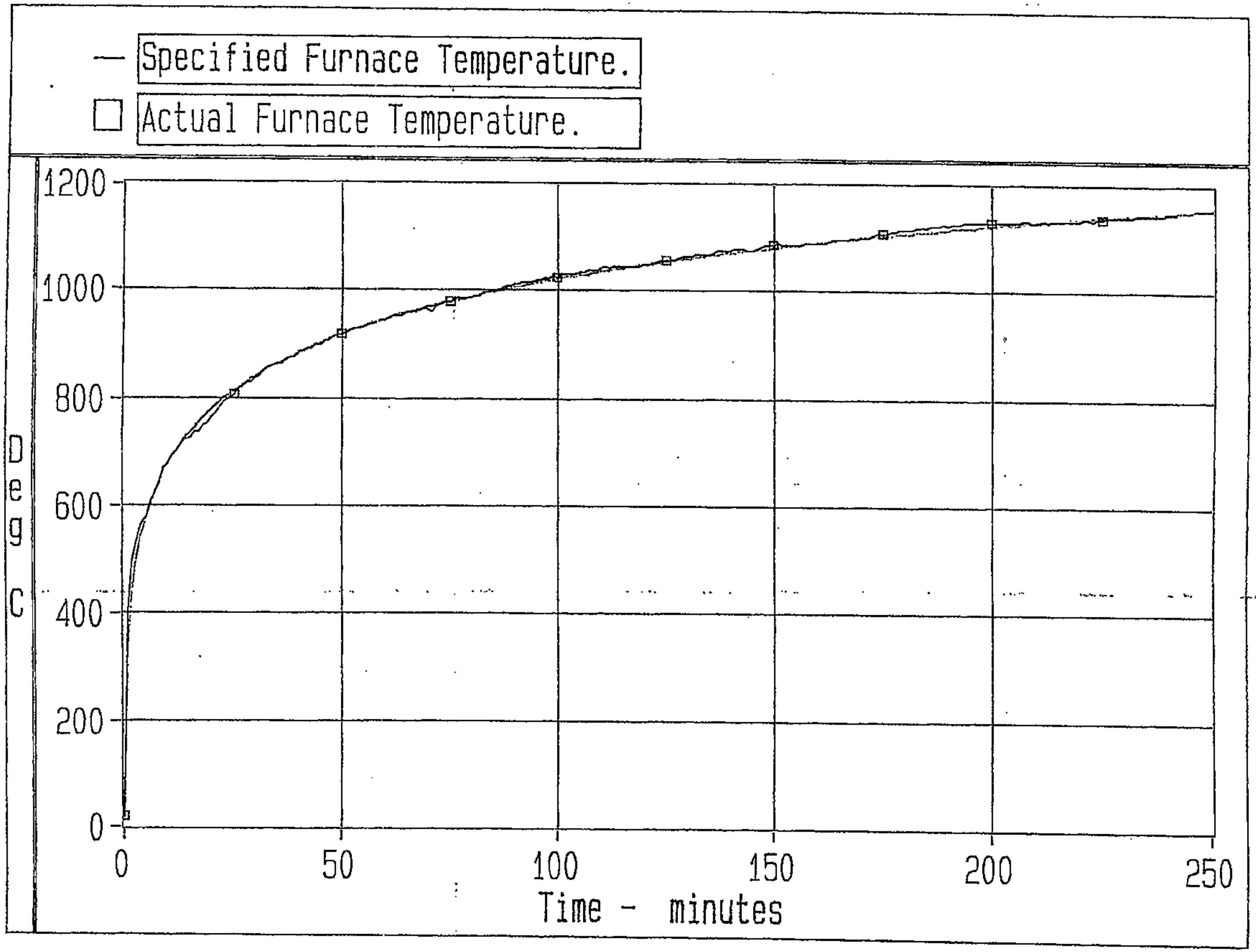

Specified Furnace Temperature.
Actual Furnace Temperature.
1200
1000
800
600
400
200
0
Deg C
0
50
100
150
200
250
Time - minutes

FIGURE 2

ANNEX C

OBSERVATIONS MADE DURING THE TEST

The following observations were made during the test by Warrington Fire Research Centre

E - Observations from exposed side
U - Observations from unexposed side

Time			
mins	secs		
00	00		The test commences.
03	00	U	A slight smoke release is visible emanating from the end of the 100 mm wide linear gap.
60	00	U	All the specimens remain intact with regards to integrity and insulation.
120	00	U	All the specimens remain intact with regards to integrity and insulation.
142	00	U	The sealant within specimen H4 is deflecting upwards along its centre line by approximately 5-10 mm.
180	00	U	The four linear gap seal specimens remain intact with respect to integrity and insulation.
209	40	U	Specimen H4 continues to deflect upwards along its length by approximately 10-15 mm.
240	00	U	The specimens H1 to H4 continue to satisfy the integrity and insulation performance criteria.
242	00	U	The test is discontinued at the request of the sponsor.

Warrington FIRE research
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Hilti GmbH

Review of Test Report Referenced WARRES No. 71151/B

1 Introduction

1.1 The report referenced, WARRES No. 71151/B, relates to a fire resistance test conducted, utilising the general principles of BS 476: Part 20: 1987, in conjunction with additional guidelines adopted from the draft document CEN/TC 127 N579, on four different examples of linear gap sealing system, one referenced 'Hilti CP606', and three referenced 'Hilti CP601S' used to reinstate the integrity and insulation performance (as defined in BS 476: Part 20: 1987) of a simulated floor construction at positions where various structures abut.

1.2 The report concluded that the linear gap sealing systems were capable of providing 242 minutes integrity and insulation (maximum temperature rise) performance.

2 Confirmation of Specification

2.1 It has been confirmed by Hilti GmbH that there have been no changes to the specification of the construction given within WARRES No. 71151/B since the test was conducted.

3 Considerations

3.1 There is no published British Standard relating to the fire resistance testing of penetration sealing systems. As the fire resistance of the floor or wall construction into which the seal would be installed is determined by test procedures detailed within BS 476: Part 20: 1987, 'Method for determination of the fire resistance of elements of construction (general principles)', it would seem appropriate to use those as the basis for a test for evaluating the penetration sealing systems themselves. The test also utilised additional guidelines adopted from the draft document CEN/TC 127 N579.

3.2 The current test methodology with respect to the fire resistance testing of penetration sealing systems, i.e. utilising the heating conditions and performance criteria for integrity and insulation given in BS 476: Part 20: 1987, has not been amended and would, therefore, still be utilised for this purpose. The draft document CEN/TC 127 N579 from which additional guidelines where adopted has since been replaced by the draft document PrEN 1366-4, however the guidelines within that document have remained essentially the same as those originally used

3.3 At present there are no existing Resolutions adopted by the Fire Test Study Group since the original test was performed, which would affect the manner in which the test would be conducted, or the interpretation of the test results.

4 Conclusions

4.1 The procedures adopted for the original test have also been re-examined and are similar to those currently in use.

4.2 Therefore, with respect to the fire resistance test report referenced WARRES No. 71151/B, the contents should remain valid until the 1st May 2001.

5 **Validity**

5.1 This review is based on information used to formulate the original test report. No other information or data has been provided by Hilti GmbH which could affect this review.

5.2 This review should not be used in isolation but should be read in conjunction with the above referenced report.

Reviewed By:

D. Forshaw
Technical Officer
Fire Resistance Department

19th April 1999

Mr M. Drexl
Hilti Entwicklungsgesellschaft mbH
BU-Chemicals / Geb. 3
Hiltistrasse 6
86916 Kaufering
Germany

Review of Test Report Referenced WARRES No. 71151/B

1 Introduction

The test report referenced WARRES No. 71151/B provides details of a fire resistance test utilising the heating conditions of BS 476: Part 20: 1987 and additional guidelines adopted from a draft document referenced CEN/TC127 N579, conducted to assess the ability of four specimens of linear gap sealing systems to reinstate the integrity and insulation performance of sections of aerated concrete floor slabs where they abutted.

The report concluded that if each specimen was assessed against the integrity and insulation (maximum temperature rise only) performance criteria of BS 476: Part 20: 1987, the results obtained would be as follows:

Specimen Reference	Integrity	Insulation
H1	242 minutes	242 minutes
H2	242 minutes	242 minutes
H3	242 minutes	242 minutes
H4	242 minutes	242 minutes

2 Confirmation of Specification

It has been confirmed by Hilti Entwicklungsgesellschaft mbH that there have been no changes to the components or the method of construction given in the original report referenced WARRES No. 71151/B.

3 Considerations

Until the issue of BS EN 1366-4 there was no published British Standard relating to the fire resistance testing of penetration sealing systems. As the fire resistance of the floor or wall construction into which the seal would be installed is determined by test procedures detailed within BS 476: Part 20: 1987, 'Method for determination of the fire resistance of elements of construction (general principles)', it was considered appropriate to use those as the basis for a test for evaluating the penetration sealing systems themselves.

This test methodology with respect to the fire resistance testing of linear gap sealing systems, i.e. utilising the heating conditions and performance criteria for integrity and insulation given in BS 476: Part 20: 1987, has not been amended and would, therefore, still be utilised for this purpose. In addition the guidelines adopted from prEN 1366-4 remain unchanged.

At present there are no existing Resolutions adopted by the Fire Test Study Group since the original test was performed, which would affect the manner in which the test would be conducted, or the interpretation of the test results.

4 Conclusions

The procedures adopted for the original test have been re-examined and are similar to those currently in use.

Therefore, with respect to the test report referenced WARRES No. 71151/B, the contents should remain valid until the 1st April 2011.

5 Validity

This review is based on information used to formulate the original test report. No other information or data, other than that previously detailed has been provided by Hilti Entwicklungsgesellschaft mbH which could affect this review.

This review should not be used in isolation but should be read in conjunction with the above referenced report.

Performed by:	Reviewed By:
C. Johnson Senior Certification Engineer **Bodycote warringtonfire**	**D. Hankinson** Senior Certification Engineer **Bodycote warringtonfire**

WFRC REPORT NO. 143653

Fire Resistance Test Utilising the General Principles of BS 476: Part 20: 1987 on Four Specimens of Wall Mounted and Four Specimens of Floor Mounted Linear Gap Sealing System

Warrington FIRE research

Warrington Fire Research Centre Ltd., Holmesfield Road, Warrington, UK WA1 2DS
Tel: int + 44 (0) 1925 655116 • Fax: Int + 44 (0) 1925 646616 • www.wfrc.co.uk • Reg.No. 1247124

Summary

Objective

A fire resistance test has been conducted to assess the ability of eight specimens of a linear gap sealing system, to reinstate the fire resistance of blockwork wall and pre-cast aerated concrete floor constructions. The performance of the specimens were assessed, with respect to the integrity and insulation (maximum temperature rise only) performance criteria, as defined in BS 476: Part 20: 1987.

Sponsor

Hilti Entwicklung Befestigungstechnik GmbH , Postfach, 86915 Kaufering, Germany.

Summary of the Tested Specimen

For the purpose of the test the specimens were referenced A to H.

The section of wall had overall dimensions of 1000 mm high by 1000 mm wide by 150 mm thick and was provided with four linear joints, referenced Specimens A, B, C, and D.

The section of floor had overall dimensions of 1200 mm long by 1200 mm wide by 150 mm thick and was provided with four linear joints, referenced Specimens E, F, G, and H.

If the performance of the specimens were assessed against the integrity and insulation (maximum temperature rise only) performance criteria of BS 476: Part 20: 1987. The results obtained could be expressed as follows:

For the purpose of the test the specimen seals were referenced A to H and details of each specimen are included in the table below:

Test Specimen

Wall Mounted Specimens

Specimen Reference	Item Description
A	50 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 20 mm, backed with two 50 mm diameter backing rods.
B	10 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 6 mm, backed with two 15 mm diameter backing rods.
C	30 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 15 mm, backed with one 35 mm diameter backing rod.
D	10 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 6 mm, backed with one 15 mm diameter backing rod.

Floor Mounted Specimens

Specimen Reference	Item Description
E	50 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 20 mm, backed with two 50 mm diameter backing rods.
F	10 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 6 mm backed with two 15 mm diameter backing rods.
G	30 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 15 mm, backed with one 35 mm diameter backing rod.
H	10 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 6 mm, backed with one 15 mm diameter backing rod.

Test Results

If the performance of the specimens were assessed against the integrity and insulation (maximum temperature rise only) performance criteria of BS 476: Part 20: 1987. The results obtained could be expressed as follows:

Specimen Ref.	Integrity - Minutes	Insulation - Minutes
A	240	240
B	240	240
C	240	96
D	240	240
E	240	240
F	240	240
G	240	126
H	240	240

The test was discontinued after a period of 240 minutes.

Date of Test 20th December 2004

Signatories

Responsible Officer S. Baker* (Technical Officer)

Approved C. Johnson* (Technical Officer)

* For and on behalf of Warrington Fire Research Centre.

Report Issued
Date : 31st January 2005

CONTENTS **PAGE NO.**

Test Procedure

Introduction

Walls and floors often incorporate gaps to accommodate expansion, contraction or other movement of the structure. The fire resistance of such elements is only as good as their weakest point and it is, therefore, important that any gaps or apertures are adequately sealed, such that weaknesses are not created at these positions.

There is not, as yet, any specified British Standard fire test method for evaluating gap seals which are designed to act as an effective barrier to the penetration of fire and to reinstate the necessary fire resistance performance of the separating element. However, the fire resistance of walls and floors is determined by tests utilising the general principles given in BS 476: Part 20: 1987, and it would appear appropriate to use the principles of that Standard to evaluate the performance of gap sealing systems. Some additional guidelines were adopted from the draft European document referenced prEN 1366-4, relating to the testing of these types of sealing systems. This report should be read in conjunction with the above mentioned documents.

Fire Test Study Group/EGOLF

Certain aspects of some fire test specifications are open to different interpretations. The Fire Test Study Group and EGOLF have identified a number of such areas and have agreed Resolutions which define common agreement of interpretations between fire test laboratories which are members of the Groups. Where such Resolutions are applicable to this test they have been followed.

Instruction To Test

The test was conducted on the 20th December 2004 at the request of Hilti Entwicklung Befestigungstechnik GmbH, the sponsor of the test.

The test was witnessed by Mr. C. Abbott, a representative of the test sponsor.

Test Specimen Construction

A comprehensive description of the test construction is given in the Schedule of Components. The description is based on a detailed survey of the specimens and information supplied by the sponsor of the test.

Installation

The floor and wall constructions were supplied by Warrington Fire Research Centre. The gap sealing systems were provided and installed by a representative of the test sponsor during the week commencing 11th December 2004.

Sampling

Warrington Fire Research Centre was not involved in any sampling or selection procedure of the sealing system components.

Instrumentation

General

The instrumentation and measuring equipment provided was in accordance with BS 476: Part 20: 1987 and the draft European document, where appropriate.

Furnace

The furnace was controlled so that its mean temperature complied with the requirements of BS 476: Part 20: 1987, Clause 3.1, using four mineral insulated thermocouples distributed over a plane 100 mm from the surface of the wall test specimen construction.

Thermocouple Allocation

Thermocouples were provided to monitor the unexposed surface of the specimens and the output of all instrumentation was recorded at no less than one minute intervals as follows:

The locations and reference numbers of the various unexposed surface thermocouples are shown in Figures 1 and 2.

Roving Thermocouple

A roving thermocouple was available to measure temperatures on the unexposed surface of the specimens at any position which might appear to be hotter than the temperatures indicated by the fixed thermocouples.

Integrity Criteria

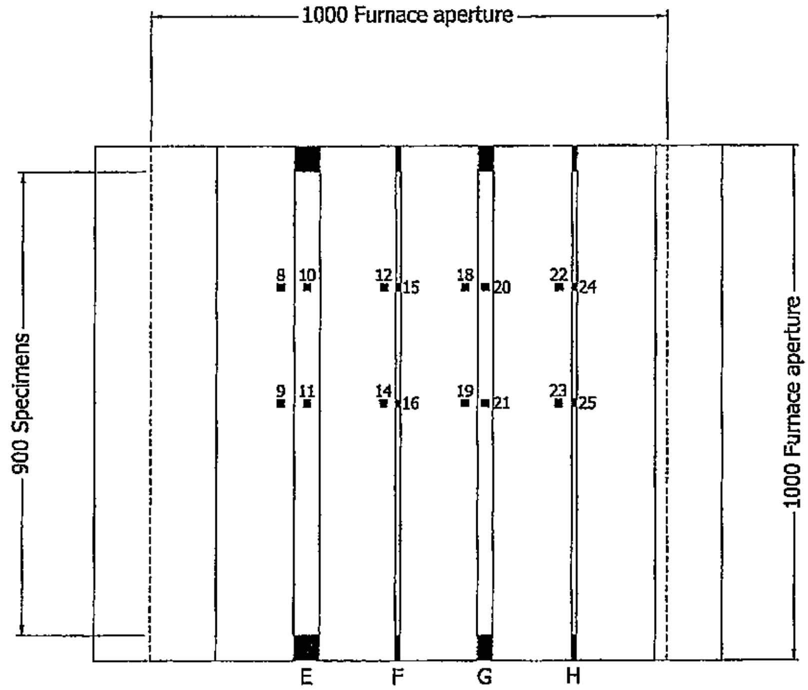
Cotton pads and gap gauges were available to evaluate the integrity of the specimens.

Furnace Pressure

After the first five minutes of testing, the furnace pressure was controlled to maintain a slightly positive pressure relative to the pressure of the laboratory. The furnace atmospheric pressure was measured and controlled such that, at a point 100 mm below the soffit of the floor assembly, the differential pressure was calculated to be between 18 Pa and 20 Pa.

Test Specimen

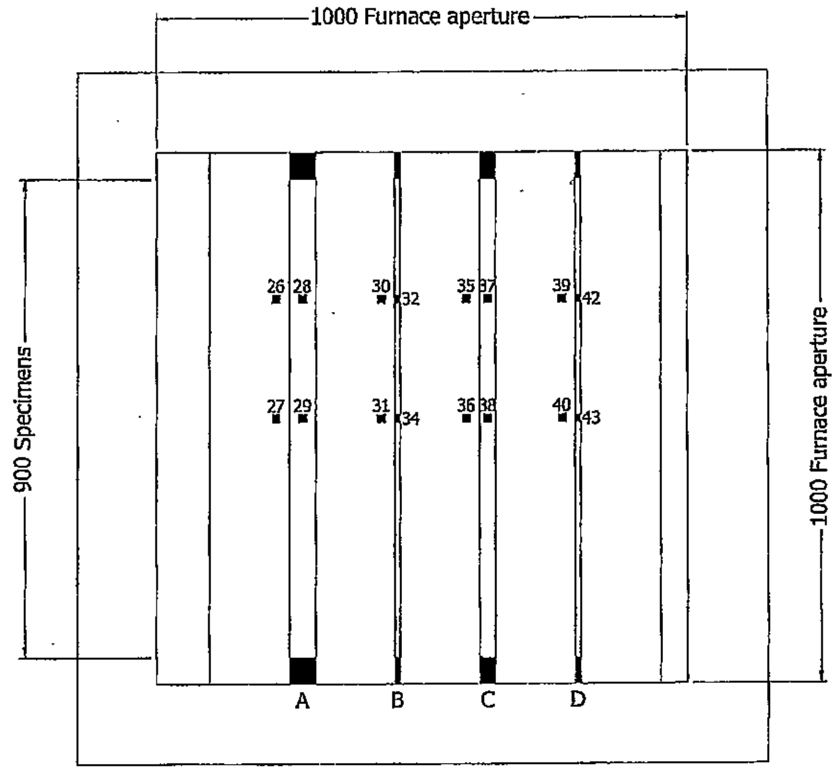
Figure 1- Plan View of Floor Specimens



▪ Positions of thermocouples

Do not scale. All dimensions are in mm

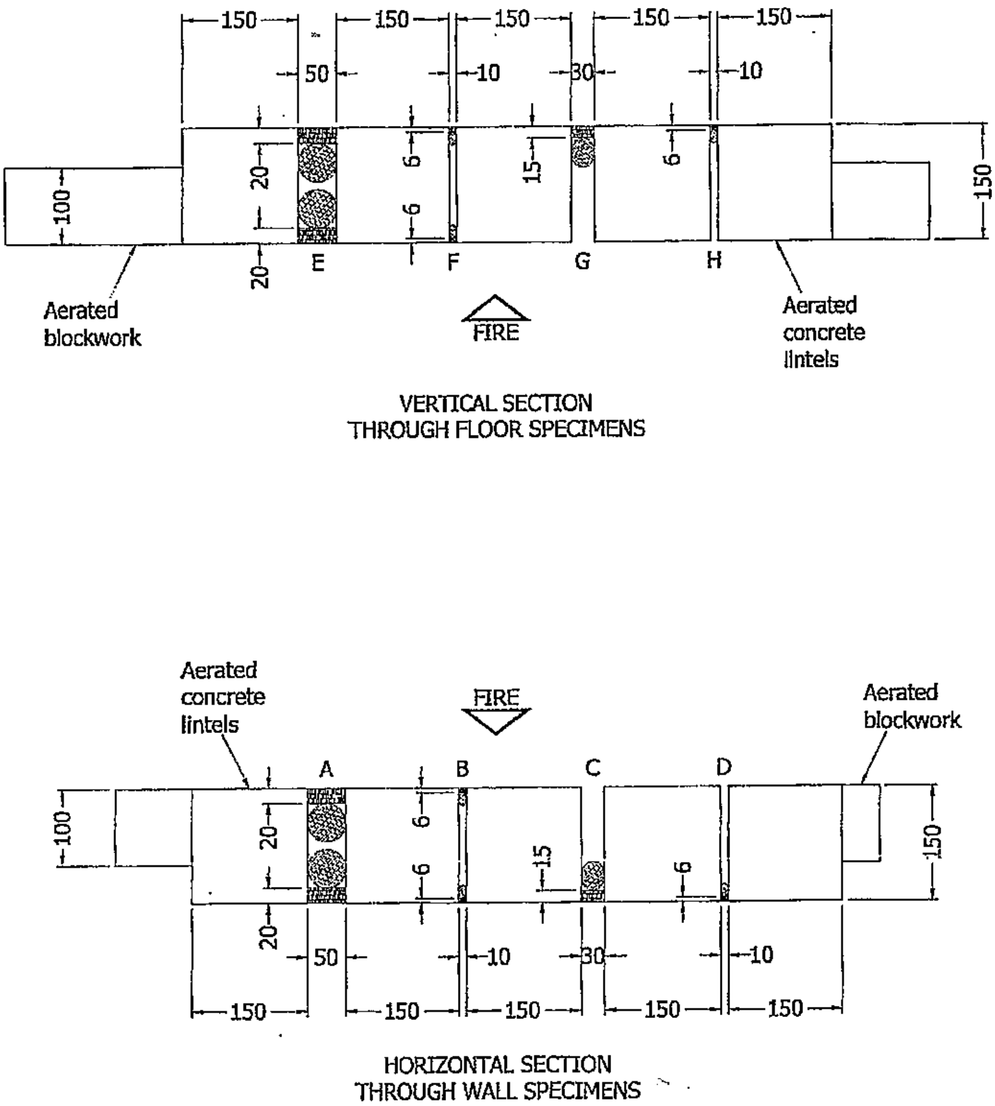
Figure 2 – General Elevation of Wall Specimens



▪ Positions of thermocouples

Do not scale. All dimensions are in mm

Figure 3 – Sections Through Specimens



Do not scale. All dimensions are in mm

Schedule of Components

(Refer to Figures 1 to 3)
(All values are nominal unless stated otherwise)
(All other details are as stated by the sponsor)

Item		Description
Specimen A		
Aperture size	:	900 mm long x 50 mm wide x 150 mm deep
Backing Rod		
i. material	:	Polyethylene, PE open cell foam
ii. overall size	:	50 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	50 mm wide x 20 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula
Specimen B		
Aperture size	:	900 mm long x 10 mm wide x 150 mm deep
Backing Rod		
i. material	:	PE open cell foam
ii. overall size	:	15 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	10 mm wide x 6 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula
Specimen C		
Aperture size	:	900 mm long x 30 mm wide x 150 mm deep
Backing Rod		
i. material	:	PE open cell foam
ii. overall size	:	35 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	30 mm wide x 15 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula

Item		**Description**
Specimen D		
Aperture size	:	900 mm long x 10 mm wide x 150 mm deep
Backing Rod		
i. material	:	PE open cell foam
ii. overall size	:	15 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	10 mm wide x 6 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula
Specimen E		
Aperture size	:	900 mm long x 50 mm wide x 150 mm deep
Backing Rod		
i. material	:	Polyethylene, PE open cell foam
ii. overall size	:	50 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	50 mm wide x 20 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula
Specimen F		
Aperture size	:	900 mm long x 10 mm wide x 150 mm deep
Backing Rod		
i. material	:	PE open cell foam
ii. overall size	:	15 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	10 mm wide x 6 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula

Item		Description
Specimen G		
Aperture size	:	900 mm long x 30 mm wide x 150 mm deep
Backing Rod		
i. material	:	PE open cell foam
ii. overall size	:	35 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	30 mm wide x 15 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula
Specimen H		
Aperture size	:	900 mm long x 10 mm wide x 150 mm deep
Backing Rod		
i. material	:	PE open cell foam
ii. overall size	:	15 mm diameter
iii. fitting method	:	Friction fitted into aperture
Seal		
i. manufacturer	:	Hilti
ii. reference	:	CP 601S
iii. material	:	Silicate based Elastic Firestop Sealant
iv. overall sizes	:	10 mm wide x 6 mm deep
v. application method	:	Cartridge gunned and smoothed with a spatula

Test Observations

Time		All observations are from the unexposed face unless noted otherwise.
mins	**secs**	The ambient air temperature in the vicinity of the test construction was 14°C at the start of the test with a maximum variation of 1°C during the test..
00	**00**	**The test commences.**
10	**00**	Slight smoke release commences from Specimens A and E.
15	**00**	No further significant change.
30	**00**	No further significant change. Integrity and Insulation of all specimens remains intact.
60	**00**	Integrity and Insulation of all specimens remains intact.
90	**00**	Integrity and Insulation of all specimens remains intact.
96	**00**	Thermocouple No. 37 reads a temperature rise in excess of 180°C. **Insulation failure of Specimen C is deemed to occur.**
120	**00**	Integrity of all specimens remains intact.
126	**00**	Thermocouple No. 21 reads a temperature rise in excess of 180°C. **Insulation failure of Specimen G is deemed to occur.**
180	**00**	Integrity of all specimens remains intact.
240	**00**	No further significant change. Integrity of all specimens remains intact.
240	**05**	**The test is discontinued.**

Temperature Data

Mean Furnace Temperature, Together With The Temperature/Time Relationship Specified In The Standard

Time Mins	Specified Furnace Temperature Deg. C	Actual Furnace Temperature Deg. C
0	20	19
10	678	638
20	781	774
30	842	849
40	885	891
50	918	915
60	945	942
70	968	966
80	988	990
90	1006	1000
100	1022	1009
110	1036	1034
120	1049	1044
130	1061	1061
140	1072	1075
150	1082	1083
160	1092	1093
170	1101	1099
180	1110	1103
190	1118	1109
200	1126	1115
210	1133	1123
220	1140	1135
230	1146	1140
240	1153	1142

Individual Temperatures Recorded On The Unexposed Surface Of Specimen A And Adjacent To Specimen A

Time Mins	T/C Number 26 Deg.C.	T/C Number 27 Deg.C.	T/C Number 28 Deg.C.	T/C Number 29 Deg.C.
0	12	14	15	14
10	14	15	15	15
20	12	13	14	14
30	11	13	13	17
40	11	13	13	20
50	11	13	13	24
60	12	14	15	27
70	11	13	15	30
80	13	15	17	34
90	14	15	20	37
100	16	17	23	40
110	17	19	27	45
120	19	21	34	50
130	23	25	41	56
140	27	29	48	60
150	32	34	54	64
160	36	39	59	68
170	41	44	63	70
180	45	48	67	71
190	49	52	70	72
200	52	56	72	72
210	55	59	75	72
220	57	61	77	72
230	58	63	78	72
240	59	64	79	72

Individual Temperatures Recorded On The Unexposed Surface Of Specimen B And Adjacent To Specimen B

Time Mins	T/C Number 30 Deg.C.	T/C Number 31 Deg.C..	T/C Number 32 Deg.C.	T/C Number 34 Deg.C.
0	14	14	15	13
10	15	13	*	12
20	14	15		*
30	13	20		
40	13	26		50
50	15	31		59
60	19	35		65
70	21	38		67
80	26	43		71
90	29	46		73
100	32	51		75
110	37	57		77
120	41	63		78
130	46	68		80
140	48	71		81
150	52	75		83
160	56	77		84
170	58	77		85
180	60	77		87
190	61	77		88
200	62	77		89
210	63	77		91
220	64	77		93
230	65	77		97
240	65	77		101

* Thermocouple Malfunction

Individual Temperatures Recorded On The Unexposed Surface Of Specimen C And Adjacent To Specimen C

Time Mins	T/C Number 35 Deg.C.	T/C Number 36 Deg.C.	T/C Number 37 Deg.C.	T/C Number 38 Deg.C.
0	13	13	14	13
10	13	14	25	20
20	13	19	74	62
30	13	35	109	99
40	15	51	125	118
50	20	63	142	133
60	26	71	159	150
70	31	73	171	165
80	37	77	180	177
90	42	78	189	187
100	48	80	197	195
110	55	82	204	203
120	60	83	210	209
130	64	84	215	215
140	66	85	222	219
150	68	86	229	223
160	68	87	233	227
170	69	88	238	229
180	70	91	240	233
190	71	96	243	235
200	72	102	246	239
210	74	107	251	242
220	76	114	256	245
230	78	116	259	249
240	78	120	259	252

Individual Temperatures Recorded On The Unexposed Surface Of Specimen D And Adjacent To Specimen D

Time Mins	T/C Number 39 Deg.C.	T/C Number 40 Deg.C.	T/C Number 42 Deg.C.	T/C Number 43 Deg.C.
0	14	12	13	13
10	14	13	*	19
20	19	17		30
30	28	21		39
40	33	25		49
50	41	30		59
60	50	36		67
70	57	40		72
80	67	49		78
90	74	59		83
100	78	67		87
110	80	72		89
120	81	74		93
130	82	75		97
140	82	75		101
150	83	75		105
160	84	75		109
170	84	75		113
180	84	75		116
190	84	75		120
200	84	76		125
210	84	76		128
220	84	77		133
230	84	76		138
240	84	77		142

* Thermocouple Malfunction

Individual Temperatures Recorded On The Unexposed Surface Of Specimen E And Adjacent To Specimen E

Time Mins	T/C Number 8 Deg.C.	T/C Number 9 Deg.C.	T/C Number 10 Deg.C.	T/C Number 11 Deg.C.
0	17	17	17	17
10	16	16	16	16
20	15	15	15	15
30	15	14	15	15
40	15	14	15	15
50	15	14	16	15
60	17	15	17	16
70	17	15	18	16
80	19	18	19	19
90	22	20	21	20
100	24	22	25	24
110	28	25	30	28
120	34	29	35	32
130	40	33	40	37
140	44	36	44	42
150	50	41	49	47
160	56	44	55	52
170	60	48	60	59
180	62	52	63	63
190	64	55	66	67
200	66	57	68	69
210	66	59	69	73
220	68	62	70	76
230	68	63	73	79
240	69	64	75	81

Individual Temperatures Recorded On The Unexposed Surface Of Specimen F And Adjacent To Specimen F

Time Mins	T/C Number 12 Deg.C.	T/C Number 14 Deg.C.	T/C Number 15 Deg.C.	T/C Number 16 Deg.C.
0	15	15	16	16
10	15	15	15	16
20	14	14	17	18
30	15	15	23	23
40	17	17	30	29
50	20	19	35	35
60	24	23	42	42
70	27	26	45	49
80	31	31	50	56
90	35	36	55	62
100	39	40	61	66
110	44	44	65	69
120	48	48	67	71
130	51	51	69	73
140	55	54	70	74
150	58	57	72	75
160	60	59	72	75
170	62	61	74	77
180	64	62	75	80
190	65	63	77	82
200	67	64	81	82
210	67	65	81	82
220	68	66	81	82
230	68	66	81	82
240	68	66	81	82

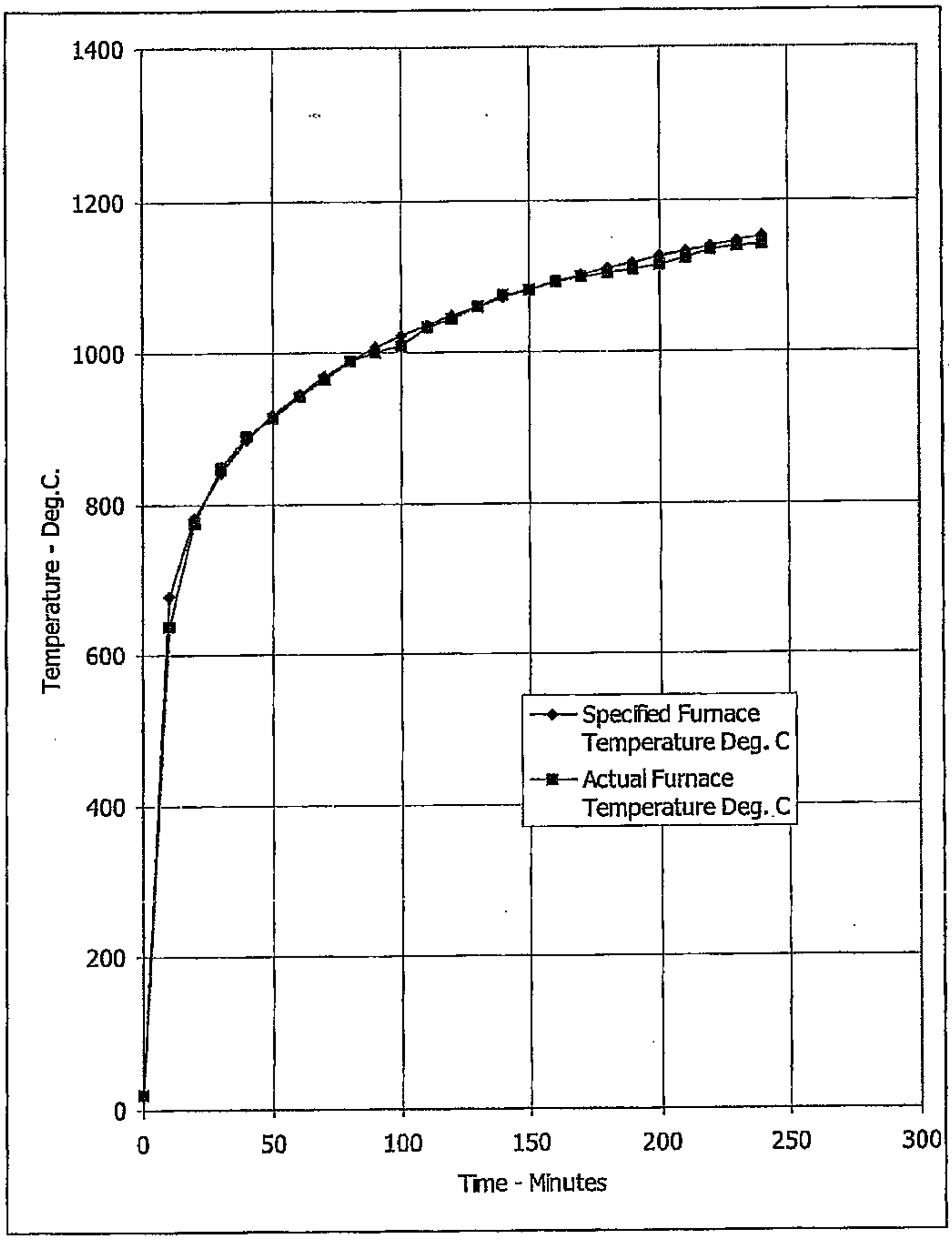
Individual Temperatures Recorded On The Unexposed Surface Of Specimen G And Adjacent To Specimen G

Time Mins	T/C Number 18 Deg.C.	T/C Number 19 Deg.C.	T/C Number 20 Deg.C.	T/C Number 21 Deg.C.
0	17	17	16	16
10	16	17	17	20
20	19	22	39	50
30	28	35	65	81
40	39	47	85	99
50	47	57	98	111
60	53	63	108	122
70	59	67	116	131
80	64	71	123	140
90	68	74	130	151
100	71	77	138	168
110	74	81	149	182
120	76	82	162	193
130	77	84	172	202
140	78	86	179	211
150	79	88	186	220
160	80	90	192	228
170	81	92	199	236
180	82	95	204	243
190	84	98	210	251
200	87	101	214	259
210	91	105	219	266
220	94	110	224	275
230	98	115	228	283
240	101	120	233	289

Individual Temperatures Recorded On The Unexposed Surface Of Specimen H And Adjacent To Specimen H

Time Mins	T/C Number 22 Deg.C.	T/C Number 23 Deg.C.	T/C Number 24 Deg.C.	T/C Number 25 Deg.C.
0	16	16	16	15
10	16	18	21	19
20	17	23	30	28
30	21	31	42	42
40	25	38	53	54
50	28	43	58	60
60	33	47	63	63
70	37	50	66	64
80	43	55	70	66
90	52	60	75	67
100	63	66	82	70
110	69	70	87	70
120	71	72	91	71
130	73	72	93	71
140	74	73	93	72
150	74	74	93	72
160	75	75	93	74
170	75	75	94	74
180	75	75	95	74
190	75	75	97	76
200	75	76	98	77
210	75	76	99	78
220	75	76	100	78
230	75	76	102	79
240	75	76	103	79

Graph Showing Mean Furnace Temperature, Together With The Temperature/Time Relationship Specified In The Standard



Performance Criteria and Test Results

Integrity It is required that there is no collapse of the specimen, no sustained flaming on the unexposed surface and no loss of impermeability. These requirements were satisfied for the periods given in the table below.

Insulation The mean and maximum temperature rise allowable on the unexposed face of the specimen by BS 476: Part 20: 1987 are 140°C and 180°C respectively, however, due to the reduced size of the specimens only the maximum temperature rise criterion was utilised. These requirements were satisfied for the periods given in the table below:

Specimen Ref.	Integrity - Minutes	Insulation - Minutes
A	240	240
B	240	240
C	240	96
D	240	240
E	240	240
F	240	240
G	240	126
H	240	240

Ongoing Implications

Limitations The results relate only to the behaviour of the specimens of the element of construction under the particular conditions of test. They are not intended to be the sole criteria for assessing the potential fire performance of the element in use, nor do they reflect the actual behaviour in fires.

The results may not be applicable to situations where the joint widths, sealant depths, orientations, supporting construction and backing material vary from those tested.

As no movement was induced into the specimens during the test there can be no evaluation of the performance of the seals where movement is induced in a building under actual fire conditions.

Review

This report covers a test which was conducted to a procedure which is not the subject of any British Standard specification, but the test utilised the general principles of fire resistance testing given in BS 476: Part 20: 1987 and prEN 1366-4: 2001. Since fire tests are the subject of a continuing Standardisation process, and because existing standards are the subject of review and possible amendment and new interpretations, it is recommended that the report be referred back to the test laboratory after a period of two years to ensure that the methodology adopted and the results obtained remain valid in the light of the situation prevailing at that time.

Conclusions

Evaluation against objective

A fire resistance test which utilised the general principles of BS 476: Part 20: 1987, in conjunction with additional guidelines adopted from prEN 1366-4: 2001, has been conducted to assess the ability of eight different floor and wall mounted specimens of linear joint sealing system to reinstate the integrity and insulation performance (as defined in BS 476: Part 20: 1987) of simulated floor and wall constructions where adjacent structures abut.

If the performance of each specimen was assessed against the performance requirements for integrity and insulation (maximum temperature rise) specified in BS 476: Part 20: 1987, the results obtained could be expressed as follows:

Test Specimens:

Wall Mounted Specimen

Specimen Reference	Item Description
A	50 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 20 mm. Incorporating two 50 mm diameter backing rods.
B	10 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 6 mm. Incorporating two 15 mm diameter backing rods.
C	30 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 15 mm. Incorporating one 35 mm diameter backing rod.
D	10 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 6 mm. Incorporating one 15 mm diameter backing rod.

Floor Mounted Specimens

Specimen Reference	Item Description
E	50 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 20 mm. Incorporating two 50 mm diameter backing rods.
F	10 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 6 mm. Incorporating two 15 mm diameter backing rods.
G	30 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 15 mm. Incorporating one 35 mm diameter backing rod.
H	10 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 6 mm. Incorporating one 15 mm diameter backing rod.

Test Results:

Specimen Ref.	Integrity - Minutes	Insulation - Minutes
A	240	240
B	240	240
C	240	96
D	240	240
E	240	240
F	240	240
G	240	126
H	240	240

warrington
certification

a Bodycote Engineering & Technology Company
www.bodycote.com
www.warringtonfire.net

5th March 2009

Mr M. Drexl
Hilti Entwicklung Befestigungstechnik GmbH
Postfach, 86915
Kaufering
Germany

Review of Fire Test Report Referenced WFRC No. 143653

1 Introduction

The report referenced WFRC No. 143653 relates to a fire resistance test performed using the general principles of BS 476: Part 20: 1987 and additional guidelines from prEN 1366-4, on wall and floor mounted linear gap sealing systems. For the purpose of the test the specimens were referenced A to H.

The section of wall had overall dimensions of 1000 mm high by 1000 mm wide by 150 mm thick and was provided with four linear joints, referenced Specimens A, B, C, and D.

The section of floor had overall dimensions of 1200 mm long by 1200 mm wide by 150 mm thick and was provided with four linear joints, referenced Specimens E, F, G, and H.

If the performance of the specimens were assessed against the integrity and insulation (maximum temperature rise only) performance criteria of BS 476: Part 20: 1987. The results obtained could be expressed as follows:

Specimen Reference	Item Description of Wall Mounted Specimens
A	50 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 20 mm, backed with two 50 mm diameter backing rods.
B	10 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 6 mm, backed with two 15 mm diameter backing rods.
C	30 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 15 mm, backed with one 35 mm diameter backing rod.
D	10 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 6 mm, backed with one 15 mm diameter backing rod.

Warrington Certification Limited • Holmesfield Road • Warrington • WA1 2DS • United Kingdom
Tel: +44 (0)1925 646 669 • Fax: +44 (0)1925 646 667 • Email: info@warringtonfire.net

Engineering & Technology is a division of Bodycote Testing Group
Bodycote Testing Limited, Registered Office: Lochend Industrial Estate • Newbridge • Midlothian • United Kingdom • EH28 8PL
Registered No. SC 70429 (Scotland)

Specimen Reference	Item Description of Floor Mounted Specimens
E	50 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 20 mm, backed with two 50 mm diameter backing rods.
F	10 mm gap width, sealed to both the unexposed face and exposed face with 'Hilti CP601S' to a depth of 6 mm backed with two 15 mm diameter backing rods.
G	30 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 15 mm, backed with one 35 mm diameter backing rod.
H	10 mm gap width, sealed to the unexposed face with 'Hilti CP601S' to a depth of 6 mm, backed with one 15 mm diameter backing rod.

The results of the test were as follows:

Specimen Ref.	Integrity - Minutes	Insulation - Minutes
A	240	240
B	240	240
C	240	96
D	240	240
E	240	240
F	240	240
G	240	126
H	240	240

2 Confirmation of Specification

It has been confirmed by Hilti Entwicklung Befestigungstechnik GmbH that there have been no changes to the specification or the construction given in the original report referenced WFRC No. 143653.

3 Considerations

Until the issue of BS EN 1366-4 there was no published British Standard relating to the fire resistance testing of penetration sealing systems. As the fire resistance of the floor or wall construction into which the seal would be installed is determined by test procedures detailed within BS 476: Part 20: 1987, 'Method for determination of the fire resistance of elements of construction (general principles)', it was considered appropriate to use those as the basis for a test for evaluating the penetration sealing systems themselves.

This test methodology with respect to the fire resistance testing of linear gap sealing systems, i.e. utilising the heating conditions and performance criteria for integrity and insulation given in BS 476: Part 20: 1987, has not been amended and would, therefore, still be utilised for this purpose. In addition the guidelines adopted from prEN 1366-4 remain unchanged.

At present there are no existing Resolutions adopted by the Fire Test Study Group since the original test was performed, which would affect the manner in which the test would be conducted, or the interpretation of the test results.

4 Conclusions

The procedures adopted for the original test have been re-examined and are similar to those currently in use.

Therefore, with respect to the fire resistance test report referenced WFRC No. 143653, its contents should remain valid until 1st April 2011.

5 Validity

This review is based on information used to formulate the original test report. No other information or data has been submitted by Hilti Entwicklung Befestigungstechnik GmbH, which could affect this review.

Performed by:

C. Johnson
Senior Certification Engineer
Bodycote warringtonfire

Reviewed By:

D. Hankinson
Senior Certification Engineer
Bodycote warringtonfire

Buildings Department

屋宇署

Our Ref. 本署檔號：(24) BD GR/BM/2(185)
Your Ref. 來函檔號：
Tel. No. 電 話：848 2838
Fax No. 圖文傳真：840 0451

26 May 1994

Hilti (Hong Kong) Ltd.
Unit 3 5/F Harbour Centre Tower 2
8 Hok Cheung Street Hung Hom
Kowloon

Dear Sirs,

Fire Resisting Penetration Sealing System
As Supplied By Hilti (GB) Ltd.

Thank you for your letters dated 4.3.94 and 27.4.94 and the accompanying test/assessment reports on the above. You are asking for comments on the acceptability of the fire resisting product in the context of relevant provisions of the Buildings Ordinance, Chapter 123 of the Law of Hong Kong and its subsidiary legislation.

Under the Buildings Ordinance, "authorized persons" (i.e. architects, engineers or surveyors registered with the Building Authority) are required to supervise building works including the selection and installation of fire resisting products and to certify compliance with the Buildings Ordinance upon completion of works. Authorized persons are therefore responsible for ensuring the safety requirements inter alia of fire resisting products in the building projects which they have been appointed by the developer to coordinate and supervise.

In establishing the acceptability of fire resisting products, reference may be made to the performance standards laid down in Building (Construction) Regulation 90, the current Code of Practice for Fire Resisting Construction issued by the Building Authority and British Standard 476: Parts 20 to 24. Reliance may also be placed on the test/assessment report prepared by a recognized laboratory or an equivalent establishment.

The Buildings Department has a list of recognized laboratories. This is available for reference at our office :

Technical Administration (Building) Unit
Buildings Department
11/F Murray Building
Garden Road Hong Kong

Before fire resisting products are installed in a building project, the authorized person appointed for the project should be approached for advice and guidance.

Your test/assessment reports are returned herewith. In this respect, please note that paragraph 3 of my letter dated 25 January 1994 is no longer applicable. The delay in replying is regretted.

Yours faithfully,

(Patrick H. Tsui)
Technical Secretary/Building
for Director of Buildings

PT/FC/av

消 防 處
防 火 組
香港九龍尖沙咀東部康莊道1號
消防總部大廈

FIRE SERVICES DEPARTMENT,
FIRE PROTECTION BUREAU,
FIRE SERVICES HEADQUARTERS BUILDING,
No. 1 Hong Chong Road,
Tsim Sha Tsui, East, Kowloon,
Hong Kong.

本處檔號 Our Ref.: FPB 207/0005
來函檔號 Your Ref.: L026/92HK
電訊掛號 Telex: 39607 HKFSD HX
圖文傳真 Fax: ~~852-3110066~~ ~~852-3689~~744 (24 小時 Hours)
電話 Tel. No.: 733 7596

29 April 1992

Hilti (Hong Kong) Ltd.,
Unit 3, 5/F, Harbour Centre,
Tower 2,
8 Hok Cheung Street,
Hunghom, Kowloon.

Dear Sirs,

"HILTI" Fire Prevention System

I refer to your letter of 30.3.92 and the enclosures attached thereto.

Based on the information contained in your letter under reference and the given test report, I understand that the captioned product is a building material which should be approved by the Director of Buildings and Lands. As such, I am not in a position to process your application and you are advised to refer your enquiry to the Director of Buildings and Lands, whose address is listed hereunder :-

The Director of Buildings and Lands,
(Attn.: Technical Secretary/Building, B.O.O.)
Murray Building,
Garden Road,
Central,
Hong Kong.

Please feel free to contact us should you have any other question in this matter.

Yours faithfully,

(TSE Yu-hing)
for Director of Fire Services

TYH/jt

ARCHITECTURAL SERVICES DEPARTMENT 建築署
QUEENSWAY GOVERNMENT OFFICES, 66 QUEENSWAY, HONG KONG. 香港金鐘道六十六號金鐘道政府合署
FAX 852-2869 0289

Our Ref	:	ASD 16/92101/AML/APP	06 June 1997
Your Ref.	:	--------	
Tel. No.	:	2867 3631	
Fax No.	:	2877 0594	

Hilti (HK) Ltd
17/F, Tower 6, China HK City,
33 Canton Rd,. TST

Dear Sirs,

Architectural Services Department
List of Acceptable Materials
Hilti Firestop Products
Ref. no. 0001P

I am pleased to inform you that approval has been given to include the above product/material in this Department's List of Acceptable Materials. Initially, this listing is for a probationary status and this will be reviewed after the submission of satisfactory performance reports on completion of projects undertaken by this Department where your product has been used.

The Architectural Services Department List of Acceptable Materials is a restricted internal document. This letter should not be used for commercial or marketing purposes and failure to comply with this may result in the removal of the product from the List.

Yours faithfully,

WM Tang

(W.M. TANG)
Technical Secretary/2
for Chief Architect/ Central Management Branch
Architectural Services Department

Filecode : 95202 - LIST_LE.DOC
WMT/WHY/by

Attn. **: To whom it may concern**

Date : 2 June 2006
Ref. : LE/TC/236/06

Subject **: Hilti CP601S Elastic Firestop Sealant**

Dear Sirs / Madams,

Enclosed please find the information of Hilti CP601S Elastic Firestop Sealant.

Brand Name	: Hilti
Model Name	: Hilti CP601S Elastic Firestop Sealant
Manufacturer	: Hilti Corporation
Address of Manufacturer	: FL-9494, Principality of Liechtenstein.
Supplier	: Hilti (Hong Kong) Ltd
Address of Supplier	: 17/F, Tower 6, China Hong Kong City, 33 Canton Road, Tsim Sha Tsui, Kowloon, Hong Kong.
Country of Origin	: Germany

Should you have further questions, please do not hesitate to contact our Technical Representatives or Customer Service Hotline at 8228-8118.

Yours sincerely,
Hilti (Hong Kong) Ltd.

Thomas Choy
Marketing Manager

Hilti (Hong Kong) Limited
17/F I Tower 6 I China Hong Kong City
33 Canton Road I Tsim Sha Tsui
Kowloon I Hong Kong
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www.hk.hilti.com

Material Safety Data Sheet
According to 91/155 EEC

Printing date 02.12.2005 Reviewed on 02.12.2005

1 Identification of substance:

· **Product details:**

· **Trade name:** CP 601S

· **Application of the substance / the preparation** Silicone sealing

· **Manufacturer/Supplier:**
Hilti AG
Feldkircherstr. 100
Postfach 333
FL-9494 Schaan Liechtenstein
Tel: +423 234 2111
Fax: +423 234 2965

· **Informing department:** see section 16
· **Emergency information:**
Tel.: 00423 / 234 - 2111
Fax.: 00423 / 234 - 2965
Schweizerisches Toxikologisches Informationszentrum - 24 h Service
Tel.: 0041 / 1 251 51 51 (international)

2 Composition/Data on components:

· **Chemical characterization**
· **Description:** Mixture consisting of the following components.

· **Dangerous components:**			
CAS: 1185-55-3 EINECS: 214-685-0	trimethoxy(methyl)silane	Xi, F; R 11-36/38	2-5%

· **Additional information** For the wording of the listed risk phrases refer to section 16.

3 Hazards identification

· **Hazard designation:** void
· **Information pertaining to particular dangers for man and environment** void
· **Classification system**
The classification is in line with current EC lists. It has been expanded, however, by information from technical literature, by information furnished by suppliers and by national regulations which have to be observed in chapter 15.

4 First aid measures

· **General information** No special measures required.
· **After inhalation** Take affected persons into the open air and position comfortably
· **After skin contact** Instantly wash with water and soap and rinse thoroughly.
· **After eye contact** Rinse opened eye for several minutes under running water. Then consult doctor.
· **After swallowing** Seek immediate medical advice.

5 Fire fighting measures

· **Suitable extinguishing agents** CO2, extinguishing powder or water jet. Fight larger fires with water jet or alcohol-resistant foam.
· **For safety reasons unsuitable extinguishing agents** Water with a full water jet.
· **Special hazards caused by the material, its products of combustion or resulting gases:**
Can be released in case of fire
Carbon monoxide (CO)
Carbon dioxide (CO2)
· **Protective equipment:** Do not inhale explosion gases or combustion gases.

6 Accidental release measures

· **Person-related safety precautions:**
Ensure adequate ventilation
Wear protective clothing.
Particular danger of slipping on leaked/spilled product.
· **Measures for environmental protection:** Do not allow product to reach sewage system or water bodies.
· **Measures for cleaning/collecting:**
Collect mechanically.
Dispose of contaminated material as waste according to item 13.

7 Handling and storage

· **Handling**
· **Information for safe handling:** No special measures required.
· **Information about protection against explosions and fires:** No special measures required.

(Contd. on page 2)

Material Safety Data Sheet
According to 91/155 EEC

Printing date 02.12.2005 Reviewed on 02.12.2005

Trade name: CP 601S

(Contd. of page 1)

· **Storage**
· **Requirements to be met by storerooms and containers:** Keep containers securely closed and dry, store at 5 - 25°C.
· **Information about storage in one common storage facility:** Not required.
· **Further information about storage conditions:** None.

8 Exposure controls and personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

· **Components with limit values that require monitoring at the workplace:**
The product does not contain any relevant quantities of materials with critical values that have to be monitored at the workplace.
· **Additional information:** The lists that were valid during the compilation were used as basis.

· **Personal protective equipment**
· **General protective and hygienic measures** The usual precautionary measures should be adhered to general rules for handling chemicals.
· **Breathing equipment:** Not necessary if room is well-ventilated.
· **Protection of hands:** Protective gloves.
· **Material of gloves** Synthetic gloves
· **Penetration time of glove material**
The exact break trough time has to be found out by the manufacturer of the protective gloves and has to be observed.
· **Eye protection:** Safety glasses
· **Body protection:** Protective work clothing.

9 Physical and chemical properties:

· **General Information**	
Form:	Pasty
Colour:	According to product specification
Odour:	Characteristic
· **Change in condition**	
Melting point/Melting range:	Not determined
Boiling point/Boiling range:	Not determined
· **Flash point:**	> 100°C (DIN 53213)
· **Self-inflammability:**	Product is not selfigniting.
· **Danger of explosion:**	Product is not explosive.
· **Vapour pressure at 20°C:**	23 mbar
· **Density at 20°C**	1,3 g/cm3 (DIN 51757)
· **Solubility in / Miscibility with**	
Water:	Unsoluble
· **Solvent content:**	
Organic solvents:	0,0 %

10 Stability and reactivity

· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
· **Dangerous reactions** Reacts with water
· **Dangerous products of decomposition:**
Formaldehyde
Methanol

11 Toxicological information

· **Acute toxicity:**
· **Primary irritant effect:**
· **on the skin:** No irritant effect.
· **on the eye:** No irritant effect.
· **Sensitization:** No sensitizing effect known.
· **Additional toxicological information:**
When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us.

12 Ecological information:

· **General notes:**
Do not allow undiluted product or large quantities of it to reach ground water, water bodies or sewage system.

(Contd. on page 3)

Material Safety Data Sheet
According to 91/155 EEC

Printing date 02.12.2005 Reviewed on 02.12.2005

Trade name: CP 601S

(Contd. of page 2)

Water hazard class 1 (German Regulation) (Self-assessment): slightly hazardous for water.

13 Disposal considerations

- **Product:**
- **Recommendation** For disposal, local regulations issued by the authorities must be observed.

· **European waste catalogue**	
08 00 00	WASTES FROM THE MANUFACTURE, FORMULATION, SUPPLY AND USE (MFSU) OF COATINGS (PAINTS, VARNISHES AND VITREOUS ENAMELS), ADHESIVES, SEALANTS AND PRINTING INKS
08 04 00	wastes from MFSU of adhesives and sealants (including waterproofing products)
08 04 10	waste adhesives and sealants other than those mentioned in 08 04 09

- **Uncleaned packagings:**
- **Recommendation:** Disposal must be made according to official regulations.

14 Transport information

- **Land transport ADR/RID (cross-border)**
- **ADR/RID-GGVS/E Class:** -

- **Maritime transport IMDG:**
- **IMDG Class:** -

- **Air transport ICAO-TI and IATA-DGR:**
- **ICAO/IATA Class:** -

- **Transport/Additional information:** Not dangerous according to the above specifications.

15 Regulatory information

- **Designation according to EC guidelines:**
The product is not subject to classification according to the calculation methods of the "General Classification Guideline for Preparations of the EC" as issued in the last version.
Observe the normal safety regulations when handling chemicals.

- **Safety phrases:**
2 Keep out of the reach of children.
25 Avoid contact with eyes.
36 Wear suitable protective clothing.

- **Special designation of certain preparations:**
Safety data sheet available for professional user on request.

- **National regulations**

- **Water hazard class:** Water hazard class 1 (Self-assessment): slightly hazardous for water.

16 Other information:

These data are based on our present knowledge. However, they shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

- **Relevent R-phrases**
11 Highly flammable.
36/38 Irritating to eyes and skin.

- **Department issuing data specification sheet:**

Hilti Corp.
BU Chemicals
Quality/Safety/Environment

FL-9494 Schaan
Tel: 00423 234 2046
Fax: 00423 234 6046
· **Contact:** Christoph Aubauer

Job/Application Reference

14-Mar-08

Ref No	Date	Project	Contractor	Consulting Engineer	Product	Application
20859	12-07	Skycity Marriott Hotel	POON POR ENGINEERING CO LTD.	OAP / JRP	Firestop sealant CP 601S 310ML grey	Top of wall joint sealing
20890	12-07	City of Dreams Resort, Macau	SHU KEE CONSTRUCTION (MACAU) LTD	Mott Connell / JRP / Meinhardt Façade	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing
18739	11-07	City of Dreams Resort, Macau	SHU KEE CONSTRUCTION (MACAU) LTD	Mott Connell / JRP / Meinhardt Façade	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing
18411	11-07	Four Seasons Hotel, Macau	YUNG KEE ELECTRICAL MECHANICAL &	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
18393	11-07	Four Seasons Hotel, Macau	NAM KWONG PETROLEUM &	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
17287	10-07	Four Seasons Hotel, Macau	WAI BO ELECTRICAL COMPANY	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
17643	10-07	City of Dreams Resort, Macau	SHU KEE CONSTRUCTION (MACAU) LTD	Mott Connell / JRP / Meinhardt Façade	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing
17167	10-07	City of Dreams Resort, Macau	YUNG KEE ELECTRICAL MECHANICAL &	Mott Connell / JRP / Meinhardt Façade	Firestop sealant CP 601S 310ML grey	Metal pipe penetration sealing
17293	10-07	Four Seasons Hotel, Macau	YUNG KEE ELECTRICAL MECHANICAL &	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
16334	09-07	HSBC Data Center	GAMMON CONSTRUCTION LTD	Meinhardt	Firestop sealant CP 601S 310ML white	Movement / construction joint sealing
16519	09-07	City of Dreams Resort, Macau	SHU KEE CONSTRUCTION (MACAU) LTD	Mott Connell / JRP / Meinhardt Façade	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing
15804	08-07	The Venetian Casino Resort, Macau	NGO KEE (MACAU) LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML grey	curtain wall / façade gap sealing
15117	08-07	Four Seasons Hotel, Macau	OCEAN ELECTRICAL ENGINEERING	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
15673	08-07	Four Seasons Hotel, Macau	OCEAN ELECTRICAL ENGINEERING	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	Air duct penetration through fire rated board
15140	08-07	Four Seasons Hotel, Macau	YUNG KEE ELECTRICAL MECHANICAL &	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing

Job/Application Reference

14-Mar-08

Ref No	Date	Project	Contractor	Consulting Engineer	Product	Application
15398	08-07	Skycity Marriott Hotel	POON POR ENGINEERING CO LTD.	OAP / JRP	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing
14788	07-07	Four Seasons Hotel, Macau	NGO KEE (MACAU) LTD	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML white	curtain wall / façade gap sealing
14787	07-07	Four Seasons Hotel, Macau	NGO KEE (MACAU) LTD	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML grey	curtain wall / façade gap sealing
14772	07-07	The Venetian Casino Resort, Macau	NGO KEE (MACAU) LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML grey	curtain wall / façade gap sealing
14139	07-07	Science Park Phase 2	KWONG SHUN CO	Meinhardt / Maunsell	Firestop sealant CP 601S 310ML grey	cable / cable tray penetraton sealing
14129	07-07	E Max	HANG SENG ENG CO LTD	WMKY / PBA	Firestop sealant CP 601S 310ML grey	Air duct penetration through fire rated board
13667	06-07	Skycity Marriott Hotel	POON POR ENGINEERING CO LTD.	OAP / JRP	Firestop sealant CP 601S 310ML grey	Top of wall joint sealing
13130	05-07	Nam Wan Tunnel and West Tsing Yi Viaduct (HY/2001/16)	GAMMON CONSTRUCTION LTD	Ove Arup & Partners	Firestop sealant CP 601S 310ML white	Top of wall joint sealing
12975	05-07	Union Square Phase 6	DURACLAD ENGINEERING LTD	OAP / JRP	Firestop sealant CP 601S 310ML white	Movement / construction joint sealing
7662	05-07	Ho Tung Lau Development	Hip Hing	OAP / PBA	Firestop sealant CP 601S 310ML	curtain wall / façade gap sealing
11725	04-07	Nam Wan Tunnel and West Tsing Yi Viaduct (HY/2001/16)	GAMMON CONSTRUCTION LTD	Ove Arup & Partners	Firestop sealant CP 601S 310ML white	Top of wall joint sealing
10401	02-07	The Venetian Casino Resort, Macau	SURE WEALTH (MACAU) ENG LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	glass fencing / balustrade fixing
10352	02-07	Eagle's Nest Tunnel & Associated Works (HY/2003/02)	LEIGHTON KUMAGAI JV	Maunsell Hyder JV	Firestop sealant CP 601S 310ML grey	Top of wall joint sealing
10317	02-07	The Venetian Casino Resort, Macau	SURE WEALTH (MACAU) ENG LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	Blockwork gap sealing
9789	01-07	Improvement to Sheung Shui Station and Associated Works (LCC-204)	SUN FOOK KONG CONST LTD	Meinhardt	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing

Job/Application Reference

14-Mar-08

Ref No	Date	Project	Contractor	Consulting Engineer	Product	Application
8712	12-06	The Venetian Casino Resort, Macau	TOP BUILDERS INTERNATIONAL CO.LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML grey	Top of wall joint sealing
8836	12-06	The Venetian Casino Resort, Macau	CHINA HUASHI ENTREPRISES	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML grey	Metal pipe penetration sealing
8079	11-06	Lok Ma Chau Terminus and Associated Works (LCC-300)	MAN HO METALLLIC ENGINEERING CO LTD	Mott Connell	Firestop sealant CP 601S 310ML grey	Fire rated board sealing
7661	10-06	Tiu Keng Leng Station Residental Development Package 1	Able	Maunsell	Firestop sealant CP 601S 310ML	curtain wall / façade gap sealing
7469	10-06	Lok Ma Chau Terminus and Associated Works (LCC-300)	BALFOUR BEATTY LAM JOINT VENTURE	Mott Connell	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing
7458	09-06	Sheung Shui to Chau Tau Tunnels (LDB-201)	DRAGAGES (HK) JOINT VENTURE	KCRC	Firestop sealant CP 601S 310ML grey	Movement / construction joint sealing
7529	08-06	Landmark Redevelopment	ALPHA BLDG CONSTRUCTION LTD	Maunsell / Meinhardt	Firestop sealant CP 601S 310ML white	Top of wall joint sealing
9127	07-06	The Venetian Casino Resort, Macau	NAM KWONG PETROLEUM &	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
9406	06-06	Las Vegas Sands Casino Extension, Macau	CIA. DE CONST. CIVIL BSC, LDA	OAP / PBA / Arup Façade	Firestop sealant CP 601S 310ML grey	Top of wall joint sealing
7470	05-06	The Venetian Casino Resort, Macau	SHINRYO (HK) LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	Movement / construction joint sealing
7475	05-06	Pok Oi Hospital Yuen Long	INTELLIGENT HEALTHCARE SYSTEM LTD	Moth Connell / PBA	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
9276	04-06	The Venetian Casino Resort, Macau	UNI-STRENGTH ENGINEERING LIMITED	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	Fire rated board sealing
9176	04-06	The Venetian Casino Resort, Macau	PERFECT CITY ENGINEERING LIMITED	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
7663	04-06	Tsuen Wan Town Center Redevelopment	China State Construction Co Ltd	C M Wong / Wong & Ouyang	Firestop sealant CP 601S 310ML	curtain wall / façade gap sealing
9539	03-06	The Venetian Casino Resort, Macau	LONG YUAN CONS GROUP (MACAU) CO LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML grey	Top of wall joint sealing

Job/Application Reference

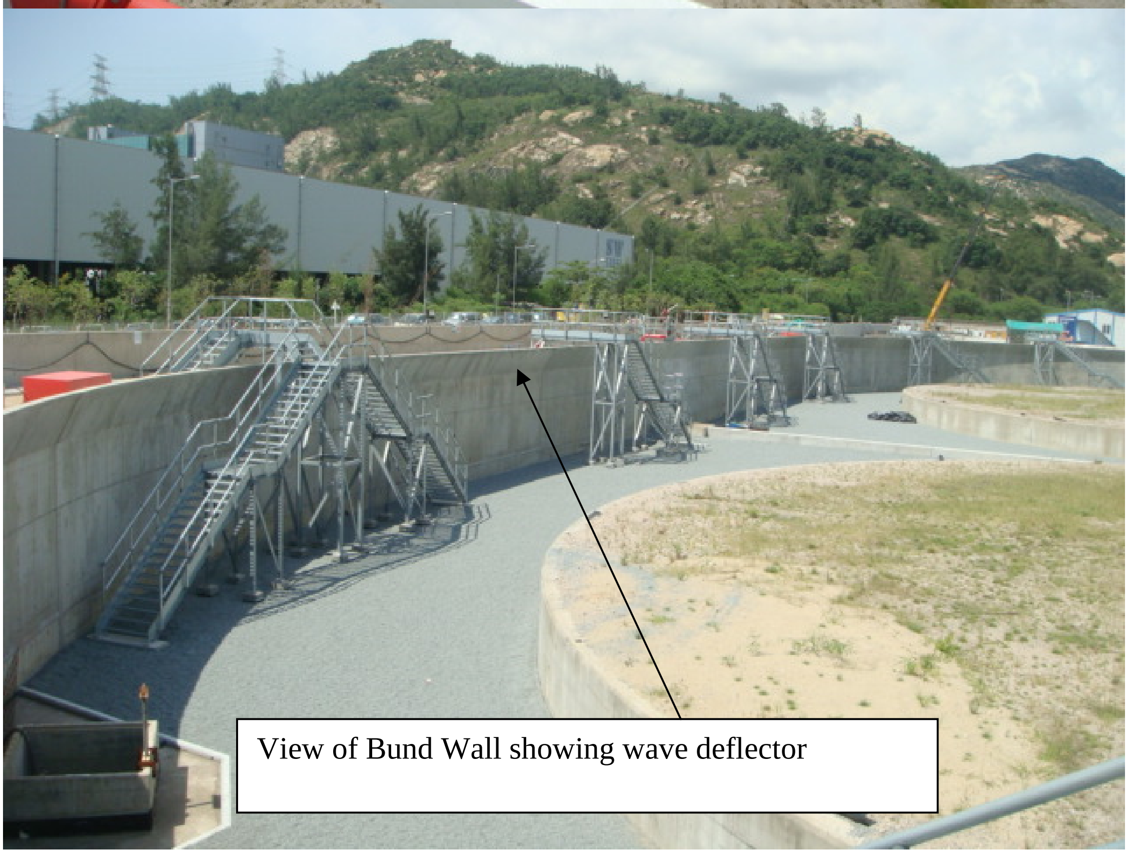
14-Mar-08

Ref No	Date	Project	Contractor	Consulting Engineer	Product	Application
7803	03-06	Lok Ma Chau Terminus and Associated Works (LCC-300)	CHEUNG WAH BLDG MATERIAL LTD	Mott Connell	Firestop sealant CP 601S 310ML white	Fire rated board sealing
7750	02-06	Pok Oi Hospital Yuen Long	HSIN CHONG CONST CO LTD	Moth Connell / PBA	Firestop sealant CP 601S 310ML white	Top of wall joint sealing
7660	02-06	Wo Yi Hop Road Services Appartment	Paul Y	Maunsell / Meinhardt	Firestop sealant CP 601S 310ML	curtain wall / façade gap sealing
8950	02-06	The Venetian Casino Resort, Macau	GTECH ENGINEERING (MACAU) LTD	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing
8837	01-06	The Venetian Casino Resort, Macau	CHINA HUASHI ENTREPRISES	OAP / PBA / Hyder / Arup Façade	Firestop sealant CP 601S 310ML white	Metal pipe penetration sealing

Photographs

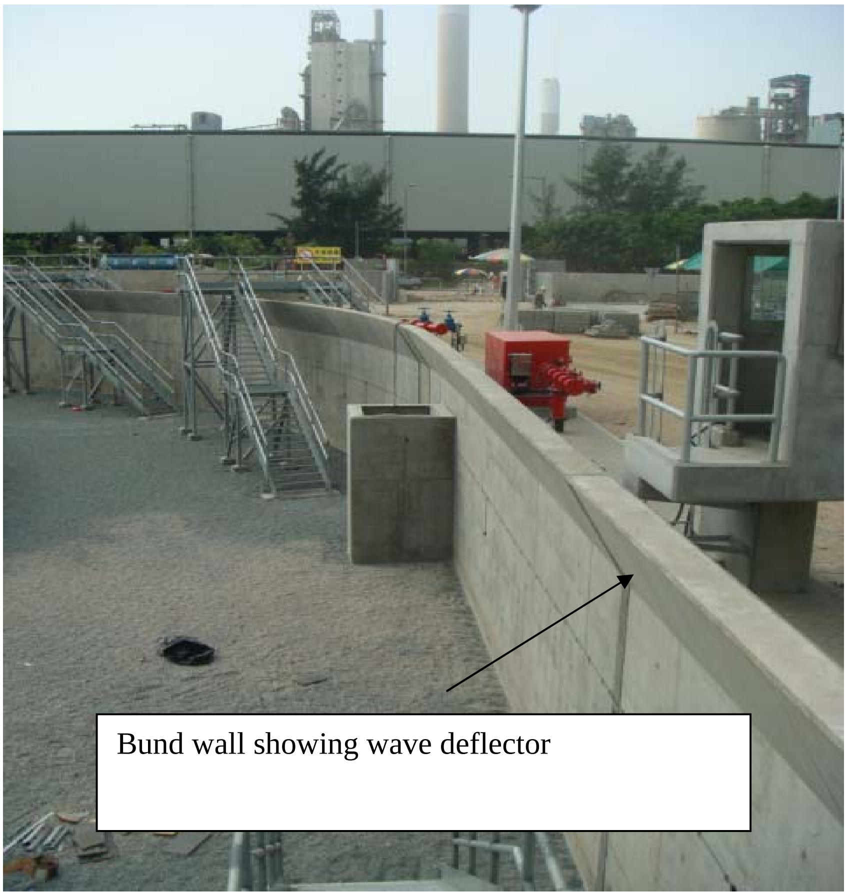
Bund Wall

View of bund wall showing difference in height between the ground level inside and outside the bund wall.



View of Bund Wall showing wave deflector

Security Wall wave deflector



Bund wall showing wave deflector

Finished movement joint in bund wall with stainless steel cover

View of intermediate bund

View of intermediate bunds between tanks 2, 4, 5 and 6

香港機場管理局 | AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (a) (i)
Date of Report:	24 November 2009
Date prepared by ET:	24 November 2009
Date received by IEC:	24 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (a) (i)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(a) Containment Systems of Aviation Fuel Storage Tank
Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular :

(i) All aviation fuel storage tanks shall be located in bunded compounds with capacity of more than 110% of the contents of the largest aviation fuel storage tank in the bunded compounds;

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 24 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

PP Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE
A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. Submissions or Measures during the Construction of Certain Parts of the Project

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

a) Containment Systems of Aviation Fuel Storage Tank Farm

Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular:

i) All aviation fuel storage tanks shall be located in bunded compounds with capacity of more than 110% of the contents of the largest aviation fuel storage tank in the bunded compounds;

Environmental Impact Assessment Report Requirement

3 DESCRIPTION OF PROJECT AND ASSUMPTIONS

3.2 Tank Farm and Onshore Facilities

3.2.1 About 6.75 ha of land is required to accommodate the aviation fuel tank farm and associated facilities. The proposed site for the tank farm at Tuen Mun Area 38 has been reclaimed by Government and is zoned for special industrial use. The site is situated at Siu Lang Shui just southeast of the Castle Peak Power station and is adjoined on the west by the Shiu Wing Steel Mill and on the south-east by the proposed EcoPark and adjacent to that is land earmarked for industrial use in keeping with the other land uses in the area. Further east is the River Trade Terminal. The allocated plot has a short length of sea frontage of 60m in width which extends inland for about 140m before widening out to a square area of about 217m in length by 278m in width, see Figure 3.2c.

3.2.2 No residential developments are present in the area and the closest substantial development, Melody Garden in Tuen Mun, is at least 3 kilometres from the proposed site. The villages at Lung Kwu Tan are closer at about 2km away but are screened from the site by the Castle Peak topography. However, there is a planned Holiday Camp to the North-East of the site along Lung Man Road which is over 500m away.

3.2.3 It should be noted that the previous EIA study (April 2002) was undertaken based upon the project layout detailed in Figure 3.2a and a tank design capacity of 420,000m^3. However, changes were made to the detailed layout and an application for a variation (Application No. VEP-133/2004) to the then valid Environmental Permit EP-139/2002 was made. However, during the development of the detailed design, FSD placed a restriction on the height of the storage tanks above the emergency access. Thus, in order to comply with FSD's requirement on the tank height (requested in April 2003), the height of the tanks were reduced from 32.0m to 24.7m and the volume of the largest tanks reduced from 39,000m^3 to 35,000m^3. As a result, the ultimate capacity of the facility was reduced to 388,000m^3 from 420,000m^3, resulting in variation to the environmental permit (EP-139/2002/A) which was granted by EPD in February 2004. Details of the revised layout approved by the VEP are provided in Figure 3.2b and details of the improvements made to the tank farm layout are detailed in EP Variation Application No. VEP-133/2004 and summarized in Table 3.2 below. Also, as part of the changes made, and as shown in Figure 3.2b, the whole site has been shifted 10m to the southeast from that proposed in the original EIA of April 2002, to accommodate Lands Department's commitment of a land extension to Shiu Wing Steel Mill.

Table 3.2 Summary of Tank Farm Improvements

Item		Previous EIA Report (April 2002)	Current Design	Improvement / Neutral	Change Initiated By
Dimension					
1	Volume (largest tank)	39,000 cu.m.	35,000 cu.m.	Improvement	FSD
2	Tank height (highest) (total)	32.0 m	24.7 m (23m above ground)	Improvement	FSD
3	Distance from tank to bund	10.0 m	10.0 m	Neutral	--
4	Distance from bund to security wall	8.0 m	8.5 m	Improvement	FSD
5	Distance from bund to boundary	16.5 m (minimum)	18.5 m	Improvement	AA
Bunding					
1	Bund with wave wall	None	Included	Improvement	AA
2	Height of bund wall (average)	4.6 m	4.8 m	Improvement	AA
3	Height of inner security wall	2.0 m	2.0 m	Neutral	--
4	Drainage ditch	Included	Included	Neutral	--
5	Earth bund in landscaped area	None	1.5 m high	Improvement	Planning/EP
6	Outer security fence/wall	Open mesh fence	Impervious wall	Improvement	AA

3.2.4 In addition to these changes, the phasing of the tanks has changed with 8 (eight) to be constructed initially as shown in Figure 3.2c. While Figures 3.2b and 3.2c show the current layout for the site and phasing for the construction of the tanks, indicative cross sections between the tanks and the lot boundaries with Shiu Wing Steel and the EcoPark are provided in Figures 3.2d and 3.2e respectively with the location of the cross-sections shown in Figure 3.2c.

3.2.5 The tank farm will initially house 8 storage tanks, 6 tanks of 43.5m diameter by 24.7m in height, one of 41.5m diameter by 24.7m in height and one of 35m diameter by 24.7m in height. The tank heights refer to the total tank height but it should be noted that part of the tank will be positioned in the ground and as such only 23m will protrude above ground level. The tanks provide a storage capacity of between 22,000m^3 to 35,000m^3. It is intended that the tankage capacity would be increased once the initial capacity of 264,000m^3 has been reached around 2025 to 2030. It is intended that the remaining 4 tanks would be built all together between 2025 and 2030 to increase the tankage capacity to the ultimate design tankage capacity of PAFF i.e. 388,000m^3. The heights of 3 of the remaining tanks would be 24.7m, with one tank of 23m and their capacities would vary accordingly between 35,000m^3 and 19,000m^3. When planning for the 4 remaining tanks in the final phase of the development, latest technology, industrial standards and statutory requirements at that time would be used. Also the EIA would be reviewed if appropriate in view of the latest technology, standards and statutory requirements at that time.

3.2.10 The tank farm would be provided with bundwalls and contained drainage. There are 2 main bunds (designed to contain any spills from the tank or tank piping), each containing 6 tanks in future but 4 tanks initially. The height of the bundwalls has also been increased from previous April 2002 EIA in order to improve the retention of any fuel spillage from the tanks within the PAFF boundary. The initial bund containment with 4 tanks in each bund would amount to at least 180% of the volume of the largest tank (well exceeding the required 110%) and ultimately (2040) this would be at least 150% of the volume of the largest tank with 6 tanks in each bund. Each tank is also separated by intermediate bund walls to hold minor spills. There are also 2 emergency shutdown valves on the pipeline inlet to the tank farm from jetty and another 2 on the pipeline outlet of the tank farm to the Airport. These valves are operated via motorized electric actuators. The tank bunds and the pump platform are contained areas and drain to the interceptor via bund drain valves. Other leakage prevention devices include fuel tank high-high level alarm and leak detection system for the pipeline. The storm water drain will also have a remotely operated block valve to contain any oil spill on site.

Mitigation Measures

6.1.1 Operational Phase

6.1.1.2 Other mitigation measures recommended for the operational phase include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- all tanks shall be bunded to a capacity of at least 150% of the largest individual tank in each compound at the ultimate phase of 2040. For the initial development phase, as only 4 tanks will be present in each bund, a containment capacity of about 175% will be achieved. Tank pits shall be protected by an impermeable bed (e.g. geotextile sheeting) to prevent seepage of aviation fuel to ground. A leak detection system shall be installed beneath the containment membrane;
- there shall be no direct outlet from the bund. A collection sump shall be included in the base. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator;

10 HAZARD TO LIFE ASSESSMENT

10.1.2 Overview of PAFF Hazards

10.1.2.8 The PAFF will be built to internationally recognised standards and best practices for fuel storage. Cylindrical steel storage tanks with conical roofs (to API 650) are used throughout the world for storage of liquid hydrocarbon fuels. The same types of tanks are also used to store more volatile fuels such as gasoline, although internal floating roofs are now standard for gasoline to reduce environmental emissions of vapour. Bund walls, will surround the tanks so that, in the case of leaks, any fuel leak is collected and can be cleaned up. The containment capacities of the bunds at the PAFF greatly exceed international standards. The PAFF design also has two additional impervious security walls as well as the more usual single bund wall and fence. This will further reduce the chance of any spill affecting off-site areas.

10.1.4.7 The tank bund design is such that the total capacity of the bund significantly exceeds the usual 110% of the capacity of the largest tank. The bund containment capacities are 166% and 156% of the capacity of the largest tank for the bunds nearest to the sea and furthest from the sea respectively, with all tanks constructed [12]. Initially, with only four of the tanks in each bund constructed, the bund capacities will be 195% and 188% of the capacity of the largest tank [12].

10.1.5.12 The storage tanks will be located within a bund, which is designed to contain any spills from the tank or tank piping. The bund is designed to hold much more than the required 110% of the contents of the largest tank in the bund. The bund will be provided with a drain, which will be discharged by a manually operated valve to the sea through an oil interceptor. Drainage from unbunded areas onsite will be discharged through the storm water drain to the sea. The storm water drain will be provided with a remotely operated block valve to contain any oil spill on site.

16. SUMMARY OF ENVIRONMENTAL OUTCOMES

Design

16.2.8 All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure, and the resultant leaks/spills, to the lowest practicable extent. Fuel storage tanks will be constructed in a bunded area which will have collection capacity greater than the maximum content of the largest tank, to contain any fuel leaks or spills. There shall be no direct outlet from the bund to ensure retention of any spilled material. A collection sump shall be included in the base. Protection against leaks or spills from the bottom of the tanks will be achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. A spill detection system will be fitted underneath this membrane to provide additional security. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

(i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting
(ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings
(iii) Sampling and product recovery system
(iv) Manifolding to tank farm and existing aviation fuel system simultaneously
(v) Fire protection system
(vi) Power supply and independent standby power generator or second supply
(vii) Buildings including offices, canteen, control room, workshop, stores
(viii) Emergency response facilities
(ix) Storage tanks for fuel, water, chemicals and wastes
(x) Utility and other systems including back-up systems
(xi) Cathodic protection
(xii) Lightning protection
(xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities
(xiv) Electronic tank servo gauges
(xv) Hard standing, roads and parking
(xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services;

EPC – Franchisee's Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services; and associated fire protection;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed.

Also, in the detail design additional standards may be referenced for specific items.

5. Storage Tank (including BUND Wall and Foundation)

5.1 GENERAL

The main storage tanks will be circular and made of steel plate with diameters of 6 x 43.5m, 1 x 41.5m, 1 x 35m and a height of 24.7 metres and nominal capacities of 35,000, 32,000, 22,000 cubic metres respectively. The tanks will be founded on a reinforced concrete ring beam. The eight storage tanks will be contained within two reinforced concrete bund walls (4 nos. of fuel tank for each bund wall) with a membrane lining to contain any leakage. All bund walls will include a wave wall to assist in containing Jet A1 within the bunded area.

5.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) API 650 Vertical Storage Tanks
(b) BS EN 12285 Horizontal Storage Tanks
(c) British Standard for Concrete Structures
(d) Code of Practice for Oil Storage Installations 1992 – Building Authority Hong Kong
(e) IP Code of Practice Part 15

5.3 SPECIFIC CRITERIA

5.3.4 Bund Walls

1. The bund walls shall be of reinforced concrete.

2. The capacities of the bunded areas will be 57,691 cubic metres for phase 1a & 2 tank farms and a minimum of 50,695 cubic metres for phase 1b & 2 tank farm, which are not less than 38,500 cubic metres (110% of a 35,000 cubic metres tank) for both areas.

3. The construction of the bund walls joints will provide a continuous barrier to any spill within the bunded area.

4. The bund walls shall be designed to retain the bunded area when full of water or the impact load of an instantaneous release from a simple storage tank which ever is greater.

5. A means of access in and out of the bunded area will be provided adjacent to the stairs fitted to the main storage tanks and as directed by the FSD.

6. The bund wall alignment will allow 25% of the circumstance of each tank to be with in 15 metres of the EVA.

5.3.6 Secondary Containment

The security walls adjacent to the bund wall facing public areas will in addition be constructed of reinforced concrete to contain potential overtopping of the bund wall. Gates in the security walls are to be solid and sealed up to the first hinge on the gate.

Contract Drawings

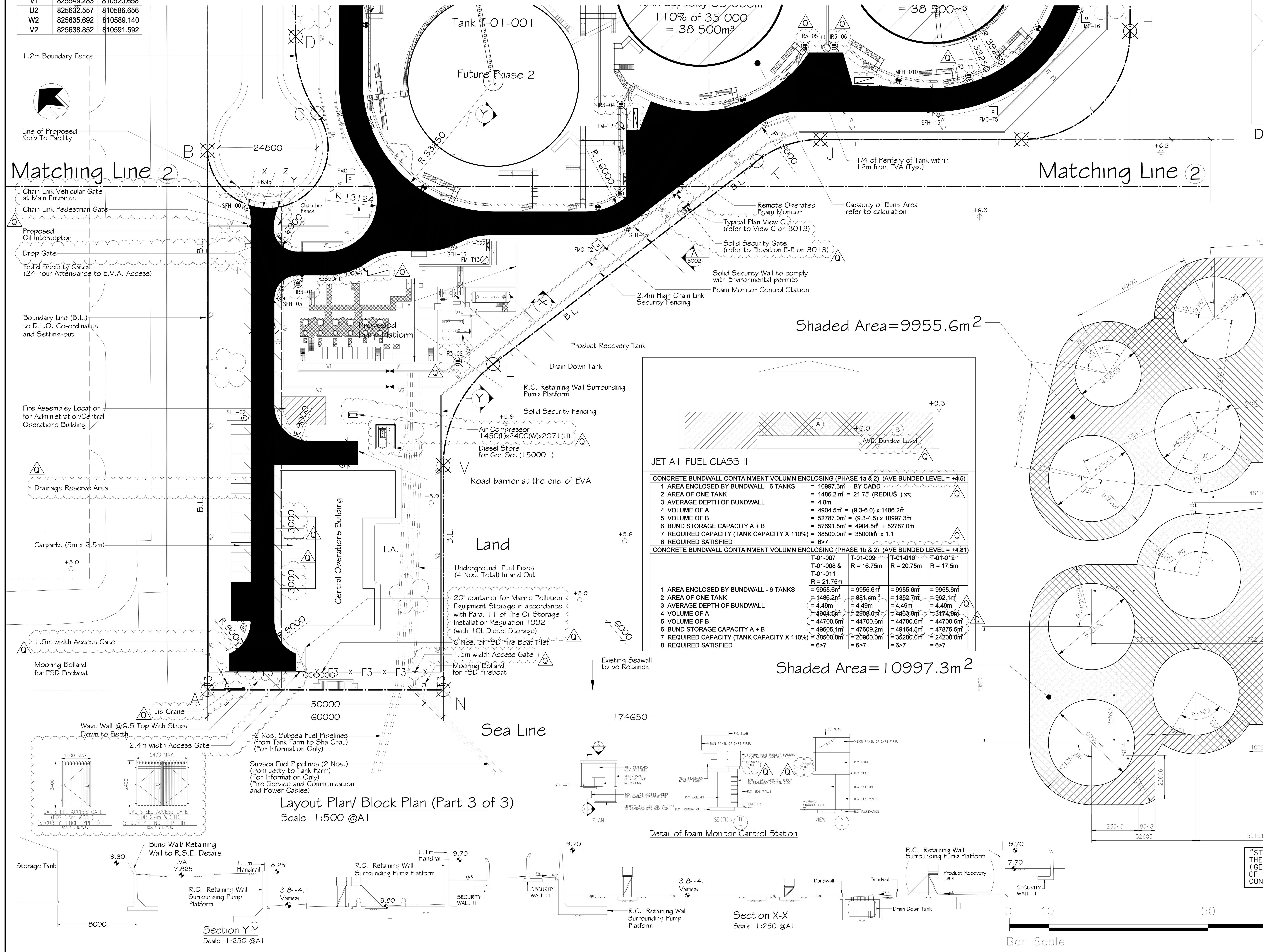
Calculation for Capacity of Bunded Area

- **PAFF/RJ/02/DWG/G/3015(EX) Revision Q Layout Plan / Block Plan**

Oil Buckets

- **PAFF/RJ/02/DWG/G/3014(EX) Revision Q Layout Plan / Block Plan**
- **PAFF/BA/02/DWG/C/1721 Revision Q3 Tank Farm Bund Wall Details (sheet 1 of 4)**

POINT	COORDINATES NORTHING	EASTING
X	825457.738	810432.809
Y	825452.595	810438.404
Z	825454.958	810435.129
U1	825545.651	810517.779
W1	825552.416	810523.140
V1	825549.283	810520.658
U2	825632.557	810586.656
W2	825635.692	810589.140
V2	825638.852	810591.592



JET A1 FUEL CLASS II

CONCRETE BUNDWALL CONTAINMENT VOLUMN ENCLOSING (PHASE 1a & 2) (AVE BUNDED LEVEL = +4.5)	
1 AREA ENCLOSED BY BUNDWALL - 6 TANKS	= 10997.3m² - BY CADD
2 AREA OF ONE TANK	= 1486.2 m² = 21.75² (REDIUS²) x π
3 AVERAGE DEPTH OF BUNDWALL	= 4.8m
4 VOLUME OF A	= 4904.5m³ = (9.3-6.0) x 1486.2m²
5 VOLUME OF B	= 52787.0m³ = (9.3-4.5) x 10997.3m²
6 BUND STORAGE CAPACITY A + B	= 57691.5m³ = 4904.5m³ + 52787.0m³
7 REQUIRED CAPACITY (TANK CAPACITY X 110%)	= 38500.0m³ = 35000m³ x 1.1
8 REQUIRED SATISFIED	= 6>7

CONCRETE BUNDWALL CONTAINMENT VOLUMN ENCLOSING (PHASE 1b & 2) (AVE BUNDED LEVEL = +4.81)	T-01-007 T-01-008 & T-01-011 R = 21.75m	T-01-009 R = 16.75m	T-01-010 R = 20.75m	T-01-012 R = 17.5m
1 AREA ENCLOSED BY BUNDWALL - 6 TANKS	= 9955.6m²	= 9955.6m²	= 9955.6m²	= 9955.6m²
2 AREA OF ONE TANK	= 1486.2m²	= 881.4m²	= 1352.7m²	= 962.1m²
3 AVERAGE DEPTH OF BUNDWALL	= 4.49m	= 4.49m	= 4.49m	= 4.49m
4 VOLUME OF A	= 4904.5m³	= 2908.6m³	= 4463.9m³	= 3174.9m³
5 VOLUME OF B	= 44700.6m³	= 44700.6m³	= 44700.6m³	= 44700.6m³
6 BUND STORAGE CAPACITY A + B	= 49605.1m³	= 47609.2m³	= 49164.5m³	= 47875.5m³
7 REQUIRED CAPACITY (TANK CAPACITY X 110%)	= 38500.0m³	= 20900.0m³	= 35200.0m³	= 24200.0m³
8 REQUIRED SATISFIED	= 6>7	= 6>7	= 6>7	= 6>7

"STATEMENT II : THE WORKS SHOWN ON THESE PLANS ARE TYPE II WORKS (GENERAL BUILDING PLAN) IN RESPECT OF WHICH THE BUILDING AUTHORITY'S CONSENT IS APPLIED FOR."

B.D. REF.: BD 2/0001/02
F.S.D. REF.: FP 8/27622

Drawing Indication Plan
Scale N.T.S.

Legend and Abbreviations

Earth (unexcavated)
Hardcore or dry fill
Concrete (plain or reinforced)
Solid Concrete Blocks (100mm thick)
Plaster or Cement Rendering
Mosaic or other non- absorbant floor tiles
Mosaic or other non- absorbant wall tiles
Glass
Timber doors
Sanitary fittings
Disability Provision
Lightweight Concrete (Lightweight Concrete fill on Floor Slab)

General Abbreviations

B.F.	Balanced Flue Opening	G.L.	Ground level
B.L.	Boundary line	H.R.	Hose Reel
C.I.	Cast Iron	H.W.	Hardwood
C/W	Completed with	S.C.	Self-closing
CU	Copper	S.L.	Street light
E.V.A.	Emergency Vehicular Access	TYP.	Typical
Ex.	Existing	W/	With
/F.	Floor level	W.G.	Wired glass
F.E.	Fire Extinguisher	UPVC	Unplasticised Polyvinyl Chloride
F.F.L.	Finished floor level		
F.H.	Fire Hydrant		
G.I.	Galvanised Iron		

Notes: Security gates are capable of being readily opened from inside without the use of key(s).

Legend

Phase 1a and 1b Stage of Tank Works (Tank T-01-002, T-01-004 to T-01-006, T-01-008 and T-01-10 to T-01-012) Subject of this G.B.P. Submission
Phase 2 Stage of Construction (Tank T-01-001, T-01-003, T-01-007 and T-01-009 Inclusive)
Site Boundary (without Boundary Fence)
Site Boundary (with 1.2m Boundary Fence)
Chain Link Fence
Proposed 2.4m High Chain Line Security Fencing
Subsea Pipelines
Solid Security Wall to comply with Environmental permits (Type 1)
W2 - Security Wall 2, 2.4m (H) (Type 2)
Bund Wall
Fire Hydrant Ring
Drainage Reserve
Fire Hydrant/ Hose Reel Cabinet along Hydrant Ring
EVA Emergency Vehicle Access Sign
Typical Arrangement for in-line Balanced Pressure Proportioner with Group of High Back Pressure Foam Maker
Pedestrian Gate — Pedestrian Access
FH/HR Cabinet Contains 4x65 Dia. Fire Hydrant Outlets, Hose Reel, Breakglass unit, Alarm Bell, Hand Held foam Branch, Canvas Hose & Foam Storage Cylinder
Pillar Box — Flame Detector
Solid Pedestrian Gate
MFH 2x100 Dia Fire Hydrant Outlets for Mobile foam Cannon C/W Breakglass unit
Deluge Valve Set
Existing WA's Pedestal Hydrant
SFH Street Fire Hydrant
PH Proposed New Pedestal Hydrant from Diverted Government Mains
T/X ROOM Transformer room
Existing Level — Exit Exit Sign
Proposed Level — Directional Sign
Disable — H.R. Hose Reel
FMC-T1 Foam Monitor Control Station for Tank No.T-01-001 — FM-T1 Remote Operated Foam Monitor for Tank No.T-01-001
V.M.A.P. Value Maintenance Access Platform (Steel)
BD Berthing Dolphin
LP Loading Platfrom
MD Mooring Dolphin
LA Landscaped Area
1/2 hr. FRP H.W. Self-closing door — 1/2 hr. FRP H.W. door w/ panic bolt
2 hr. FRP H.W. Self-closing door — Metal door
1/2 hr. FRP H.W. Self-closing door w/ W.G. upper panel — Existing approved door to be retained
1 hr. FRP H.W. Self-closing door w/ 1 hr FRP transparent upper panel — 44mm H.C. Flush Panel Door
50mm Thk. H.W. door w/ clear glass upper panel — 12mm Tempered Clear Glass

BD/FSD Approved Chop

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
-'	04/10/02	B.D. Submission (as submitted)	
A	05/12/02	B.D. Re-Submission (F.S.D./ B.D. Comment)	
B	21/02/03	Amended to F.S.D./ B.D. Comment	
C	19/06/03	Amended to F.S.D./ B.D. Comment	
D	31/0703	Amended to Client Comment	
E	01/03/04	Amended to B.D. Submission	
E*	06/05/04	Amended to BD Approval Plan on 27 Apr 04	
F	08/11/05	BD Submission for additional two tanks T-01-005 & T-01-006	
G	24/01/05	As per F.S.D. comments dated 28 Dec., 2005 and Re-Submission	
H	22/06/06	Amended to B.D. comment	
I	09/01/07	Amended for B.D. Submission with Eight Tanks in Phase 1	
J	12/04/07	Amended to F.S.D. comment	
K	25/07/07	Resubmission to BD with eight tanks in phase 1 after withdrawal	
L	19/09/07	Resubmission as per FSD's comments	
M	21/12/07	Amended to B.D. comment	
N	21/05/08	Amended to B.D. SUBMISSION	
O	18/06/08	Amended to B.D. comment	
P	31/10/08	Amended to Land Department's Comment	
Q	19/06/09	Amended to B.D. Submission	

Scale	As Shown	Date	JAN 2007
Designed BW	Drawn SKL	Checked LHS	
Design Team Leader	LHS	Date	JAN 2007
Approved	LHS	Date	JAN 2007

ECO

Contractor
LEIGHTON CONTRACTORS (ASIA) LIMITED
Tel: (852) 2880 9789
Fax: (852) 2565 5561

JACOBS

Project: Permanent Aviation Fuel Facility Area 38, Tuen Mun, N.T. Hong Kong

Title: Layout Plan/ Block Plan

Project | Originator | Location | Category | Discipline | Number | Revision
Drawing No. PAFF/RJ/02/DWG/G/3015(EX) Q

DATE : 6/26/2009
TIME : 10:51:04 AM

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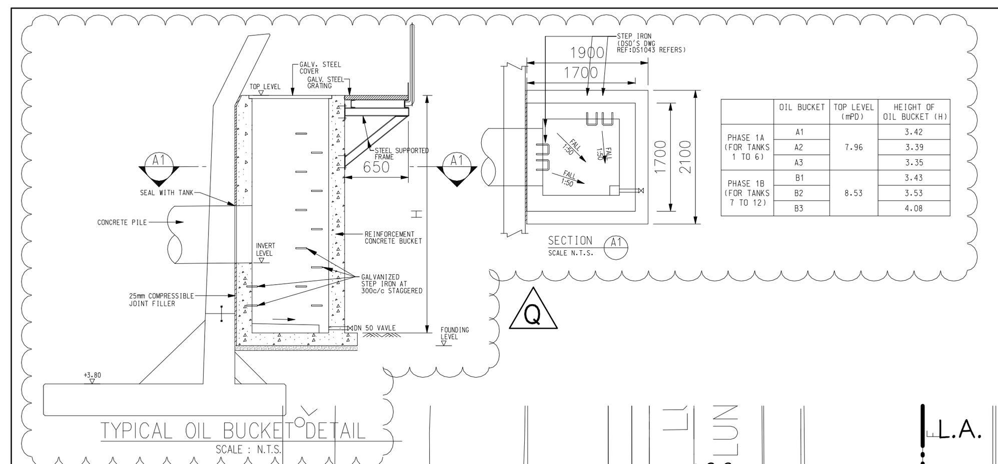

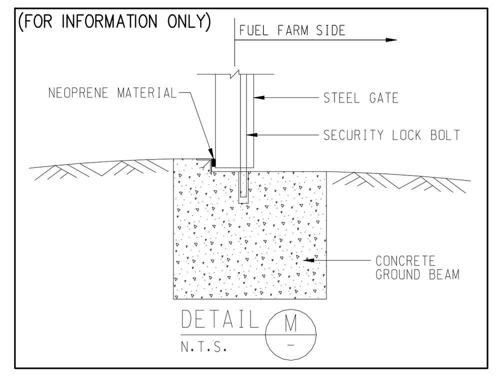

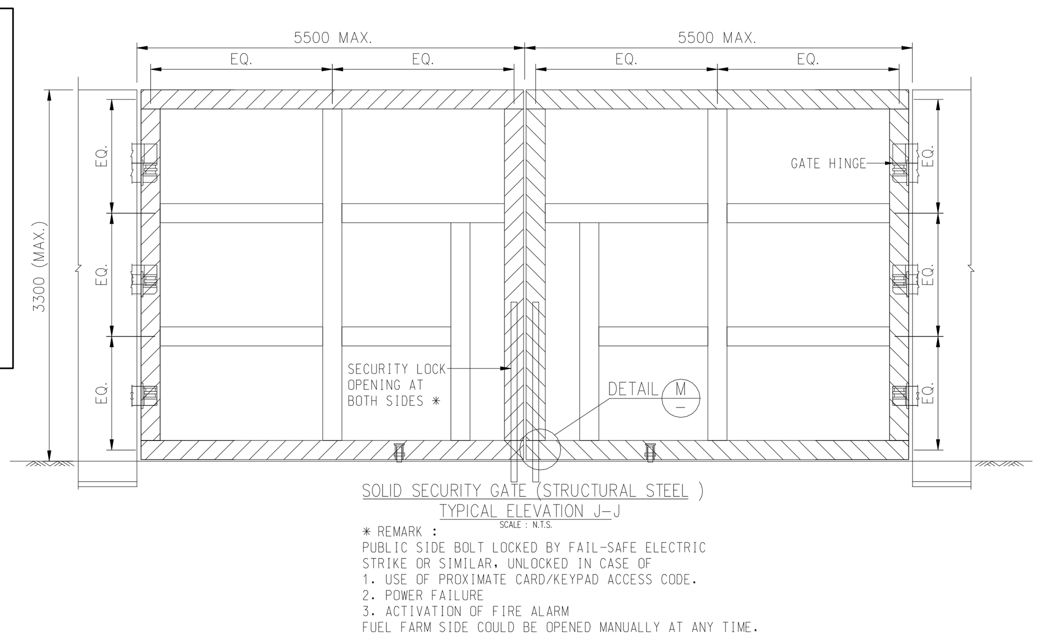

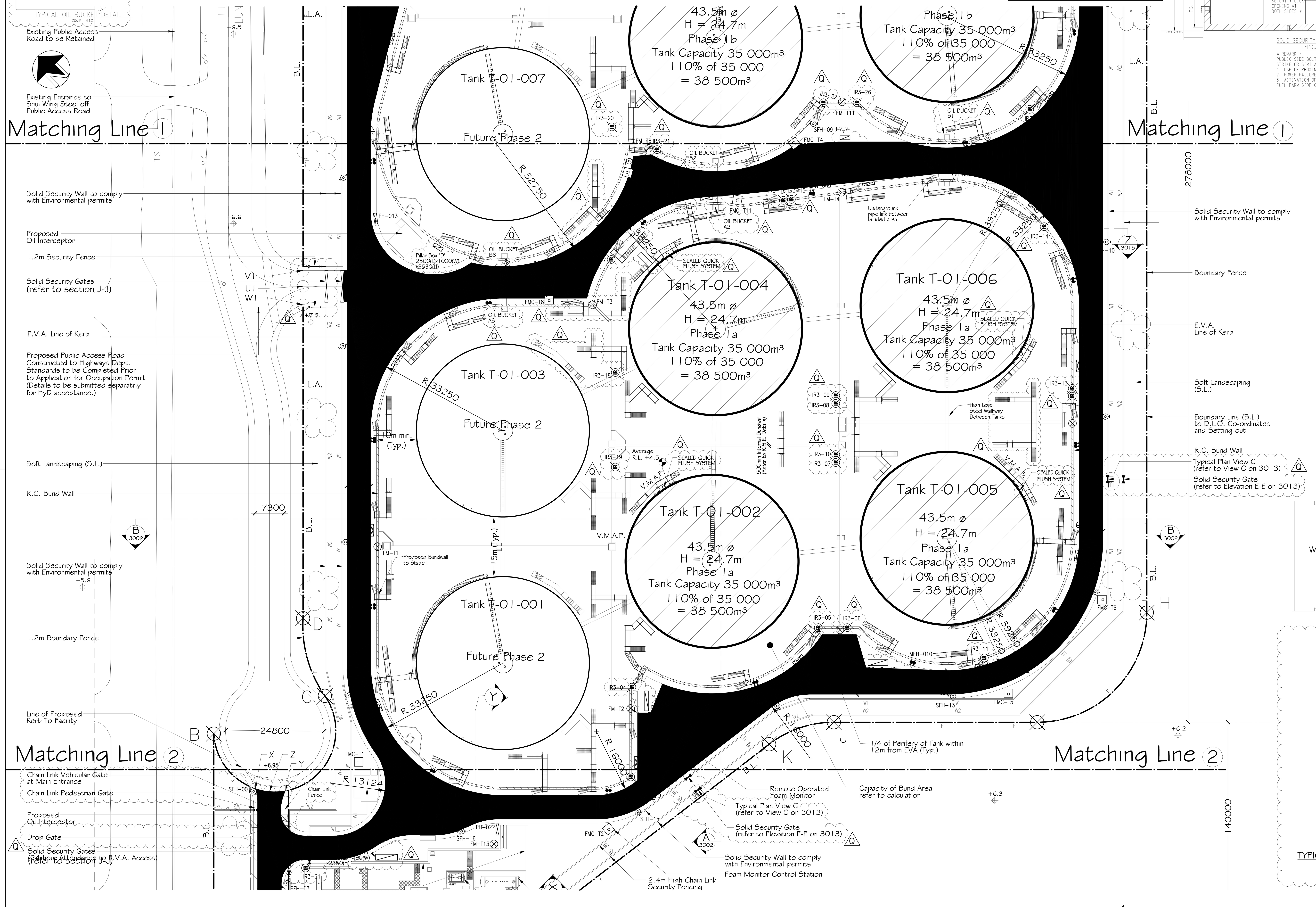

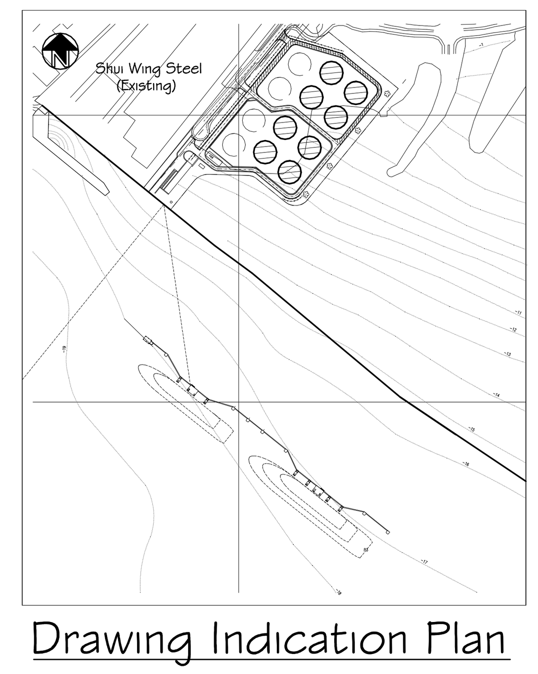

Drawing Indication Plan

Scale N.T.S.

POINT	COORDINATES	
	NORTHING	EASTING
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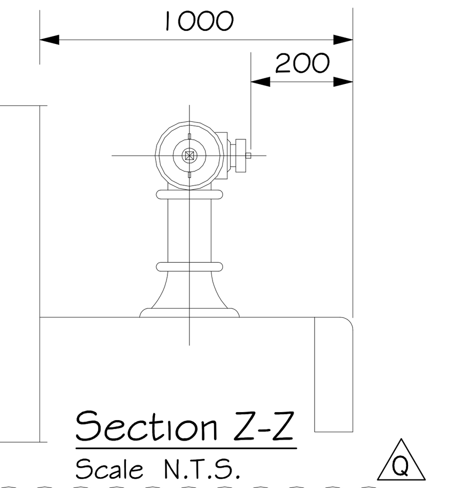
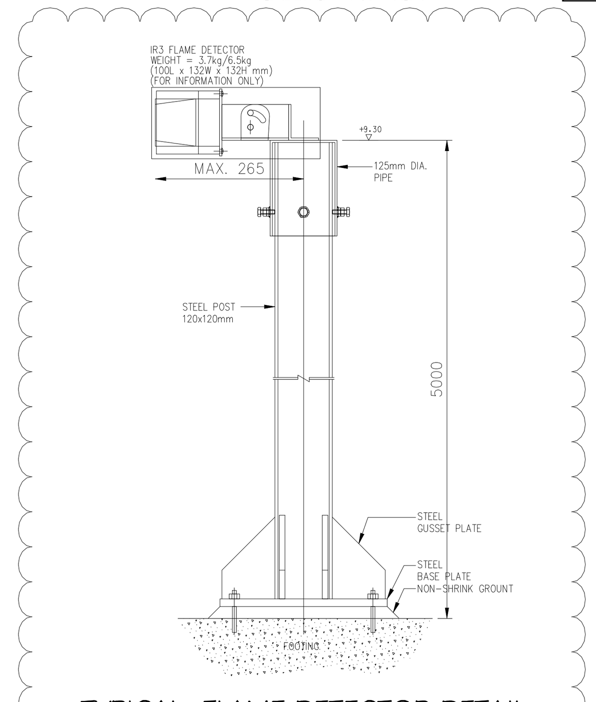


Section Z-Z

Scale N.T.S.



TYPICAL FLAME DETECTOR DETAIL

SCALE N.T.S.

B.D. REF.: BD 2/0001/02

F.S.D. REF.: FP 8/27622

Legend and Abbreviations

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- Lightweight Concrete (Lightweight Concrete fill on Floor Slab)

General Abbreviations

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Ex.	Existing	W/	With
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F.E.	Fire Extinguisher	UPVC	Unplasticised Polyvinyl Chloride
F.F.L.	Finished floor level		
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G.I.	Galvanised Iron		

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Security gates are capable of being readily opened from inside without the use of key(s).

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- F — Site Boundary (with 1.2m Boundary Fence)
- —x—F1—x— Chain Link Fence
- —x—F3—x— Proposed 2.4m High Chain Line Security Fencing
- Subsea Pipelines
- W1 — Solid Security Wall to comply with Environmental permits (Type 1)
- W2 — W2 - Security Wall 2, 2.4m (H) (Type 2)
- Bund Wall
- Fire Hydrant Ring
- Coloured Pink Area (Refer to Land Department's Plan Dwg. TM 4388-Dd)
- Drainage Reserve
- Fire Hydrant/ Hose Reel Cabinet along Hydrant Ring
- EVA — Emergency Vehicle Access Sign
- Typical Arrangement for in-line Balanced Pressure Proportioner with Group of High Back Pressure Foam Maker
- Pedestrian Gate; Pedestrian Access
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- T/X ROOM — Transformer room
- Existing Level; Exit — Exit Sign
- Proposed Level; Directional Sign
- Disable; H.R. — Hose Reel
- FMC-T1 — Form Monitor Control Station for Tank No.T-01-001; FM-T1 — Remote Operated Foam Monitor for Tank No.T-01-001
- V.M.A.P. — Value Maintenance Access Platform (Steel)
- BD — Berthing Dolphin
- LP — Loading Platfrom
- MD — Mooring Dolphin
- LA — Landscaped Area
- 1/2 hr. FRP H.W. Self-closing door
- 1/2 hr. FRP H.W. door w/ panic bolt
- 2 hr. FRP H.W. Self-closing door
- Metal door
- 1/2 hr. FRP H.W. Self-closing door w/ W.G. upper panel
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- 44mm H.C. Flush Panel Door
- 50mm Thk. H.W. door w/ clear glass upper panel
- 12mm Tempered Clear Glass

BD/FSD Approved Chop

Layout Plan/ Block Plan (Part 2 of 3)

Scale 1:500 @A1

"STATEMENT II : THE WORKS SHOWN ON THESE PLANS ARE TYPE II WORKS (GENERAL BUILDING PLAN) IN RESPECT OF WHICH THE BUILDING AUTHORITY'S CONSENT IS APPLIED FOR."

0 10 50 100m
Bar Scale

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A	05/12/02	B.D. Re-Submission (F.S.D./ B.D. Comment)		I	09/01/07	Amended for B.D. Submission with Eight Tanks in Phase 1	
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E*	06/05/04	Amended to BD Approval Plan on 27 Apr 04		O	18/06/08	Amended to B.D. comment	
F	08/11/05	BD Submission for additional two tanks T-01-005 & T-01-006		P	31/10/08	Amended to Land Department's Comment	
G	24/01/05	As per F.S.D. comments dated 28 Dec., 2005 and Re-Submission		Q	19/06/09	Amended to B.D. Submission	

Scale: As Shown		Date: JAN 2007	
Designed: BW	Drawn: SKL	Checked: LHS	
Design Team Leader: LHS		Date: JAN 2007	
Approved: LHS		Date: JAN 2007	

ECO

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Fax: (852) 2565 5561

Project: Permanent Aviation Fuel Facility Area 38, Tuen Mun, N.T. Hong Kong

Title: Layout Plan/ Block Plan

Drawing No.	Project / Originator / Location / Category / Discipline / Number	Revision
	PAFF/RJ/02/DWG/G/3014(EX)	Q

DATE : 6/26/2009
TIME : 10:50:40 AM

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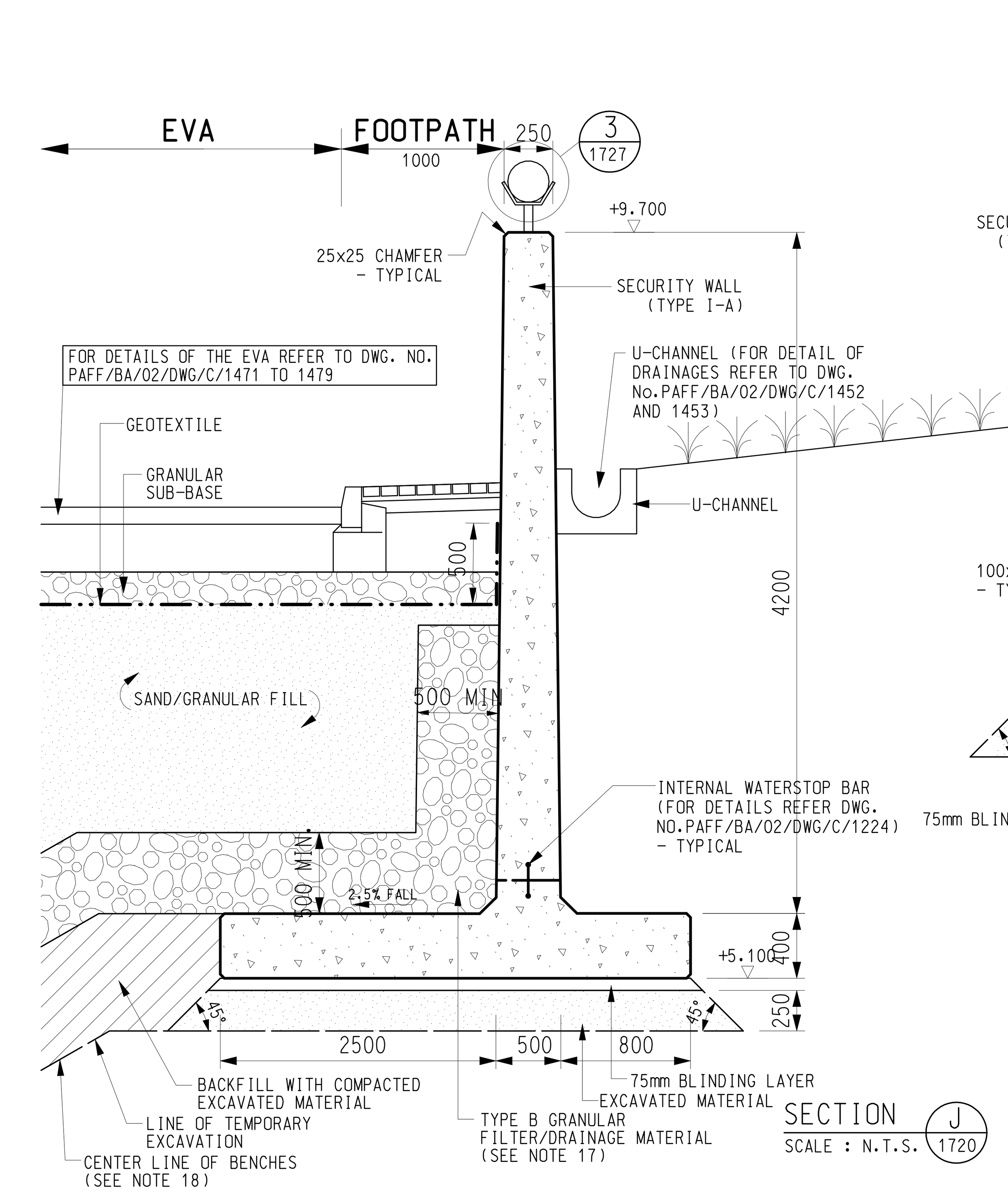
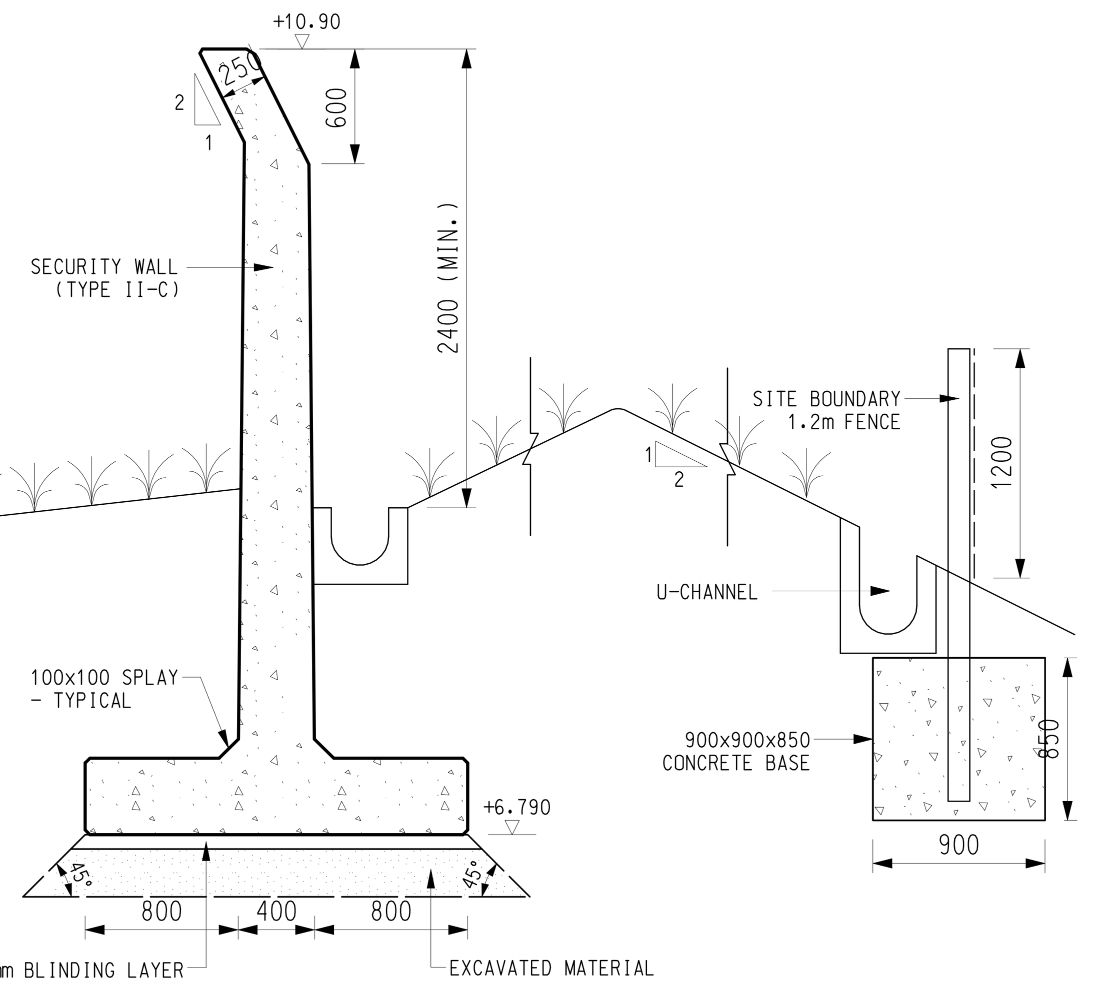
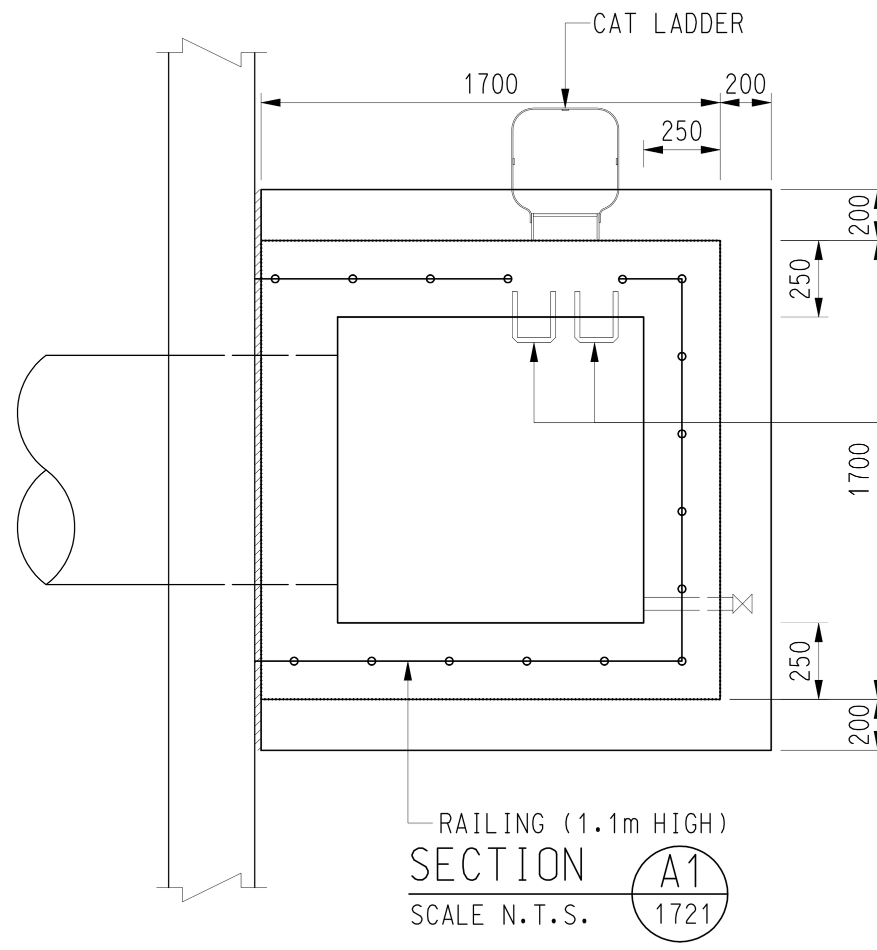
BD REF. NO. 3/0001/02

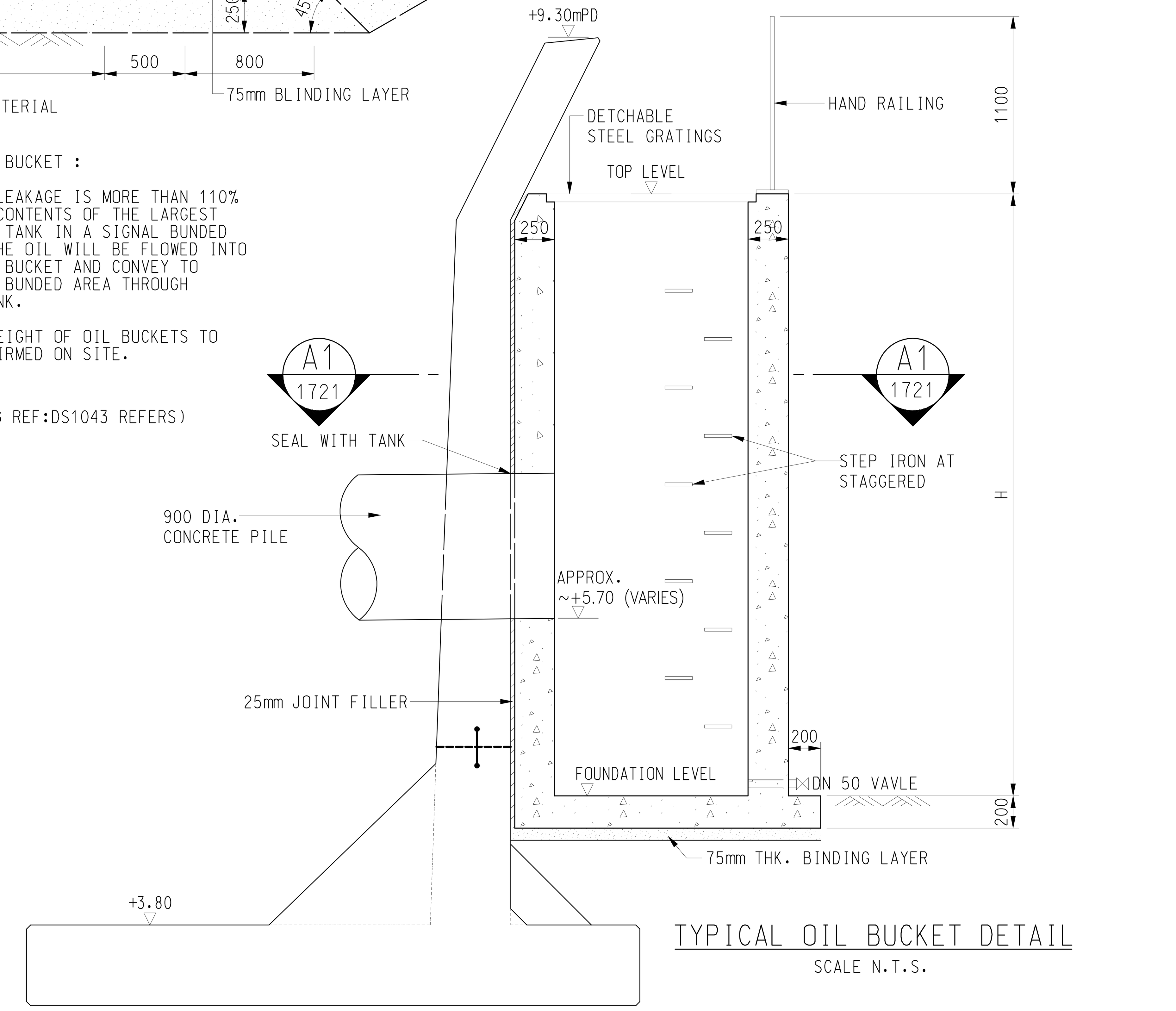






NOTE ON OIL BUCKET :

1. IF OIL LEAKAGE IS MORE THAN 110% OF THE CONTENTS OF THE LARGEST STORAGE TANK IN A SIGNAL BUNDED AREA, THE OIL WILL BE FLOWED INTO THE OIL BUCKET AND CONVEY TO ANOTHER BUNDED AREA THROUGH PIPE LINK.
2. EXACT HEIGHT OF OIL BUCKETS TO BE CONFIRMED ON SITE.



TYPICAL OIL BUCKET DETAIL

SCALE N.T.S.

	OIL BUCKET	TOP LEVEL (mPD)	FOUNDING LEVEL (APPROX.)	HEIGHT OF OIL BUCKET (H)
PHASE 1A (FOR TANKS 1 TO 6)	A1	7.96	4.54	3.42
	A2		4.57	3.39
	A3		4.61	3.35
PHASE 1B (FOR TANKS 7 TO 12)	B1	8.53	5.10	3.43
	B2		5.00	3.53
	B3		4.45	4.08

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	FEB 2004	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	OCT 2007	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale	Date
AS SHOWN (A1)	JAN 2006

Designed	Drawn	Checked
BW	SKL	AS

Design Team Leader	Date
AS	JAN 2006
Approved	**Date**
LHS	JAN 2006

ECO

Contractor
LEIGHTON CONTRACTORS (ASIA) LIMITED
39th Floor
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JACOBS
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Fax: (852) 2565 5561

Permanent Aviation Fuel Facility

Title
TANK FARM
BUND WALL DETAILS
(SHEET 1 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1721 | Revision 3

DATE : 3/2/2009
TIME : 10:05:45 AM
PLOT DRV: $PLTDRVL$

FILENAME : S:\Drawings\DGN\Babtie\20090225\1721-3.dgn

Photographs

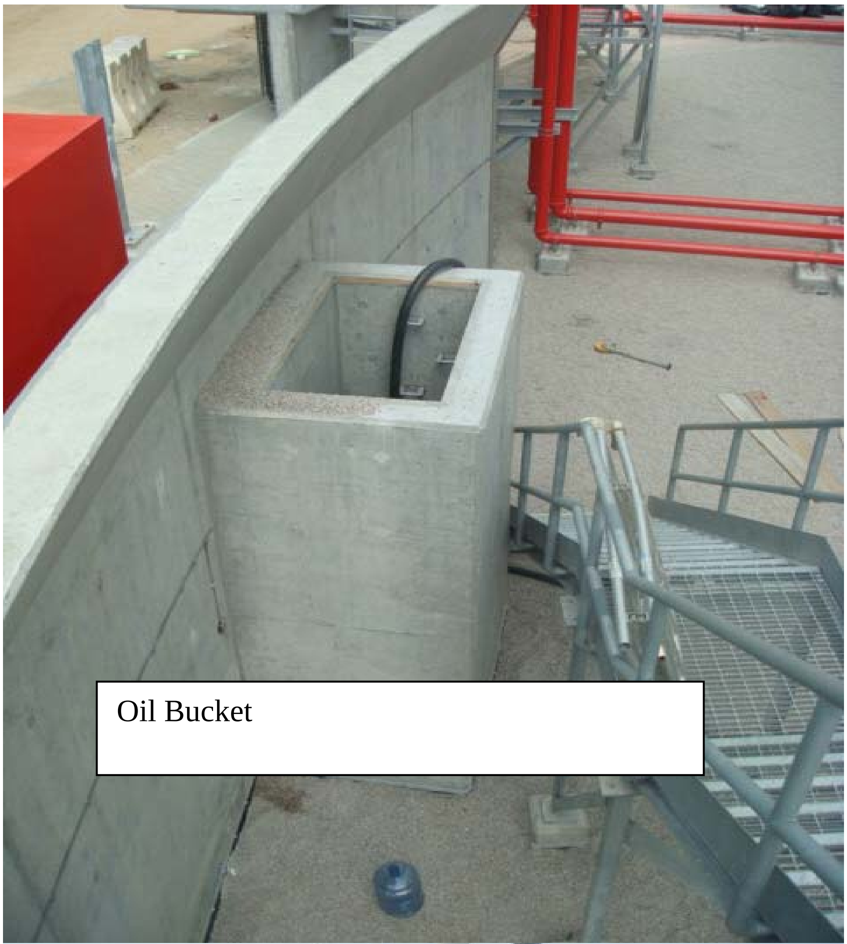
Bund Wall

View from Tank 4 showing bund wall, EVA and Security Wall 1

View of Bund Wall

View from Tank 5 showing Bund Wall, Security Wall 1 and 2

Security Wall 1 and 2


Oil Bucket

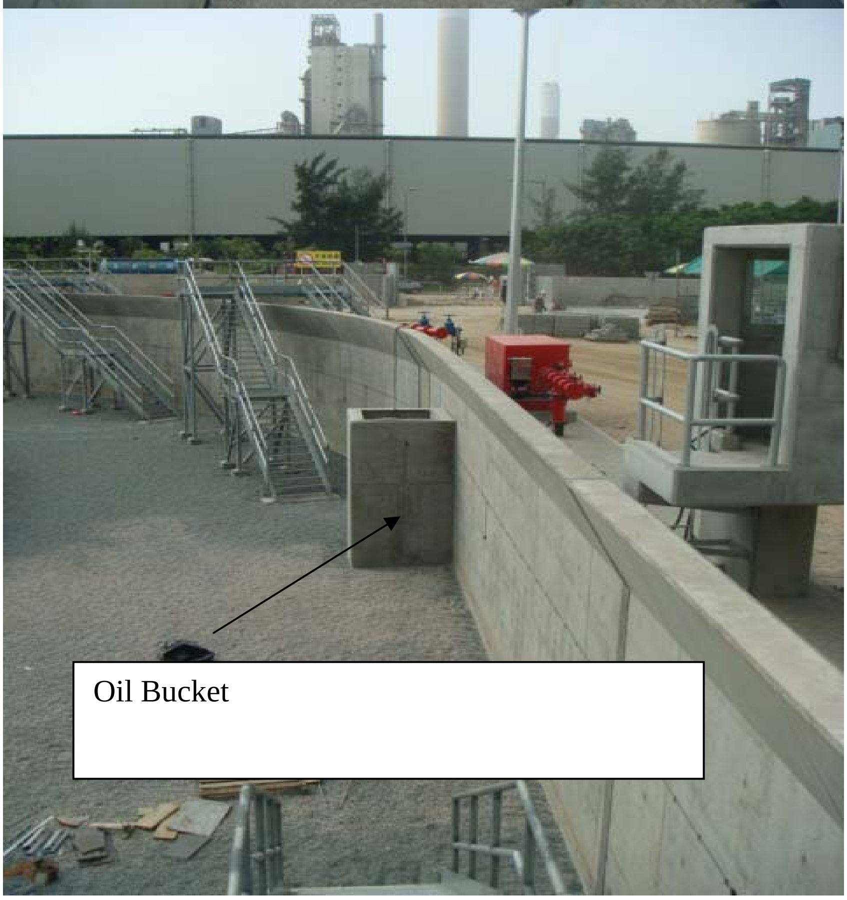

Oil Bucket

Table 1 EP Condition 3.5 (a)(iii) - Summary of the document

	Content	Remarks
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 (a)(iii)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; section 3 clause 3.3, section 6, clause 6.1.1, section 10 clause 10.1.2 and section 16 clause 16.2.8
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and (i) and Franchisee Requirements Clause 1.05 item (b)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10, section 5 and section 14
5	Contract drawings & table	**a. Security walls and landscape berm** - PAFF/BA/02/DWG/C/1721 Revision 3 Tank Farm Bund Wall Details (sheet 1 of 4) - PAFF/BA/02/DWG/C/1722 Revision 3 Tank Farm Bund Wall Details (sheet 2 of 4) - PAFF/BA/02/DWG/C/1723 Revision 3 Tank Farm Bund Wall Details (sheet 3 of 4) - PAFF/BA/02/DWG/C/1724 Revision 3 Tank Farm Bund Wall Details (sheet 4 of 4) - PAFF/LC/02/DWG/C/0865 Revision B Landscaping Area - PAFF/LC/02/DWG/C/0866 Revision B Fill Between Site Boundary and Security Wall (sheet 1 of 3) - PAFF/LC/02/DWG/C/0867 Revision B Fill Between Site Boundary and Security Wall (sheet 2 of 3) - PAFF/LC/02/DWG/C/0870 Revision B Fill Between Site Boundary and Security Wall (sheet 4 of 3) - Table showing difference in ground level at Site Boundary and Bund level at Security Wall 2 to show height of landscape berm
7	Photographs	Photographs of the completed works, landscape berm and details of landscape berm around site perimeter.

	Content	Remarks
8	Justification	• Drawings PAFF/BA/02/DWG/C/1721-1724 show the construction of two impervious security walls outside the bunded compounds as the tertiary and fourth containments after the tank itself as the primary containment and bund wall as the secondary containment. The concept of the landscape bund is to give extra height to the trees planted on the bund and therefore achieve better screening of the fuel tanks. • The height and shape of the landscape berms as shown in Figures 3.2d and 3.2e of the EIA report and Figure 4 in the EP bare no resemblance to the actual ground contours and levels on sites. It should be noted that for the Section B-B of the Figure 3.2e and Figure 4 it shows the ground level outside PAFF being higher than the ground level inside PAFF. In fact the ground level outside the site is actually lower, except for the side facing Shiu Wing Steel (Cross-sections W-W to Y-Y in drawing PAFF/LC/02/DWG/C/0865 Revision B Landscaping Area) • The security walls surrounding the site have been constructed at a higher level than that shown on the reference figures. This higher level gives the landscape berm its height above the surrounding land. (see 'Table showing difference in ground level at Site Boundary and Bund level at Security Wall 2 to show height of landscape berm') • The four sections A-A to D-D show the profile against part of the ECO park. Drawings and attached photographs show there is not enough room to construct a bund in this area of the project boundary. • It is not possible to construct a landscape berm as shown on the EIA and EP sections without major retaining walls at sections W-W to Y-Y. The height of the road and the top of the slope give the necessary height to comply with the requirements of the EIA and EP and the philosphy behind the requirement of the landscape berm to increase the height of the trees thus improving the screening effect.

香港
機場管理局 | AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (a) (iii)
Date of Report:	24 November 2009
Date prepared by ET:	24 November 2009
Date received by IEC:	24 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (a) (iii)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(a) Containment Systems of Aviation Fuel Storage Tank
Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular :

(iii) Two impervious security walls and a landscaped berm of at least 1.5m high shall be designed and constructed outside the bunded compounds;

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 24 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. Submissions or Measures during the Construction of Certain Parts of the Project

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements:-

a) Containment Systems of Aviation Fuel Storage Tank Farm

Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular:

iii) Two impervious security walls and a landscaped berm of at least 1.5m high shall be designed and constructed outside the bunded compounds;

Environmental Impact Assessment Report Requirement

3 DESCRIPTION OF PROJECT AND ASSUMPTIONS

3.2 Tank Farm and Onshore Facilities

3.2.1 About 6.75 ha of land is required to accommodate the aviation fuel tank farm and associated facilities. The proposed site for the tank farm at Tuen Mun Area 38 has been reclaimed by Government and is zoned for special industrial use. The site is situated at Siu Lang Shui just southeast of the Castle Peak Power station and is adjoined on the west by the Shiu Wing Steel Mill and on the south-east by the proposed EcoPark and adjacent to that is land earmarked for industrial use in keeping with the other land uses in the area. Further east is the River Trade Terminal. The allocated plot has a short length of sea frontage of 60m in width which extends inland for about 140m before widening out to a square area of about 217m in length by 278m in width, see Figure 3.2c.

3.2.2 No residential developments are present in the area and the closest substantial development, Melody Garden in Tuen Mun, is at least 3 kilometres from the proposed site. The villages at Lung Kwu Tan are closer at about 2km away but are screened from the site by the Castle Peak topography. However, there is a planned Holiday Camp to the North-East of the site along Lung Man Road which is over 500m away.

3.2.3 It should be noted that the previous EIA study (April 2002) was undertaken based upon the project layout detailed in Figure 3.2a and a tank design capacity of 420,000m^3. However, changes were made to the detailed layout and an application for a variation (Application No. VEP-133/2004) to the then valid Environmental Permit EP-139/2002 was made. However, during the development of the detailed design, FSD placed a restriction on the height of the storage tanks above the emergency access. Thus, in order to comply with FSD's requirement on the tank height (requested in April 2003), the height of the tanks were reduced from 32.0m to 24.7m and the volume of the largest tanks reduced from 39,000m^3 to 35,000m^3. As a result, the ultimate capacity of the facility was reduced to 388,000m^3 from 420,000m^3, resulting in variation to the environmental permit (EP-139/2002/A) which was granted by EPD in February 2004. Details of the revised layout approved by the VEP are provided in Figure 3.2b and details of the improvements made to the tank farm layout are detailed in EP Variation Application No. VEP-133/2004 and summarized in Table 3.2 below. Also, as part of the changes made, and as shown in Figure 3.2b, the whole site has been shifted 10m to the southeast from that proposed in the original EIA of April 2002, to accommodate Lands Department's commitment of a land extension to Shiu Wing Steel Mill.

Table 3.2 Summary of Tank Farm Improvements

Item		Previous EIA Report (April 2002)	Current Design	Improvement / Neutral	Change Initiated By
Dimension					
1	Volume (largest tank)	39,000 cu.m.	35,000 cu.m.	Improvement	FSD
2	Tank height (highest) (total)	32.0 m	24.7 m (23m above ground)	Improvement	FSD
3	Distance from tank to bund	10.0 m	10.0 m	Neutral	--
4	Distance from bund to security wall	8.0 m	8.5 m	Improvement	FSD
5	Distance from bund to boundary	16.5 m (minimum)	18.5 m	Improvement	AA
Bunding					
1	Bund with wave wall	None	Included	Improvement	AA
2	Height of bund wall (average)	4.6 m	4.8 m	Improvement	AA
3	Height of inner security wall	2.0 m	2.0 m	Neutral	--
4	Drainage ditch	Included	Included	Neutral	--
5	Earth bund in landscaped area	None	1.5 m high	Improvement	Planning/EP
6	Outer security fence/wall	Open mesh fence	Impervious wall	Improvement	AA

3.2.4 In addition to these changes, the phasing of the tanks has changed with 8 (eight) to be constructed initially as shown in Figure 3.2c. While Figures 3.2b and 3.2c show the current layout for the site and phasing for the construction of the tanks, indicative cross sections between the tanks and the lot boundaries with Shiu Wing Steel and the EcoPark are provided in Figures 3.2d and 3.2e respectively with the location of the cross-sections shown in Figure 3.2c.

3.2.5 The tank farm will initially house 8 storage tanks, 6 tanks of 43.5m diameter by 24.7m in height, one of 41.5m diameter by 24.7m in height and one of 35m diameter by 24.7m in height. The tank heights refer to the total tank height but it should be noted that part of the tank will be positioned in the ground and as such only 23m will protrude above ground level. The tanks provide a storage capacity of between 22,000m^3 to 35,000m^3. It is intended that the tankage capacity would be increased once the initial capacity of 264,000m^3 has been reached around 2025 to 2030. It is intended that the remaining 4 tanks would be built all together between 2025 and 2030 to increase the tankage capacity to the ultimate design tankage capacity of PAFF i.e. 388,000m^3. The heights of 3 of the remaining tanks would be 24.7m, with one tank of 23m and their capacities would vary accordingly between 35,000m^3 and 19,000m^3. When planning for the 4 remaining tanks in the final phase of the development, latest technology, industrial standards and statutory requirements at that time would be used. Also the EIA would be reviewed if appropriate in view of the latest technology, standards and statutory requirements at that time.

3.2.10 The tank farm would be provided with bundwalls and contained drainage. There are 2 main bunds (designed to contain any spills from the tank or tank piping), each containing 6 tanks in future but 4 tanks initially. The height of the bundwalls has also been increased from previous April 2002 EIA in order to improve the retention of any fuel spillage from the tanks within the PAFF boundary. The initial bund containment with 4 tanks in each bund would amount to at least 180% of the volume of the largest tank (well exceeding the required 110%) and ultimately (2040) this would be at least 150% of the volume of the largest tank with 6 tanks in each bund. Each tank is also separated by intermediate bund walls to hold minor spills. There are also 2 emergency shutdown valves on the pipeline inlet to the tank farm from jetty and another 2 on the pipeline outlet of the tank farm to the Airport. These valves are operated via motorized electric actuators. The tank bunds and the pump platform are contained areas and drain to the interceptor via bund drain valves. Other leakage prevention devices include fuel tank high-high level alarm and leak detection system for the pipeline. The storm water drain will also have a remotely operated block valve to contain any oil spill on site.

Mitigation Measures

6.1.1 Operational Phase

6.1.1.2 Other mitigation measures recommended for the operational phase include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- all tanks shall be bunded to a capacity of at least 150% of the largest individual tank in each compound at the ultimate phase of 2040. For the initial development phase, as only 4 tanks will be present in each bund, a containment capacity of about 175% will be achieved. Tank pits shall be protected by an impermeable bed (e.g. geotextile sheeting) to prevent seepage of aviation fuel to ground. A leak detection system shall be installed beneath the containment membrane;

- there shall be no direct outlet from the bund. A collection sump shall be included in the base. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator;

8. LANDSCAPE AND VISUAL ASSESSMENT

8.6.1 Landscape Mitigation Measure 2 (LMM2) – Advanced Transplantation and Boundary Planting Buffer/Perimeter Landscape Bund

8.10.3.1 In accordance with the recommendation of the previous EIA Report (April 2002) which stated that the transplantation of the existing road side and site trees and vegetation should be undertaken as early as possible in the construction period, as noted above, the transplantation of 209 trees and whips was undertaken at the very start of the original construction period in 2005 prior to the quashing of the Environmental Permit and the subsequent suspension of works. A raised landscaped perimeter bund comprising containment bund-wall, access road and planting buffer is proposed around the tank farm. The planting buffer will be planted on the higher parts of the bund. This measure will help soften and screen the built elements and mitigate the landscape and visual impacts (refer to Figures 8.7.1 & 8.7.2). Planting will be undertaken to form a perimeter landscaped bund around the site at phase 2009. This will allow the maximum time for establishment period and higher success rate for the survival and the early establishment of new screen and compensatory planting. The planting buffer will comprise a mix of native species and species that have a tall habit and are fast growing. This will include rows of Causuarina (*Causuarina equisetifolia*) trees that will form a tall and evergreen buffer. The Causuarina trees are anticipated to form an effective and mature screen by 2040. The following boundary planting mix is proposed:

a. **Dominant Species:** *Causuarina equisetifolia* (Planted as whips and heavy standards/mature specimens where required) will be used to provide the screen effect and will therefore form the dominant species.

b. **Edge Species:** Native and dense mix of planting is proposed along the edge (and within) of the dominant species. This will provide a more mixed edge effect and break-up the overall visual dominance of the Causuarina. The following species are proposed:

Trees Low maintenance, salt and wind tolerant tree planting of heavy-standard and seedling sized trees	**Shrubsand Small Tree Mix** Low maintenance, salt and wind tolerant densely planted large shrubs	**Hydro_seeding Shrub and Groundcover mix** Low maintenance, salt and wind tolerant grass and shrub planting
Tristania conferta	Nerium indicum	Thevetia peruviana
Cassia suranttensis	Thevetia peruviana	Nerium indicum
Cassia siamea	Bauhinia tormentosa	
Bombax malabaricum	Bauhinia galpinii	Ligustrum sinense
Casuarina equetisetifolia	Bauhinia acumentata	

Sapium discolour	Hibiscus rosa-sinensis	Mekastoma candidum
Schefflera octophylla	Murraya paniculata	Clerodendron fragrans
Ficus microcarpa	Rhododendron pulchrum	Cynodon dactylon (Bermuda grrass)
Malaleuca leucadendron		Paspalum notadum
Schima superba		Lolium perenne
Schefflera aboricola		

10 HAZARD TO LIFE ASSESSMENT

10.1.2 Overview of PAFF Hazards

10.1.2.8 The PAFF will be built to internationally recognised standards and best practices for fuel storage. Cylindrical steel storage tanks with conical roofs (to API 650) are used throughout the world for storage of liquid hydrocarbon fuels. The same types of tanks are also used to store more volatile fuels such as gasoline, although internal floating roofs are now standard for gasoline to reduce environmental emissions of vapour. Bund walls, will surround the tanks so that, in the case of leaks, any fuel leak is collected and can be cleaned up. The containment capacities of the bunds at the PAFF greatly exceed international standards. The PAFF design also has two additional impervious security walls as well as the more usual single bund wall and fence. This will further reduce the chance of any spill affecting off-site areas.

10.1.4.7 The tank bund design is such that the total capacity of the bund significantly exceeds the usual 110% of the capacity of the largest tank. The bund containment capacities are 166% and 156% of the capacity of the largest tank for the bunds nearest to the sea and furthest from the sea respectively, with all tanks constructed [12]. Initially, with only four of the tanks in each bund constructed, the bund capacities will be 195% and 188% of the capacity of the largest tank [12].

10.1.5.12 The storage tanks will be located within a bund, which is designed to contain any spills from the tank or tank piping. The bund is designed to hold much more than the required 110% of the contents of the largest tank in the bund. The bund will be provided with a drain, which will be discharged by a manually operated valve to the sea through an oil interceptor. Drainage from unbunded areas onsite will be discharged through the storm water drain to the sea. The storm water drain will be provided with a remotely operated block valve to contain any oil spill on site.

16. SUMMARY OF ENVIRONMENTAL OUTCOMES

Design

16.2.8 All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure, and the resultant leaks/spills, to the lowest practicable extent. Fuel storage tanks will be constructed in a bunded area which will have collection capacity greater than the maximum content of the largest tank, to contain any fuel leaks or spills. There shall be no direct outlet from the bund to ensure retention of any spilled material. A collection sump shall be included in the base. Protection against leaks or spills from the bottom of the tanks will be achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. A spill detection system will be fitted underneath this membrane to provide additional security. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages.

16.2.10 The design of the tank farm has also incorporated a perimeter landscaped bund which will be implemented early in the construction process in order to provide screening for Phase 1 tanks. The perimeter bund will also screen future tanks.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

(i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting
(ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings
(iii) Sampling and product recovery system
(iv) Manifolding to tank farm and existing aviation fuel system simultaneously
(v) Fire protection system
(vi) Power supply and independent standby power generator or second supply
(vii) Buildings including offices, canteen, control room, workshop, stores
(viii) Emergency response facilities
(ix) Storage tanks for fuel, water, chemicals and wastes
(x) Utility and other systems including back-up systems
(xi) Cathodic protection
(xii) Lightning protection
(xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities
(xiv) Electronic tank servo gauges
(xv) Hard standing, roads and parking
(xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services;

(f) Landscape works;

EPC – Franchisee's Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services; and associated fire protection;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed.

Also, in the detail design additional standards may be referenced for specific items.

5. Storage Tank (including BUND Wall and Foundation)

5.1 GENERAL

The main storage tanks will be circular and made of steel plate with diameters of 6 x 43.5m, 1 x 41.5m, 1 x 35m and a height of 24.7 metres and nominal capacities of 35,000, 32,000, 22,000 cubic metres respectively. The tanks will be founded on a reinforced concrete ring beam. The eight storage tanks will be contained within two reinforced concrete bund walls (4 nos. of fuel tank for each bund wall) with a membrane lining to contain any leakage. All bund walls will include a wave wall to assist in containing Jet A1 within the bunded area.

5.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) API 650 Vertical Storage Tanks
(b) BS EN 12285 Horizontal Storage Tanks
(c) British Standard for Concrete Structures
(d) Code of Practice for Oil Storage Installations 1992 – Building Authority Hong Kong
(e) IP Code of Practice Part 15

5.3 SPECIFIC CRITERIA

5.3.4 Bund Walls

1. The bund walls shall be of reinforced concrete.

2. The capacities of the bunded areas will be 57,691 cubic metres for phase 1a & 2 tank farms and a minimum of 50,695 cubic metres for phase 1b & 2 tank farm, which are not less than 38,500 cubic metres (110% of a 35,000 cubic metres tank) for both areas.

3. The construction of the bund walls joints will provide a continuous barrier to any spill within the bunded area.

4. The bund walls shall be designed to retain the bunded area when full of water or the impact load of an instantaneous release from a simple storage tank which ever is greater.

5. A means of access in and out of the bunded area will be provided adjacent to the stairs fitted to the main storage tanks and as directed by the FSD.

6. The bund wall alignment will allow 25% of the circumstance of each tank to be with in 15 metres of the EVA.

5.3.6 Secondary Containment

The security walls adjacent to the bund wall facing public areas will in addition be constructed of reinforced concrete to contain potential overtopping of the bund wall. Gates in the security walls are to be solid and sealed up to the first hinge on the gate.

14. LANDSCAPING

14.1 GENERAL

The Theme of the Landscaping will be to minimize the visual impact of the facility particularly to traffic along Lung Mun Road.

Landscaping will commence as soon as practicable to allow the maximum development time for trees. The existing trees will where possible be replanted into the soft landscaping.

14.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) Siltech Landscape Details, Hong Kong Government

(b) General Specification for Civil Engineering Works (1992) – Specification for the landscape work.

14.3 SPECIFIC CRITERIA

Before detail design an audit of the existing vegetation on site will be conducted to determine the suitability of species for replanting.

14.4 ENVIRONMENTAL MITIGATION MEASURES

- advanced screen mounding and screen planting
- advanced boundary bund and buffer planting
- advanced transplantation of existing trees
- selection of fast growing and nature trees and shrub mixes
- recessive colours and recessive night time lighting

14.5 MATERIALS

- **Dominant Species:** *Causuarina equisetifolia* (Planted as whips and heavy standards/mature specimens where required) will be used to provide the screen effect and will therefore from the dominant species.

- **Edge Species :** Native mix of planting is proposed along the edge (and within) of the dominant species. This will provide a more mixed edge effect and break-up the overall visual dominance of the Causuarina. The following species are proposed:

Trees	Shrubs/Groundcovers	Climbing Plants
Acacia auriculaeformis	Hibiscus tilaceus	Ficus pumilla
Albizzia lebbek	Pandanus tectorius	Parthronacissus sp
Cerbera manghas	Pongamia pinnata	Campsis Grandiflora
Ficus microcarpa	Thespesia populnea	
Ficus virens		
Macaranga tanarius		
Terminalia catappa		

14.6 DESIGN AND ANALYSIS METHOD

14.6.1 Consideration shall be given to the micro climatic condition in relation to the landscaping works. Site appraisal will be taken to provide a thorough analysis including tree species found within and beyond site for future design guide line.

14.6.2 Design Report

PAFF/BA/02/DSG/C/1401 - Landscaping

14.7 MAIN INTERFACES

14.7.1 INPUT DAT

I). LAYOUT PLAN
ii). Architectural Plans

14.7.2 Interfaces

- Tank Farm
- Building Structures
- Access Road

Consideration shall also be given on the alignment of underground utilities service, structural footing etc. located within the planting strip when designing the planting proposal.

14.7.3 Environmental Permit Requirements

14.7.4 Town Planning Application Requirements

Contract Drawings & Table

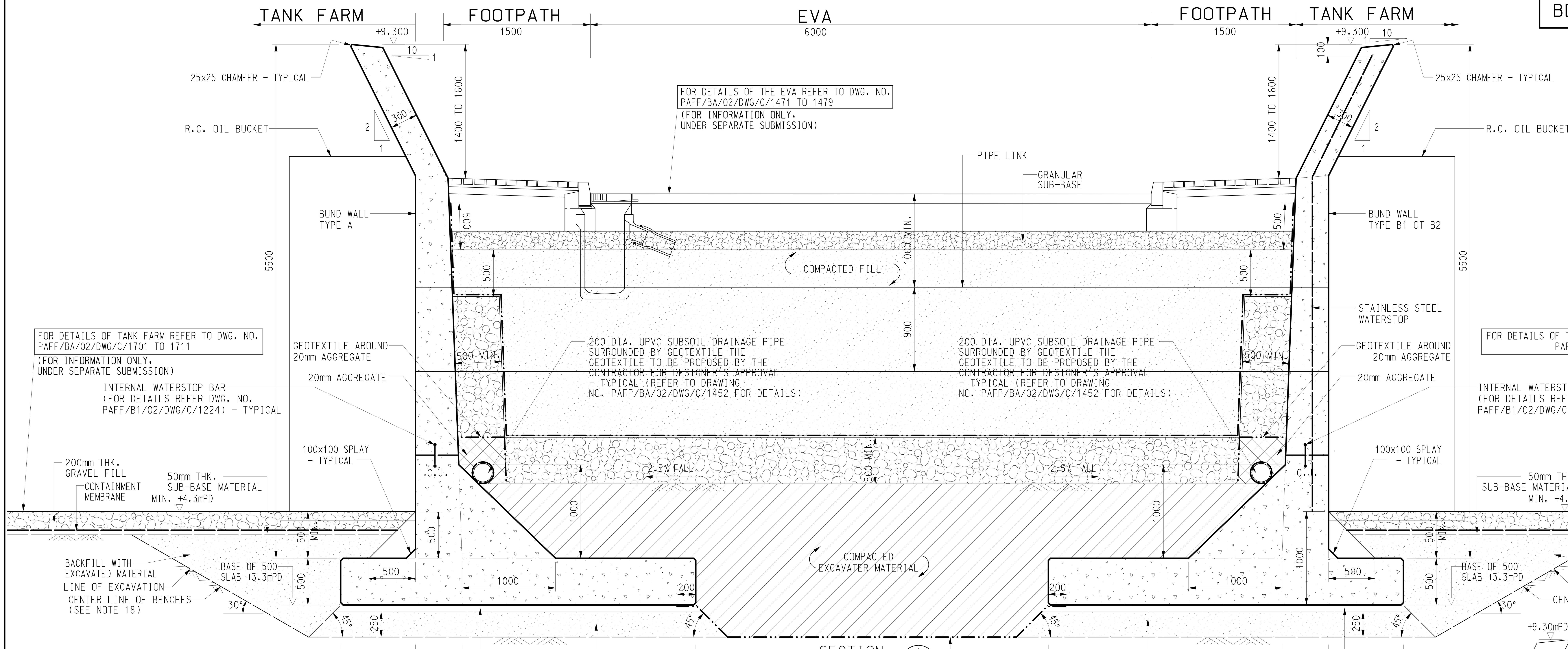
Security Walls and Landscape Berm

- **PAFF/BA/02/DWG/C/1721 Revision 3 Tank Farm Bund Wall Details (sheet 1 of 4)**
- **PAFF/BA/02/DWG/C/1722 Revision 3 Tank Farm Bund Wall Details (sheet 2 of 4)**
- **PAFF/BA/02/DWG/C/1723 Revision 3 Tank Farm Bund Wall Details (sheet 3 of 4)**
- **PAFF/BA/02/DWG/C/1724 Revision 3 Tank Farm Bund Wall Details (sheet 4 of 4)**

- **PAFF/LC/02/DWG/C/0865 Revision B Landscaping Area**
- **PAFF/LC/02/DWG/C/0866 Revision B Fill Between Site Boundary and Security Wall (sheet 1 of 3)**
- **PAFF/LC/02/DWG/C/0867 Revision B Fill Between Site Boundary and Security Wall (sheet 2 of 3)**
- **PAFF/LC/02/DWG/C/0870 Revision B Fill Between Site Boundary and Security Wall (sheet 4 of 3)**

- **Table showing difference in ground level at Site Boundary and Bund level at Security Wall 2 to show height of landscape berm**

BD REF. NO. 3/0001/02



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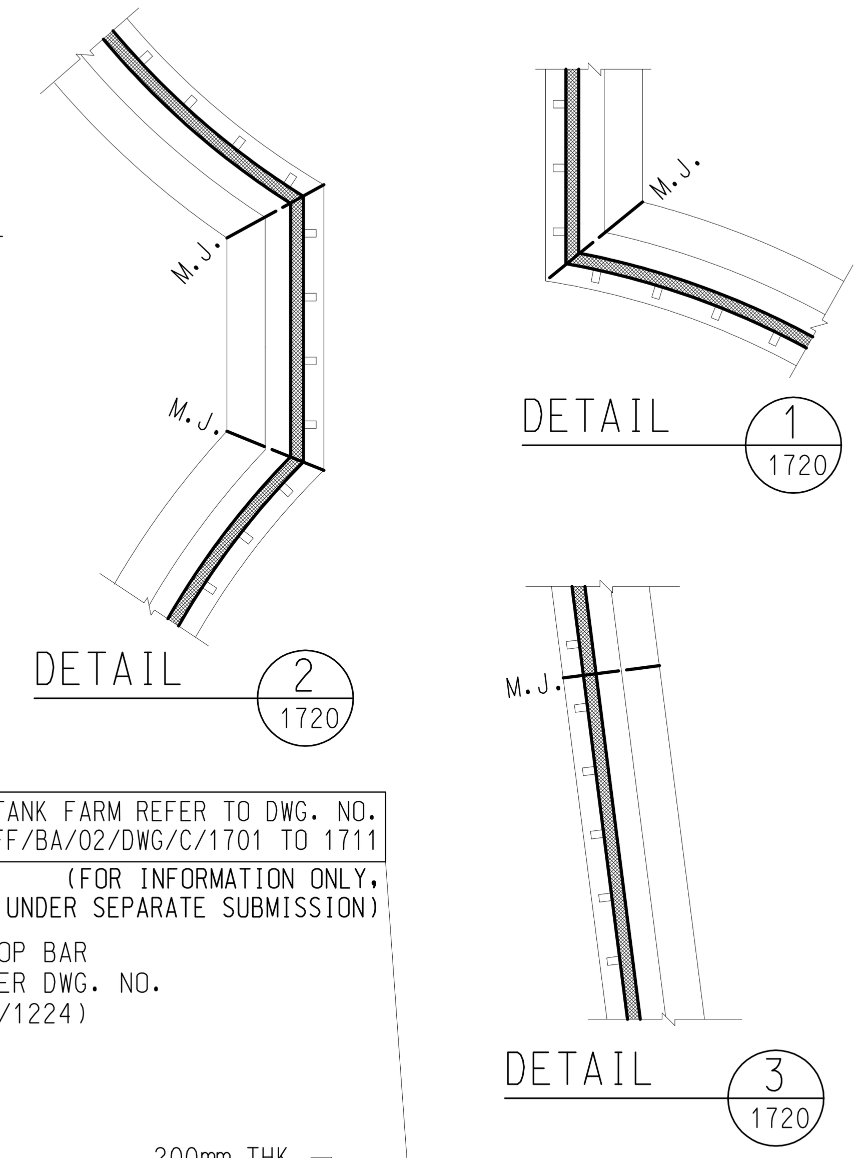

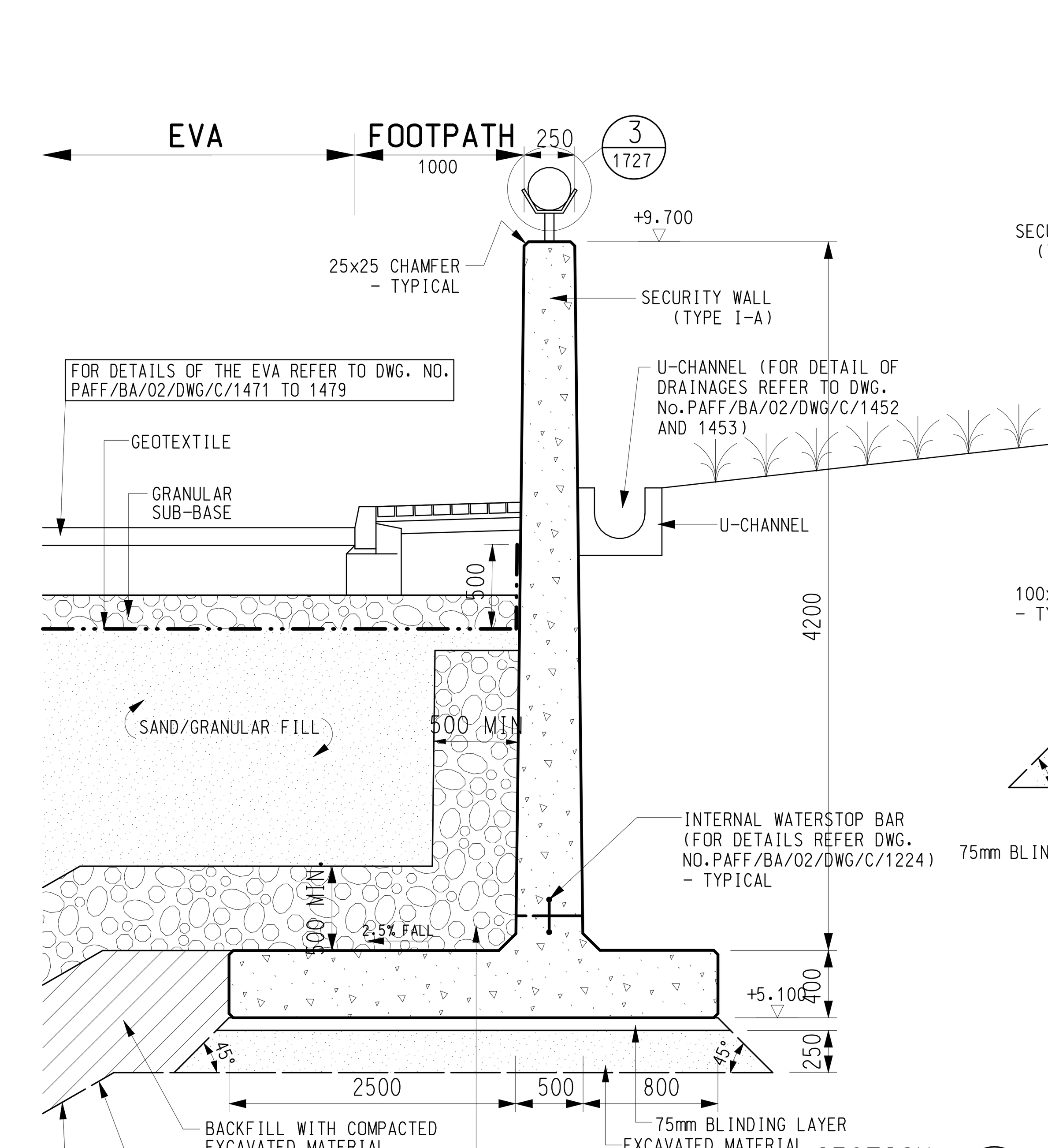

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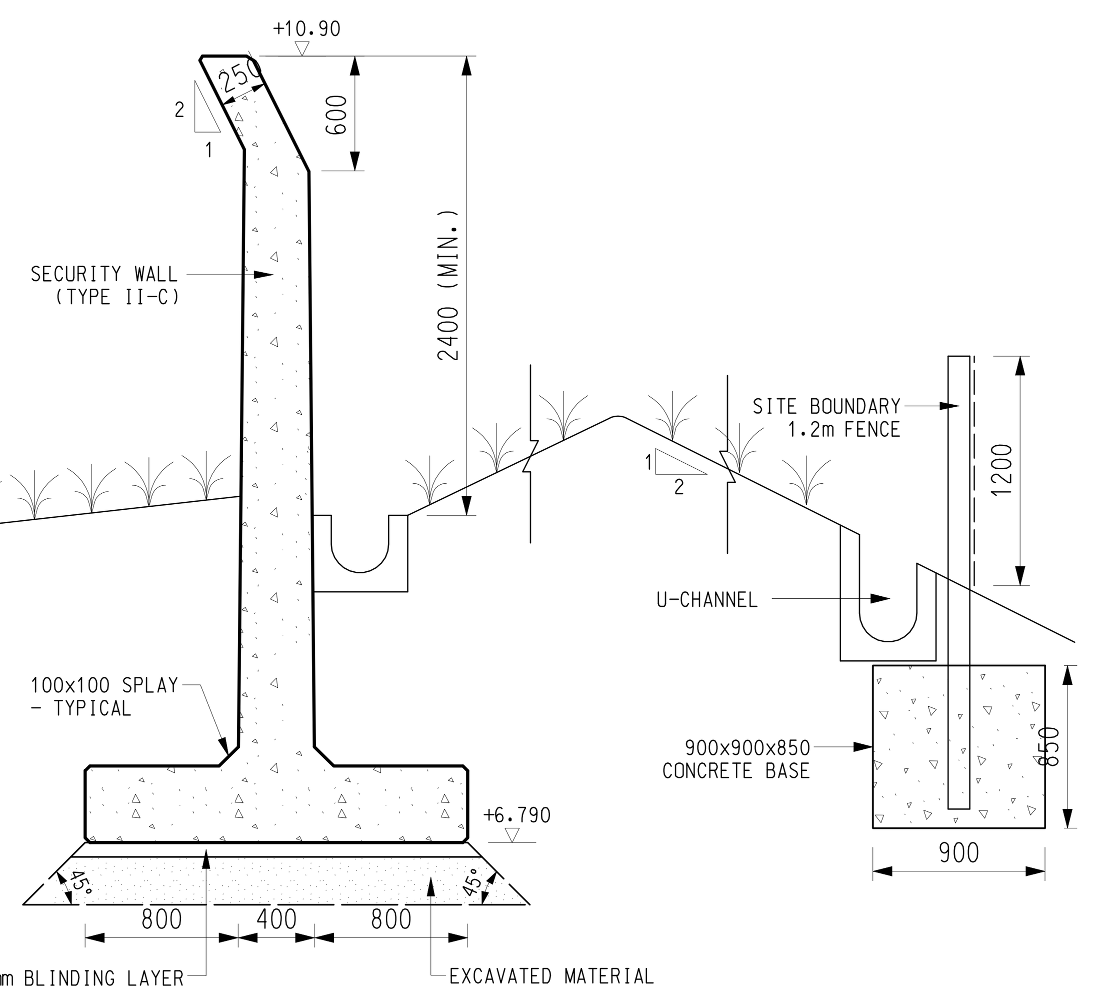
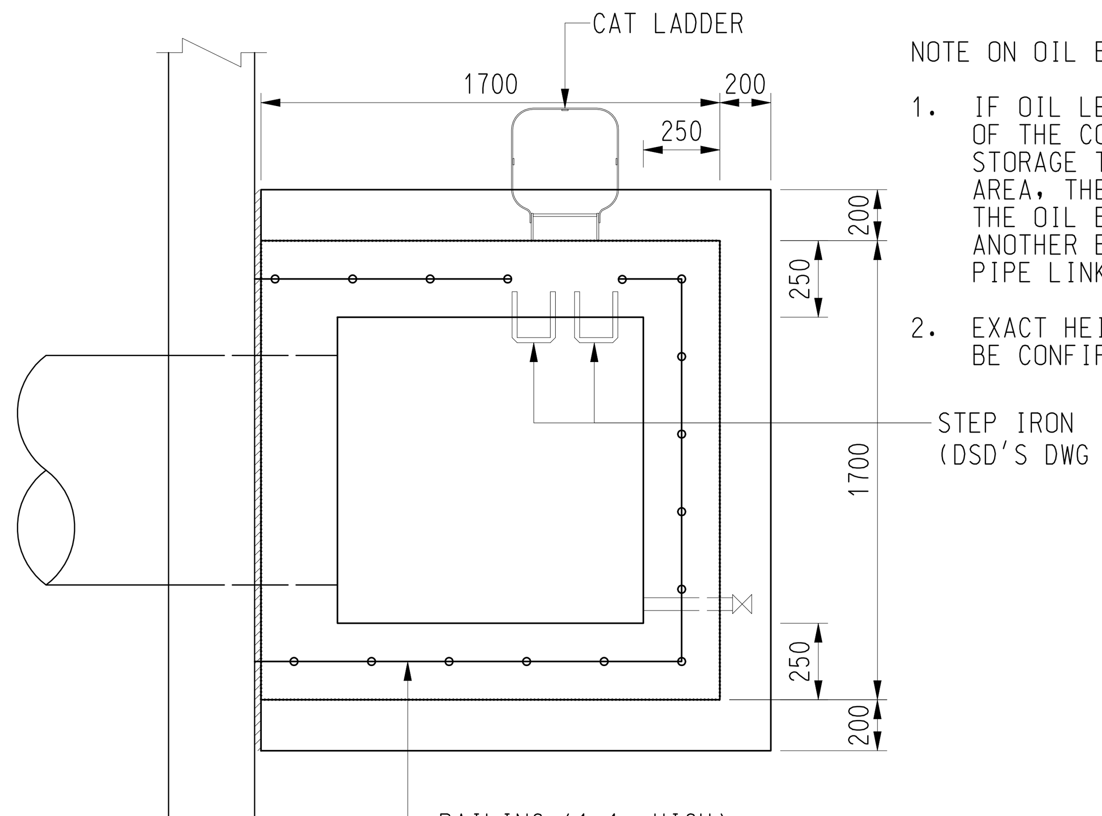


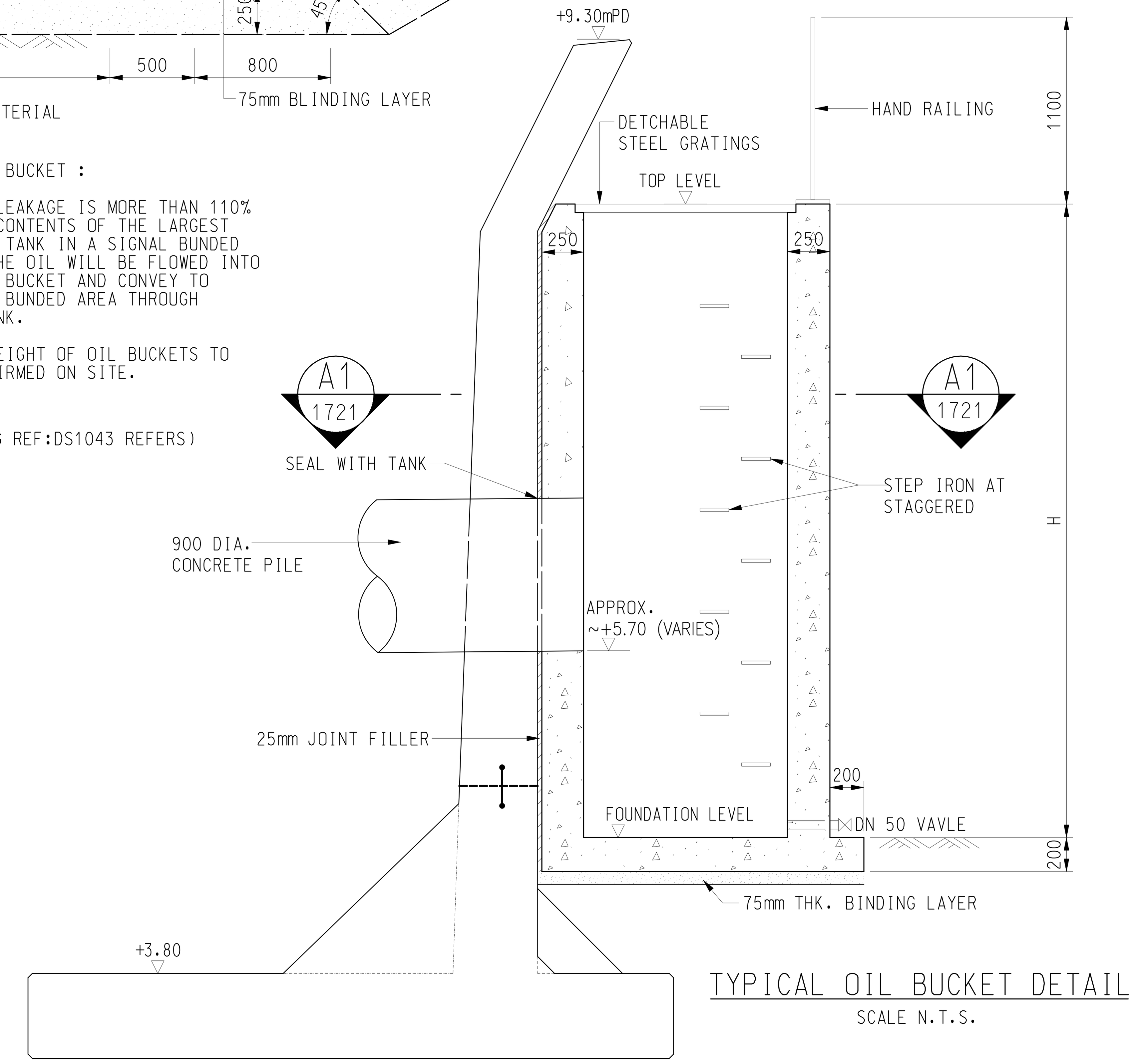


SECTION A1 (1721)
SCALE N.T.S.

NOTE ON OIL BUCKET :

1. IF OIL LEAKAGE IS MORE THAN 110% OF THE CONTENTS OF THE LARGEST STORAGE TANK IN A SIGNAL BUNDED AREA, THE OIL WILL BE FLOWED INTO THE OIL BUCKET AND CONVEY TO ANOTHER BUNDED AREA THROUGH PIPE LINK.
2. EXACT HEIGHT OF OIL BUCKETS TO BE CONFIRMED ON SITE.

	OIL BUCKET	TOP LEVEL (mPD)	FOUNDING LEVEL (APPROX.)	HEIGHT OF OIL BUCKET (H)
PHASE 1A (FOR TANKS 1 TO 6)	A1	7.96	4.54	3.42
	A2		4.57	3.39
	A3		4.61	3.35
PHASE 1B (FOR TANKS 7 TO 12)	B1	8.53	5.10	3.43
	B2		5.00	3.53
	B3		4.45	4.08



TYPICAL OIL BUCKET DETAIL
SCALE N.T.S.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
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6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	FEB 2004	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	OCT 2007	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale: AS SHOWN (A1)	Date: JAN 2006	
Designed: BW	Drawn: SKL	Checked: AS
Design Team Leader: AS		Date: JAN 2006
Approved: LHS		Date: JAN 2006

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Permanent Aviation Fuel Facility

Title
TANK FARM
BUND WALL DETAILS
(SHEET 1 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1721 Revision 3

DATE : 3/2/2009
TIME : 10:05:45 AM
PLOT DRV: $PLTDRVL$

FILENAME : S:\Drawings\DGN\Babtie\20090225\1721-3.dgn

BD REF. NO. 3/0001/02

NOTES :
1. FOR GENERAL NOTES REFER TO DWG. NO. PAFF/BA/02/DWG/C/1721.

SECTION B
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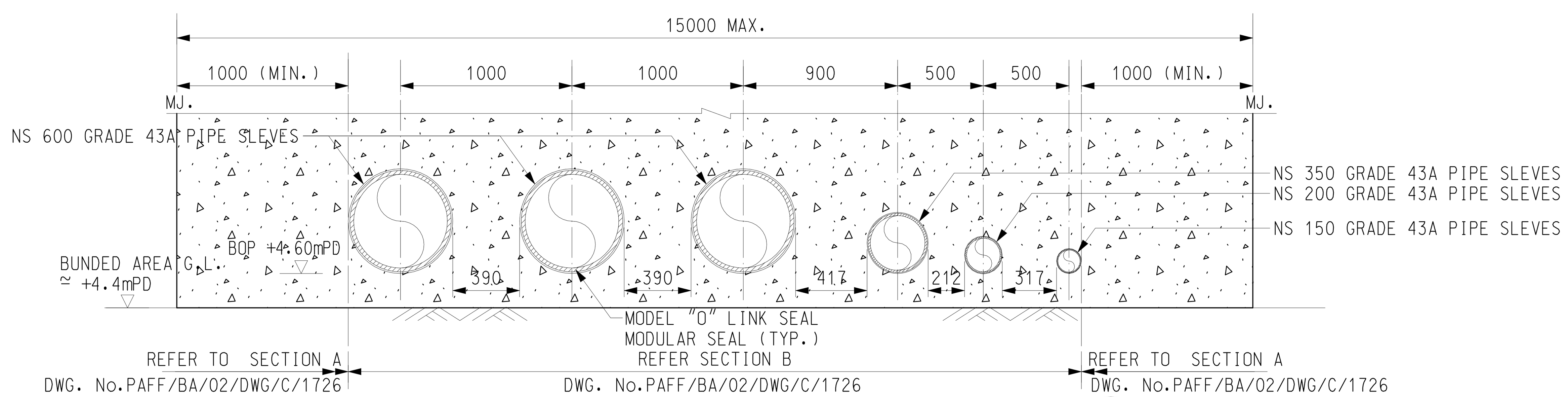
1720



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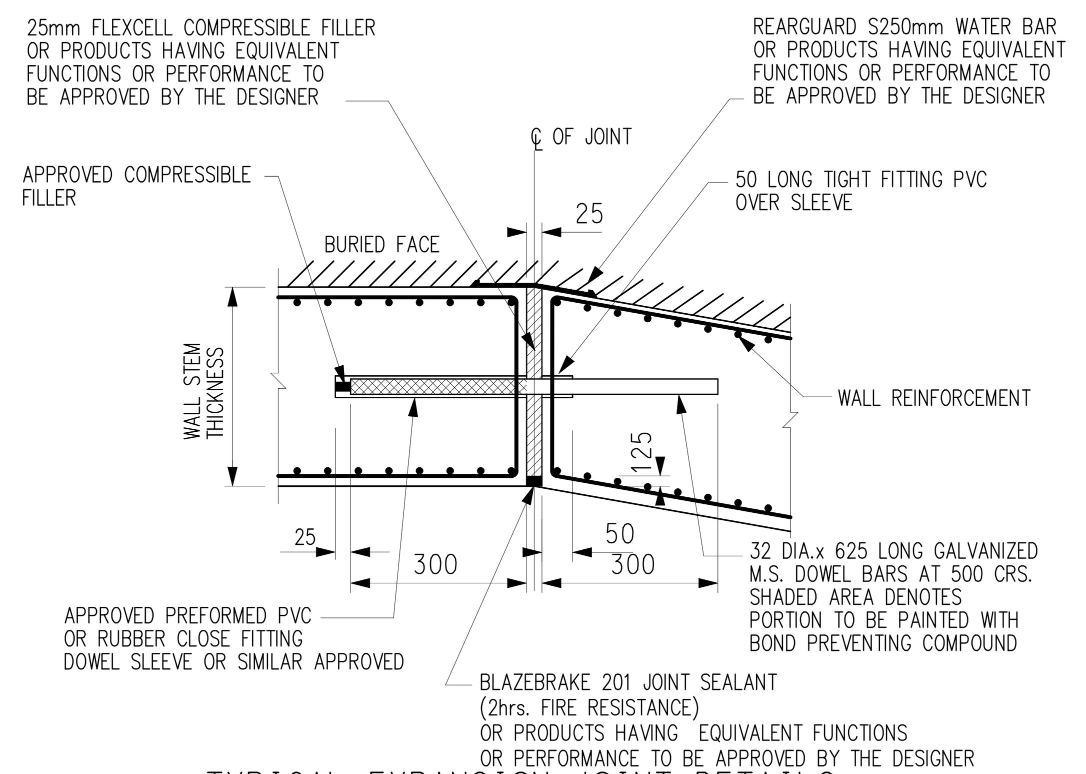
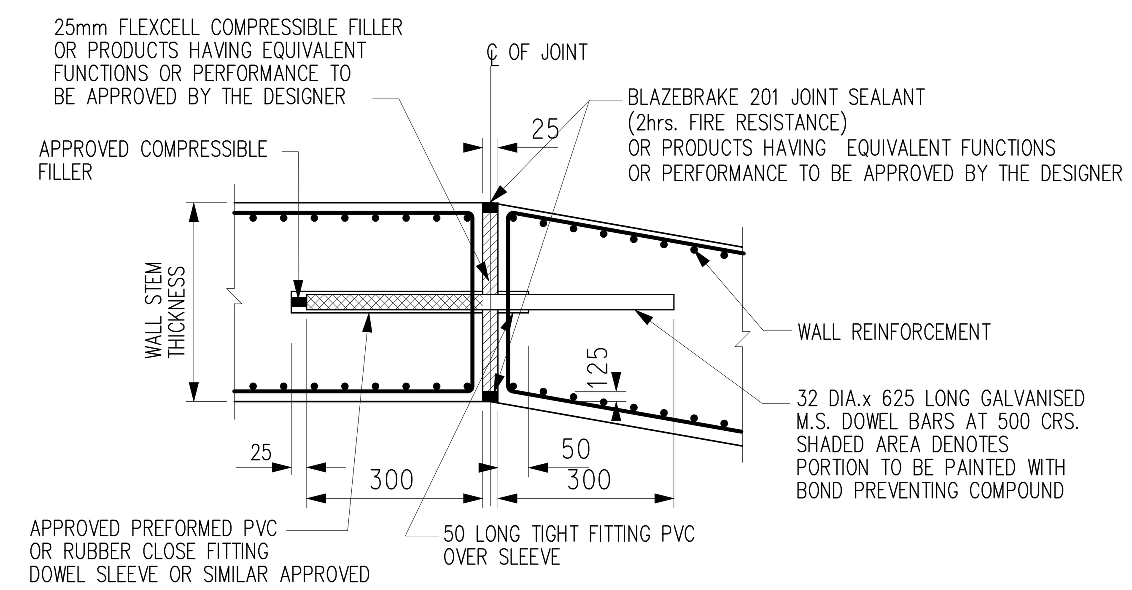
REFER SECTION B DWG. No.PAFF/BA/02/DWG/C/1726

REFER TO SECTION A DWG. No.PAFF/BA/02/DWG/C/1726

FRONT VIEW OF BUND WALL WITHIN BUNDED AREA
6
1720
SCALE: N.T.S.



TYPICAL EXPANSION JOINT DETAILS
FOR SECURITY WALLS & BUND WALL TYPE A
AT THE BEND WHERE ONE FACE IS BURIED
SCALE: N.T.S.



TYPICAL EXPANSION JOINT DETAILS
FOR SECURITY WALLS & BUND WALL TYPE A
AT THE BEND WHERE BOTH FACES ARE EXPOSED
SCALE: N.T.S.

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Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	OCT 2007	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale		Date
1:25 (A1)		OCT 2002
Designed	Drawn	Checked
BW	SKL	AS
Design Team Leader		Date
AS		OCT 2002
Approved		Date
LHS		OCT 2002

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Permanent Aviation Fuel Facility

Title
TANK FARM
BUND WALL DETAILS
(SHEET 2 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1722 Revision 3

DATE : 3/2/2009
TIME : 10:06:04 AM
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BD REF. NO. 3/0001/02

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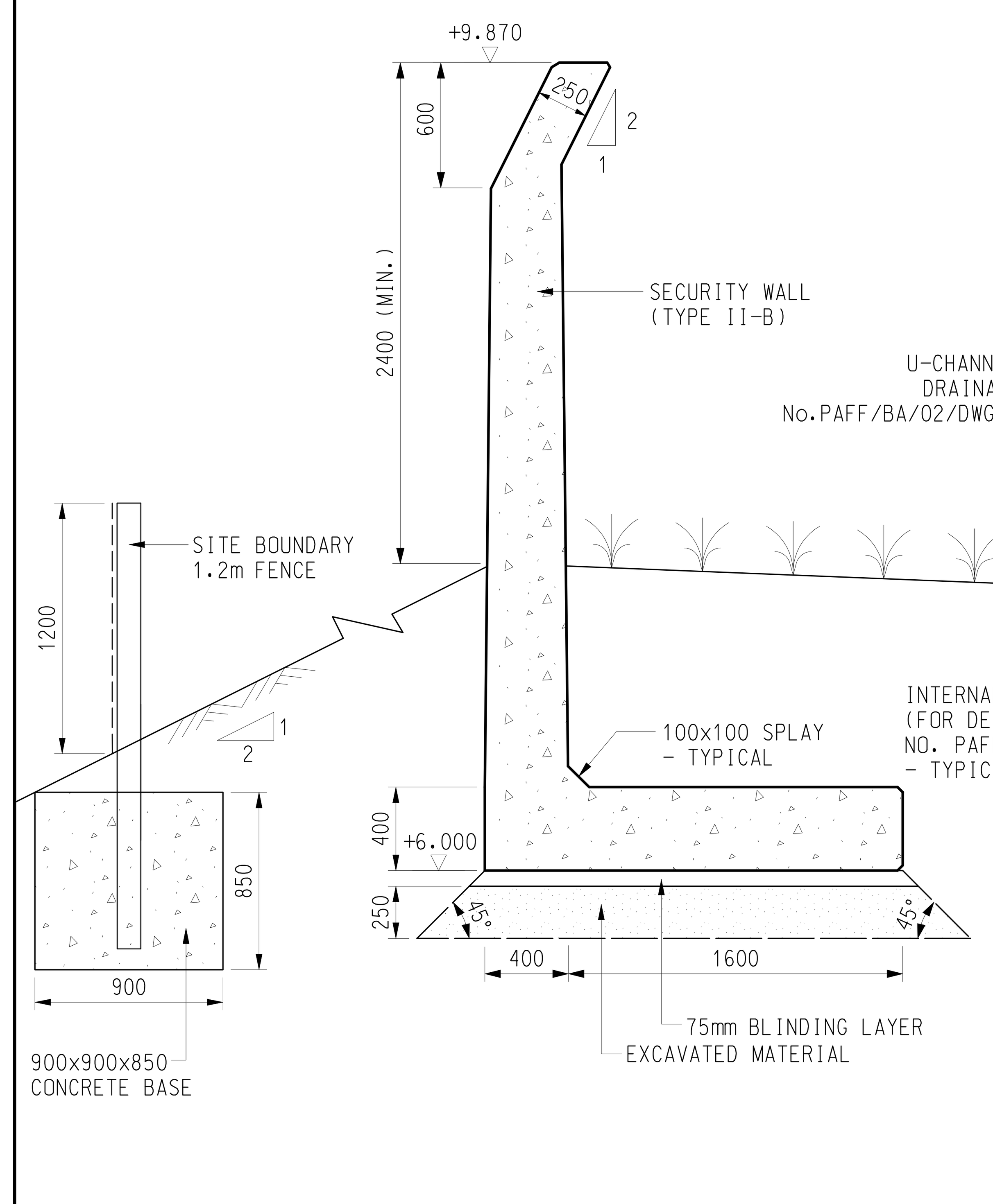
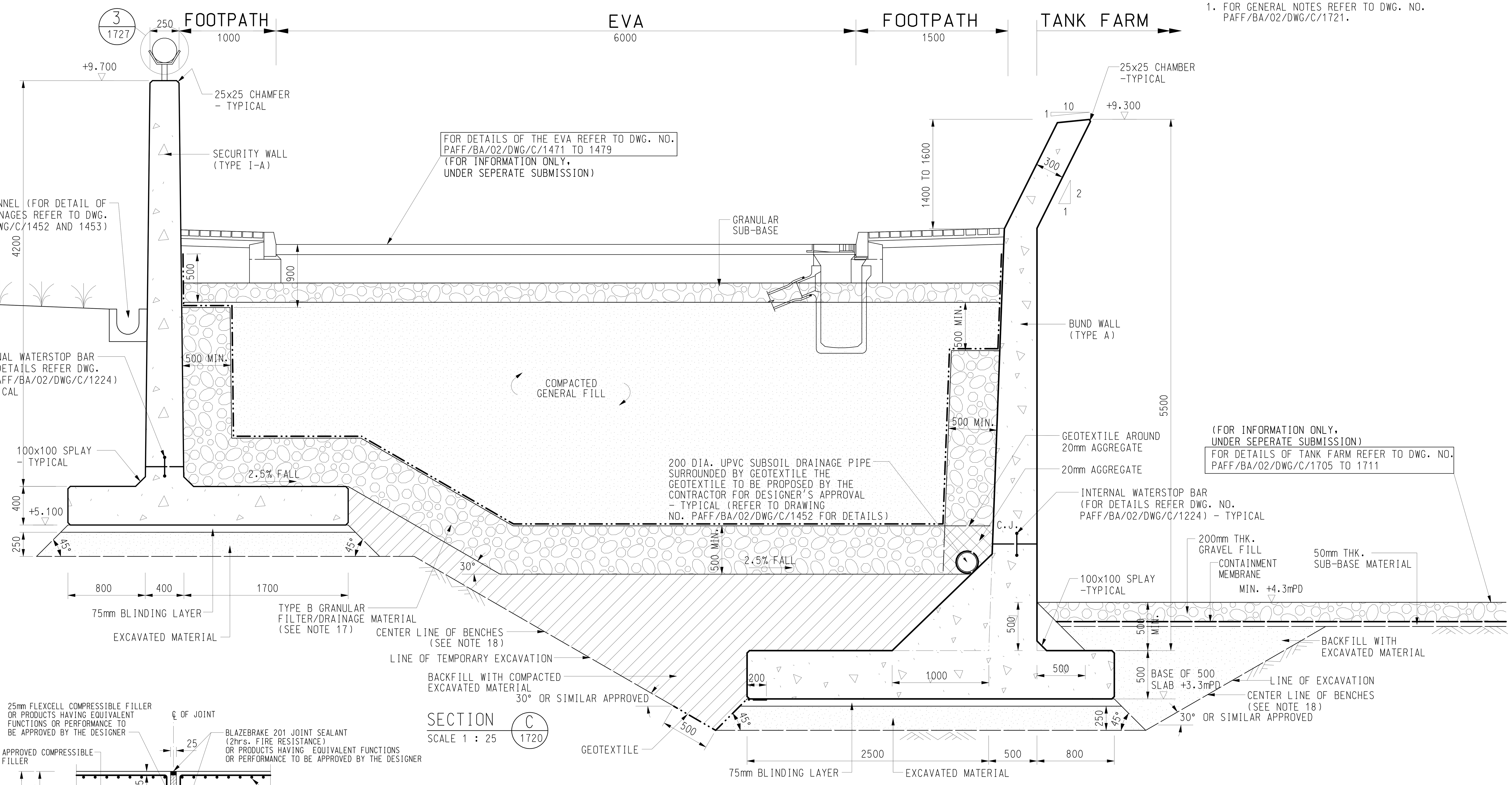

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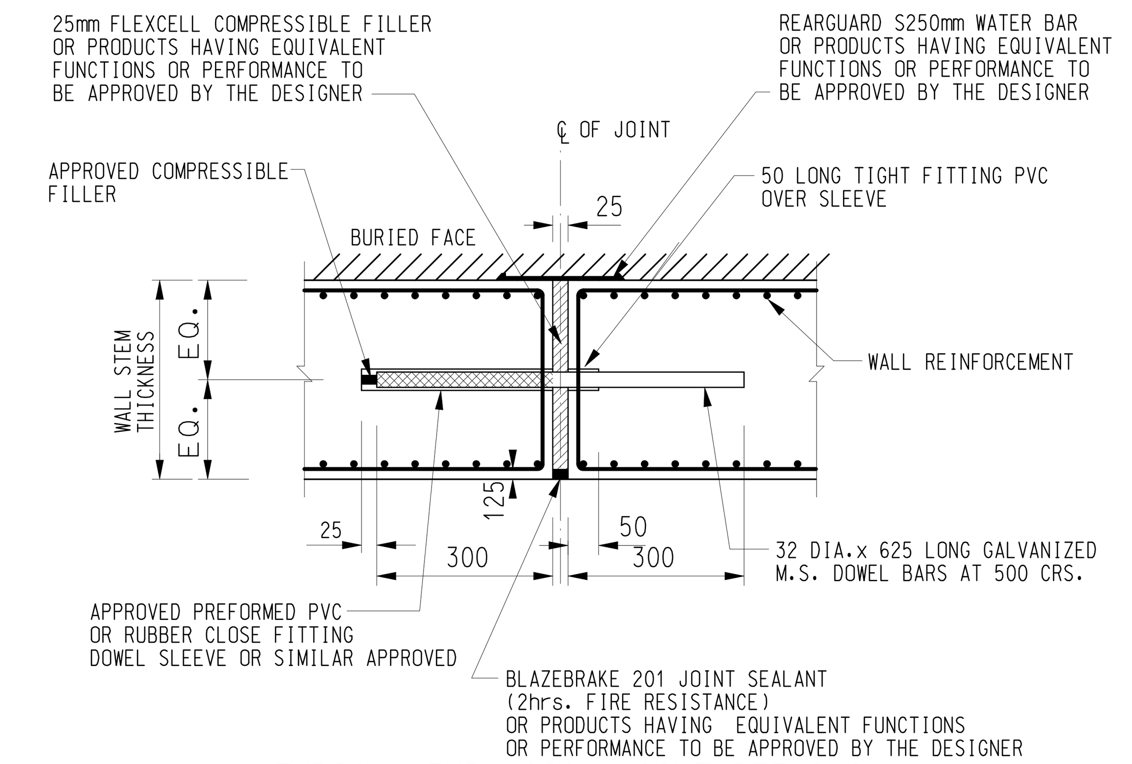

TYPICAL EXPANSION JOINT DETAILS
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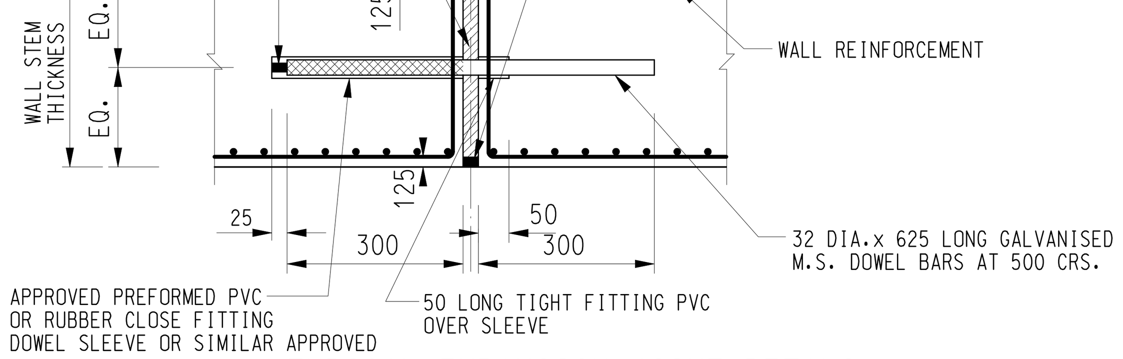
WHERE ONE FACE IS BURIED AND
BASE SLAB OF BUND WALL TYPE B



TYPICAL EXPANSION JOINT DETALS
FOR SECURITY WALLS AND BUND WALL TYPE A
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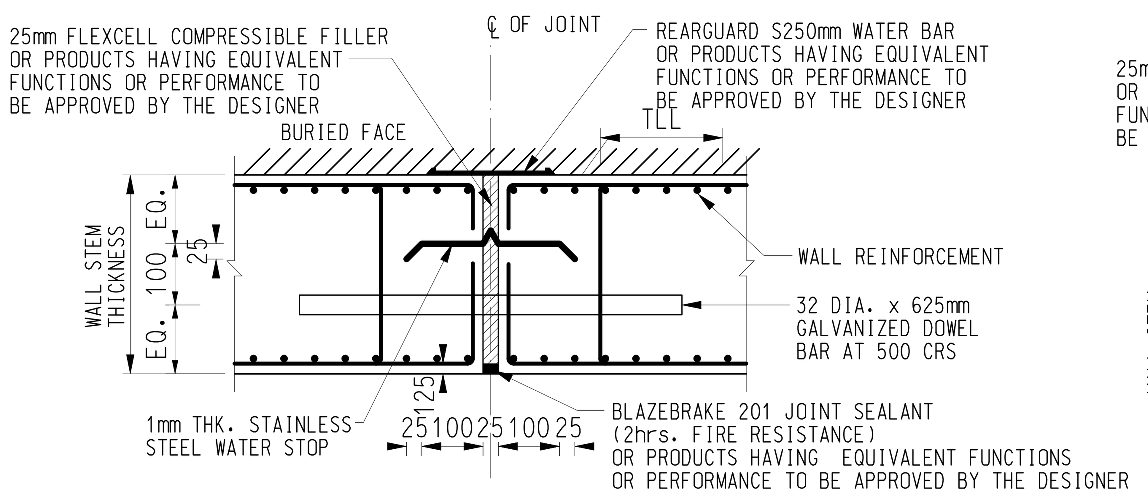

TYPICAL EXPANSION JOINT DETAILS
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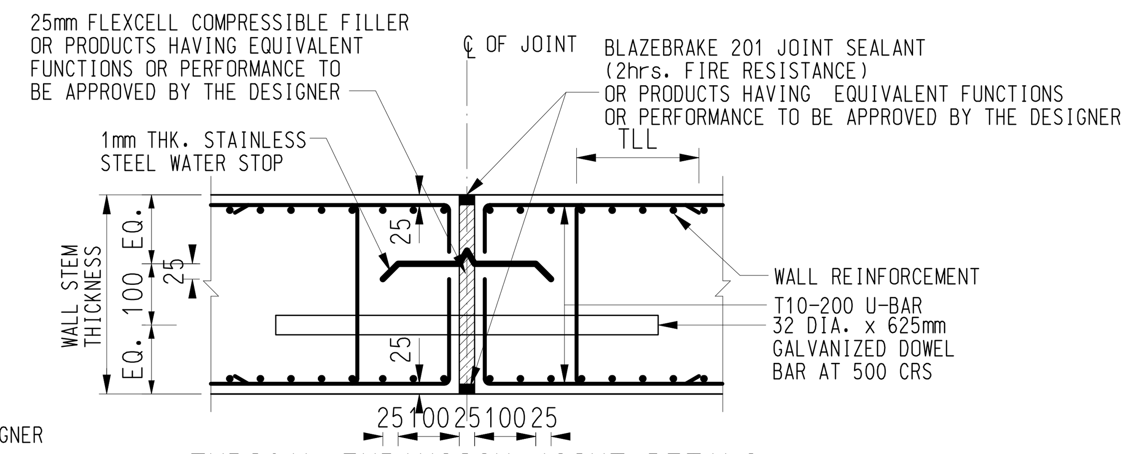

TYPICAL EXPANSION JOINT DETALS
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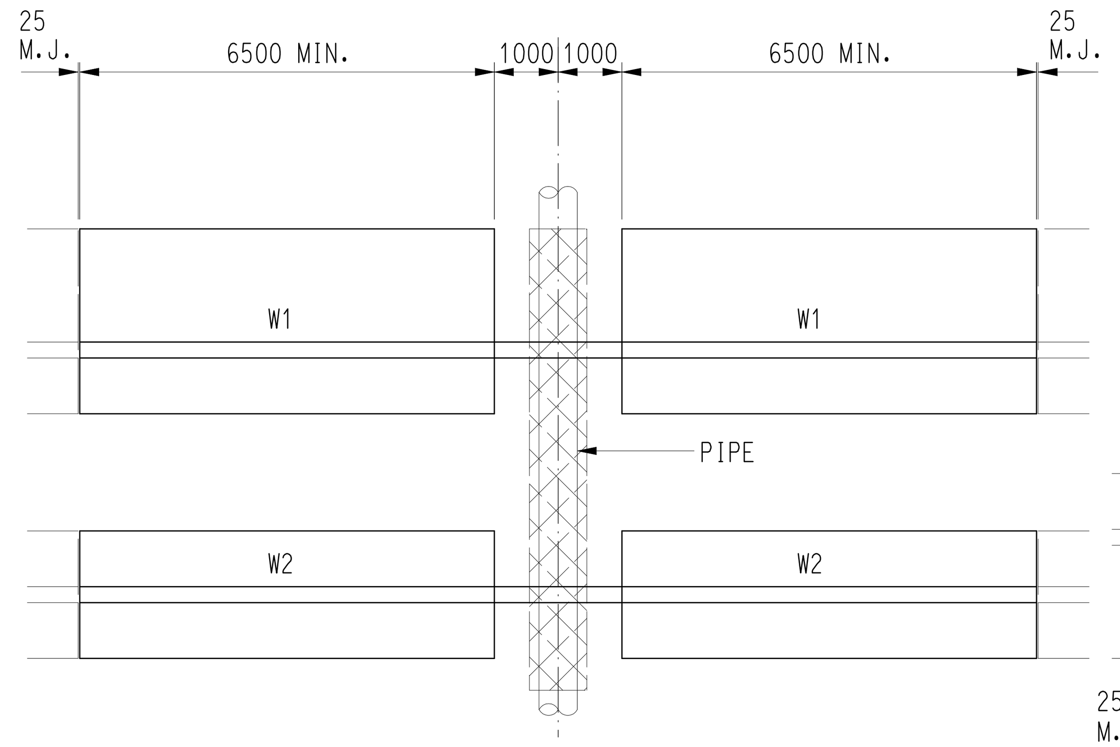
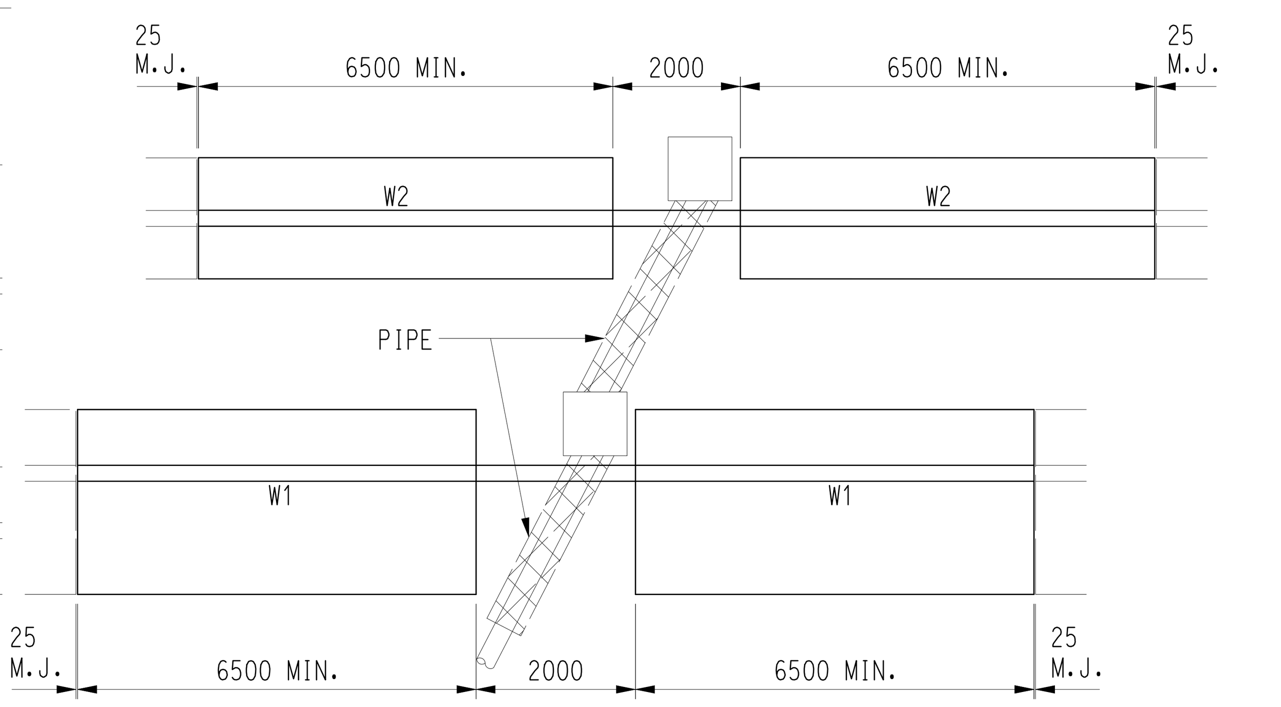


DETAIL 4 / 1720



DETAIL 5 / 1720

Notes:
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Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	SEP 2008	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale		Date
1:25 (A1)		OCT 2002
Designed BW	Drawn SKL	Checked AS
Design Team Leader AS		Date OCT 2002
Approved LHS		Date OCT 2002

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Permanent Aviation Fuel Facility

Title
TANK FARM
BUND WALL DETAILS
(SHEET 3 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1723 Revision 3

DATE : 3/2/2009
TIME : 10:06:23 AM
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FILENAME : S:\Drawings\DGN\Babtie\20090225\1723-3.dgn

BD REF. NO. 3/0001/02

NOTES :
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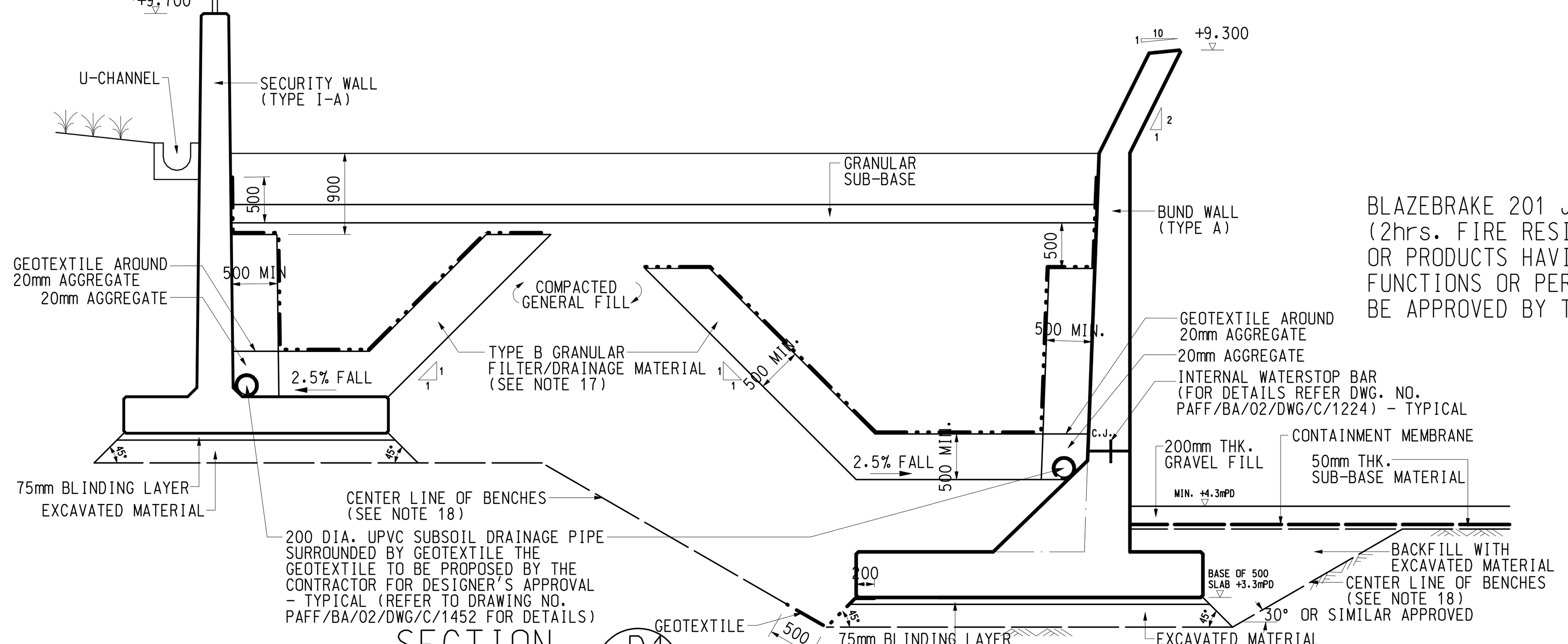

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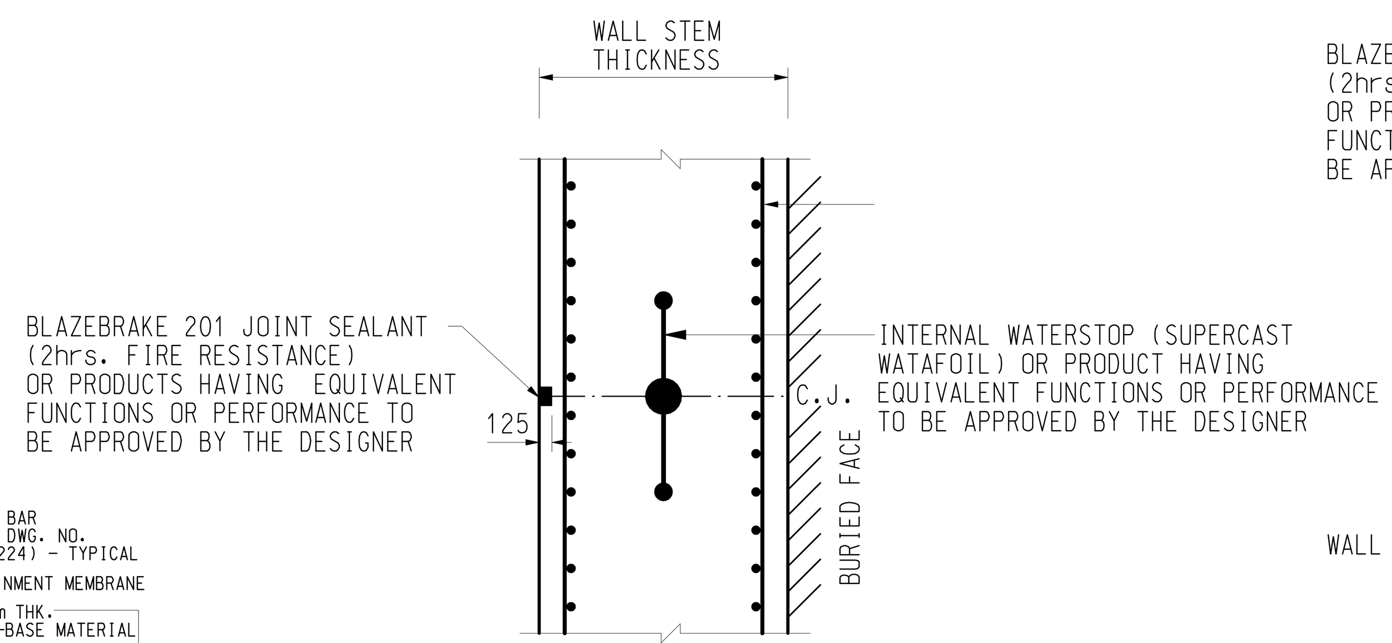

TYPICAL CONSTRUCTION JOINT DETAILS
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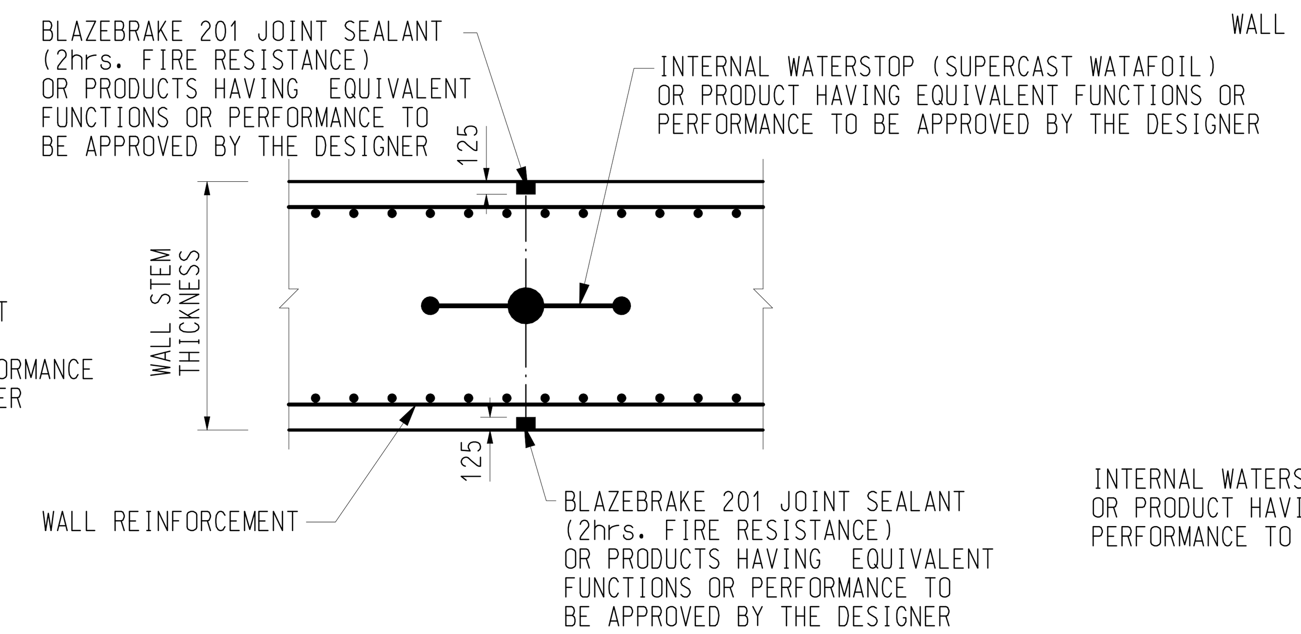
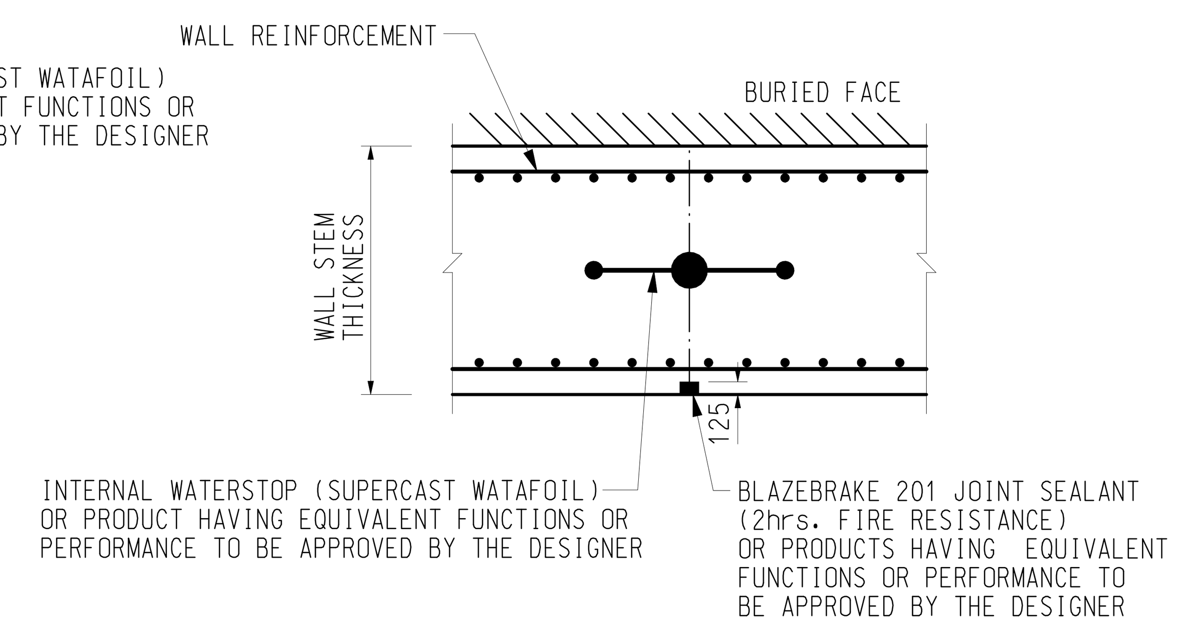


TYPICAL CONSTRUCTION JOINT DETAILS
WHERE BOTH FACES ARE EXPOSED
(VERTICAL SECTION)
N.T.S.



TYPICAL CONSTRUCTION JOINT DETAILS
WHERE ONE FACE IS EXPOSED
(VERTICAL SECTION)
N.T.S.

Notes:
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Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	OCT 2007	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale: 1:25 (A1)		Date: OCT 2002
Designed: BW	Drawn: SKL	Checked: AS
Design Team Leader: AS		Date: OCT 2002
Approved: LHS		Date: OCT 2002

ECO

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Permanent Aviation Fuel Facility

Title
TANK FARM
BUND WALL DETAILS
(SHEET 4 OF 4)

Drawing No. PAFF/BA/02/DWG/C/1724 Revision 3

DATE : 3/2/2009
TIME : 10:06:50 AM
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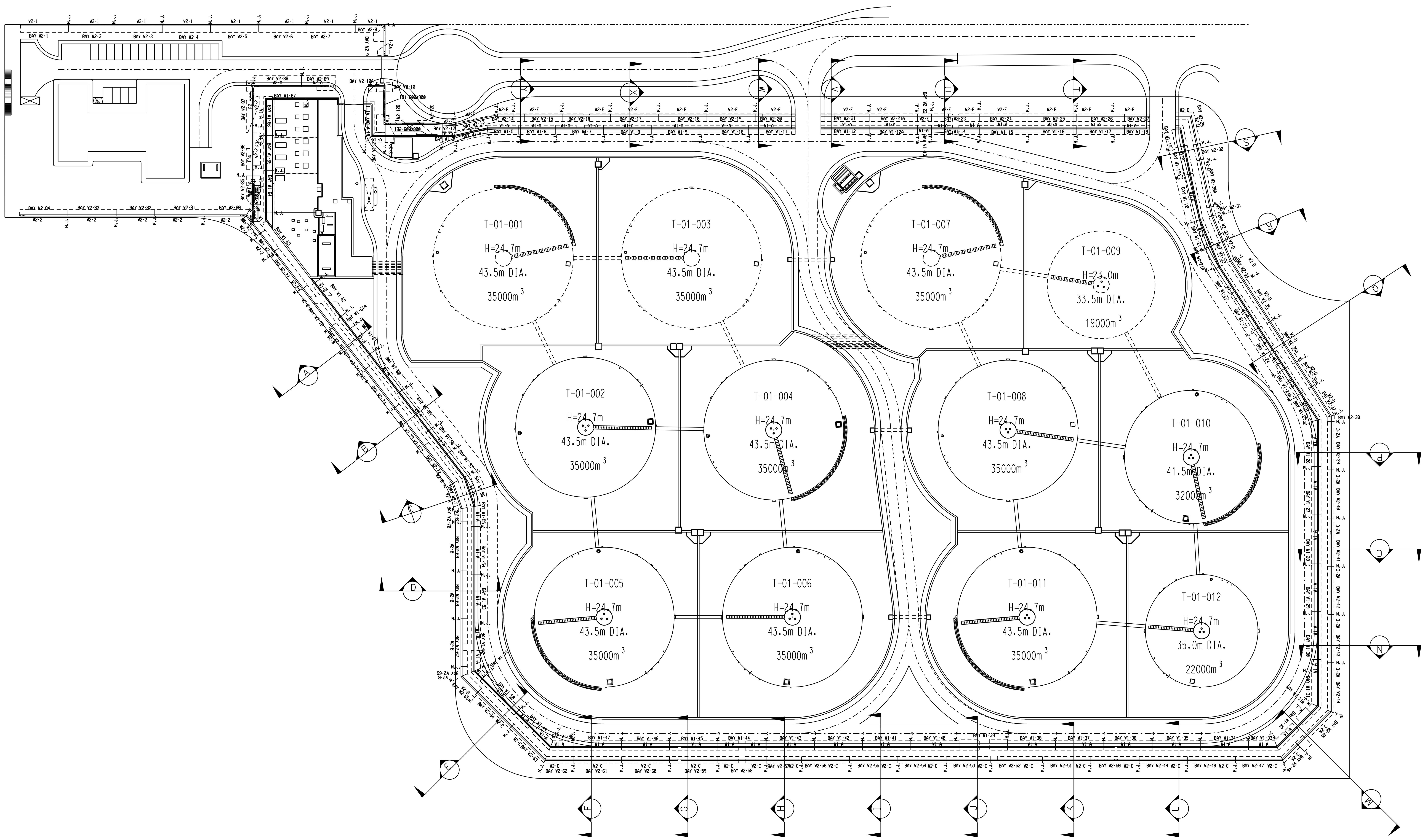

Notes:
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Rev.	Date	Description	Checked
A	2-04-09	For Review	
B	19-11-09	LANDSCAPING STAGE REMOVED	

Scale FOR A1 1:700 | Date 02-04-2009
Designed D.H | Drawn KY.LUI | Checked Dan.L
Design Team Leader | Date
Approved | Date

ECO

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Fax: (852) 2565 5561

Permanent Aviation Fuel Facility
Title
LANDSCAPING AREA'S
Project | Originator | Location | Category | Discipline | Number | Revision
Drawing No. PAFF/LC/02/DWG/C/0865 | B

DATE : 11/19/2009
TIME : 4:22:49 PM

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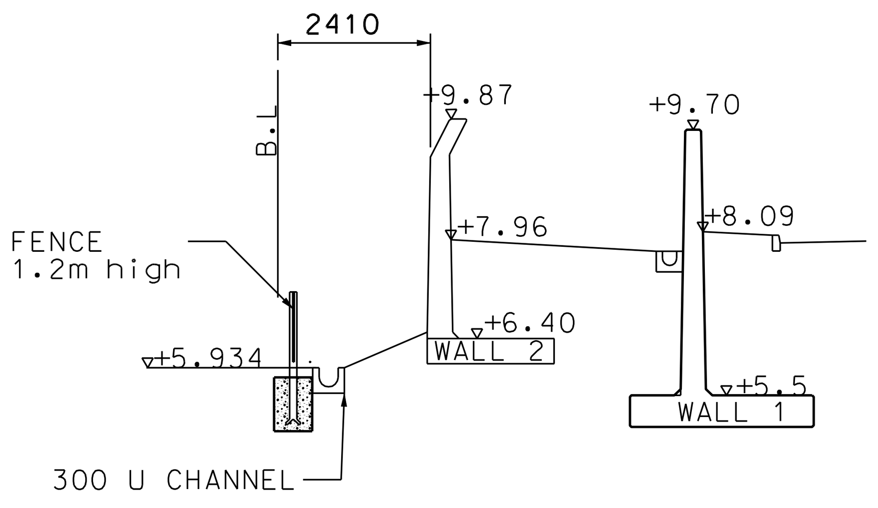
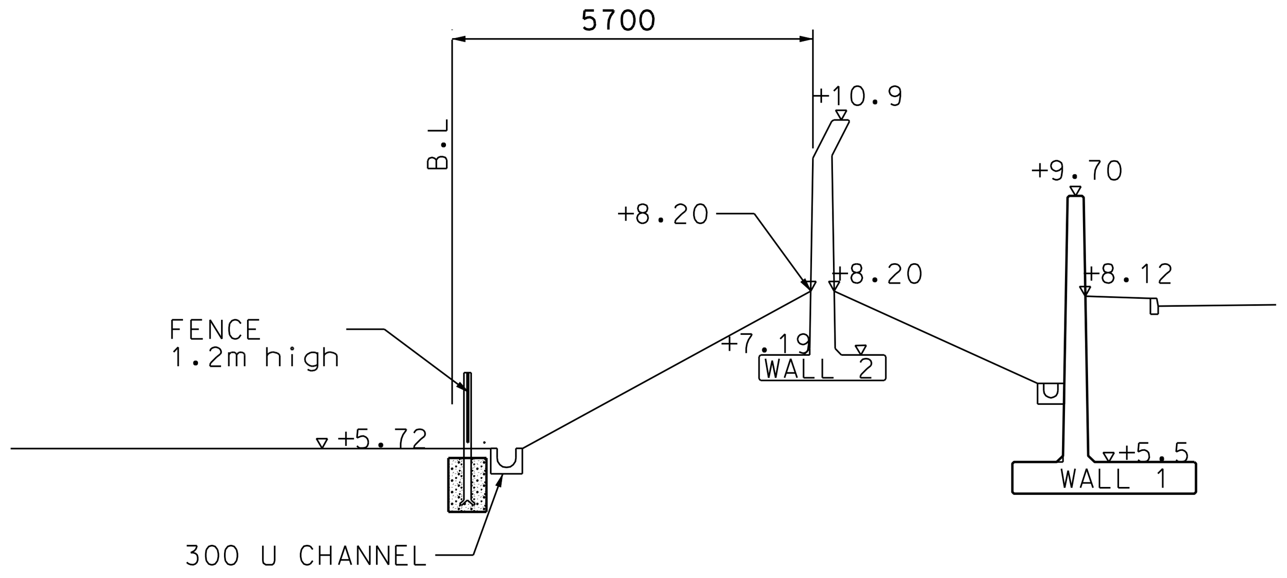


SECTION C-C



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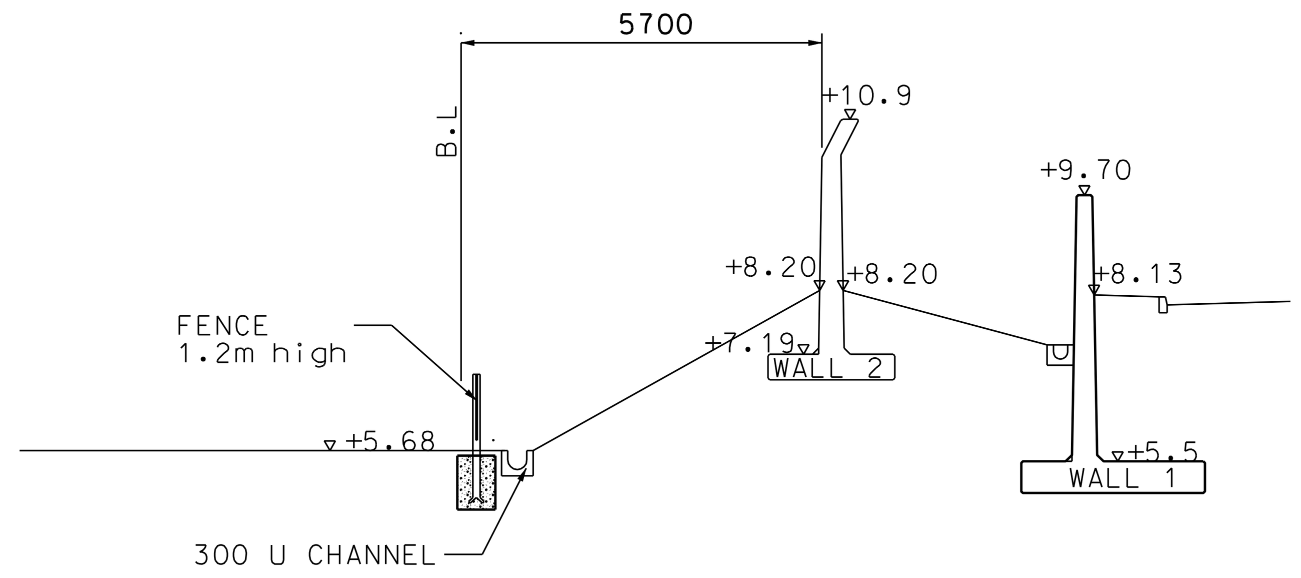

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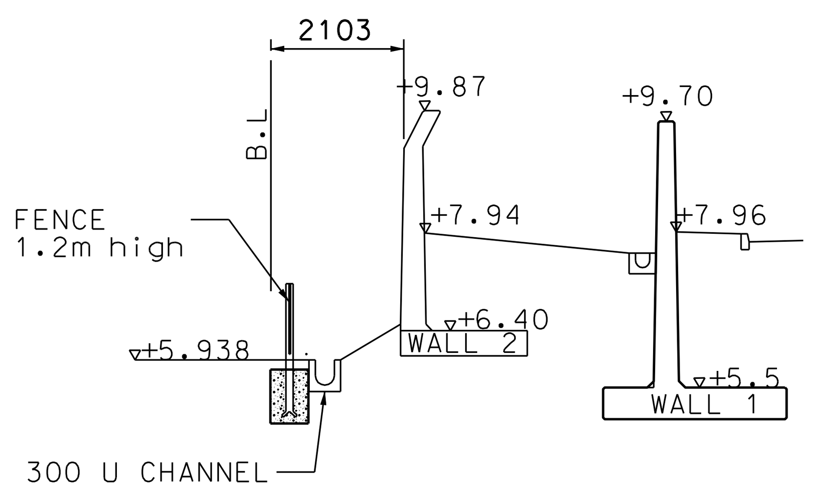

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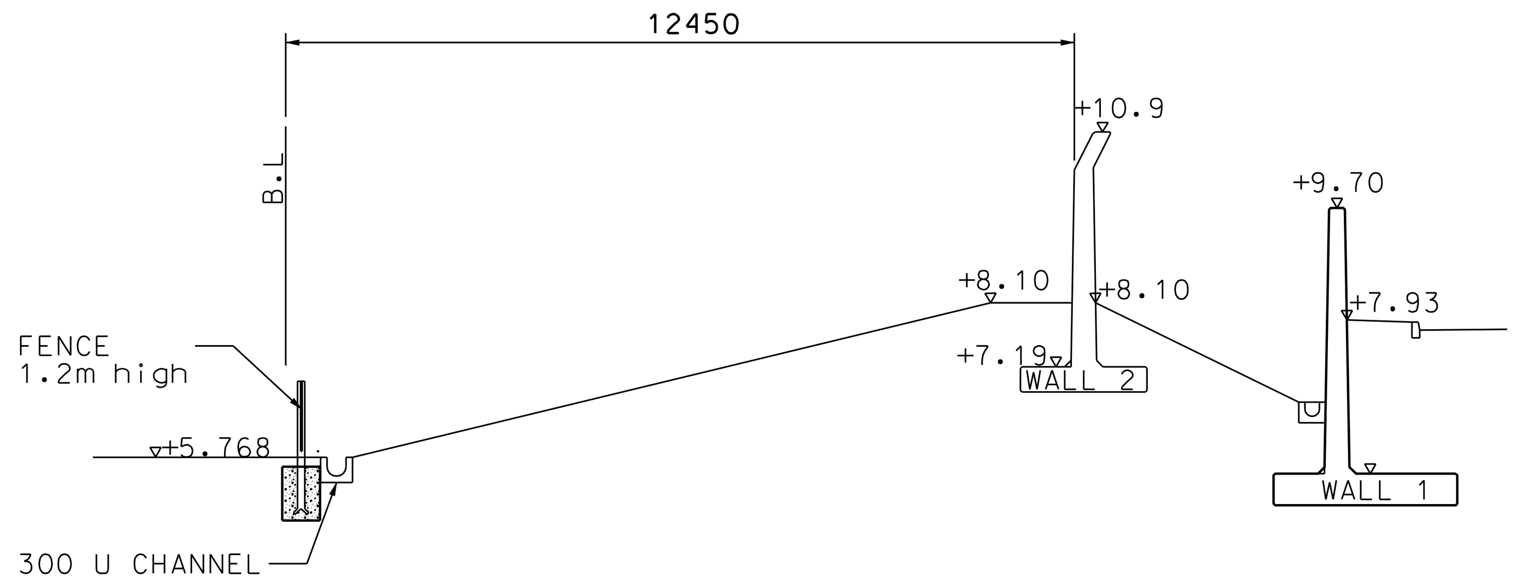

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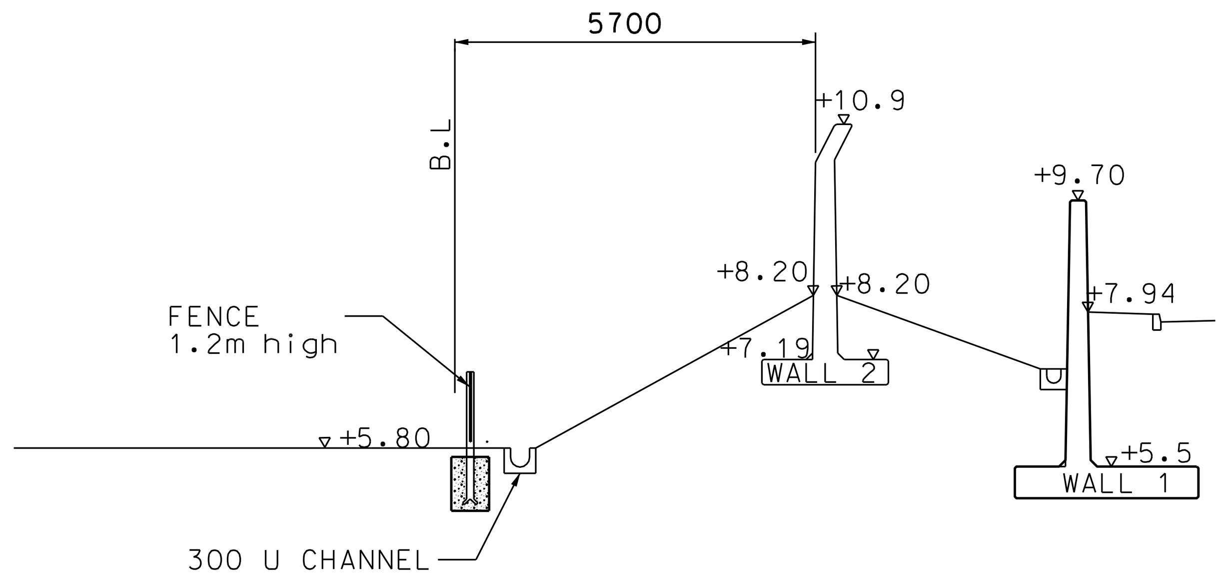

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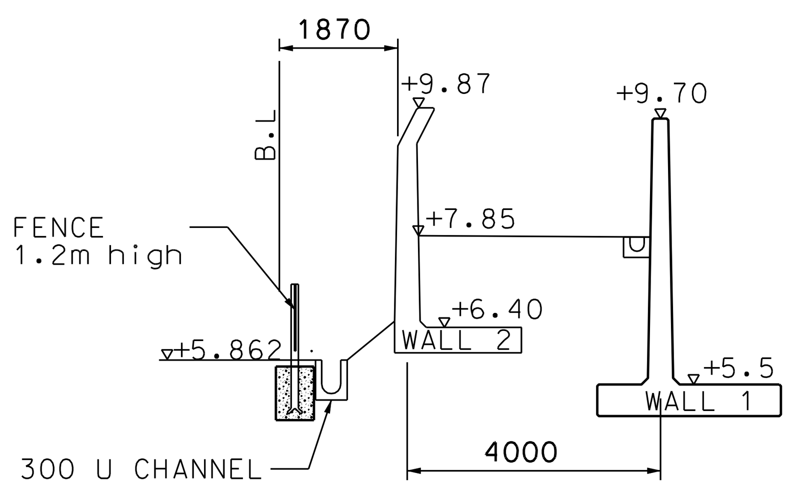

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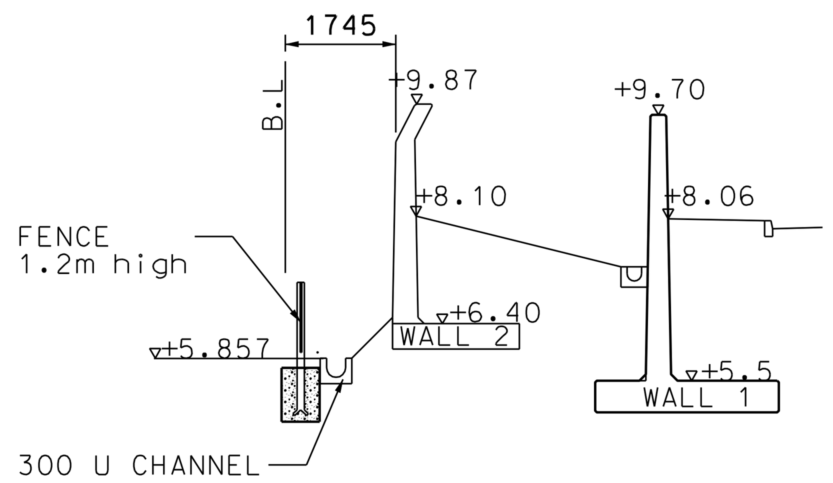

SECTION D-D

Notes:
1. Measurements are based on metric system.
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Rev.	Date	Description	Checked
A	02-04-09	For Review	
B	19-11-09	AS BUILT PROFILE ADDED	

Rev.	Date	Description	Checked

Scale: For A1 1:100
Date: 02-04-209
Designed: D.H | Drawn: KY.LUI | Checked: Dan.L
Design Team Leader | Date
Approved | Date

ECO

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Permanent Aviation Fuel Facility
Title: Fill Between Site Boundary And Security Wall (Sheet 1 of 3)

Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No. PAFF/LC/02/DWG/C/0866	B

DATE : $DATE$
TIME : $TIME$
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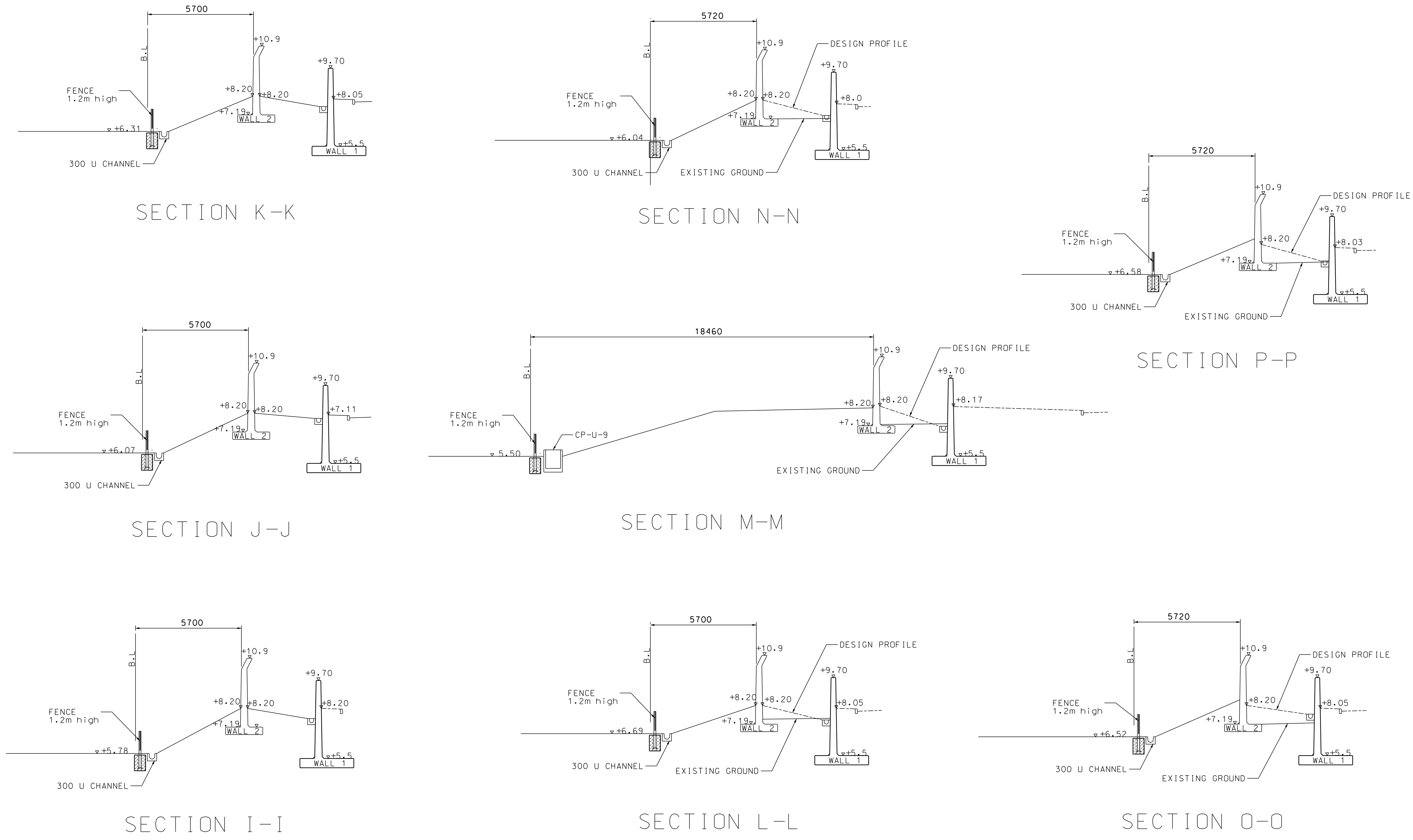

Notes:
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Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
A	02-04-09	For Review					
B	19-11-09	AS BUILT PROFILE ADDED					

Scale		Date
For A1 1:100		
Designed	Drawn	Checked
Design Team Leader		Date
	02-04-209	
Approved		Date
D.H	KY.LUI	Dan.L

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Permanent Aviation Fuel Facility

Title: Fill Between Site Boundary And Security Wall (Sheet 2 of 3)

Drawing No. (Project / Originator / Location / Category / Discipline / Number)	Revision
PAFF/LC/02/DWG/C/0867	B

DATE : $DATE$ TIME : $TIME$

FILENAME : $FILE$

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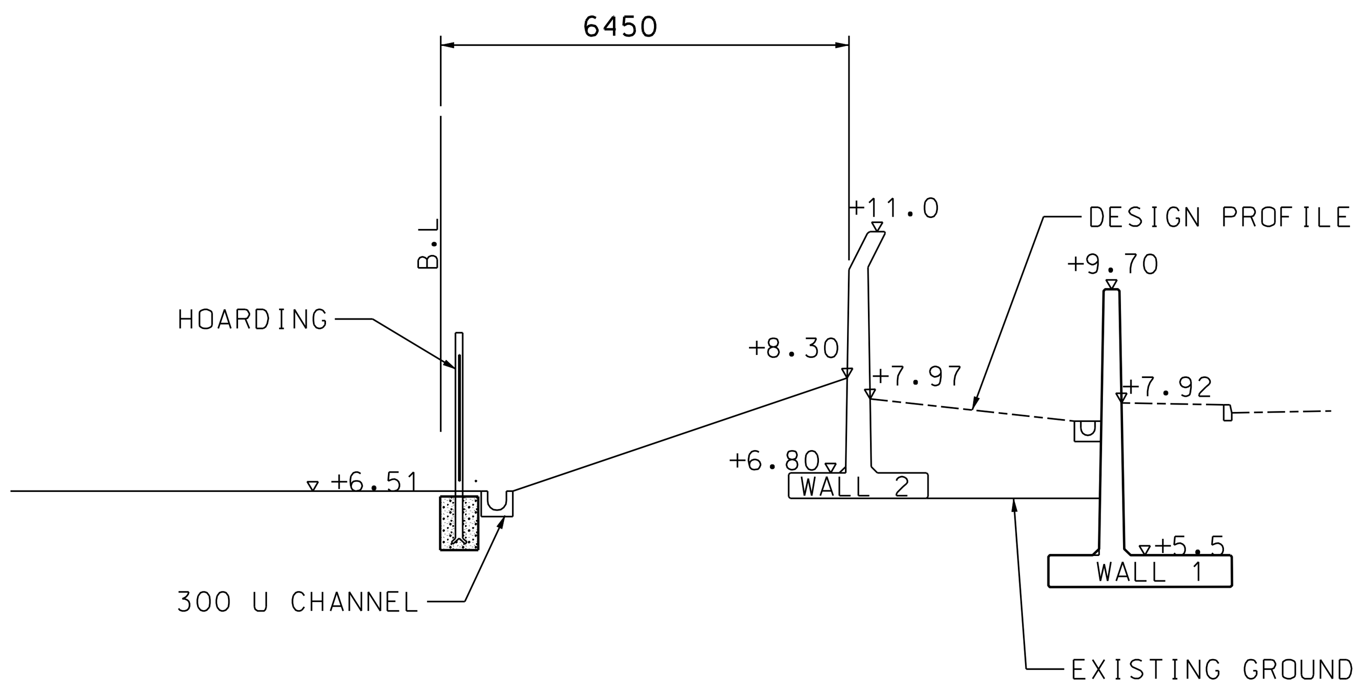

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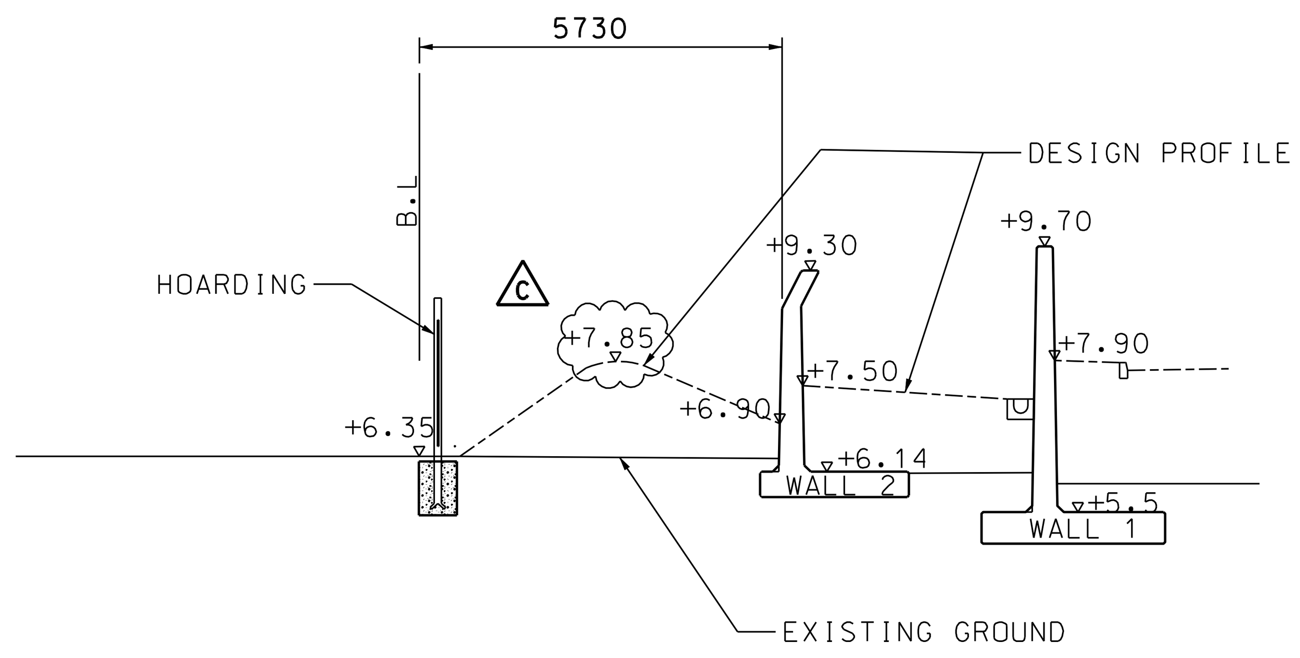

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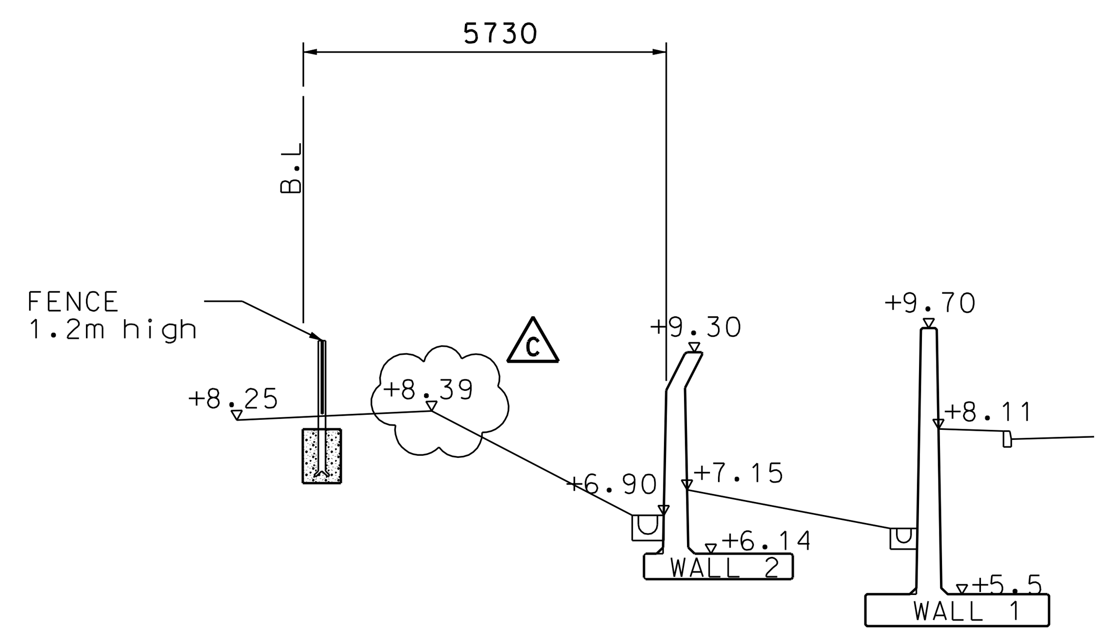

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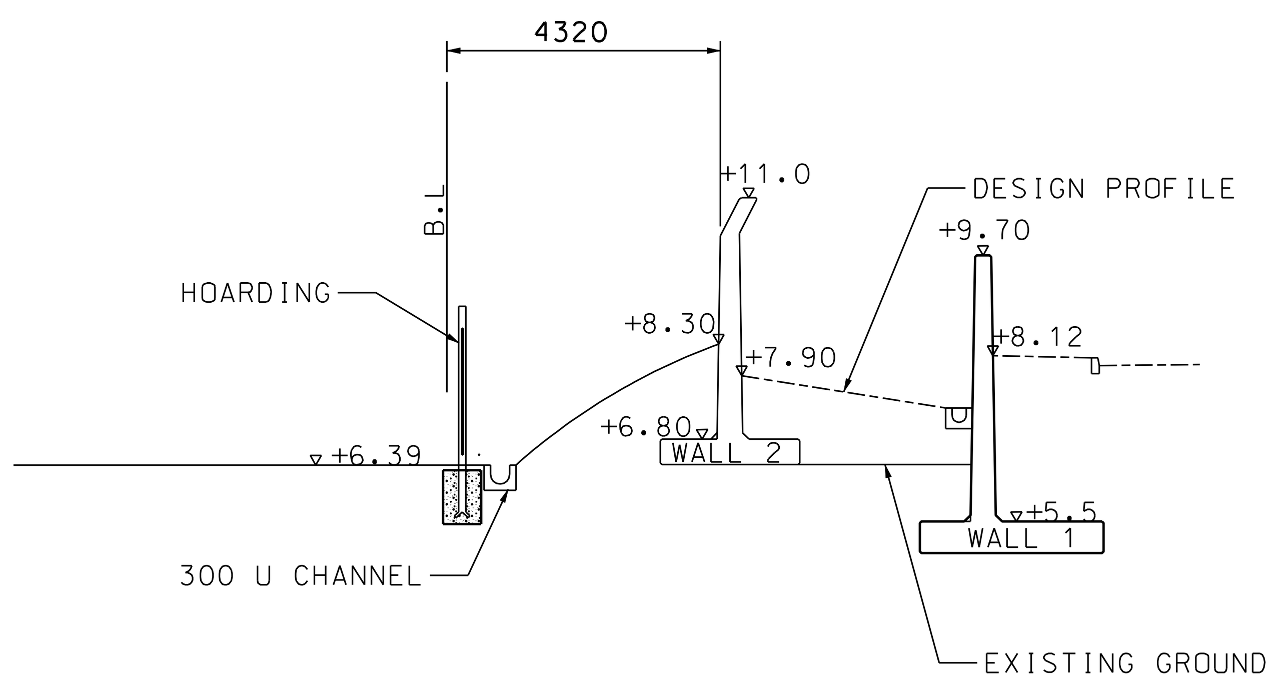

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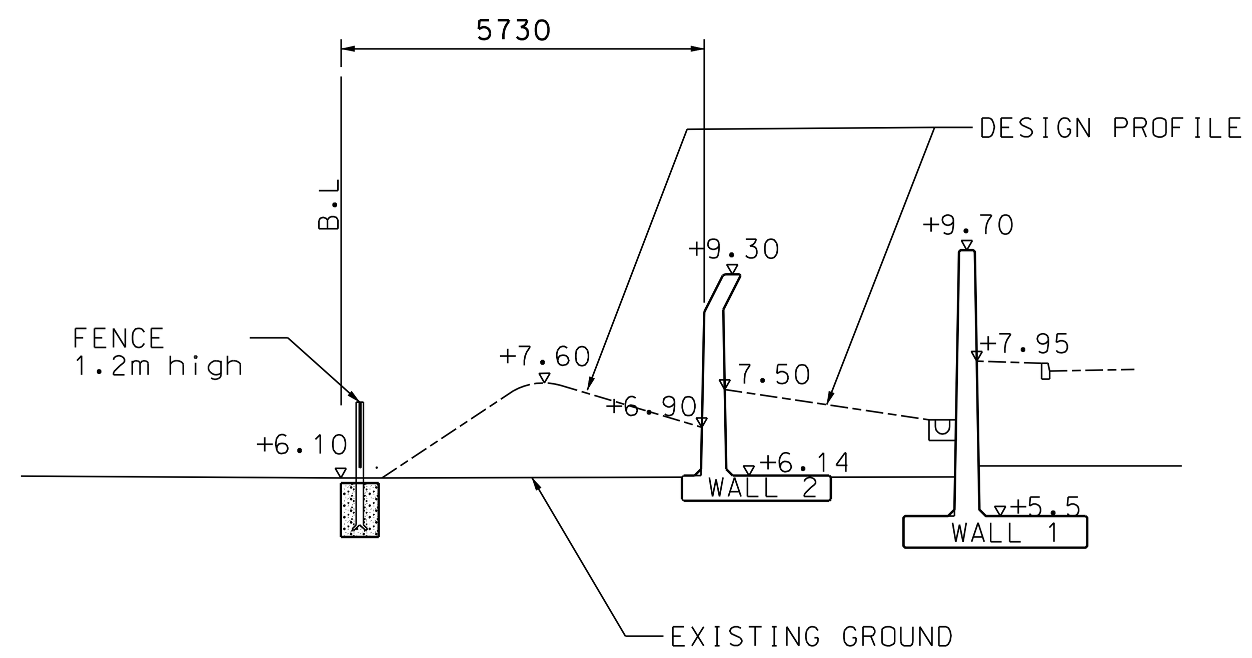

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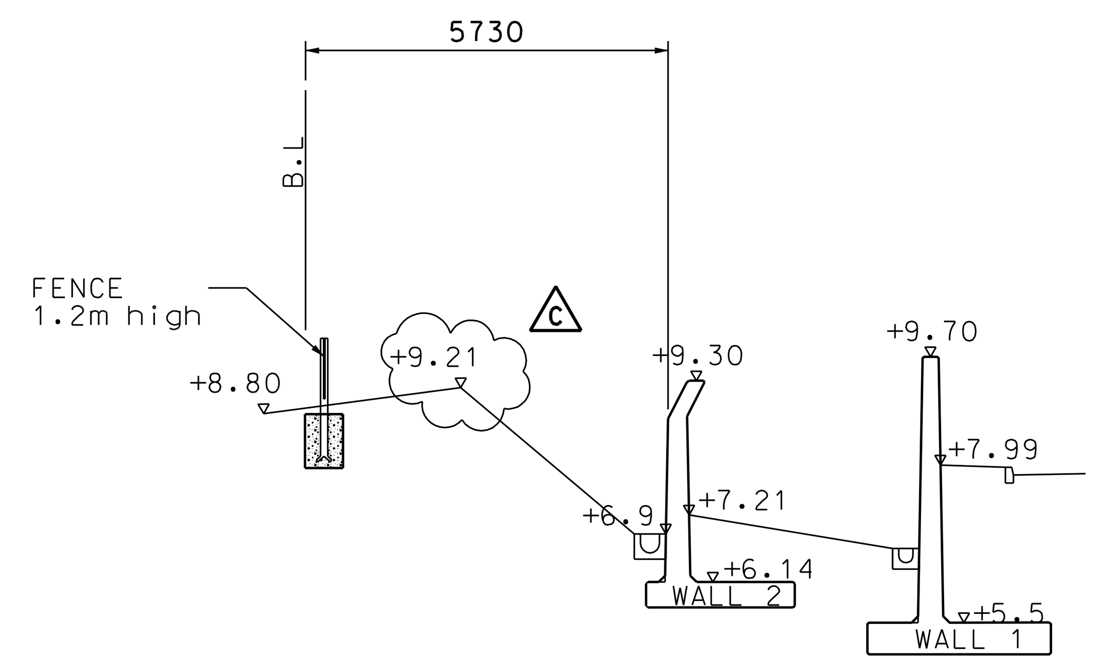

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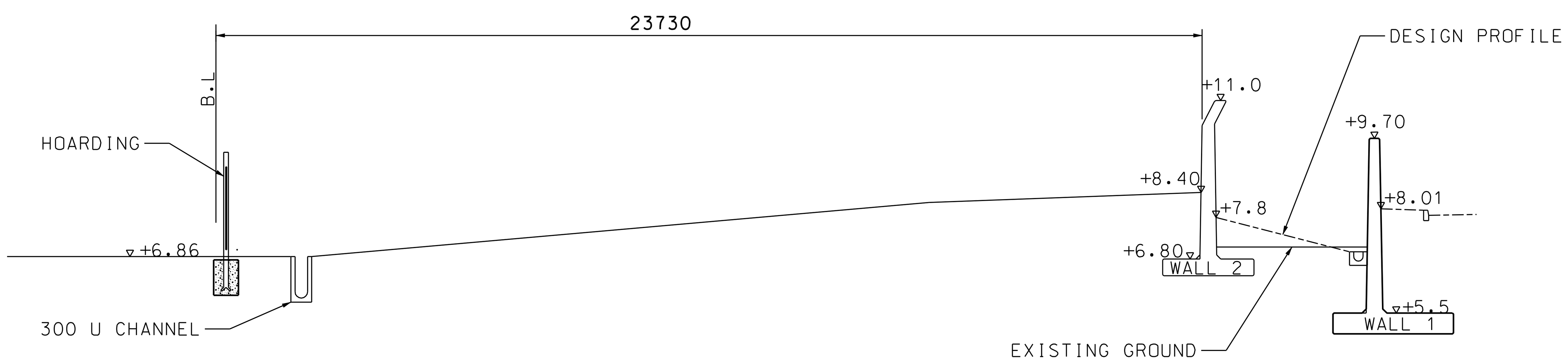

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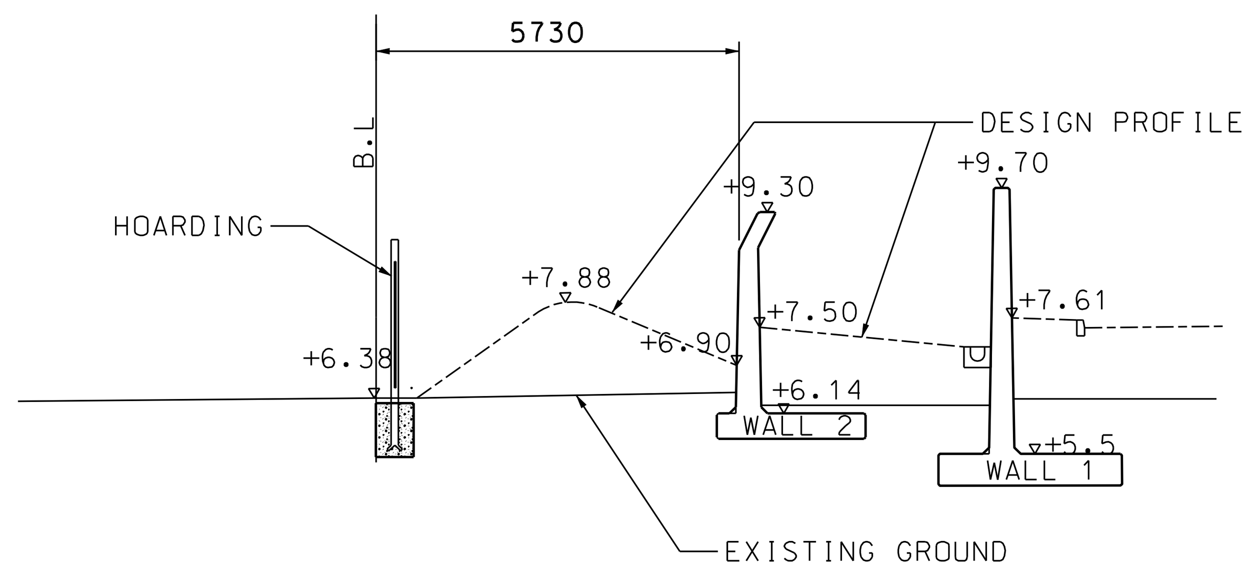

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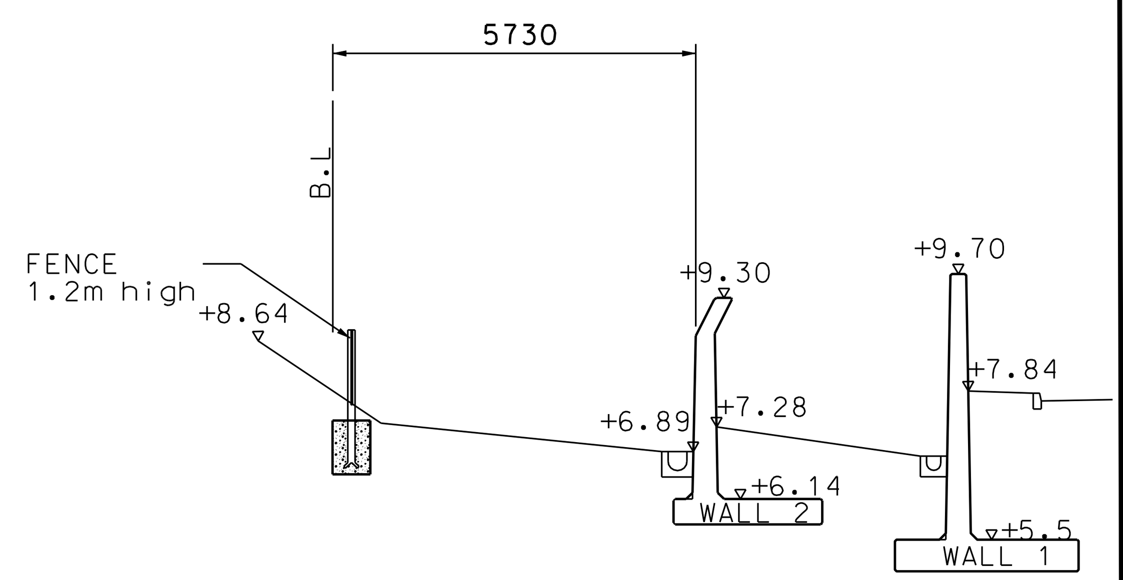

SECTION W–W

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TIME : $TIME$

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
A	02-04-09	For Review					
B	19-11-09	AS BUILT PROFILE ADDED					
C	23-11-09	SECTION V-V LEVEL CHANGED, SECTION X-X & SECTION Y-Y LEVELS ADDED					

Scale	Date
1:100	02-04-209

Designed	Drawn	Checked
D.H	KY.LUI	Dan.L

Design Team Leader — Date

Approved — Date

ECO

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Permanent Aviation Fuel Facility

Title: Fill Between Site Boundary And Security Wall (Sheet 3 of 3)

Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No. PAFF/LC/02/DWG/C/0870	C

FILENAME : $FILE$

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Table showing difference in ground level at Site Boundary and Bund level at Security Wall 2 to show height of landscape berm

Environmental Permit No.: EP-262/2007/B, Condition 3.5 a iii)
Containment Systems of Aviation Fuel Storage Tank Farm

Cross - Section	Ground Level at Site Boundary (highest point)	Bund Level at Security wall 2	Ground Level Difference	Comment
A-A	5.86	6.4	+.46	Insufficient width to construct landscape berm
B-B	5.94	6.4	+.46	Insufficient width to construct landscape berm
C-C	5.93	6.4	+.47	Insufficient width to construct landscape berm
D-D	5.86	6.4	+.54	Insufficient width to construct landscape berm
E-E	5.77	8.10	+2.33	>1.50m
F-F	5.72	8.20	+2.48	>1.50m
G-G	5.80	8.20	+2.40	>1.50m
H-H	5.68	8.20	+2.52	>1.50m
I-I	5.78	8.20	+2.42	>1.50m
J-J	6.07	8.20	+2.13	>1.50m
K-K	6.31	8.20	+1.89	>1.50m
L-L	6.69	8.20	+1.51	>1.50m
M-M	5.50	8.20	+2.70	>1.50m
N-N	6.04	8.20	+2.16	>1.50m
O-O	6.52	8.20	+1.68	>1.50m
P-P	6.58	8.20	+1.62	>1.50m
Q-Q	6.86	8.40	+1.54	>1.50m
R-R	6.39	8.30	+1.91	>1.50m
S-S	6.51	8.30	+1.79	>1.50m
T-T	6.38	7.88	+1.50	=1.50m To be constructed
U-U	6.10	7.60	+1.50	=1.50m To be constructed
V-V	6.35	7.85	+1.50	=1.50m To be constructed
W-W	8.64	6.89	-1.75	>1.50m Road is higher
X-X	8.80 (9.21)	6.90	-1.90 (2.31)	>1.50m Road is higher
Y-Y	8.25 (8.39)	6.90	-1.35 (-1.49)	<1.50m Road is higher

Photographs

Security Wall

Security Wall 1 and 2

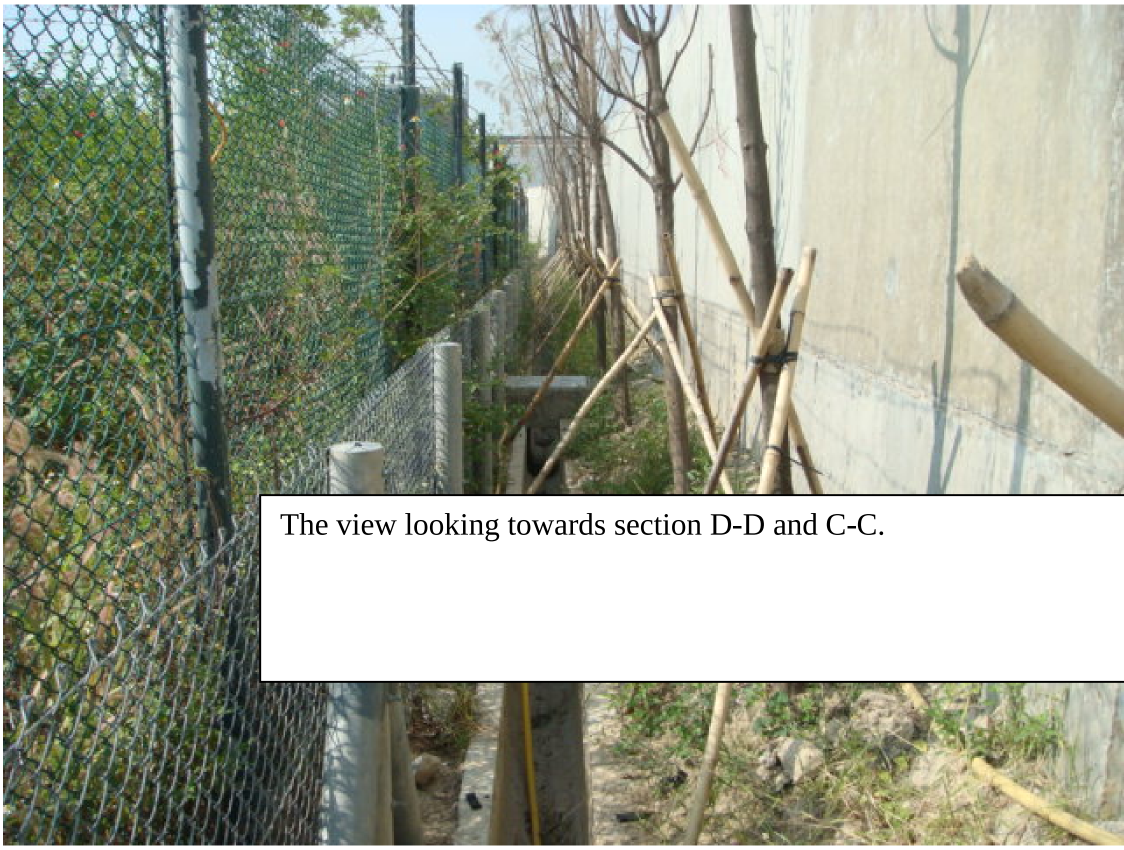
Security Wall 1 and 2

Landscape berm

Landscape berm

View looking towards section A-A. The distance between the face of the concrete wall and the low fence is approximately 2.0 m

The view looking towards section B-B and C-C.



The view looking towards section D-D and C-C.

View of section Y-Y. Note that the height of the road is lower than the height of the landscape bund.

Table 1 EP Condition 3.5 (a)(iv) - Summary of the document

	Content	Remarks
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 (a)(iv)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; Section 10 clause 10.5.13.5
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and Franchisee Requirements Clause 1.05 item (b)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10, section 5 and section 15
5	Contract drawings	**Gates** - PAFF/BA/02/DWG/C/1727 Revision 1 Tank farm Security wall, Fence and Gate Details - PAFF/HK/02/DWG/C/9894 Revision 0 Flood Gate - PAFF/HK/02/DWG/C/9895 Revision 0 Flood Gate 2 - PAFF/LC/02/DWG/C/0558 Revision A Section at Gates to Fuel Farm
6	Photographs	Photographs of the completed works
7	Justification	- Drawing PAFF/BA/02/DWG/C/1727 shows that solid gates at the security walls would provide sealing in case of any fuel spillage outside the bunded areas within the aviation fuel storage tank farm. - A 1m ramp requires a maximum gradient of 10% to comply with the Buildings Ordinance and space limitations ie a minimum length of 10m would be required. - As shown on drawing PAFF/LC/02/DWG/C/0558 the 1m high ramp would be physically impossible to construct as the height of the gates would be too high for the surrounding area. The ramp on the outside of the gates would disrupt the road levels at both gates severely. It should be noted that the height of the EVA is governed by the ground levels inside the bunded area and the requirements of the height of the bund wall. The seal has also been extended to the full height of the gates (whereas the EIA only requires the seal up to the first hinge) as such providing better protection than a 1m high ramp.

香港
機場管理局
AIRPORT
AUTHORITY
HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (a) (iv)
Date of Report:	24 November 2009
Date prepared by ET:	24 November 2009
Date received by IEC:	24 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (a) (iv)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(a) Containment Systems of Aviation Fuel Storage Tank
Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular :

(iv) Gates at the security walls shall be properly designed and constructed to provide sealing in case of any fuel spillage within the aviation fuel storage tank farm.

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 24 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

pp Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

**ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13**

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

**ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE
A DESIGNATED PROJECT**

建造及營辦指定工程項目的環境許可證

3. **Submissions or Measures during the Construction of Certain Parts of the Project**

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements:-

a) Containment Systems of Aviation Fuel Storage Tank Farm

Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular:

iv) Gates at the security walls shall be properly designed and constructed to provide sealing in case of any fuel spillage within the aviation fuel storage tank farm;

Environmental Impact Assessment Report Requirement

10 Hazard To Life Assessment

10.5.13 Fire due to release from top of tank due to overfilling (T12)

10.5.13.5 A cross section of the tank, the bund wall and the boundary fence is shown in Figure 10.2. The tank height is 24.7 m and its diameter is 43.5 m. The distance from the nearest tank shell to bund wall is 10m. The height of the proposed bund wall is 4.8m with respect to the bund floor and includes a wave deflector. The site roads around the bund wall (which form the general site area) are raised to about 3.2 m with respect to the bund floor, i.e. the bund wall is not free standing but will act as a retaining wall. A security wall (of breeze block type) 2m high from road level is provided at the far side of the road (8.5 m away), which will act as a secondary containment in the event of overtopping of the bund. The roads around the tank bund will be provided with storm water drains, which will collect any liquid overtopping the bund. A further 4 m beyond this security wall is a further impervious security wall ~2.4m high before a 1.5 m landscaped bund planted with trees and the site fence. A drainage ditch with a sloping catchment will be provided in the 4m strip between the security wall and the further impervious security wall to trap any liquid splashed over the first security wall and the gate. This ditch will be designed to handle 35 m3 of liquid and will discharge via a drainage outlet in the sea wall to the sea. Also, the security gate will be provided with a 1m ramp as well as a leak tight seal at the bottom of the gate up to the first hinge to contain any spill within the site.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

(i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting
(ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings
(iii) Sampling and product recovery system
(iv) Manifolding to tank farm and existing aviation fuel system simultaneously
(v) Fire protection system
(vi) Power supply and independent standby power generator or second supply
(vii) Buildings including offices, canteen, control room, workshop, stores
(viii) Emergency response facilities
(ix) Storage tanks for fuel, water, chemicals and wastes
(x) Utility and other systems including back-up systems
(xi) Cathodic protection
(xii) Lightning protection
(xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities
(xiv) Electronic tank servo gauges
(xv) Hard standing, roads and parking
(xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services;

EPC – Franchisee's Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services; and associated fire protection;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed.

Also, in the detail design additional standards may be referenced for specific items.

5. Storage Tank (including BUND Wall and Foundation)

5.1 GENERAL

The main storage tanks will be circular and made of steel plate with diameters of 6 x 43.5m, 1 x 41.5m, 1 x 35m and a height of 24.7 metres and nominal capacities of 35,000, 32,000, 22,000 cubic metres respectively. The tanks will be founded on a reinforced concrete ring beam. The eight storage tanks will be contained within two reinforced concrete bund walls (4 nos. of fuel tank for each bund wall) with a membrane lining to contain any leakage. All bund walls will include a wave wall to assist in containing Jet A1 within the bunded area.

5.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) API 650 Vertical Storage Tanks
(b) BS EN 12285 Horizontal Storage Tanks
(c) British Standard for Concrete Structures
(d) Code of Practice for Oil Storage Installations 1992 – Building Authority Hong Kong
(e) IP Code of Practice Part 15

5.3 SPECIFIC CRITERIA

5.3.4 Bund Walls

1. The bund walls shall be of reinforced concrete.

2. The capacities of the bunded areas will be 57,691 cubic metres for phase 1a & 2 tank farms and a minimum of 50,695 cubic metres for phase 1b & 2 tank farm, which are not less than 38,500 cubic metres (110% of a 35,000 cubic metres tank) for both areas.

3. The construction of the bund walls joints will provide a continuous barrier to any spill within the bunded area.

4. The bund walls shall be designed to retain the bunded area when full of water or the impact load of an instantaneous release from a simple storage tank which ever is greater.

5. A means of access in and out of the bunded area will be provided adjacent to the stairs fitted to the main storage tanks and as directed by the FSD.

6. The bund wall alignment will allow 25% of the circumstance of each tank to be with in 15 metres of the EVA.

5.3.6 Secondary Containment

The security walls adjacent to the bund wall facing public areas will in addition be constructed of reinforced concrete to contain potential overtopping of the bund wall. Gates in the security walls are to be solid and sealed up to the first hinge on the gate.

15. FENCING

15.1 General

The works identified for the fencing are as follows:

1. The perimeter of the tank farm will in general be protected by double security walls with intruder detection between the walls. The walls will be of reinforced concrete. The inner security wall will be 2.4 m high topped with razor wire.

2. Additionally gates in the concrete wall will be constructed to provide a solid barrier to product splashing through the fence line.

3. The main vehicle entrance access to the carpark will be restricted by a full height 2.5m drop gate.

4. Access card reader and closed circuit television (CCTV) systems shall be installed in accordance with Section 18.

15.2 CODES AND TECHNICAL STANDARDS

As highlighted in section 1.10.

15.3 SPECIFIC CRITERIA

Environmental Permit requirements for external fences and gates.

15.4 MATERIALS

15.4.1 Concrete

The design shall use the following minimum concrete grades for structural concrete in accordance with the BS 8007:

Reinforced concrete structures C40/20

Concrete cover to reinforcement shall be 40mm.

In respect of reinforced concrete the design shall be based on the properties detailed in Section 1.9.

15.5 DESIGN AND ANALYSIS METHODS

15.5.1 Static analysis shall be used to calculate the stability of the reinforced retained fence wall for the various load cases. The design shall be in accordance with the requirement of codes and standards.

15.5.2 Design Report Fencing

PAFF/BA/02/DSG/C/1501 - Fencing

15.6 INPUT DATA AND Main Interfaces

15.6.1 INPUT DATA

i) Layout plan
ii) Geotechnical site Investigation Results

15.6.2 Interfaces

- Architectural
- Geotechnical
- Environmental Impact Assessment

Contract Drawings

Gates

- **PAFF/BA/02/DWG/C/1727 Revision 1 Tank farm Security wall, Fence and Gate Details**
- **PAFF/HK/02/DWG/C/9894 Revision 0 Flood Gate**
- **PAFF/HK/02/DWG/C/9895 Revision 0 Flood Gate 2**
- **PAFF/LC/02/DWG/C/0558 Revision A Section at Gates to Fuel Farm**

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Rev.	Date	Description	Checked
0	OCT 2007	FOR CONSTRUCTION	
1	FEB 2009	FOR CONSTRUCTION	

Scale: AS SHOWN (A1)
Designed: BW | Drawn: SKL | Checked: AS
Design Team Leader: AS | Date: MAY 2006
Approved: LHS | Date: MAY 2006

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Permanent Aviation Fuel Facility

Title
TANK FARM
SECURITY WALL, FENCE
AND GATE DETAILS

Drawing No. PAFF/BA/02/DWG/C/1727 Revision 1

DATE : 3/2/2009
TIME : 10:08:02 AM
PLOT DRV: $PLTDRVL$
FILENAME : S:\Drawings\DGN\Babtie\20090225\1727-1.dgn

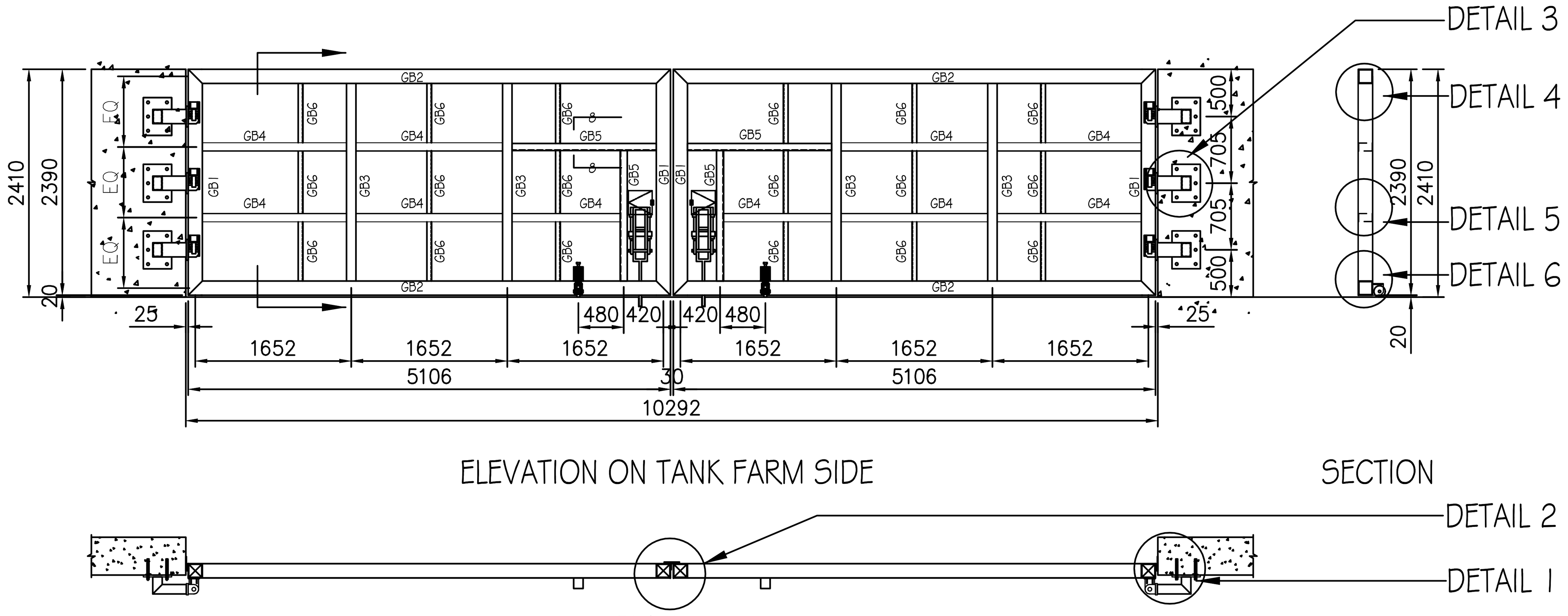
FLOOD GATE	STRUCTURAL OPENING	
	WIDTH(mm)	HEIGHT(mm)
SG1	10292	2410
SG2	5975	2850
SG3	8000	2625
SG4	8000	1925
SG5	8000*	3300*
SG6	8000*	2150*

*DESIGN DATA

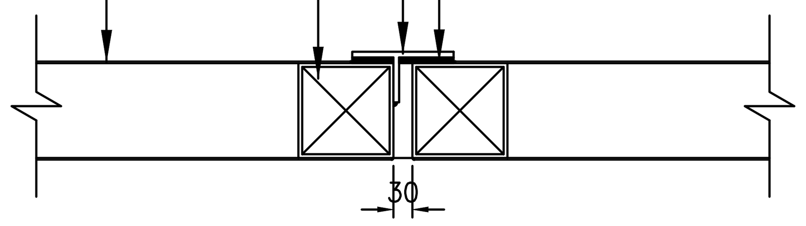
MEMBER SCHEDULE:

GB1: 150X150X8mm THK. GMS SHS
GB2: 150X150X6mm THK. GMS SHS
GB3: 100X150X6mm THK. GMS RHS
GB4: 90X90X6mm THK. GMS ANGLE
GB5: 150X75X18kg/m GMS CHANNEL
GB6: 50x50x5mm thk. GMS ANGLE

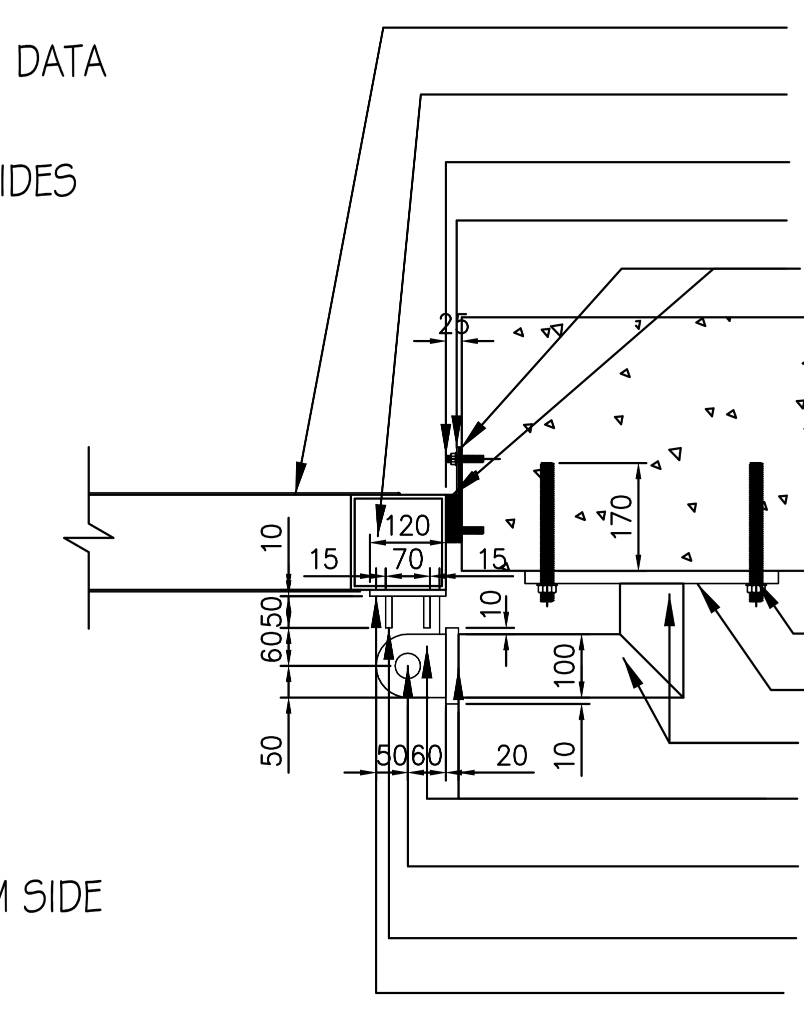
B.D. REF.:



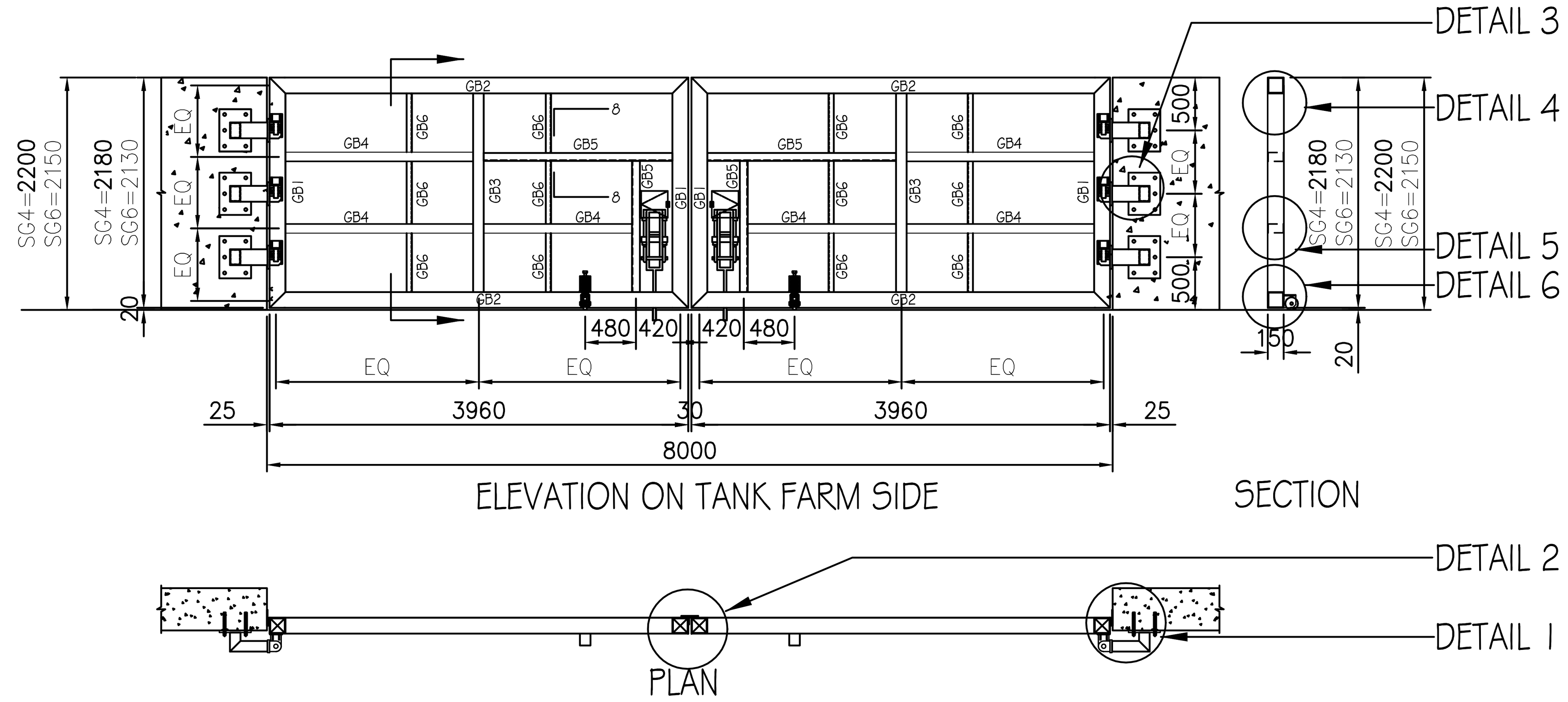
TYPE 1 FLOOD GATE (SG1)



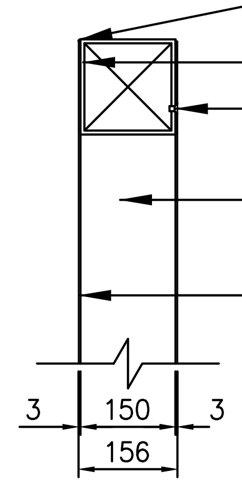
DETAIL 2



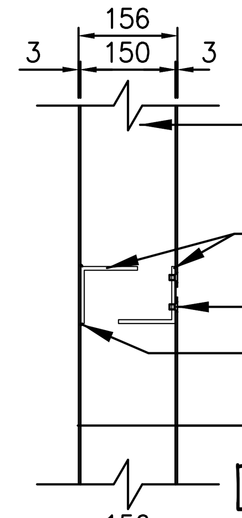
DETAIL 1



TYPE 2 FLOOD GATE (SG4 & SG6)



DETAIL 4



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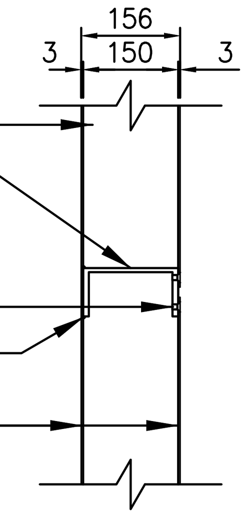

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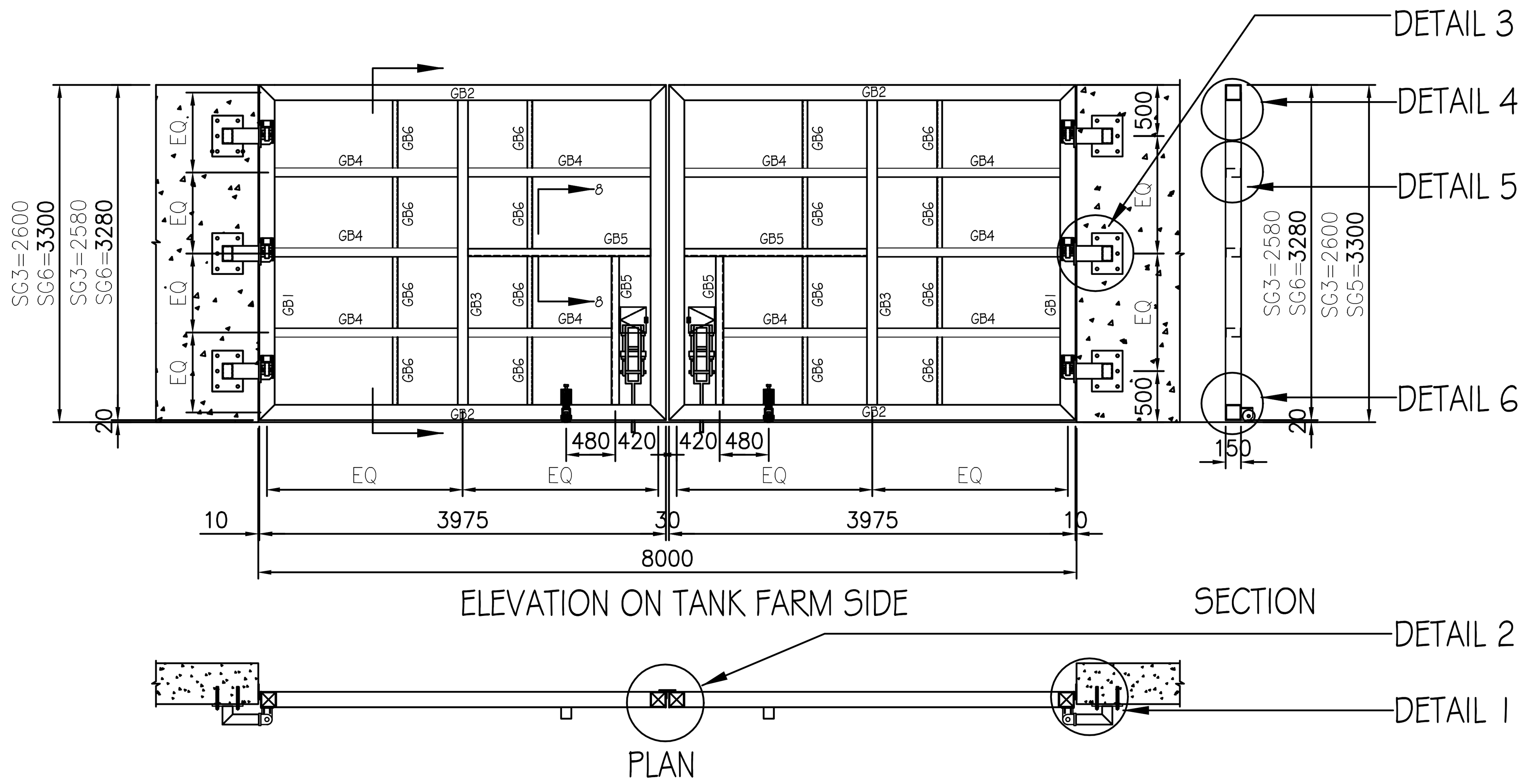
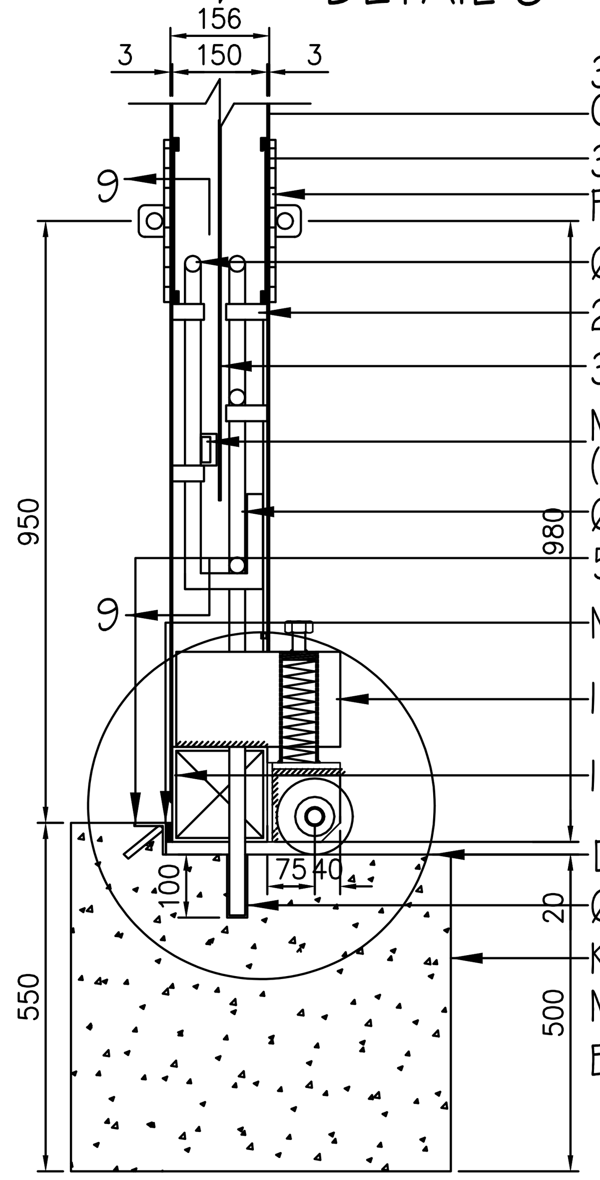


TYPE 2 FLOOD GATE (SG3 & SG5)



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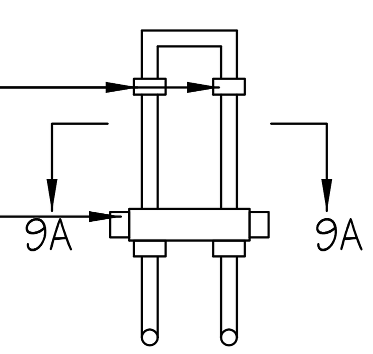

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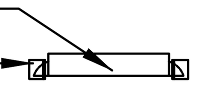
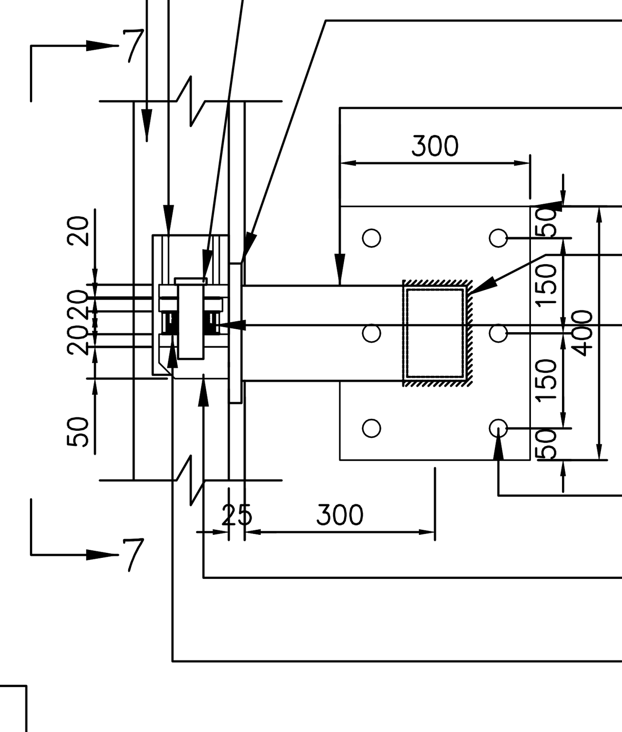
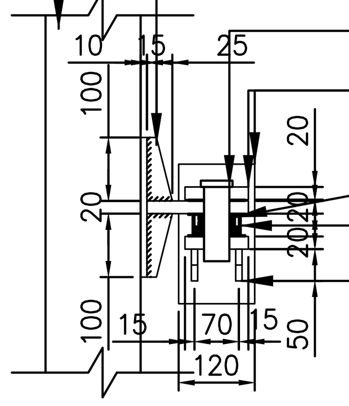


DETAIL 9A



DETAIL 3



DETAIL 7

Notes:
Measurements are based on metric system.
All levels are in metres to Principal Datum (mPD) unless noted otherwise.
Do not scale drawing.
Figure dimensions are to be followed.
Do not use for construction unless expressly permitted.
The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	AUG 2009	FOR CONSTRUCTION	

Scale 1:100 | Date APR 2009
Designed LSH | Drawn LSH | Checked YYC
Design Team Leader | Date
Approved YYC | Date APR 2009

Contractor: LEIGHTON CONTRACTORS (ASIA) LIMITED

JACOBS
15th Floor, Cornwall House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong
Tel: (852) 2880 9788 E-mail: bablie@bablie.com.hk
Fax: (852) 2565 5561

Prepared by: HONG KI ENGINEERING LTD

Project: Permanent Aviation Fuel Facility, Area 38, Tuen Mun, N.T. Hong Kong

Title: FLOOD GATE

Drawing No. PAFF/HK/02/DWG/C/9894 | Revision 0

FILENAME :

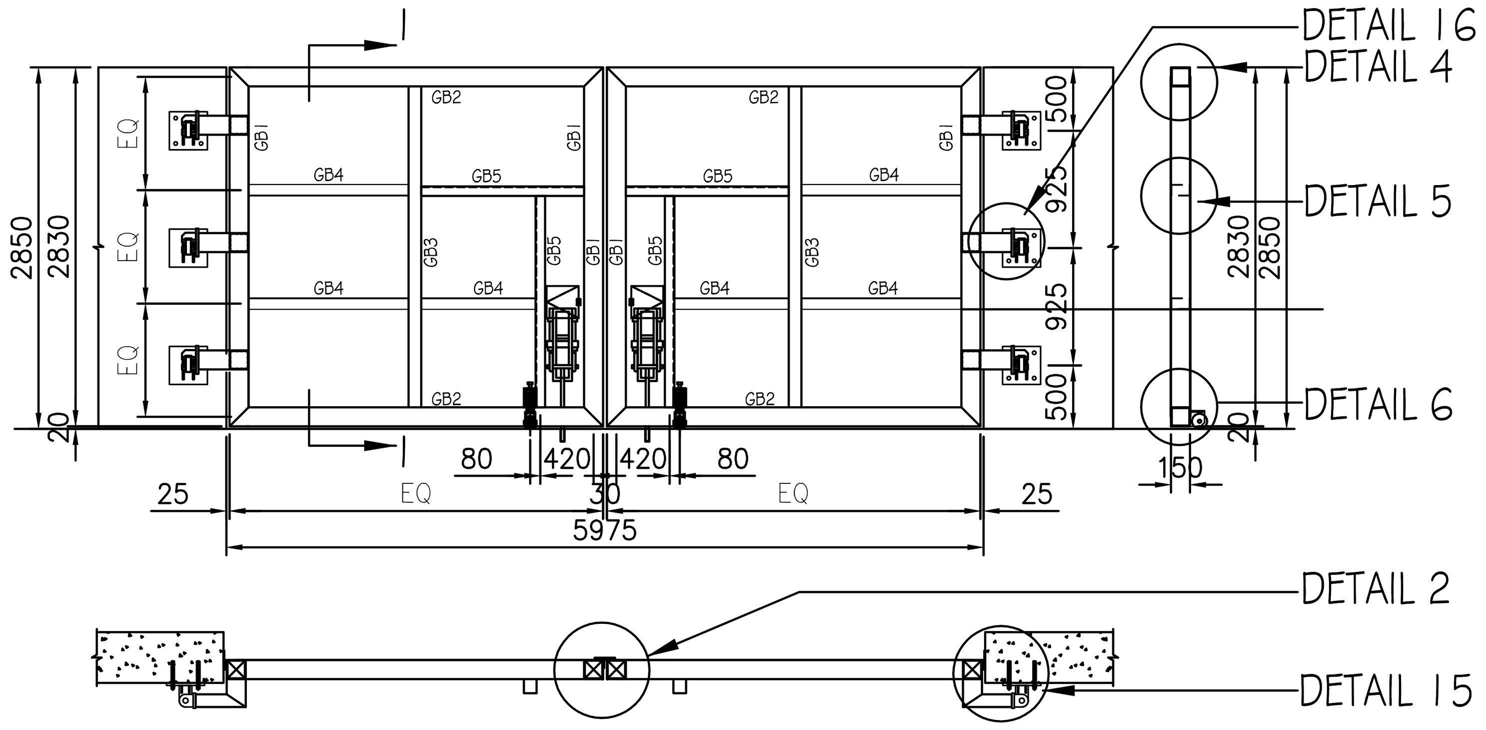
FLOOD GATE	STRUCTURAL OPENING	
	WIDTH(mm)	HEIGHT(mm)
SG1	10292	2410
SG2	5975	2850
SG3	8000	2625
SG4	8000	1925
SG5	8000*	3300*
SG6	8000*	2150*

*DESIGN DATA

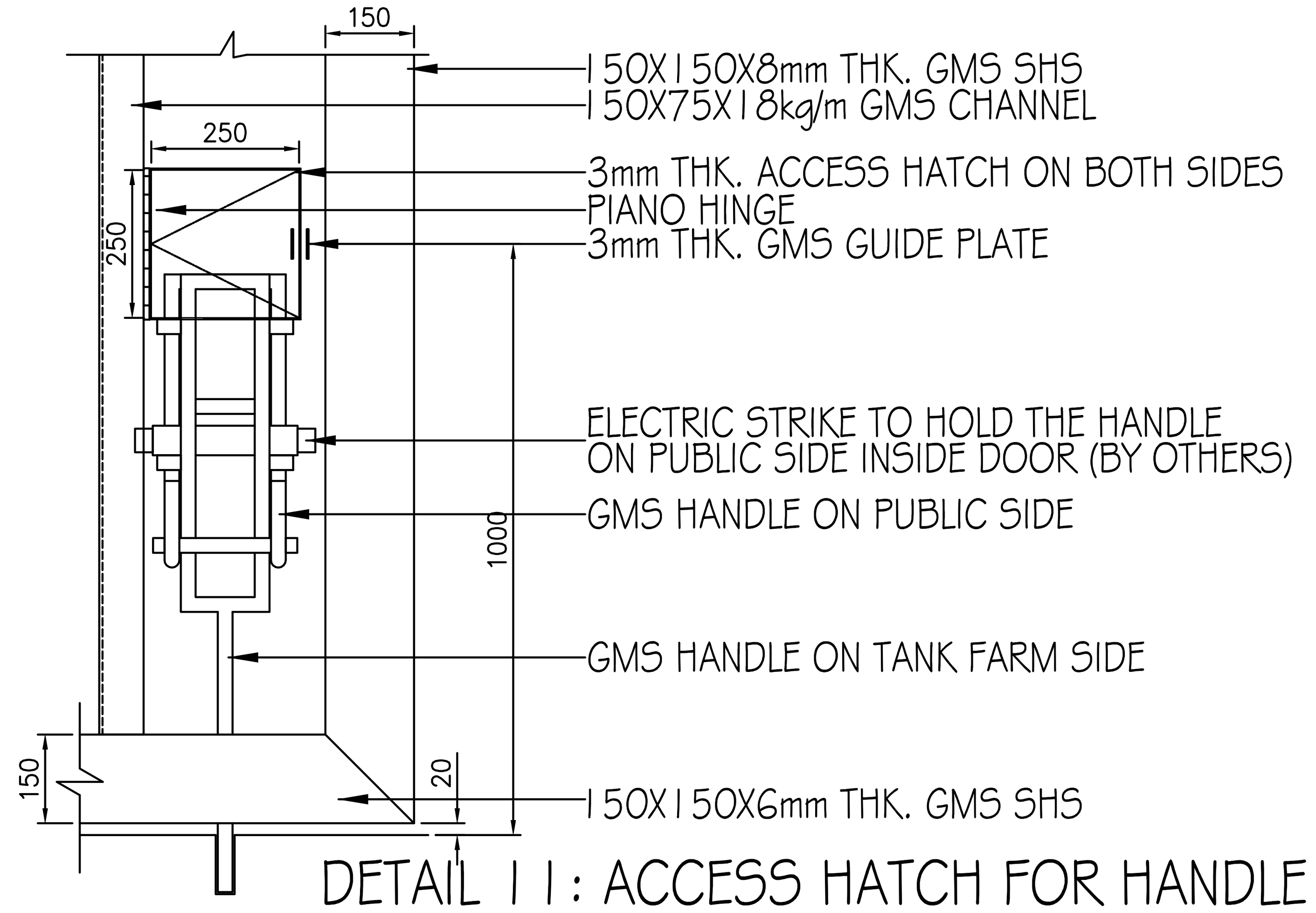
MEMBER SCHEDULE:

GB1: 150X150X8mm THK. GMS SHS
GB2: 150X150X6mm THK. GMS SHS
GB3: 100X150X6mm THK. GMS RHS
GB4: 90X90X6mm THK. GMS CHANNEL
GB5: 150X75X18kg/m GMS CHANNEL
GB6: 50X50X5mm THK. GMS ANGLE

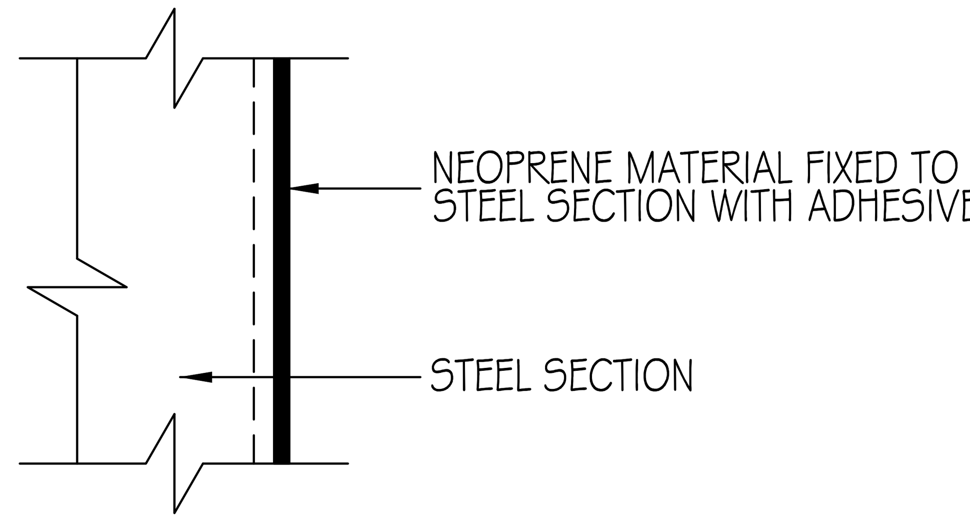
B.D. REF.:



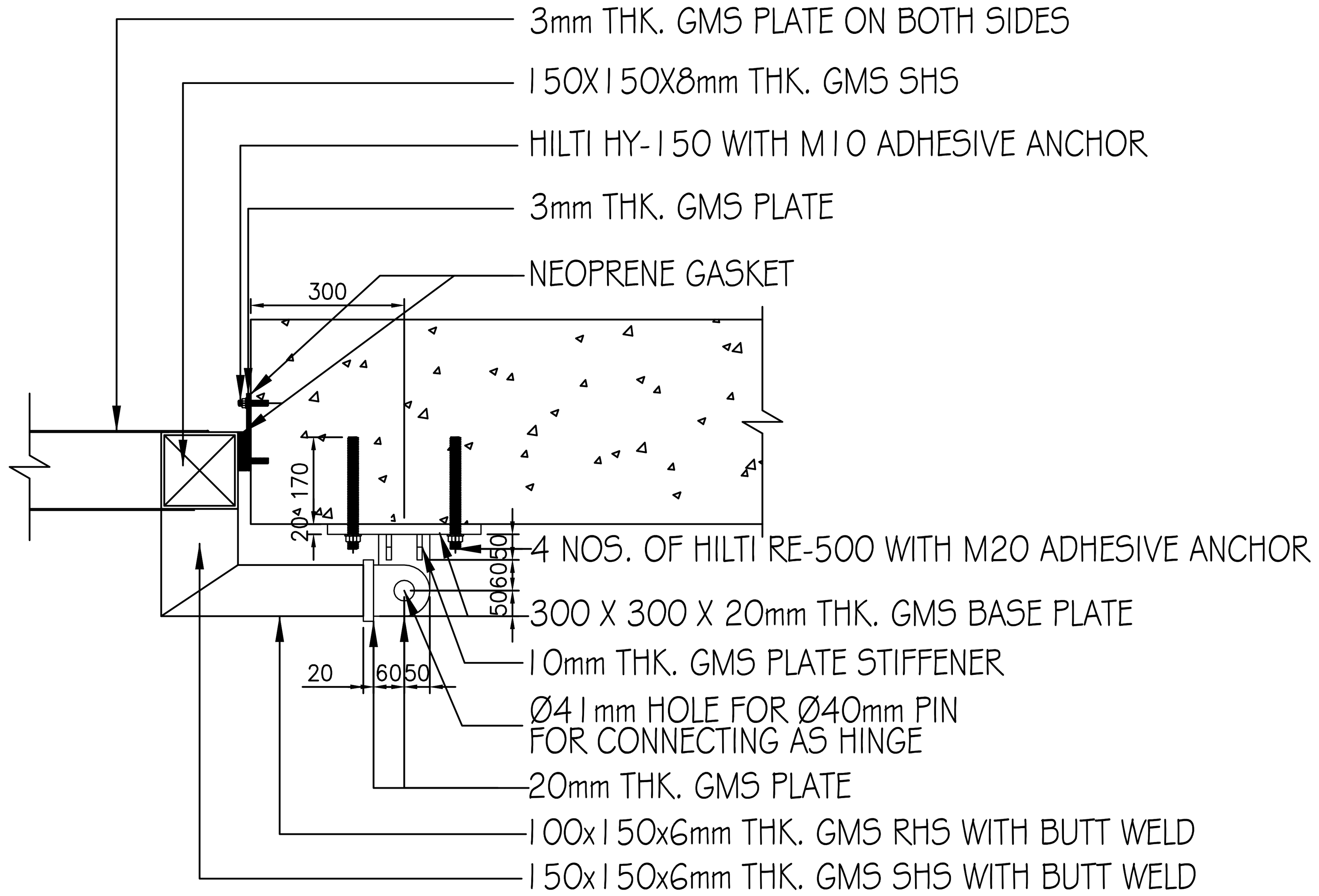
TYPE 3 FLOOD GATE (SG2)



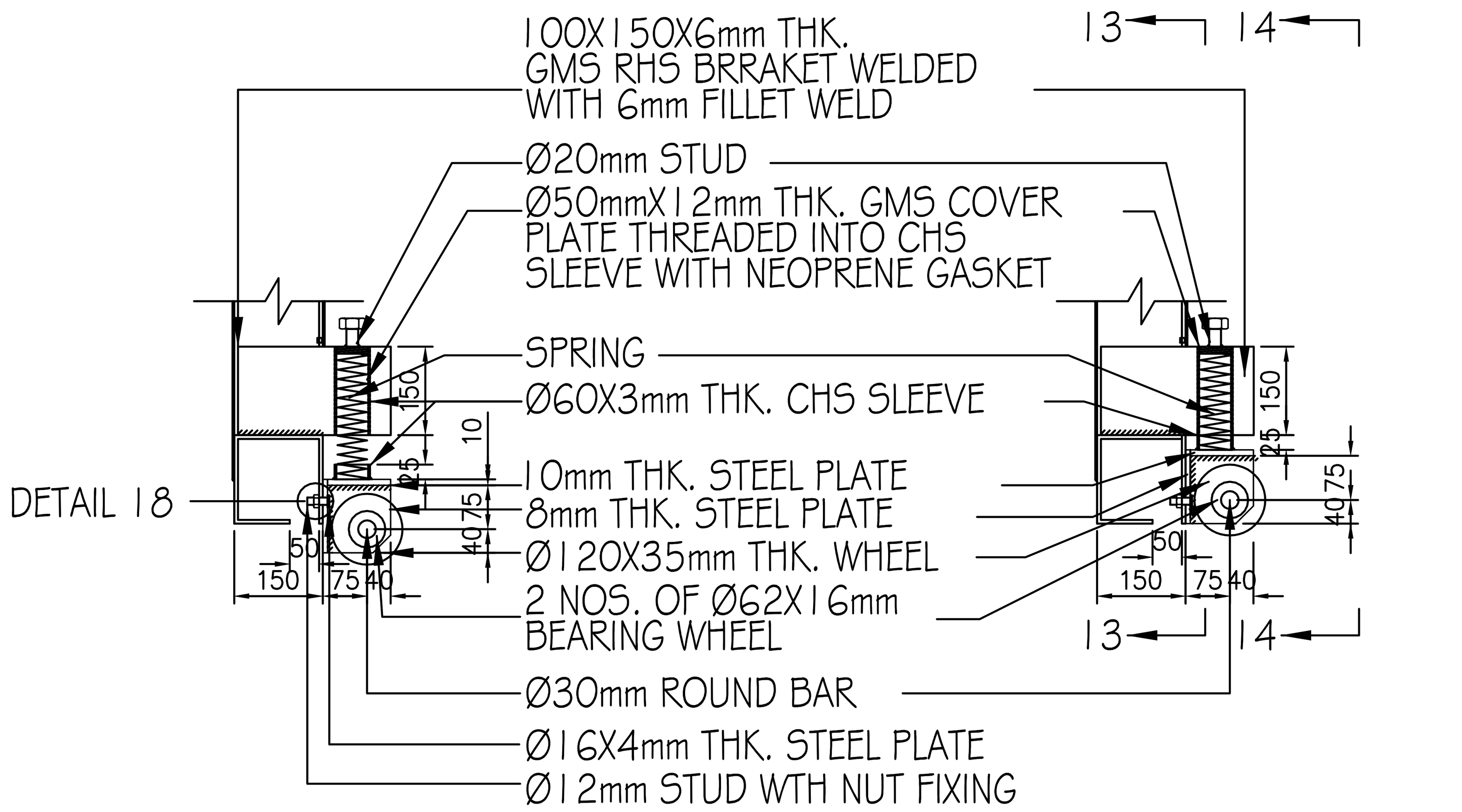
DETAIL 11: ACCESS HATCH FOR HANDLE



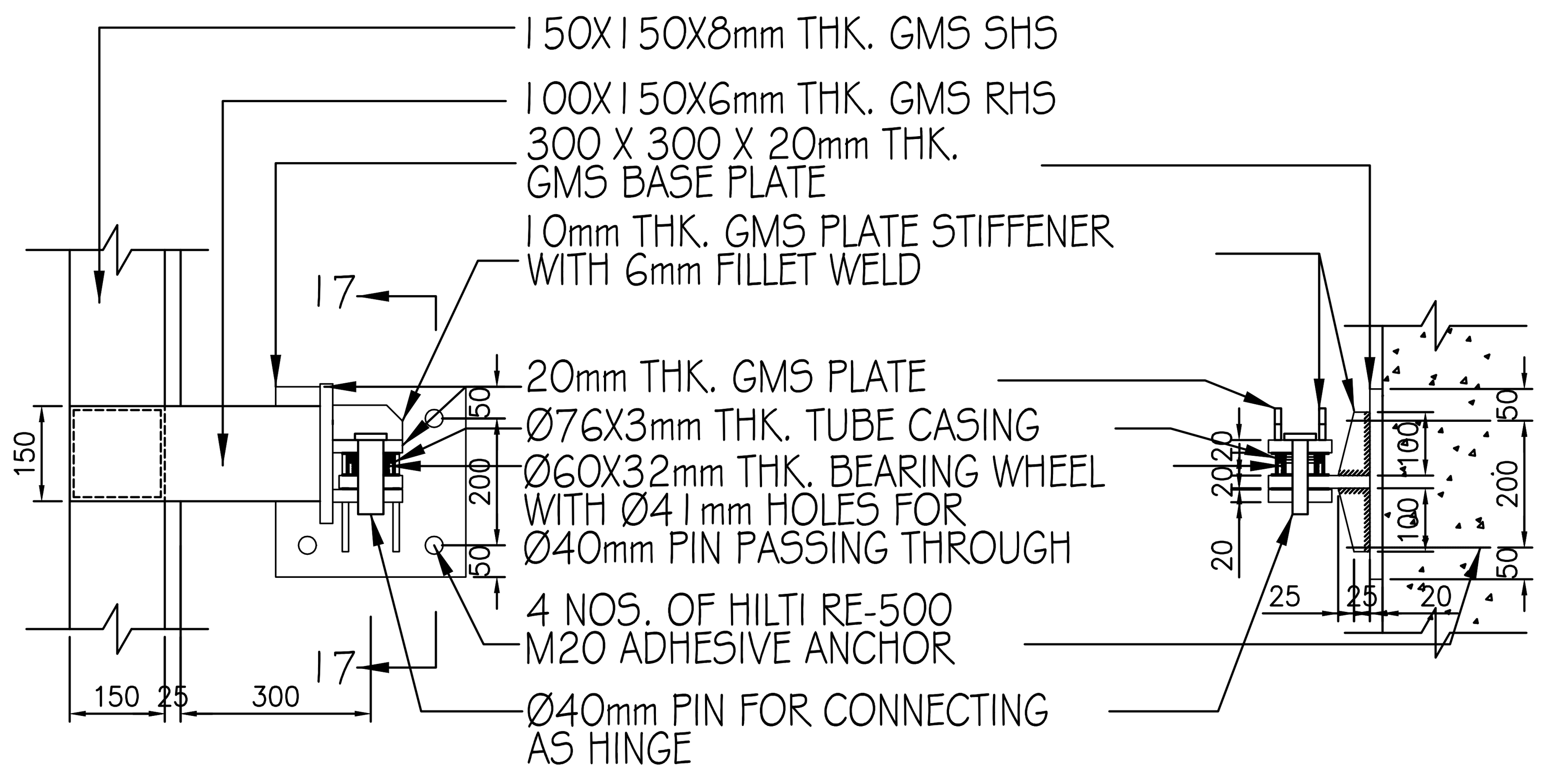
DETAIL 19: FIXING DETAIL OF NEOPRENE GASKET



DETAIL 15



DETAIL 12: BEARING WHEEL DETAIL

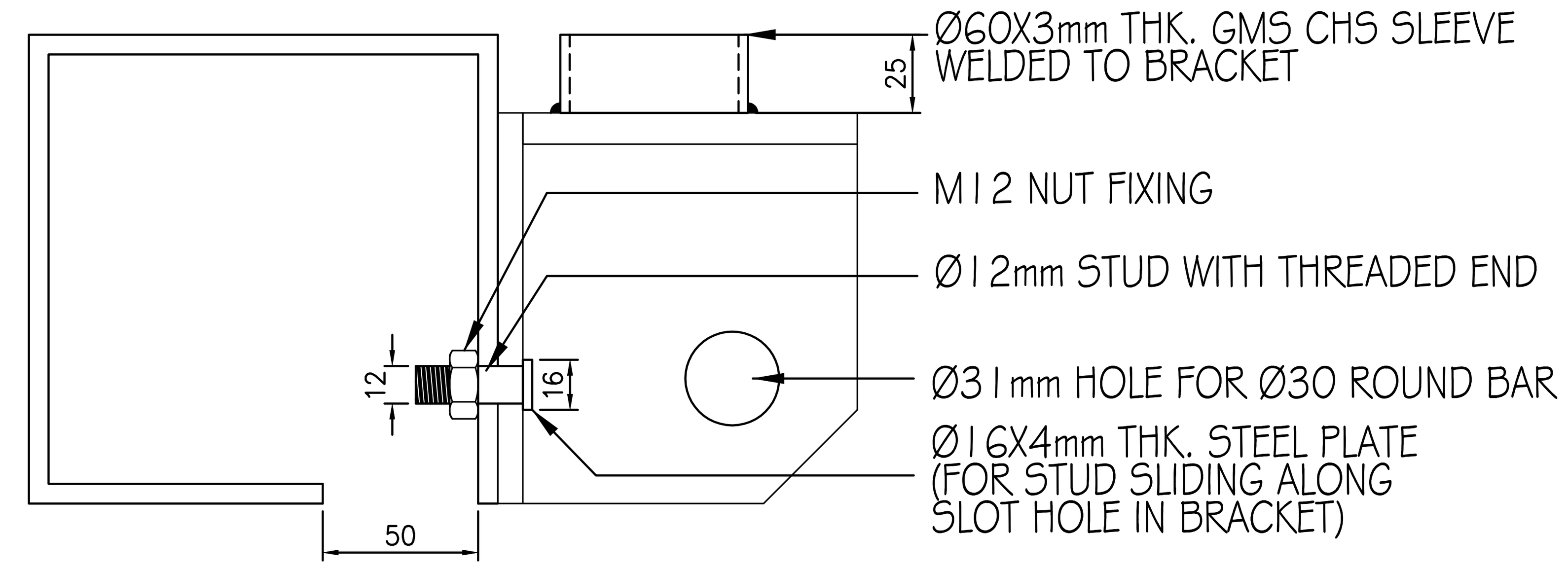


DETAIL 16

DETAIL 17

DETAIL 13

DETAIL 14



DETAIL 18: STUD DETAIL BEHIND THE WHEEL

Notes:
Measurements are based on metric system.
All levels are in metres to Principal Datum (mPD) unless noted otherwise.
Do not scale drawing.
Figure dimensions are to be followed.
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The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	AUG 2009	FOR CONSTRUCTION	

Scale 1:100 | Date APR 2009
Designed LSH | Drawn LSH | Checked YYC
Design Team Leader | Date
Approved YYC | Date APR 2009

ECO

Contractor: LEIGHTON CONTRACTORS (ASIA) LIMITED

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15th Floor, Cornwall House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong
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Fax: (852) 2565 5561

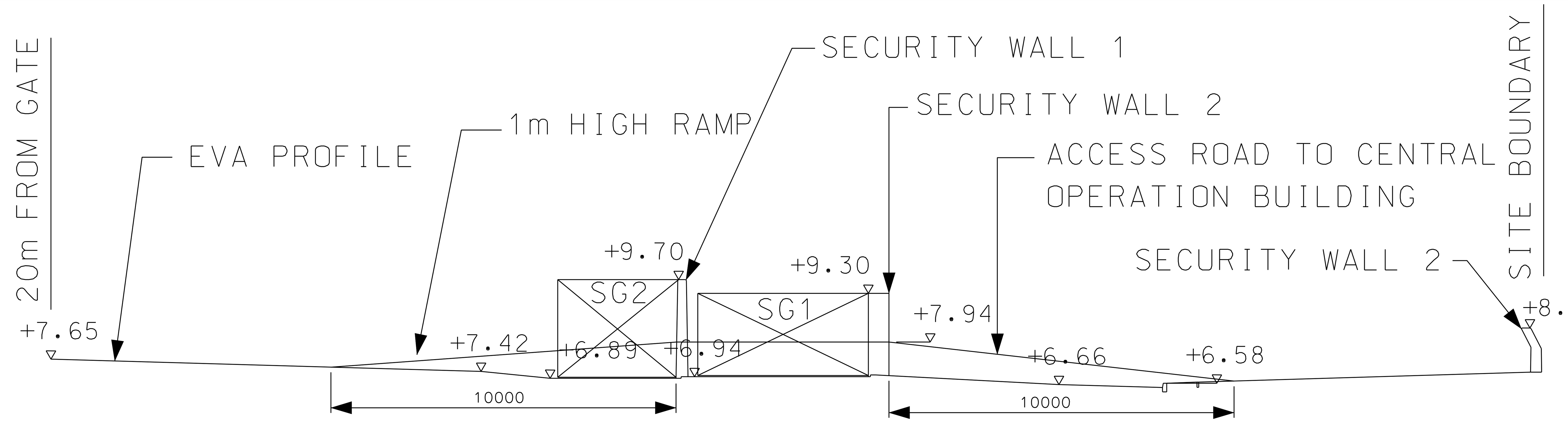
Prepared by: HONG KI ENGINEERING LTD

Project: Permanent Aviation Fuel Facility Area 38, Tuen Mun, N.T. Hong Kong

Title: FLOOD GATE 2

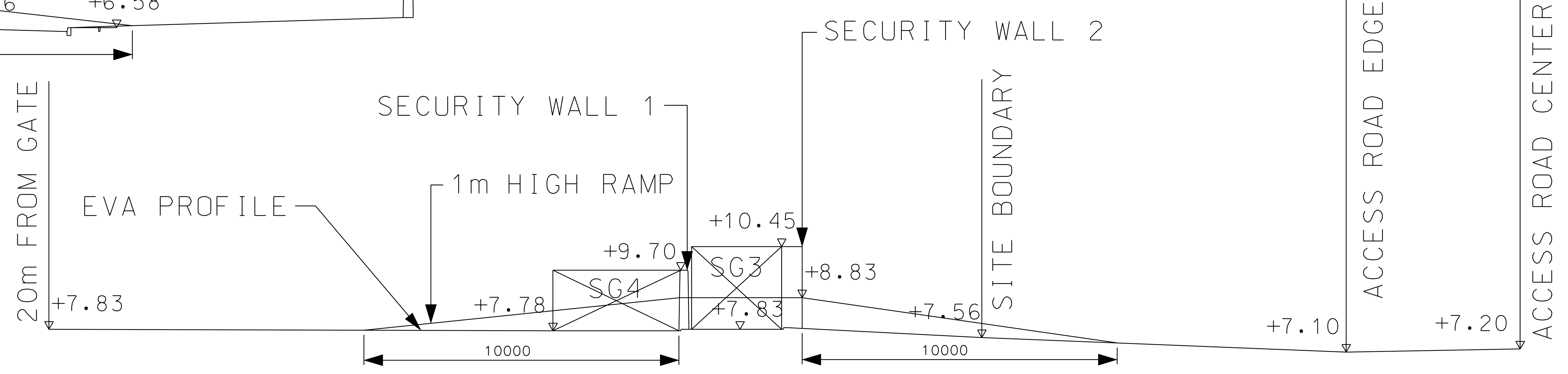
Drawing No. PAFF/HK/02/DWG/C/9895 | Revision 0

FILENAME :

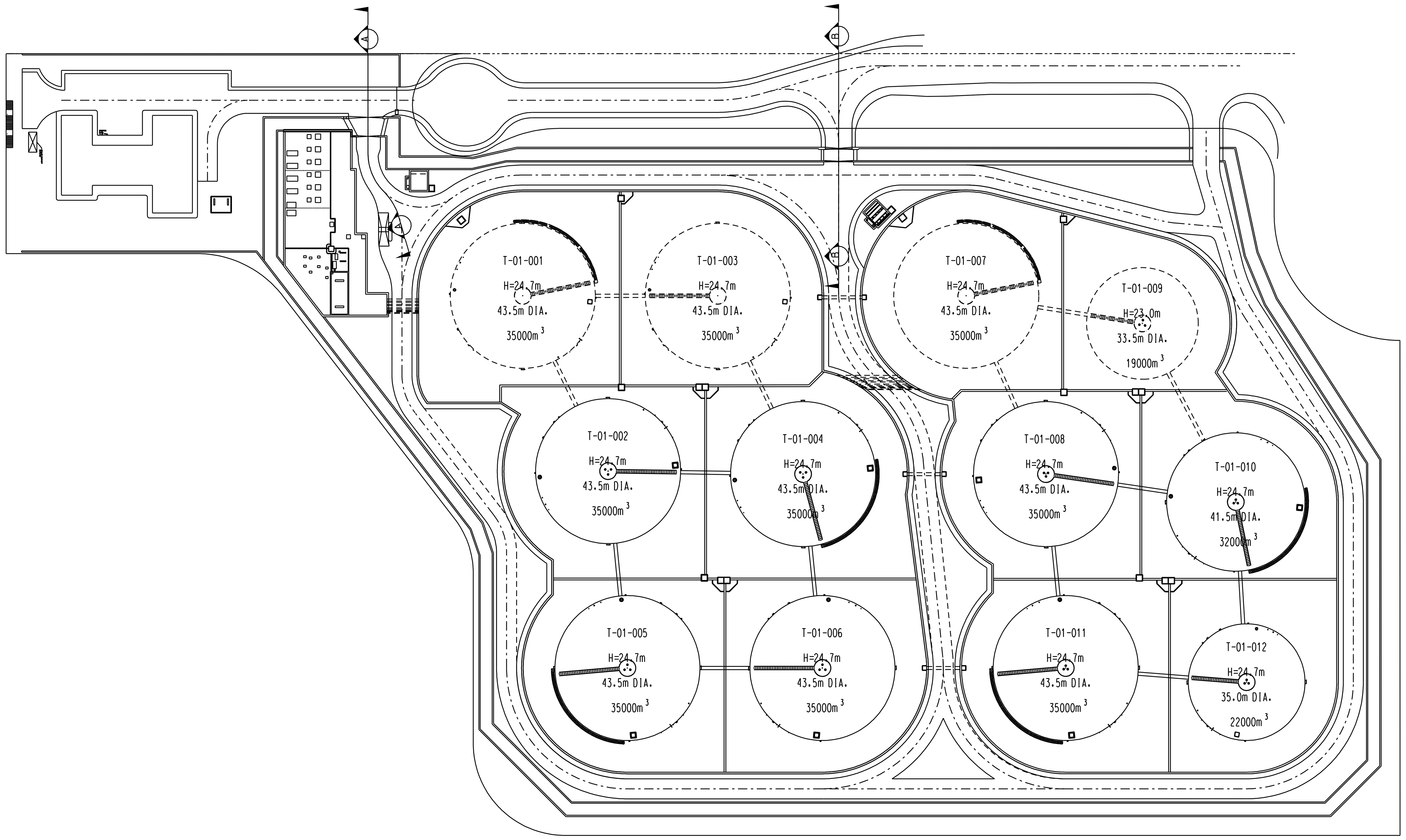


SECTION A

SCALE: 1:100



SECTION B SCALE: 1:100



PLAN

SCALE: 1:1000

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

DATE : $DATE$
TIME : $TIME$

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
A	19-11-09	FOR INFORMATION					

Scale	Date
AS SHOWN	19-11-09

Designed	Drawn	Checked
D.H.	K.Y.LUI	D.H.

Design Team Leader Date

Approved Date

ECO

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Permanent Aviation Fuel Facility

Title SECTION AT GATES TO FUEL FARM

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/LC/02/DWG/C/0558	A

FILENAME : $FILE$

...\Pafflc02dwgc0558_A.dgn 11/20/2009 10:21:01 AM

Photographs

Gates

Gates - Sealant

Sealant the full height and width of the gate

Sealant the full width of the gate and the steel contact surface

Table 1 EP Condition 3.5 (a)(v) - Summary of the document

	Content	Remarks
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 (a)(v)
2	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and Franchisee Requirements Clause 1.05 item (b)
3	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10, section 5 and section 15
4	Contract drawings	**Reinforced Concrete** - PAFF/BA/02/DWG/C/1720 Revision 3 Tank Farm General Arrangement & Key Plan - PAFF/BA/02/DWG/C/1726 Revision 3 Tank farm R.C. Details for Bund & Security Wall (Sheet 1 of 3) - PAFF/BA/02/DWG/C/1728 Revision 0 Tank farm R.C. Details for Bund & Security Wall (Sheet 2 of 3) - PAFF/BA/02/DWG/C/1730 Revision 0 Tank farm R.C. Details for Bund & Security Wall (Sheet 3 of 3)
5	Photographs	Photographs of the completed works
6	Justification	Drawings PAFF/BA/02/DWG/C/1726, 1728, and 1730 show that all the bund and security walls are constructed by reinforced concrete to provide sufficient structural strength to withstand any liquid surged load in case of any accidents.

香港機場管理局 AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (a) (v)
Date of Report:	24 November 2009
Date prepared by ET:	24 November 2009
Date received by IEC:	24 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (a) (v)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(a) Containment Systems of Aviation Fuel Storage Tank
Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular :

(v) All the bund and security walls shall be properly designed and constructed using reinforced concrete to provide sufficient structural strength to withstand any liquid surged load in case of any accidents.

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 24 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

pp Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. <u>Submissions or Measures during the Construction of Certain Parts of the Project</u>

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements:-

a) <u>Containment Systems of Aviation Fuel Storage Tank Farm</u>

Containment systems including bund walls, security walls and landscaped berm shall be properly designed and constructed for the aviation fuel storage tank farm in accordance with the arrangements as shown in Figure 4 of this Permit, in particular:

v) All the bund and security walls shall be properly designed and constructed using reinforced concrete to provide sufficient structural strength to withstand any liquid surged load in case of any accidents.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

(i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting
(ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings
(iii) Sampling and product recovery system
(iv) Manifolding to tank farm and existing aviation fuel system simultaneously
(v) Fire protection system
(vi) Power supply and independent standby power generator or second supply
(vii) Buildings including offices, canteen, control room, workshop, stores
(viii) Emergency response facilities
(ix) Storage tanks for fuel, water, chemicals and wastes
(x) Utility and other systems including back-up systems
(xi) Cathodic protection
(xii) Lightning protection
(xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities
(xiv) Electronic tank servo gauges
(xv) Hard standing, roads and parking
(xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services;

EPC – Franchisee's Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services; and associated fire protection;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed.

Also, in the detail design additional standards may be referenced for specific items.

5. Storage Tank (including BUND Wall and Foundation)

5.1 GENERAL

The main storage tanks will be circular and made of steel plate with diameters of 6 x 43.5m, 1 x 41.5m, 1 x 35m and a height of 24.7 metres and nominal capacities of 35,000, 32,000, 22,000 cubic metres respectively. The tanks will be founded on a reinforced concrete ring beam. The eight storage tanks will be contained within two reinforced concrete bund walls (4 nos. of fuel tank for each bund wall) with a membrane lining to contain any leakage. All bund walls will include a wave wall to assist in containing Jet A1 within the bunded area.

5.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) API 650 Vertical Storage Tanks
(b) BS EN 12285 Horizontal Storage Tanks
(c) British Standard for Concrete Structures
(d) Code of Practice for Oil Storage Installations 1992 – Building Authority Hong Kong
(e) IP Code of Practice Part 15

5.3 SPECIFIC CRITERIA

5.3.4 Bund Walls

1. The bund walls shall be of reinforced concrete.

2. The capacities of the bunded areas will be 57,691 cubic metres for phase 1a & 2 tank farms and a minimum of 50,695 cubic metres for phase 1b & 2 tank farm, which are not less than 38,500 cubic metres (110% of a 35,000 cubic metres tank) for both areas.

3. The construction of the bund walls joints will provide a continuous barrier to any spill within the bunded area.

4. The bund walls shall be designed to retain the bunded area when full of water or the impact load of an instantaneous release from a simple storage tank which ever is greater.

5. A means of access in and out of the bunded area will be provided adjacent to the stairs fitted to the main storage tanks and as directed by the FSD.

6. The bund wall alignment will allow 25% of the circumstance of each tank to be with in 15 metres of the EVA.

5.3.6 Secondary Containment

The security walls adjacent to the bund wall facing public areas will in addition be constructed of reinforced concrete to contain potential overtopping of the bund wall. Gates in the security walls are to be solid and sealed up to the first hinge on the gate.

15. FENCING

15.1 General

The works identified for the fencing are as follows:

1. The perimeter of the tank farm will in general be protected by double security walls with intruder detection between the walls. The walls will be of reinforced concrete. The inner security wall will be 2.4 m high topped with razor wire.

2. Additionally gates in the concrete wall will be constructed to provide a solid barrier to product splashing through the fence line.

3. The main vehicle entrance access to the carpark will be restricted by a full height 2.5m drop gate.

4. Access card reader and closed circuit television (CCTV) systems shall be installed in accordance with Section 18.

15.2 CODES AND TECHNICAL STANDARDS

As highlighted in section 1.10.

15.3 SPECIFIC CRITERIA

Environmental Permit requirements for external fences and gates.

15.4 MATERIALS

15.4.1 Concrete

The design shall use the following minimum concrete grades for structural concrete in accordance with the BS 8007:

Reinforced concrete structures C40/20

Concrete cover to reinforcement shall be 40mm.

In respect of reinforced concrete the design shall be based on the properties detailed in Section 1.9.

15.5 DESIGN AND ANALYSIS METHODS

15.5.1 Static analysis shall be used to calculate the stability of the reinforced retained fence wall for the various load cases. The design shall be in accordance with the requirement of codes and standards.

15.5.2 Design Report Fencing

PAFF/BA/02/DSG/C/1501 - Fencing

15.6 INPUT DATA AND Main Interfaces

15.6.1 INPUT DATA

i) Layout plan
ii) Geotechnical site Investigation Results

15.6.2 Interfaces

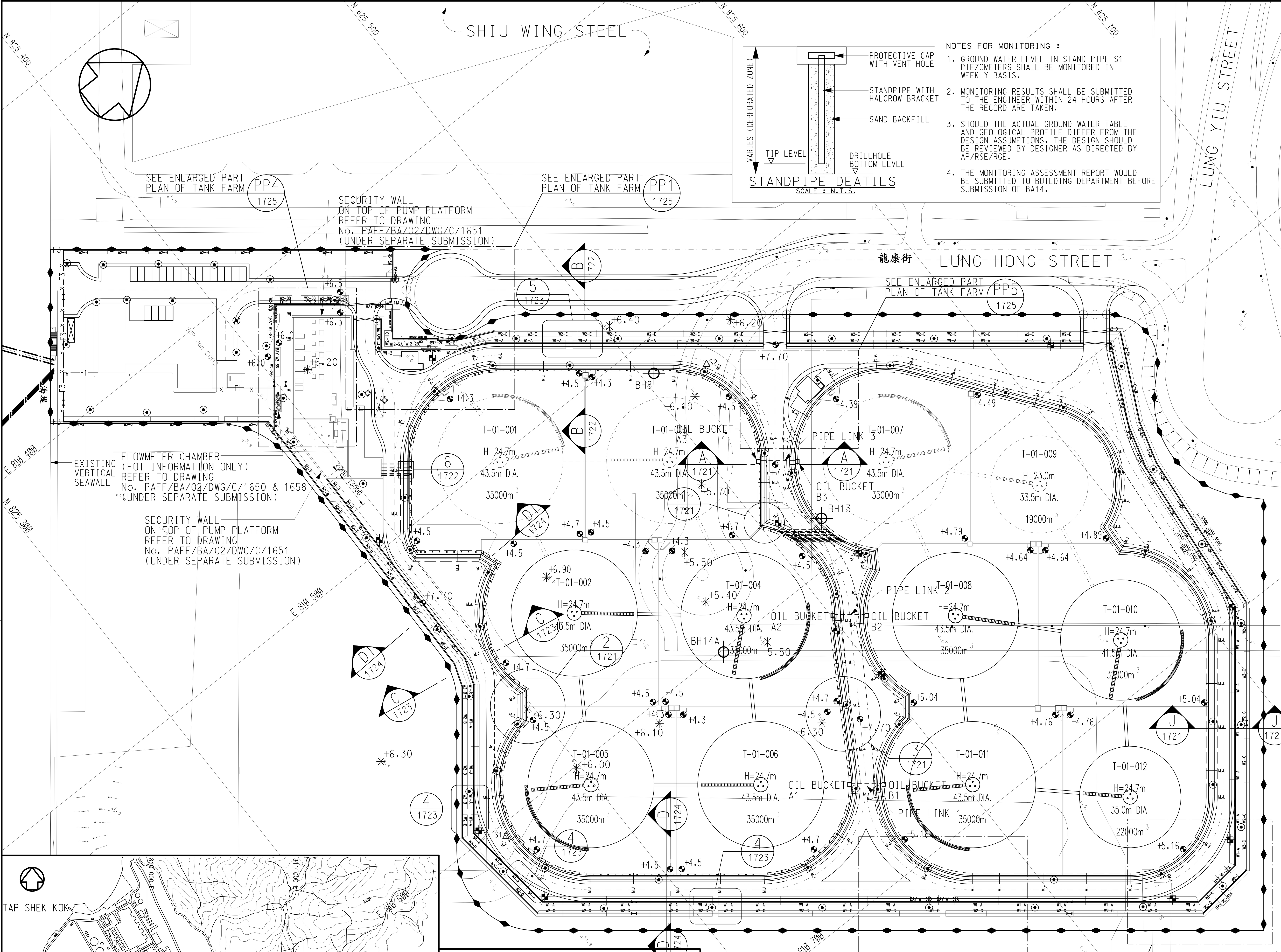
- Architectural
- Geotechnical
- Environmental Impact Assessment

Contract Drawings

Reinforced Concrete

- **PAFF/BA/02/DWG/C/1720 Revision 3 Tank Farm General Arrangement & Key Plan**
- **PAFF/BA/02/DWG/C/1726 Revision 3 Tank farm R.C. Details for Bund & Security Wall (Sheet 1 of 3)**
- **PAFF/BA/02/DWG/C/1728 Revision 0 Tank farm R.C. Details for Bund & Security Wall (Sheet 2 of 3)**
- **PAFF/BA/02/DWG/C/1730 Revision 0 Tank farm R.C. Details for Bund & Security Wall (Sheet 3 of 3)**

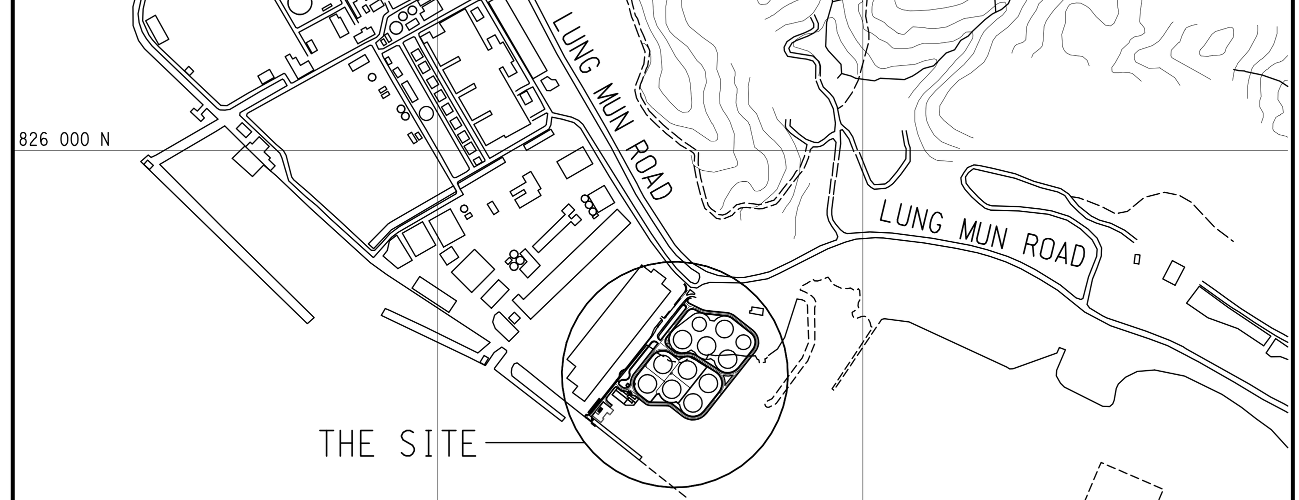
BD REF. NO. 3/0001/02



STANDPIPE DEATILS
SCALE : N.T.S.

NOTES FOR MONITORING :

1. GROUND WATER LEVEL IN STAND PIPE S1 PIEZOMETERS SHALL BE MONITORED IN WEEKLY BASIS.
2. MONITORING RESULTS SHALL BE SUBMITTED TO THE ENGINEER WITHIN 24 HOURS AFTER THE RECORD ARE TAKEN.
3. SHOULD THE ACTUAL GROUND WATER TABLE AND GEOLOGICAL PROFILE DIFFER FROM THE DESIGN ASSUMPTIONS, THE DESIGN SHOULD BE REVIEWED BY DESIGNER AS DIRECTED BY AP/RSE/RGE.
4. THE MONITORING ASSESSMENT REPORT WOULD BE SUBMITTED TO BUILDING DEPARTMENT BEFORE SUBMISSION OF BA14.



SITE LOCATION PLAN

LEGEND FOR SECURITY WALL & FENCE

—F1—	SECURITY FENCE (TYPE I)
—F3—	SECURITY FENCE (TYPE III)
—◆—◆—	SITE BOUNDARY (1.2m FENCE)
BW-X	BUND WALL
▶◀	PEDESTRIAN DOOR
W1-X	SECURITY WALL (TYPE I)
W2-X	SECURITY WALL (TYPE II)
△S1	STAND PIPE

PLEASE REFER DRAWINGS No.PAFF/BA/02/DWG/C/1725, FOR DETAILS OF THE SECURITY WALL 1 & 2)

LEGEND :

- FUTURE LEVEL (FOR EXACT DETAILS REFER TO DWG. NO. PAFF/BA/02/DWG/C/1471 TO 1479)
- EXISTING GROUND LEVEL
- BOREHOLE LOCATION
- M.J. MOVEMENT JOINT
- PROPOSED SITE BOUNDARY
- FOAM MONITOR CONTROL STATION
- LIGHT POST

NOTES :

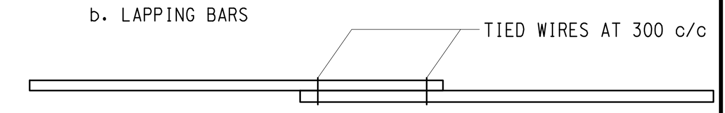
1. FOR GENERAL NOTE REFER TO DRAWING No.PAFF/BA/02/DWG/C/1721.
2. NOTES ON DEPOSITION AND COMPACTION OF FILL MATERIAL :
   A. THE PLACEMENT OF FILL SHALL BE IN ACCORDANCE WITH PNAP 55.
   B. UNLESS OTHERWISE STATED IN THE CONTRACT, AREAS OF FILL SHALL BE FORMED OF GENERAL FILL MATERIAL.
   C. MATERIALS FOR BACKFILL MUST BE FREE OF PEAT, VEGETATION, TIMBER, OR OTHER DEGRADABLE MATERIALS/ DANGEROUS OR TOXIC MATERIAL OR MATERIAL SUSCEPTIBLE TO COMBUSTION/ METAL, RUBBER, PLASTIC, OR SYNTHETIC MATERIALS/ MATERIAL SUSCEPTIBLE TO SIGNIFICANT VOLUME CHANGE/ OR SOLUBLE MATERIAL.
   D. FILL MATERIAL SHALL BE OBTAINED FROM EXCAVATION WITHIN THE SITE. IF THERE IS INSUFFICIENT FILL MATERIAL OF THE REQUIRED TYPES WITHIN THE SITE, IMPORTED FILL MATERIAL SHALL BE PROVIDED BY THE CONTRACTOR FROM SOURCES OUTSIDE THE SITE.
   E. UNLESS OTHERWISE PERMITTED BY THE ENGINEER, LAYERS OF FILL MATERIAL SHALL BE HORIZONTAL, EXCEPT FOR ANY GRADIENT REQUIRED FOR DRAINAGE, AND THE THICKNESS OF EACH LAYER SHALL BE UNIFORM OVER THE AREA TO BE FILLED.
   F. FILL MATERIAL SHALL NOT BE DEPOSITED BY END-TIPPING, BY PUSHING LOOSE MATERIAL DOWN SLOPE FACES OR BY OTHER METHODS WHICH MAY RESULT IN SEGREGATION OR INADEQUATE COMPACTION OF THE FILL MATERIAL.
   G. FILL MATERIAL DEPOSITED WITHIN 0.5M OF A STRUCTURE OR UTILITY SHALL BE FINE FILL MATERIAL UNLESS OTHERWISE STATED IN THE CONTRACT. IN ADDITION, THE MATERIAL MAY CONTAIN UP TO 5% BY WEIGHT OF FRESH, SLIGHTLY DECOMPOSED OR MODERATELY DECOMPOSED ROCK FRAGMENTS OF UP TO 200mm PROVIDED THAT THESE DO NOT CAUSE ANY DAMAGE TO STRUCTURES, NOR DO THEY INTERFERE WITH THE COMPACTION REQUIREMENTS.
   H. FILL MATERIAL SHALL BE DEPOSITED EVENLY ON ALL SIDES OF STRUCTURES AND UTILITIES AND IN SUCH A MANNER THAT THE STRUCTURE OR UTILITY IS NOT DISTURBED OR DAMAGED.
   I. FILL MATERIAL SHALL BE COMPACTED IN LAYERS TO A STABLE CONDITION AS SOON AS PRACTICABLE AFTER DEPOSITION AND IN A MANNER APPROPRIATE TO THE LOCATION AND TO THE MATERIAL TO BE COMPACTED.
   J. THE PERMISSION OF THE ENGINEER SHALL BE OBTAINED BEFORE THE NEXT LAYER IS DEPOSITED ON EACH LAYER OF COMPACTED FILL MATERIAL.
   K. FILL MATERIAL SHALL BE COMPACTED TO OBTAIN A RELATIVE COMPACTION OF AT LEAST 95% THROUGHOUT UNLESS OTHERWISE STATED.
   L. COMPACTION TESTS SHALL BE CARRIED OUT IN ACCORDANCE WITH PNAP 55, AT DEPTH INTERVALS OF 1m MAXIMUM.
   M. FILL MATERIAL OTHER THAN ROCK FILL MATERIAL SHALL BE AT OPTIMUM MOISTURE CONTENT DURING COMPACTION. THE TOLERANCE ON THE OPTIMUM MOISTURE CONTENT PERCENTAGE SHALL BE ?%, PROVIDED THAT THE FILL MATERIAL IS STILL CAPABLE OF BEING COMPACTED IN ACCORDANCE WITH THE SPECIFIED REQUIREMENTS TO FORM STABLE AREAS OF FILL. ALL NECESSARY SHALL BE TAKEN TO ACHIEVE AND MAINTAIN THE SPECIFIED MOISTURE CONTENT.
   N. EARTHWORKS FINAL SURFACES SHALL BE COMPLETED TO A STABLE CONDITION AS SOON AS PRACTICABLE AFTER EXCAVATION OR AFTER DEPOSITION AND COMPACTION OF FILL MATERIAL HAS BEEN COMPLETED. THE SUBSEQUENT PERMANENT WORK OR SURFACE PROTECTION SHALL BE CARRIED OUT AS SOON AS PRACTICABLE AFTER THE EARTHWORKS FINAL SURFACE HAS BEEN COMPLETED.
   O. EARTHWORKS FINAL SURFACES SHALL BE COMPLETED TO SMOOTH ALIGNMENTS WITHOUT ABRUPT IRREGULARITIES UNLESS OTHERWISE STATED.
   P. SAMPLES OF FILL MATERIAL TO BE TESTED FOR PARTICLE SIZE DISTRIBUTION, LIQUID LIMIT, PLASTICITY INDEX, COEFFICIENT OF UNIFORMITY AND SULPHATE CONTENT SHALL BE DELIVERED AT LEAST 14 DAYS, OR SUCH SHORTER PERIOD AGREED BY THE ENGINEER, BEFORE DEPOSITION OF THE FILL MATERIAL STARTS. THREE NOS. OF SAMPLES SHALL BE PROVIDED FROM EACH BATCH.
   Q. SAMPLES OF FILL MATERIAL TO BE TESTED FOR MOISTURE CONTENT SHALL BE TAKEN DURING DEPOSITION AND COMPACTION OF FILL MATERIAL AND SHALL BE DELIVERED NOT MORE THAN 1 HOUR AFTER THE FILL MATERIAL HAS BEEN DEPOSITED IN ITS FINAL POSITION. TWELVE NUMBER OF SAMPLES TO BE PROVIDED FROM EACH BATCH.
   R. IF THE RESULT OF ANY TEST FOR MOISTURE CONTENT OF FILL MATERIAL DIFFERS FROM THE OPTIMUM MOISTURE CONTENT BY MORE THAN THE SPECIFIED AMOUNT AND IF INSTRUCTED BY THE ENGINEER, THE MOISTURE CONTENT OF THE WHOLE OF THE BATCH OF FILL MATERIAL SHALL BE ADJUSTED. ADDITIONAL SAMPLES SHALL BE PROVIDED FROM THE SAME BATCH AND ADDITIONAL TESTS FOR MOISTURE CONTENT SHALL BE CARRIED OUT.
   S. PARTICLE SIZE DISTRIBUTION OF FILL MATERIAL :

SIZE	75mm	200mm
% BY MASS PASSING	75 - 100%	100%

   T. WATER DRAINAGE ARE FACILITATED WITH SUBSOIL PRAIN FOR BUNDWALL (NO WEEPHOLE) AND WEEPHOLE AT 1500mm c/c FOR SECURITY WALL WITH THE LEVEL DIFFERENCE BY 1000mm.

NOTES ON R.C. DETAILS:

1. ALL STRUCTURAL CONCRETE SHALL BE A DESIGN MIX OF A GRADE IN ACCORDANCE WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS. DETAILS OF THE DESIGN MIXES TO BE USED ARE GIVEN IN THE PARTICULAR SPECIFICATION.
2. ALL STRUCTURAL CONCRETE SHALL HAVE 40mm COVER.
3. UNLESS OTHERWISE NOTED ALL REINFORCEMENT FOR STRUCTURAL CONCRETE SHALL BE HOT ROLLED HIGH TENSILE STEEL DEFORMED BARS DENOTED BY 'T' WITH MINIMUM YIELD STRENGTH OF NOT LESS THAN 460 N/mm^2.
4. RADII AND BENDS IN REINFORCEMENT TO BE IN ACCORDANCE WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS AND TO BS 8666.
5. WELDING OF REINFORCEMENT IS NOT PERMITTED WITHOUT PRIOR APPROVAL OF THE DESIGNER.
6. WHERE CONCRETE IS TO BE PLACED, ALL SURFACES SHALL BE CLEANED AND ALL STANDING WATER SHALL BE REMOVED IMMEDIATELY BEFORE THE PLACING OF CONCRETE.
7. NO HOLES IN REINFORCED CONCRETE ARE TO BE FORMED OR CUT WITHOUT THE DESIGNER'S PRIOR AGREEMENT.
8. THE POSITIONS AND DETAILS OF ALL CONSTRUCTION JOINTS ARE TO BE AGREED WITH THE DESIGNER BEFORE WORK COMMENCES.
9. UNLESS OTHERWISE STATED ALL LAP LENGTHS AND ANCHORAGE VALUES OF REINFORCEMENT SHALL BE IN ACCORDANCE WITH TABLE 3.27 OF BS8110: PART 1 : 1997.
10. ALL LAPS TO BE STAGGERED LAPS.
11. UNLESS NOTED OTHERWISE ON THE DRAWINGS. ALL NEW CONCRETE WORKS FOR STRUCTURE SHALL BE GRADE 40D/20 DESIGNED MIX AND SHALL HAVE A CHARACTERISTIC STRENGTH OF 40 N/mm^2 AT 28-DAY.
12. FOR CONCRETE FINISH REFER TO GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS (1992 EDITION).CLASS OF FINISH OF WALL SHALL COMPLY WITH GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS.
13. BARS TIED WITH WIRE :
    a. WIRE SHOULD BE PROVIDED AT THE CROSSING OF ALL BARS AND
    b. LAPPING BARS



14. UNLESS NOTED OTHERWISE ALL BARS TO HAVE FULL TENSION LAP (FTL) AND ANCHORAGE (FAL) LENGTHS IN ACCORDANCE WITH THE TABLE BELOW.

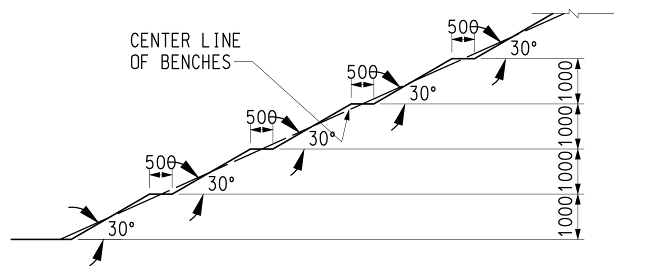
TENSION LAP AND ANCHORAGE LENGTHS
CONCRETE CLASS 40D/20
REINFORCEMENT GRADE 460

BAR DIA. D	LAP / ANCHORAGE (mm) GENERAL 32D	CONDITION (a) OR (b) 32D x 1.4 = 45D	CONDITION (a) AND (b) 32D x 2 = 64D
T10	325	450	650
T12	400	550	775
T16	525	725	1025
T20	650	900	1300
T25	800	1125	1600
T32	1025	1450	2050
T40	1300	1800	2575
T50	1600	2250	3200

CONDITION (a)TOP BARS WHERE COVER < 2D
(b)CLEAR SEPARATION BETWEEN ADJACENT LAPS < GREATER OF 75 mm OR 6D

LAP LENGTHS FOR UNEQUAL BARS TO BE BASED UPON THE SMALLER BAR

15. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE KEY PLAN DRAWING NO. PAFF/LC/02/DWG/G/0011.
16. FOR NOTES ON COMPACTION FILL REFER TO DRAWING NO. PAFF/LC/02/DWG/C/0011.
17. CONTRACTOR'S PROPOSAL ON THE TYPE B GRANULAR FILTER/DRAINAGE MATERIAL SHOULD BE SUBMITTED TO THE DESIGNER FOR THEIR AGREEMENT AND CHECK IN ACCORDANCE TO TABLE 17 OF GEOGUIDE 1.
18. THE EXCAVATED TRENCH SHOULD BE CUT WITH BENCHES AS FOLLOW :



19. THE WALL SHALL BE FOUNDED ON MATERIAL WITH AN ALLOWABLE BEARING CAPACITY IN ACCORDENCE WITH THE TABLE BELOW:

TYPE OF WALL	BEARING CAPACITY KPa
BUND WALL (TYPE A & B)	150
SECURITY WALL (TYPE I)	150
SECURITY WALL (TYPE II) (EXCEPT W2-88a, W2-88b, W2-89a & W2-89b	150
SECURITY WALL BAY W2-88a, W2-88b, W2-89a & W2-89b	210

20. ALL EXPOSED SLOPE SURFACES SHALL BE COVERED BY PLASTIC SHEETING WELL SECURED AGAINST WIND.
21. SEQUENCE OF CONSTRUCTION:
    1. EXCAVATE AS SHOWN IN SECTIONS A TO D TO REQUIRED DEPTH.
    2. PREPARE THE BEDDING.
    3. INSTALL/CAST THE BUND WALL.
    4. BACKFILL BEHIND THE BUND WALL UP TO UNDERNEATH THE SECURITY WALL.
    5. PREPARE THE BEDDING TO THE SECURITY WALL.
    6. INSTALL/CAST THE SECURITY WALL.
    7. BACKFILL WITH THE REST OF THE FILL.
22. THE FENCING IS REQUIRED TO BE EARTHED AND CONTINUITY NEEDS TO BE ENSURED BETWEEN THE PANELS.

NOTES ON STAINLESS STEEL WATERSTOP:

1. STAINLESS STEEL SHALL BE GRADE 316 TO BS EN 10288 : 2005.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	FEB 2004	FOR CONSTRUCTION	
1	SEP 2007	FOR CONSTRUCTION	
2	OCT 2007	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Rev.	Date	Description	Checked
	JAN 2009	AS UPDATED	

Scale	Date		
1 : 750 OR AS SHOWN	JAN 2006		
Designed BW	Drawn SKL	Checked AS	
Design Team Leader		Date	
Approved LHS		Date JAN 2006	

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Permanent Aviation Fuel Facility

Title GENERAL ARRANGEMENT & KEY PLAN

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/BA/02/DWG/C/1720	3

DATE : 3/2/2009
TIME : 10:05:23 AM
PLOT DRV: $PLTDRVL$

FILENAME : S:\Drawings\DGN\Babtie\20090225\1720-3.dgn

BD REF. NO. 3/0001/02

NOTES :
1. THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NO. PAFF/BA/02/DWG/C/1721.

BUND WALL TYPE	LEVEL (mPD)									
	01	02	03	04	05	06	07	08	08A	09
A	T25-150	T25-125	T20-200	T25-125	T32-150	T25-150	T20-200	T25-150	-	T20-200
B1	T25-150	T25-150	T20-200	T25-150	T25-150	T25-150	T20-200	T12-200	-	T12-200

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	JUN 2006	FOR CONSTRUCTION	
1	SEP 2008	FOR CONSTRUCTION	
2	OCT 2008	FOR CONSTRUCTION	
3	FEB 2009	FOR CONSTRUCTION	

Scale: AS SHOWN (A1)	Date	
Designed: BW	Drawn: SKL	Checked: AS
Design Team Leader: AS		Date: DEC 2003
Approved: LHS		Date: DEC 2003

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Permanent Aviation Fuel Facility

Title
TANK FARM
R.C. DETAILS FOR BUND & SECURITY WALL
(SHEET 1 OF 3)

Drawing No. (Project / Originator / Location / Category / Discipline / Number)	Revision
PAFF/BA/02/DWG/C/1726	3

DATE : 3/2/2009
TIME : 10:07:40 AM
PLOT DRV: $PLTDRVL$

FILENAME : S:\Drawings\DGN\Babtie\20090225\1726-3.dgn

BD REF. NO. 3/0001/02

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	FEB 2009	FOR CONSTRUCTION	

Scale: AS SHOWN (A1)		Date: FEB 2009
Designed: PN	Drawn: SWL	Checked: BW
Design Team Leader: BW		Date: FEB 2009
Approved: LHS		Date: FEB 2009

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Permanent Aviation Fuel Facility

Title
TANK FARM
R.C. DETAILS FOR BUND WALL & AND SECURITY WALL
(SHEET 2 OF 3)

Drawing No. PAFF/BA/02/DWG/C/1728 Revision 0

DATE : 3/2/2009
TIME : 10:08:22 AM
PLOT DRV: $PLTDRVL$

FILENAME : S:\Drawings\DGN\Babtie\20090225\1728-0.dgn

BD REF. NO. 3/0001/02

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	FEB 2009	FOR CONSTRUCTION	

Scale	Date
AS SHOWN (A1)	FEB 2009

Designed	Drawn	Checked
PN	SWL	BW

Design Team Leader	Date
AS	FEB 2009

Approved	Date
LHS	FEB 2009

Contractor

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Permanent Aviation Fuel Facility

Title
TANK FARM
R.C. DETAILS FOR BUND WALL & AND SECURITY WALL
(SHEET 3 OF 3)

Drawing No.	Revision
PAFF/BA/02/DWG/C/1730	0

FILENAME: S:\Drawings\DGN\Babtie\20090225\1730-0.dgn

Photographs

Construction of Security Wall 2 Footing

Construction of Bund Wall around Phase 1a

Construction of Bund Wall Footing Phase 1a

Construction of Security Wall 1

Construction of Security Wall 1

Table 1 EP Condition 3.5 (b) - Summary of the document

	Content	**Remarks**
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 b)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; section 3 clause 3.2.10, section 6, clause 6.7, section 10 clause 10.1.5.12, section 11 clause 11.4.1, section 13 clause 13.5.1 and 13.5.2 and section 16 clause 16.2.8.
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and (i) and Franchisee Requirements Clause 1.05 item (b)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10, section 5 and section 10.
5	Contract drawings	**a) Drainage Layout, Valves, Oil/Water Separators** - PAFF/BA/02/DWG/C/1452 Tank Farm EVA Stormwater Drainage Layout - PAFF/LC/02/DWG/C/1453 Tank Farm Manholes and Manhole Details - PAFF/LC//02DWG/C/0885 Tank Farm Drainage Layout Plan
		(b) Impermeable Lining, Leak Detection: - PAFF/BA/02/DWG/C/1705 Revision 3 Tank Farm Fuel Tank Foundations Sections and Details of Ring Beam (Sheet 1 of 2)
6	Photographs	Photographs of the completed works
7	Technical data	a) Penstock b) Containment Lining – HDPE Containment Membrane GSE HD 1.00mm c) Coalescing Plates – Mpak Coalescing Plates d) Valves for stormwater system – Premier Valves Metal Seated Wedge Gaet Valve e) Design Calculation – Supplementary Design Calculation for Stormwater Drainage System of EVA and Tank Farm

	Content	Remarks
8	Justification	- The drainage layout plans in drawings PAFF/BA/02/DWG/C/1452, PAFF/LC/02/DWG/C/1453 AND PAFF/LC//02/DWG/C/0885 show the construction of the drainage systems with appropriate falls and gradients to collect aviation fuel in case of spillage. It is meeting the Hong Kong "Code of Practice for Oil Storage Installation " item 6.2.1. - The drainage layout plans in PAFF/BA/02/DWG/C/1452, PAFF/LC/02/DWG/C/1453 and PAFF/LC//02/DWG/C/0885 show the installation of valves at the drainage outlets of bunded compounds. These valves are normally in closed positions to contain any spillage. They will only be opened under close monitoring by competent persons to release any storm waters inside the bunded areas. The effluent from the drainage outlet has been designed to pass through the oil/water separator which will capture any aviation fuel present in the effluent to prevent any oily discharge to the public drainage system and then to the sea. This is meeting the Hong Kong "Code of Practice for Oil Storage Installation" item 7.1. - Drawing PAFF/BA/02/DWG/C/1705 shows the installation of impermeable lining (GSE Containment membrane) underneath all aviation fuel storage tanks and within the bunded areas to prevent seepage of aviation fuel to the ground due to leakage from the storage tanks. This is meeting the I.P. Code Part 19 "Fire Precautions at petroleum Refineries and Bulk Storage Installations" item 3.4.2.5.2.

香港機場管理局 AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (b)
Date of Report:	24 November 2009
Date prepared by ET:	24 November 2009
Date received by IEC:	24 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (b)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

b) Drainage Isolation and Lining System for Aviation Fuel Storage Tank Farm

Drainage system shall be properly designed and constructed for the aviation fuel storage tank farm to collect aviation fuel in case of spillage. Valves and oil interceptors shall be installed at the drainage system to prevent any oily discharge to the sea. Impermeable lining shall be installed underneath all aviation fuel storage tanks to prevent seepage of aviation fuel to ground.

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 24 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

PP Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE
A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. <u>Submissions or Measures during the Construction of Certain Parts of the Project</u>

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements:-

b) <u>Drainage Isolation and Lining System for Aviation Fuel Storage Tank Farm</u>

Drainage system shall be properly designed and constructed for the aviation fuel storage tank farm to collect aviation fuel in case of spillage. Valves and oil interceptors shall be installed at the drainage system to prevent any oily discharge to the sea. Impermeable lining shall be installed underneath all aviation fuel storage tanks to prevent seepage of aviation fuel to ground.

Environmental Impact Assessment Report Requirement

3 DESCRIPTION OF PROJECT AND ASSUMPTIONS

3.2.10 The tank farm would be provided with bundwalls and contained drainage. There are 2 main bunds (designed to contain any spills from the tank or tank piping), each containing 6 tanks in future but 4 tanks initially. The height of the bundwalls has also been increased from previous April 2002 EIA in order to improve the retention of any fuel spillage from the tanks within the PAFF boundary. The initial bund containment with 4 tanks in each bund would amount to at least 180% of the volume of the largest tank (well exceeding the required 110%) and ultimately (2040) this would be at least 150% of the volume of the largest tank with 6 tanks in each bund. Each tank is also separated by intermediate bund walls to hold minor spills. There are also 2 emergency shutdown valves on the pipeline inlet to the tank farm from jetty and another 2 on the pipeline outlet of the tank farm to the Airport. These valves are operated via motorized electric actuators. The tank bunds and the pump platform are contained areas and drain to the interceptor via bund drain valves. Other leakage prevention devices include fuel tank high-high level alarm and leak detection system for the pipeline. The storm water drain will also have a remotely operated block valve to contain any oil spill on site.

6 WATER QUALITY ASSESSMENT

6.7 Mitigation Measures

6.7.2 Operational Phase

6.7.2.1 Other mitigation measures recommended for the operational phase include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- oily drainage systems and slop collection systems will connect to an oil/water separator;
- all tanks shall be bunded to a capacity of at least 150% of the largest individual tank in each compound at the ultimate phase of 2040. For the initial development phase, as only 4 tanks will be present in each bund, a containment capacity of about 175% will be achieved. Tank pits shall be protected by an impermeable bed (e.g. geotextile sheeting) to prevent seepage of aviation fuel to ground. A leak detection system shall be installed beneath the containment membrane;
- there shall be no direct outlet from the bund. A collection sump shall be included in the base. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator;
- valves shall be installed within the storm drainage system to facilitate the retention of spillages.

10 HAZARD TO LIFE ASSESSMENT

10.1.5.12 The storage tanks will be located within a bund, which is designed to contain any spills from the tank or tank piping. The bund is designed to hold much more than the required 110% of the contents of the largest tank in the bund. The bund will be provided with a drain, which will be discharged by a manually operated valve to the sea through an oil interceptor. Drainage from unbunded areas onsite will be discharged through the storm water drain to the sea. The storm water drain will be provided with a remotely operated block valve to contain any oil spill on site.

11 FUEL SPILL RISK ASSESSMENT

11.4 Mitigation Measures

11.4.1 The mitigation measures identified here are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B. All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure and resultant leaks and spills to the lowest practicable level. Tanks in the tank farms will be constructed in a bunded area surrounding the tanks which will have an ultimate (2040) collection capacity of at least 150% of the volume of the largest tank in the bund to contain any fuel spills. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages. Protection against leaks from the bottom of the tanks is achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. In respect of the pipeline, besides protection of the pipeline being covered with a protective rock armour layer, integrated methods of control will also be built into the design of the pipeline. A leak detection system will be installed to provide early detection of any leak and at the first sign of a pressure drop, would instigate an automatic shut-off system. Contingency plan procedures will require investigation and immediate action to stem the release, as described below.

13. LAND CONTAMINATION

13.1 Mitigation Measures

13.5.1 The implementation of appropriate mitigation for the oil storage facilities and pipework is required to ensure that risk of ground contamination as a result of oil spills or leaks is kept to a practical minimum. Such measures should include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- bunding of all fuel storage areas;
- adherence to relevant design standards for storage tanks, pipework, containment and drainage;
- regular plant inspections and maintenance;
- impermeable lining of tank pits;
- leak detection systems;
- controlled surface drainage and the provision of emergency shut off valves;

13.5.2 Key mitigation recommendations for the bunded containment have been identified in Section 6.7. The most important features are that all tanks shall be bunded to an ultimate capacity of at least 150% of the largest individual tank in each compound. Following completion of the first phase of works, the bund capacity will be as high as 180% of the largest individual tank in each compound; an only 4 tanks will be present within each bund. Tank pits shall be protected by an impermeable bed (e.g. geotextile sheeting, bitumen lining) to prevent seepage of oil to ground and a leak detection system shall be installed beneath the containment membrane. A concept design for a tank incorporating these features is provided in Figure 13.1.

16. SUMMARY OF ENVIRONMENTAL OUTCOMES

Design

16.2.8 All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure, and the resultant leaks/spills, to the lowest practicable extent. Fuel storage tanks will be constructed in a bunded area which will have collection capacity greater than the maximum content of the largest tank, to contain any fuel leaks or spills. There shall be no direct outlet from the bund to ensure retention of any spilled material. A collection sump shall be included in the base. Protection against leaks or spills from the bottom of the tanks will be achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. A spill detection system will be fitted underneath this membrane to provide additional security. Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

- (i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting
- (ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings
- (iii) Sampling and product recovery system
- (iv) Manifolding to tank farm and existing aviation fuel system simultaneously
- (v) Fire protection system
- (vi) Power supply and independent standby power generator or second supply
- (vii) Buildings including offices, canteen, control room, workshop, stores
- (viii) Emergency response facilities
- (ix) Storage tanks for fuel, water, chemicals and wastes
- (x) Utility and other systems including back-up systems
- (xi) Cathodic protection
- (xii) Lightning protection
- (xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities
- (xiv) Electronic tank servo gauges
- (xv) Hard standing, roads and parking
- (xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services;

EPC – Franchisee's Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services; and associated fire protection;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed.

Also, in the detail design additional standards may be referenced for specific items.

5. Storage Tank (including BUND Wall and Foundation)

5.1 GENERAL

The main storage tanks will be circular and made of steel plate with diameters of 6 x 43.5m, 1 x 41.5m, 1 x 35m and a height of 24.7 metres and nominal capacities of 35,000, 32,000, 22,000 cubic metres respectively. The tanks will be founded on a reinforced concrete ring beam. The eight storage tanks will be contained within two reinforced concrete bund walls (4 nos. of fuel tank for each bund wall) with a membrane lining to contain any leakage. All bund walls will include a wave wall to assist in containing Jet A1 within the bunded area.

5.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) API 650 Vertical Storage Tanks
(b) BS EN 12285 Horizontal Storage Tanks
(c) British Standard for Concrete Structures
(d) Code of Practice for Oil Storage Installations 1992 – Building Authority Hong Kong
(e) IP Code of Practice Part 15

5.3 SPECIFIC CRITERIA

5.3.4 Bund Walls

1. The bund walls shall be of reinforced concrete.

2. The capacities of the bunded areas will be 57,691 cubic metres for phase 1a & 2 tank farms and a minimum of 50,695 cubic metres for phase 1b & 2 tank farm, which are not less than 38,500 cubic metres (110% of a 35,000 cubic metres tank) for both areas.

3. The construction of the bund walls joints will provide a continuous barrier to any spill within the bunded area.

4. The bund walls shall be designed to retain the bunded area when full of water or the impact load of an instantaneous release from a simple storage tank which ever is greater.

5. A means of access in and out of the bunded area will be provided adjacent to the stairs fitted to the main storage tanks and as directed by the FSD.

6. The bund wall alignment will allow 25% of the circumstance of each tank to be with in 15 metres of the EVA.

5.3.5 Containment Inside Bunded Areas

1. The floor of the bunded area shall be lined with a seam welded high density polythelyne (HDPE) membrane of not less than 1mm think and covered with a 200 mm thick layer of compacted road base.

2. The HDPE membrane shall be sealed to the concrete foundations, and intermediate bunds to provide a continuous barrier across the bunded area floor.

3. The HDPE membrane shall be laid under the main storage tanks to form a central sump. A tell tail pipe will run from within the central sump through the tank foundation to provide a visual indication of product leaks in the floor plates of the tanks.

4. The bunded area will have a series of open drains leading to a single outlet point. The outlet point will have a manually operated valve (normally closed) leading to an oil interceptor.

5. The bund area will be partitioned by intermediate containment bunds of up to 500m high subject to ground contours around each tank.

5.3.6 Secondary Containment

The security walls adjacent to the bund wall facing public areas will in addition be constructed of reinforced concrete to contain potential overtopping of the bund wall. Gates in the security walls are to be solid and sealed up to the first hinge on the gate.

10. STORMWATER DRAINAGE

10.1 GENERAL

The drainage designs shall incorporate drainage from the buildings, the road drainage and any runoff from undeveloped portion of the lot known as the “remaining area”.

The drainage of the “remaining area” shall be separated from the general site drainage, and be simple and economical. The general site drainage shall not pass through the “remaining area”.

10.2 CODES AND TECHNICAL STANDARDS

i) Laws of Hong Kong Cap 123 Building Regulations, Section I (BR, I), including relevant PNAP’s.

ii) Stormwater Drainage Manual and DSD 2000 (SDDM)

iii) Civil Engineering Manual, Chapter VI

iv) Road Note 6, Road Pavement Drainage, HYDBRD/RN/006 May, 1994.

v) EPD, PNPP, ProPEC PN 5/93: "Drainage Plans Subject to Comment by the EPD."

vi) DSD Standard Drawings

vii) HyD Standard Drawings

viii) EPD Standard Drawings

10.3 SPECIFIC CRITERIA

10.3.1 Drainage Pipes

(b) Storm water within the bund wall is collected by sump pits. Other areas will be collected by U-channels and gullies. Then the collected storm water will be discharged to the sea by gravity via storm water manholes and an oil interceptor.

10.3.3 Bunded Areas

All stormwater drainage from within the bunded areas shall discharge through an oil water interceptor. Normally the discharge from the bunded area shall be closed. A manually operated discharge valve will control flow into the oil water interceptor.

Contract Drawings

Drainage Layout, Valves, Oil / Water Separators

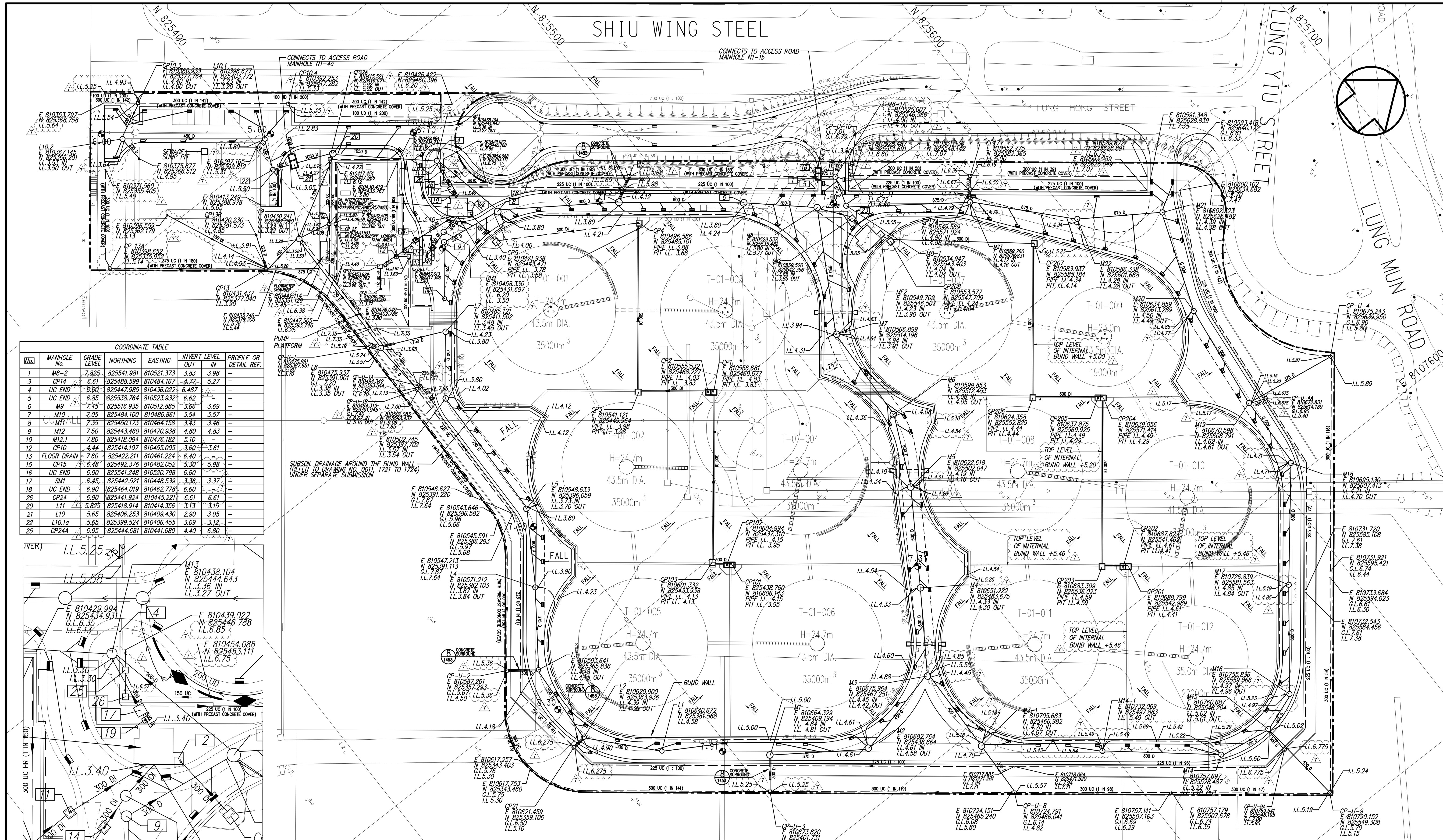
- **PAFF/BA/02/DWG/C/1452 Revision 7 Tank Farm EVA Stormwater Drainage Layout**
- **PAFF/BA/02/DWG/C/1453 Revision 5 Tank Farm Manholes and Manhole Details**
- **PAFF/LC/02/DWG/C/0885 Revision A Tank Farm Drainage Layout Plan**

Impermeable Lining, Leak Detection

- **PAFF/BA/02/DWG/C/1705 Revision 3 Tank Farm Fuel Tank Foundations - Sections and Details of Ring Beam (Sheet 1 of 2)**

BD REF. NO. 4/0001/02

SHIU WING STEEL



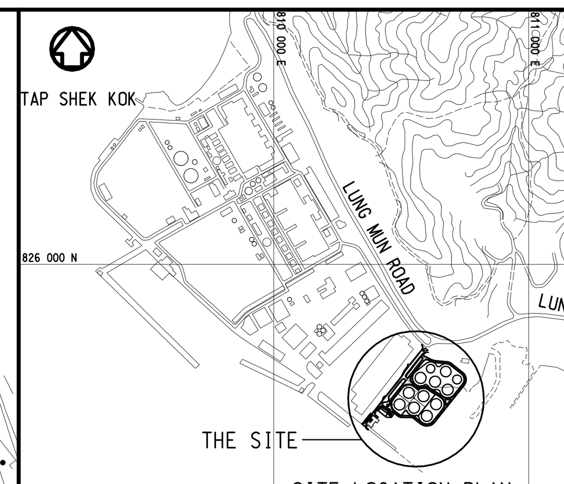
DRAINAGE LAYOUT PLAN

SCALE 1 : 1000

OIL INTERCEPTOR DRAINAGE ALIGNMENT

COORDINATE TABLE

No.	MANHOLE No.	GRADE LEVEL	NORTHING	EASTING	INVERT LEVEL OUT	INVERT LEVEL IN	PROFILE OR DETAIL REF.
1	M8-2	7.825	825541.981	810521.373	3.83	3.98	–
3	CP14	6.61	825488.599	810484.167	4.77	5.27	–
4	UC END	6.60	825447.985	810436.022	6.487	–	–
5	UC END	6.85	825538.764	810523.932	6.62	–	–
6	M9	7.45	825516.935	810512.885	3.66	3.69	–
7	M10	7.05	825484.100	810486.861	3.54	3.57	–
8	M11	7.35	825450.173	810464.158	3.43	3.46	–
9	M12	7.50	825443.460	810470.938	4.80	4.83	–
10	M12.1	7.80	825418.094	810476.182	5.10	–	–
12	CP10	4.44	825414.107	810455.005	3.60	3.61	–
13	FLOOR DRAIN	7.60	825422.211	810461.224	6.40	–	–
15	CP15	6.48	825492.376	810482.052	5.30	5.98	–
16	UC END	6.90	825541.248	810520.798	6.60	–	–
17	SM1	6.45	825442.521	810448.539	3.36	3.37	–
18	UC END	6.90	825464.019	810462.778	6.60	–	–
26	CP24	6.90	825441.924	810445.221	6.61	6.61	–
20	L11	5.825	825418.914	810414.356	3.13	3.15	–
21	L10	5.65	825406.253	810409.430	2.90	3.05	–
22	L10.1a	5.65	825399.524	810406.455	3.09	3.12	–
25	CP24A	6.95	825444.681	810441.680	4.40	6.80	–



SITE LOCATION PLAN

LEGEND :

- SITE BOUNDARY
- CATCH PIT
- GULLY
- SEWAGE SUMP PIT
- PROPOSED STORMWATER MANHOLE
- U-CHANNEL (300 UC)
- STORMWATER DRAINAGE PIPES
- EXISTING GROUND LEVEL (+6.3)
- SUB-SOIL DRAIN (200 UD)
- PROPOSED ROAD LEVEL (7.40)
- EXISTING FOUL WATER DRAIN AND MANHOLE
- EXISTING STORMWATER DRAIN AND MANHOLE
- VALVE
- J-CHANNEL (600 JC)
- SM1 MONITORING AND SAMPLING POINT

CATCH PIT AND VALVE SCHEDULE

CP No.	G.L. (mPD)	Inlet From	Inlet Dia. (mm)	Inlet I.L. (mPD)	Outlet To	Outlet Dia. (mm)	Outlet I.L. (mPD)	Pipe Class	Pipe length (m)	Gradient (1 IN)
CP-U-1	5.80	–	300 UC	5.19	L8	300	3.70	L	5	16
		–	300 UC	5.24						
CP-U-2	5.67	–	300 UC	5.36	L3	300	4.50	L	10	31
		–	300 UC	5.36						
CP-U-3	5.80	–	300 UC	5.25	M1	300	4.96	L	11	92
		–	300 UC	5.25						
CP-U-4	6.90	–	300 UC	5.87	M19	375	5.80	L	31.5	48
		–	300 UC	5.89						
CP24	6.40	–	150 UC	5.80	CP24A	150 UC	5.80	–	5	100
		–	–	–						
CP24A	6.40	CP24	150 UC	5.30	300 D	150 UPVC	4.40	–	4	5
		–	150 UC	5.80						
CP-U-8	6.14	–	300 UC	5.57	M3-1	300	4.82	L	18	150
CP-U-9	5.70	–	300 UC	5.24	M15	450	5.15	L	28	215
		–	300 UC	5.19						
CP17	5.40	–	300 UC	5.10	CP17A	300	5.00	L	3	30
		–	300 UC	5.10						
CP15	6.28	–	300 UC	6.26	CP14	300	5.30	L	3.5	117
		–	300 UC	5.98						
CP14	6.61	–	225 UC	5.98	M10	300	4.77	L	3.5	5
		–	225 UC	5.65						
		CP15	300	5.27						
CP10.3	5.87	CP10.4	300 UC	4.80	L10.2	300	4.00	L	11	23
CP13	5.60	–	375 UC	4.81	L9	450	3.90	L	23	37
		CP13B	225	3.93						
CP21	5.60	–	300 UC	6.275	L2	300	5.10	L	3.5	18
		–	300 UC	6.275						
G1	7.55	CP10	300 DI	3.55	MF1	300 DI	3.50	DI	14	133
CP10	4.10	CP11	300 DI	3.61	G1	300 DI	3.60	DI	7	175
		–	300UC HR	3.61						
		–	300UC HR	3.61						
CP11	4.44	–	–	–	CP10	300 UC	3.66	–	5	100
G2	7.475	–	–	–	MF1	300 DI	3.50	DI	13	6
G3	6.425	MF1	300 DI	3.40	SM1	300 DI	3.38	DI	2	133
CP-U-4A	6.85	–	225UC	6.20	M19	300	5.4	L	4.5	23
		–	225UC	5.82						
CP-U-9A	7.00	–	225UC	5.92	M15	300	5.9	L	7.6	25
		–	225UC	5.92						
CP-U-1A	8.00	–	225UC	7.10	CP-U-1B	225	6.7	L	1.5	50
		–	225UC	7.60						
CP-U-1B	7.40	–	225UC	7.00	L8	225	5.1	L	17	15
		–	225UC	7.13						
		CP-U-1A	225	6.67						
CP8	4.00	–	–	–	CP11	150UC HR	3.77	–	6	60
CP9	3.90	–	300UC HR	3.63	CP10	300UC HR	3.63	–	5	250
~~CP13A~~	~~5.75~~	~~–~~	~~375UC~~	~~5.20~~	~~CP13~~	~~375UC~~	~~5.2~~	~~–~~	~~48~~	~~178~~
CP13B	6.05	CP13C	100DI	4.85	CP13	100DI	4.85	DI	10	100
~~CP17A~~	7.00	~~–~~	~~225UC~~	6.67	~~M23~~	~~300~~	~~4.88~~	~~L~~	~~3~~	~~25~~
		–	225UC	6.50						
		CP17	225UC	~~4.90~~						
CP23	6.35	–	225UC	5.87	CP22	225	4.08	L	3.5	39
		–	225UC	6.12						
CP22	6.60	CP22A	225UC	5.66	L9	225	3.98	L	6	38
		–	225UC	6.21						
		CP23	225UC	3.99						
~~CP22A~~	6.35	~~–~~	~~225UC~~	5.92	~~CP22~~	~~225UC~~	5.92	~~–~~	~~25~~	~~100~~
CP10.4	5.63	–	300UC	5.33	CP10.3	300UC	5.33	–	49	57

MANHOLE SCHEDULE FOR TANK FARM DRAINAGE

Manhole No	Manhole Type	G.L. (mPD)	Inlet From	Inlet Dia. (mm)	Inlet I.L. (mPD)	Outlet To	Outlet Dia. (mm)	Outlet I.L. (mPD)	Pipe Class	Pipe length (m)	Gradient (1 IN)
CP5	C.P.	5.00	CP4	300 DI	3.78	MF1	300 DI	3.78	300 DI	11	79
MF1	Oil Interceptor	7.32	CP5	300 DI	3.73	G3	300 DI	3.40	300 DI	6	133
			G2	300 DI	3.40						
			G1	300 DI	3.40						
SM1	F	6.45	G3	300 DI	3.37	M13	300	3.36	300 DI	4.5	150
SM2	F	7.70	G4	300 DI	3.85	M8	300	3.85	300 DI	10	143
MF2	Oil Interceptor	7.60	CP208	300 DI	4.23	SM2	300 DI	3.85	300 DI	3	133

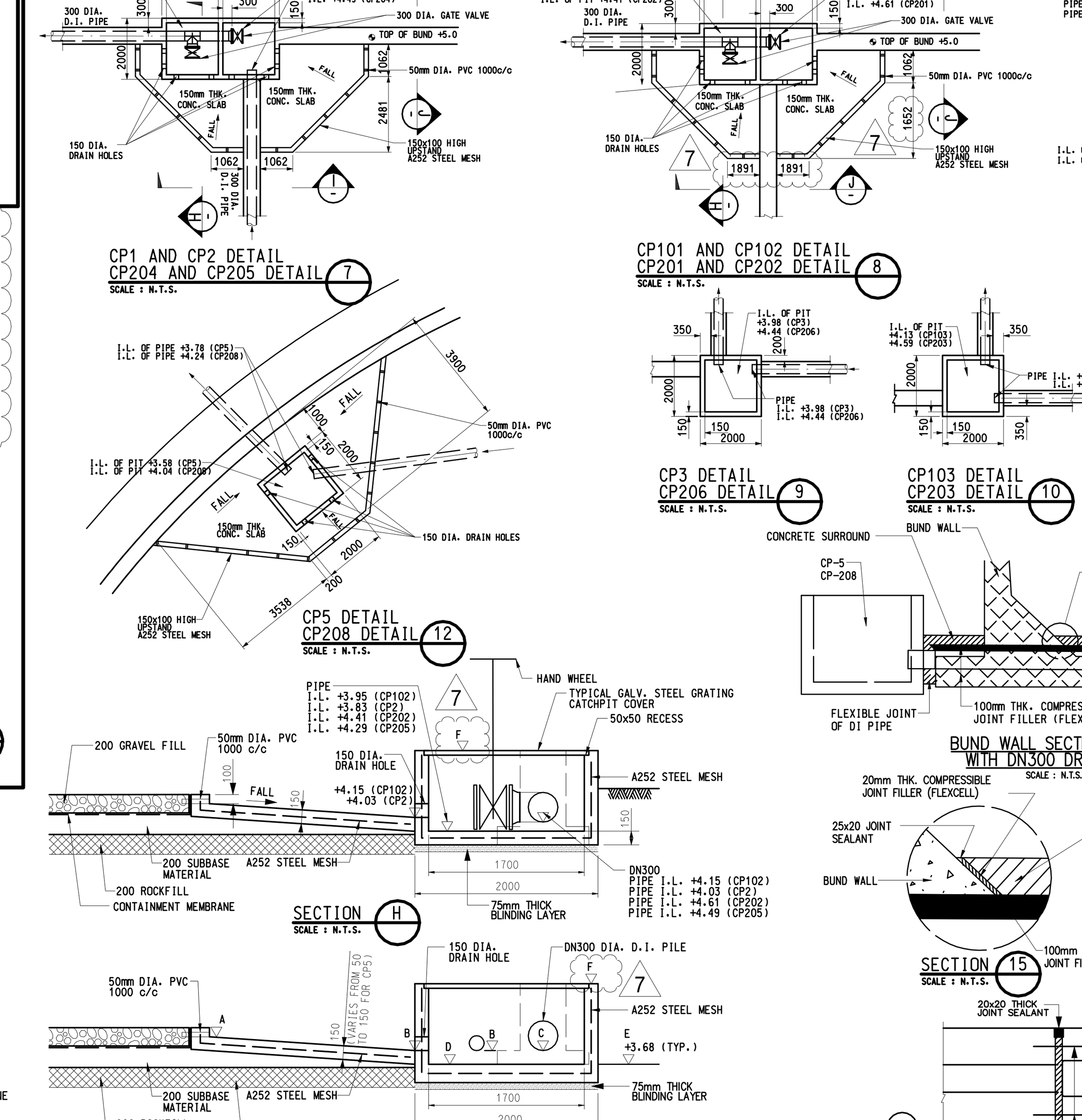
MANHOLE SCHEDULE ALONG EMERGENCY VEHICLE ACCESS

Manhole No	Manhole Type	G.L. (mPD)	Inlet From	Inlet Dia. (mm)	Inlet I.L. (mPD)	Outlet To	Outlet Dia. (mm)	Outlet I.L. (mPD)	Pipe Class	Pipe length (m)	Gradient (1 IN)
M1	F	8.10	CP-U-3	300	4.84	M2	375	4.81	L	35	175
M2	F	7.90	M1	375	4.61	M3	450	4.58	L	28	215
M3	F	7.70	M2	450	4.45	M4	600	4.42	M	28	311
			M3-1	600	4.45						
M4	F	7.45	M3	600	4.33	M5	600	4.30	M	34	310
M5	F	7.15	M4	600	4.19	M6	600	4.16	M	25	313
M6	F	7.20	M5	600	4.08	M7	600	4.05	M	33	300
M7	I	7.45	M6	600	3.94	M8	750	3.91	L	43	391
M8	I	7.55	M7	750	3.80	M9	750	3.77	L	25	313
			SM2	300	3.78						
M9	I	7.45	M8	750	3.69	M10	900	3.66	L	41	456
M10	I	7.08	M9	900	3.57	M11	900	3.54	L	35	438
			CP14	300	3.57						
M11	I	7.35	M10	900	3.46	M13	900	3.43	L	26.5	379
			M12	300	4.00						
M12	E	7.50	M12.1	225	4.83	M11	300	4.80	L	26	33
M13	I	6.49	M11	900	3.36	L11	1050	3.27	L	31.5	286
			SM1	300	3.30						
M12.1	E	7.80	–	–	–	M12	225	5.10	L	19	70
L1	F	7.75	–	–	–	L2	300	4.58	L	26	137
L2	F	7.95	L1	300	4.39	L3	300	4.36	L	27	150
			CP21	300	4.90						
L3	L	8.20	L2	300	4.18	L4	375	4.15	L	29	104
			CP-U-2	300	4.18						
L4	L	8.10	L3	375	3.87	L5	600	3.84	M	25	227
L5	I	7.90	L4	600	3.73	L6	750	3.70	L	46	354
L6	L	7.85	L5	750	3.57	L7	750	3.54	L	23	383
L7	L	7.88	L6	750	3.48	L8	750	3.45	L	25	357
L8	I	7.20	L7	750	3.38	L9	750	3.35	L	22	314
			CP-U-1	300	3.57						
			CP-U-1B	225	3.95						
L9	I	7.20	L8	750	3.23	L11	900	3.22	L	42	467
			CP13	450	3.28						
			CP22	225	3.82						
L10	T2	5.81	L11	1050	3.05	N1-4a	1200	2.90	L	11	157
			L10.1a	450	3.05						
L11	I	5.82	M13	1050	3.16	L10	1050	3.13	L	16	200
			L9	900	3.15						
L10.1a	E	5.65	L10.1	450	3.12	L10	450	3.09	L	5.5	138
L10.1	E	5.64	L10.2	450	3.23	L10.1a	450	3.20	L	9.5	119
			BUILDING	150	3.88						
L10.2	E	5.90	CP10.3	300	3.53	L10.1	450	3.50	L	47	174
			BUILDING	225	3.68						
M3-1	E	6.00	CP-U-8	300	4.70	M3	600	4.67	M	31	141
			M3-2	300	4.70						
–	–	–	–	–	–	–	–	–	–	–	–
M8-2	T2	7.825	M8-1	675	3.98	N1-1b	675	3.83	M	6.5	217
M14-1	E1	7.75	–	–	–	M14	300	5.49	L	40	148
M14	E1	7.95	M14-1	300	5.22	M15	300	5.2	L	11.5	64
M15	E1	7.85	M14	300	5.02	M16	600	5.01	M	12	300
M16	E1	7.75	M15	600	4.97	M17	600	4.96	M	35	318
M17	E1	7.80	M16	600	4.85	M18	600	4.84	M	39	300
M18	F1	7.90	M17	600	4.71	M19	600	4.7	M	23	288
M19	F1	7.75	M18	600	4.62	M20	600	4.61	M	34	309
			CP-U-4	375	5.15						
			CP-U-4A	300	5.20						
M20	F1	7.85	M19	600	4.50	M21	600	4.49	M	32	320
M21	F1	7.75	M20	600	4.39	M22	675	4.38	M	27	300
M22	F1	7.75	M21	675	4.29	M23	675	4.28	M	34.5	314
M23	F1	7.85	M22	675	4.17	M8-1	675	4.16	M	26.5	294
			CP17A	300	4.76						
M8-1	F1	7.50	M23	675	4.04	M8-2	675	4.04	M	18	300
			CP17A	300	4.76						

VALVE TABLE

No.	VALVE No.	GRADE LEVEL	NORTHING	EASTING	INVERT LEVEL
2	MF1	7.325	825442.493	810458.882	3.73
11	G1	7.53	825442.557	810454.747	3.50
14	G2	7.475	825425.500	810460.303	6.30
19	G3	6.425	825442.236	810450.325	3.38
23	G4	7.67	825542.564	810541.317	3.86

FOR INFORMATION ONLY



CP1 AND CP2 DETAIL / CP204 AND CP205 DETAIL (7)

CP101 AND CP102 DETAIL / CP201 AND CP202 DETAIL (8)

CP4 DETAIL / CP207 DETAIL (11)

CP3 DETAIL / CP206 DETAIL (9)

CP103 DETAIL / CP203 DETAIL (10)

MF1 DETAIL / MF2 DETAIL (13)

CP5 DETAIL / CP208 DETAIL (12)

BUND WALL SECTION DETAIL WITH DN300 DRAIN PIPE

SECTION (15) · SECTION (16)

MOVEMENT JOINT DETAIL AT EVERY 12m (K)

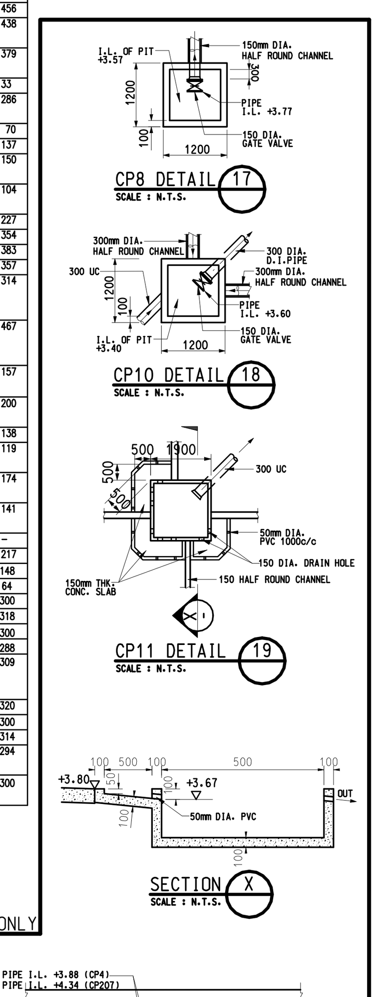
SECTION (L)

TYPICAL SECTION FOR CATCH PIT & INTERNAL BUND WALL (14)

SCALE : N.T.S.

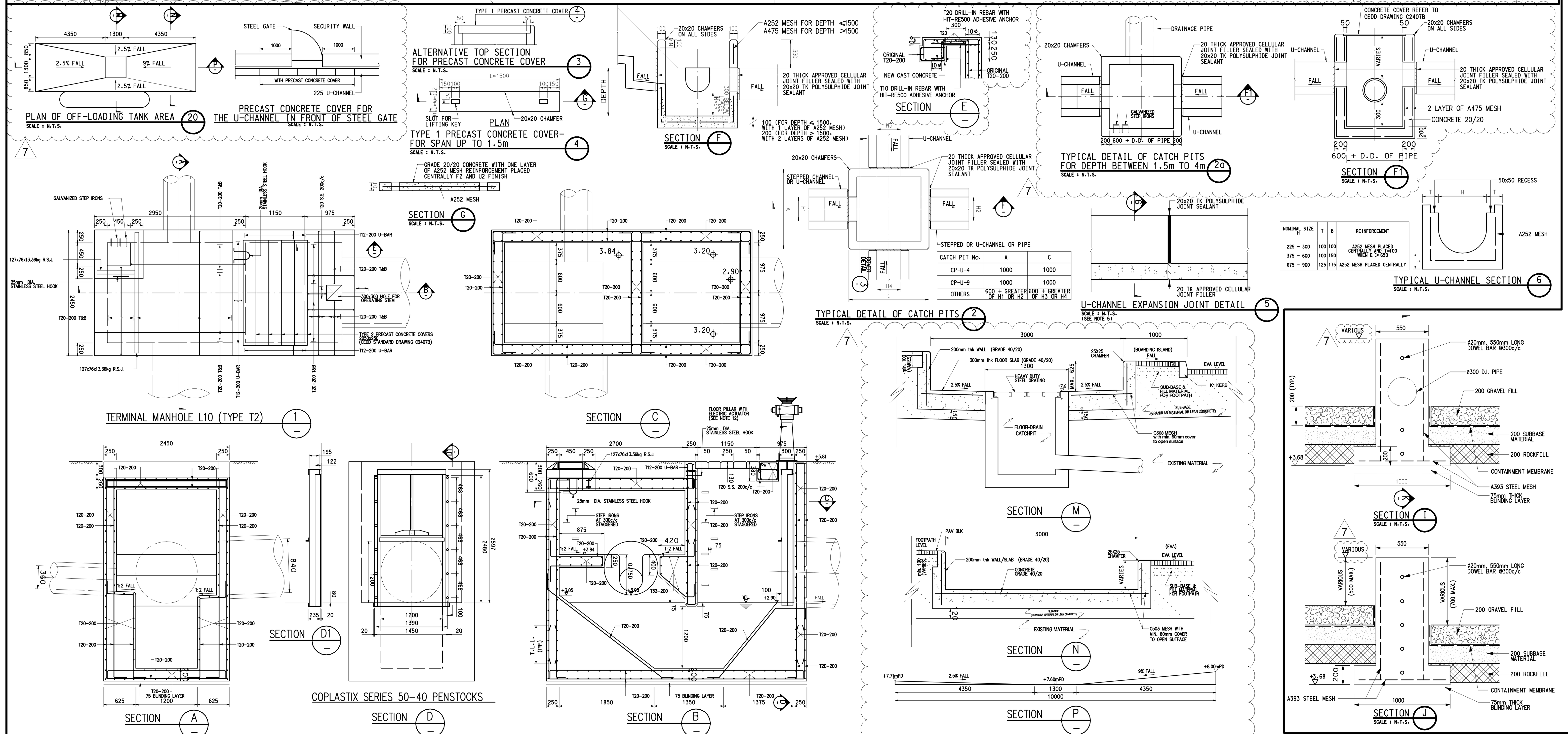
	A I.L. OF ø50 PVC	B I.L. OF ø150 DRAIN HOLES	C I.L. OF ø300 D.I. PIPE	D I.L. OF CATCH PIT	E BASE LEVEL OF INTERNAL BUND	F TOP LEVEL OF CATCH PIT
CP102 (CP102 TO CP103)	4.20	4.15	4.15	3.95	3.68	5.00
CP103 (CP102 TO CP103)	–	–	4.13	4.13	3.68	5.00
CP103 (CP103 TO CP1)	–	–	4.13	4.13	3.68	5.00
CP1 (CP103 TO CP1)	4.20	4.03	4.03	3.83	3.68	5.00
CP2 (CP2 TO CP3)	4.20	4.03	4.03	3.83	3.68	5.00
CP3 (CP2 TO CP3)	–	–	3.98	3.98	3.68	5.00
CP3 (CP3 TO CP4)	–	–	3.98	3.98	3.68	5.00
CP4 (CP3 TO CP4)	4.20	3.88	3.88	3.68	3.68	5.00
CP5 (CP4 TO CP5)	4.20	4.19	3.78	3.58	–	5.00
CP202 (CP202 TO CP203)	4.66	4.61	4.61	4.41	3.68	5.46
CP203 (CP202 TO CP203)	–	–	4.59	4.59	3.68	5.46
CP203 (CP203 TO CP204)	–	–	4.59	4.59	3.68	5.46
CP204 (CP203 TO CP204)	4.54	4.49	4.49	4.29	3.68	5.20
CP205 (CP205 TO CP206)	4.54	4.49	4.49	4.29	3.68	5.20
CP206 (CP205 TO CP206)	–	–	4.44	4.44	3.68	5.20
CP206 (CP206 TO CP207)	–	–	4.44	4.44	3.68	5.20
CP207 (CP206 TO CP207)	4.39	4.34	4.34	4.14	3.68	5.00
CP208 (CP207 TO CP208)	4.29	4.24	4.24	4.04	–	5.00

"STATEMENT II : THE WORKS SHOWN ON THESE PLANS ARE TYPE II WORKS (DRAINAGE WORKS) IN RESPECT OF WHICH THE BUILDING AUTHORITY'S CONSENT IS APPLIED FOR."



CP8 DETAIL (17) · CP10 DETAIL (18) · CP11 DETAIL (19) · SECTION (X)

SCALE : N.T.S.



PLAN OF OFF-LOADING TANK AREA (20)

PRECAST CONCRETE COVER FOR THE U-CHANNEL IN FRONT OF STEEL GATE

ALTERNATIVE TOP SECTION FOR PRECAST CONCRETE COVER

TYPE 1 PRECAST CONCRETE COVER FOR SPAN UP TO 1.5m (4)

TYPICAL DETAIL OF CATCH PITS FOR DEPTH BETWEEN 1.5m TO 4m

TYPICAL DETAIL OF CATCH PITS (3)

U-CHANNEL EXPANSION JOINT DETAIL (5)

TYPICAL U-CHANNEL SECTION (6)

TERMINAL MANHOLE L10 (TYPE T2) (1)

COPLASTIX SERIES 50-40 PENSTOCKS

SECTION (A) · SECTION (B) · SECTION (C) · SECTION (D) · SECTION (D1) · SECTION (E) · SECTION (F) · SECTION (F1) · SECTION (M) · SECTION (N) · SECTION (P) · SECTION (H) · SECTION (I) · SECTION (J)

NOTES :

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRG. NO. PAFF/BA/01/DWG/C/1453.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE INDICATED. ALL LEVELS ARE IN METRES ABOVE PRINCIPAL DATUM.
3. ALL PRECAST CONCRETE PIPES AND FITTING SHALL COMPLY WITH BS5911 : PART 100.
4. ALL PRECAST CONCRETE PIPES AND FITTINGS SHALL HAVE FLEXIBLE JOINTS OF SPIGOTS AND SOCKET OR REBATED TYPE. THEY SHALL BE DESIGNED TO INCORPORATE AN ELASTOMERIC RING COMPLYING WITH TYPE D OF BS2494. THE TEST FOR JOINT SHALL COMPLY WITH BS5911 : PART 100 & GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS.
5. DIRECTION CHANGE OF CONCRETE PIPELINES SHALL BE MADE AT MANHOLE ONLY.
6. MANHOLE COVERS AND FRAMES WITHIN THE CARRIAGEWAY AND PROPOSED FOOTPATH SHALL BE HEAVY DUTY TYPE UNLESS OTHERWISE INDICATED.
7. ALL DI PIPES AND FITTING SHALL COMPLY WITH BS 4772 & GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS. PIPES AND FITTINGS SHALL BE LINED INTERNALLY WITH CEMENT MORTAR AND SHALL BE COATED EXTERNALLY WITH BITUMINOUS COATING.
8. CONCRETE PIPE CLASS (L, M & H) SHOULD REFER TO BS 5911 : PART 100.
9. AREAS WITHIN BUND WALL AND PUMP PLATFORM ARE DESIGNED AS BUNDED AREA.
10. THE JUNCTION OF A SINGLE BRANCH DRAIN WITH ANOTHER DRAIN AT AN ANGLE OF NOT MORE THAT 45° IN THE DIRECTION OF FLOW MAY BE MADE BY MEANS OF A PURPOSED-MADE Y JUNCTION.
11. GROUND SURFACE PAVING SHALL BE LAID TO FALL AT A GRADIENT OF NOT LESS THAN 1 IN 80 TO A GULLY TRAP OR DRAINAGE CHANNELS CONNECTED TO A SURFACE WATER DRAIN.
12. STEEL PENSTOCKS TO BE INSPECTED BY OPERATOR EVERY 60 MINUTES TO ENSURE THEY ARE NOT SHUTTED ACCIDENTALLY.
13. THE ABANDONED DRAINS, SEWERS AND MANHOLES WITHIN THE SITE BOUNDARY SHOULD EITHER BE REMOVED OR FILLED WITH FOAMED CONCRETE IN ACCORDANCE WITH THE REQUIREMENTS AS RECOMMENDED IN DSD'S TECHNICAL CIRCULAR No. 2/2008.
14. MINIMUM GRADIENT FOR PIPES

PIPE DIAMETERS (mm)	GRADIENT	PIPE DIAMETERS (mm)	GRADIENT
225	1 IN 100	600	1 IN 324
250	1 IN 100	750	1 IN 396
300	1 IN 150	900	1 IN 468
375	1 IN 180	1050	1 IN 540
450	1 IN 216	1200	1 IN 648
		675	1 IN 324

15. ALL ARISE SHOULD HAVE A MINIMUM 25mm CHAMFER UNLESS STATED OTHERWISE.
16. THE SIZE OF OPENING OF MANHOLE M14-1, M14 TO M23, M8-1 AND SM2 ARE 675mmx675mm.
17. DETAILS OF CP13B SHALL REFER TO DRAWINGS NO.PAFF/CSA/01/DWG/B/3806.

NOTES FOR MANHOLE :

1. CONCRETE GRADE :
   40D/20 FOR STRUCTURAL CONCRETE.
   10/20 FOR BLINDING & MASS CONCRETE.
2. ALL GALVANIZED STEEL ITEMS TO BE HOT-DIPPED.
3. MINIMUM COVER TO OUTERMOST REINFORCEMENT TO BE 40mm UNLESS OTHERWISE STATED.
4. RADII AND BENDS FOR REINFORCEMENT TO BE IN ACCORDANCE WITH BS4466.
5. BAR REFERENCING :
   EXAMPLE : 16T32-01-200 ABBRE
   NUMBER OF BARS 16
   TYPE OF STEEL T (REFER TO NOTES 8 & 9)
   DIAMETER OF BARS 32mm
   MARK NO. (IF REQUIRED) 01
   PITCH OF BARS (IF APPLICABLE) 200mm
   ABBREVIATIONS MAY BE ADDED TO THE STRING:
   B BARS IN BOTTOM OF SLAB
   B1 FIRST LAYER OF BOTTOM REINFORCEMENT
   B2 SECOND LAYER OF BOTTOM REINFORCEMENT (ABOVE B1 LAYER)
   T BARS IN TOP OF SLAB
   T1 FIRST LAYER OF TOP REINFORCEMENT
   T2 SECOND LAYER OF TOP REINFORCEMENT (BELOW T1 LAYER)
6. UNLESS OTHERWISE STATED, ANCHORAGE BOND LENGTHS AND LAP LENGTHS OF REINFORCEMENT SHALL AS BE FOLLOWS:-

CONCRETE GRADE	ANCHORAGE BOND LENGTHS & LAP LENGTHS (MULTIPLES OF BAR DIAMETER) HIGH YIELD STEEL
40D/20	32

NOTES:-

(A) i) TENSION LAP LENGTHS (DENOTED BY T.L.L.) SHALL BE AT LEAST TO THE ANCHORAGE BOND LENGTH.

ii) WHERE A LAP OCCURS AT THE TOP OF A SECTION AS CAST AND THE MINIMUM COVER IS LESS THAN TWICE THE SIZE OF THE LAPPED REINFORCEMENT. THE REQUIRED LAP LENGTH SHOULD BE MULTIPLIED BY A FACTOR OF 1.4.

iii) WHERE A LAP OCCURS AT THE CORNER OF A SECTION AND THE MINIMUM COVER TO EITHER FACE IS LESS THAN TWICE THE SIZE OF THE LAPPED REINFORCEMENT OR WHERE THE DISTANCE BETWEEN ADJACENT LAPS IS LESS THAN 75mm OR SIX TIMES THE SIZE OF THE LAPPED REINFORCEMENT. WHICHEVER IS THE GREATER, THE REQUIRED LAP LENGTH SHOULD BE MULTIPLIED BY A FACTOR OF 1.4.

iv) IN CASES WHERE BOTH CONDITIONS (ii) AND (iii) APPLY, THE REQUIRED LAP LENGTH SHOULD BE MULTIPLIED BY A FACTOR OF 2.0.

(B) i) NOMINAL LAP FOR DISTRIBUTION BARS SHALL BE 300.

(C) i) LAP LENGTH FOR UNEQUAL SIZE BARS SHALL BE BASED UPON THE SMALLER BAR.

7. ALL CONCRETE WORKS SHALL COMPLY WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS 1990, RECOMMENDATIONS OF BRITISH STANDARD CODE OF PRACTICE BS8110 THE STRUCTURAL USE OF CONCRETE 1987.
8. ALL REINFORCEMENT DENOTED BY MARK R INDICATED PLAIN ROUND BARS TO COMPLY WITH CS2:1995 WITH A CHARACTERISTIC STRENGTH OF 250N/mm 2.
9. ALL REINFORCEMENT DENOTED BY MARK T INDICATES HOT ROLLED DEFORMED BARS TO COMPLY WITH CS2:1995 WITH A CHARACTERISTIC STRENGTH OF 460N/mm 2.
10. UNLESS OTHERWISE STATED, ALL CONCRETE SHALL BE DESIGN MIX 40D/20 CONCRETE AND THE GRADE DESIGNATIONS GIVEN ARE THE CHARACTERISTIC CUBE STRENGTH AT 28 DAYS AND THE MAXIMUM AGGREGATE SIZE.
11. THE REACTIVE ALKALI OF CONCRETE EXPRESSED AS THE EQUIVALENT SODIUM OXIDE PER CUBIC METER OF CONCRETE SHOULD NOT EXCEED 3.0 KG WHEN DETERMINED IN ACCORDANCE WITH PNAP 180.

NOTES FOR OIL-WATER INTERCEPTOR

1. THE CONTRACTOR SHALL CHECK ALL DRAWINGS AND VERIFY LEVELS AND DIMENSIONS IN ADVANCE OF THE WORK AND REPORT ANY DISCREPANCIES TO THE PROJECT MANAGER IMMEDIATELY.
2. ALL WORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH THE HONG KONG BUILDING AND CONSTRUCTION REGULATION 1990.
3. ALL CONCRETE WORKS SHALL CONFORM WITH HONG KONG BUILDING CONSTRUCTION REGULATION 1990 AND STRUCTURAL USE OF CONCRETE 1987 AND DESIGN TO BS8110 & BS8007.
4. CONCRETE STRENGTH GRADE SHALL BE 40D/20.
5. NOMINAL COVER TO ALL REINFORCEMENT (INCLUDING LINKS) SHALL BE 40mm.
6. REINFORCEMENT IS TO BE HOT ROLLED HIGH YIELD DEFORMED BARS
   STRESS=460N/mm FOR BAR ⩽ 16mm ø TO BS4449.
   STRESS=425N/mm FOR BARS > 16mm ø TO BS4449.
7. WELDING OF REINFORCEMENT SHALL NOT BE PERMITTED WITHOUT THE APPROVAL OF THE DESIGNER.
8. UNLESS NOTED OTHERWISE, THE ANCHORAGE BOND OR LAP LENGTH OF REINFORCEMENT SHALL BE 46D.
9. ALL ARISES SHALL HAVE A MINIMUM 25mm CHAMFER.
10. MINIMUM BEARING CAPACITY OF FOUNDATION SOIL SHALL BE 200 kN/m.
11. THE MATERIAL OF RAILINGS SHALL BE HOT ROLLED STRUCTURAL STEEL WITH HOLLOW SECTION COMPLY WITH BS 4848: PART 2 AND WELDABLE STRUCTURAL STEEL SECTIONS COMPLY WITH BS 4360.
12. ALL STEEL RAILINGS SECTIONS SHALL BE HOT-DIP GALVANIZED IN ACCORDANCE WITH BS 729 TO A COATING THICKNESS OF AT LEAST 500 g/m2 . GALVANIZING TO STEEL SHALL BE APPLIED AFTER WELDING, DRILLING AND CUTTING ARE COMPLETED.
13. GALVANIZED BOLTS, NUTS, SCREWS, WASHERS AND RIVETS SHALL BE USED WITH GALVANIZED RAILINGS.

NOTE FOR INTERNAL BUND AND CATCH PITS WITHIN BUND WALL:

1. A CJ MAY NEED TO INTRODUCE TO THE INTERNAL BUND. ACTUAL LOCATION TO BE DETERMINED ON SITE. (CJ-CONSTRUCTION JOINT)
2. ALL ARISES SHALL HAVE A MINIMUM 25mm CHAMFER.
3. THE MINIMUM SPACING FROM THE CATCH PIT INTERNAL WALL FACE TO THE NEAREST FLANGE END OF GATE VALVE SHOULD BE 300mm.
4. THE ENDS OF DI PIPE SHOULD BE PROTRUDED AT LEAST 50mm FROM THE CATCH PIT INTERNAL WALL FACE.
5. CONCRETE GRADE:
   30D/20 FOR STRUCTURAL CONCRETE
   10/20 FOR BLINDING LAYER
6. NOMINAL COVER TO ALL REINFORCEMENT SHALL BE 40mm.
7. CLASS OF FINISH SHALL BE F2 FOR CATCH PITS, INTERNAL BUND AND U3 FOR CONCRETE SLABS.
8. EXPANSION JOINT TO BE INTRODUCED BETWEEN INTERNAL BUND AND CATCH PIT. DETAIL IS THE SAME AS SECTION J EXCEPT THERE IS NO DOWEL BAR PROVIDED IN THE EXPANSION JOINT.

NOTES FOR U-CHANNELS AND CATCH PITS OUTSIDE BUND WALL:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. ALL CONCRETE SHALL BE GRADE 20/20.
3. CONCRETE SURFACE FINISH SHALL BE CLASS U2 OR F2 AS APPROPRIATE.
4. ALL EXTERNAL EDGES OF THE COVERS SHALL BE 20mm CHAMFERED.
5. EXPANSION JOINTS SHALL BE PROVIDED AT A MAXIMUM INTERVAL OF 10 METRES.
6. STEP IRONS SHALL BE STAGGERED AT EVERY 300mm c/c IN DEPTH WITH A 75mm HORIZONTAL SPACING WITHIN A CATCH PIT. THE FIRST STEP IRON SHALL BE 600mm BELOW THE COVER SLAB.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	APR 2006	FOR CONSTRUCTION	
2	FEB 2007	FOR CONSTRUCTION	
3	JUN 2007	FOR CONSTRUCTION	
4	AUG 2007	FOR CONSTRUCTION	
5	FEB 2008	FOR CONSTRUCTION	
6	SEP 2008	FOR CONSTRUCTION	
7	SEP 2009	FOR CONSTRUCTION - INTERNAL BUND WALL LEVELS REVISED, PRECAST CONCRETE COVER ADDED, MANHOLES LEVELS & TYPES REVISED, CATCH PIT DETAILS & 300 UC ADDED	

Scale		Date
AS SHOWN (A1)		JAN 2006
Designed: BW	Drawn: SKL	Checked: AS
Design Team Leader: AS		Date: JAN 2006
Approved: LHS		Date: JAN 2006

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Permanent Aviation Fuel Facility

Title
TANK FARM
EVA
STORMWATER DRAINAGE LAYOUT

Drawing No. PAFF/BA/02/DWG/C/1452 Revision 7

DATE : 18-Nov-09
TIME : 10:23:27 AM

FILENAME : S:\Drawings\DGN\Babtie\20090928\1452-7.dgn

BD REF. NO. 4/0001/02

NOTES

1. FOR GENERAL NOTES, NOTES FOR MANHOLES AND NOTES FOR OIL-WATER INTERCEPTOR, REFER TO DRAWING No. PAFF/BA/DWG/C/1452.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	APR 2006	FOR CONSTRUCTION	
2	FEB 2007	FOR CONSTRUCTION	
3	JUN 2007	FOR CONSTRUCTION	
4	SEP 2007	FOR CONSTRUCTION	
5	SEP 2009	FOR CONSTRUCTION - MANHOLE E1, F1, BM1 ADDED, LEVELS & GRATING DETAILS OF OIL INTERCEPTOR REVISED	

Scale		Date
AS SHOWN		JAN 2006
Designed	Drawn	Checked
BW	SKL	AS
Design Team Leader		Date
AS		JAN 2006
Approved		Date
LHS		JAN 2006

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Permanent Aviation Fuel Facility

Title
TANK FARM
MANHOLE & MANHOLE DETAILS

Project | Originator | Location | Category | Discipline | Number | Revision

Drawing No. PAFF/BA/01/DWG/C/1453 | 5

DATE : 18-Nov-09
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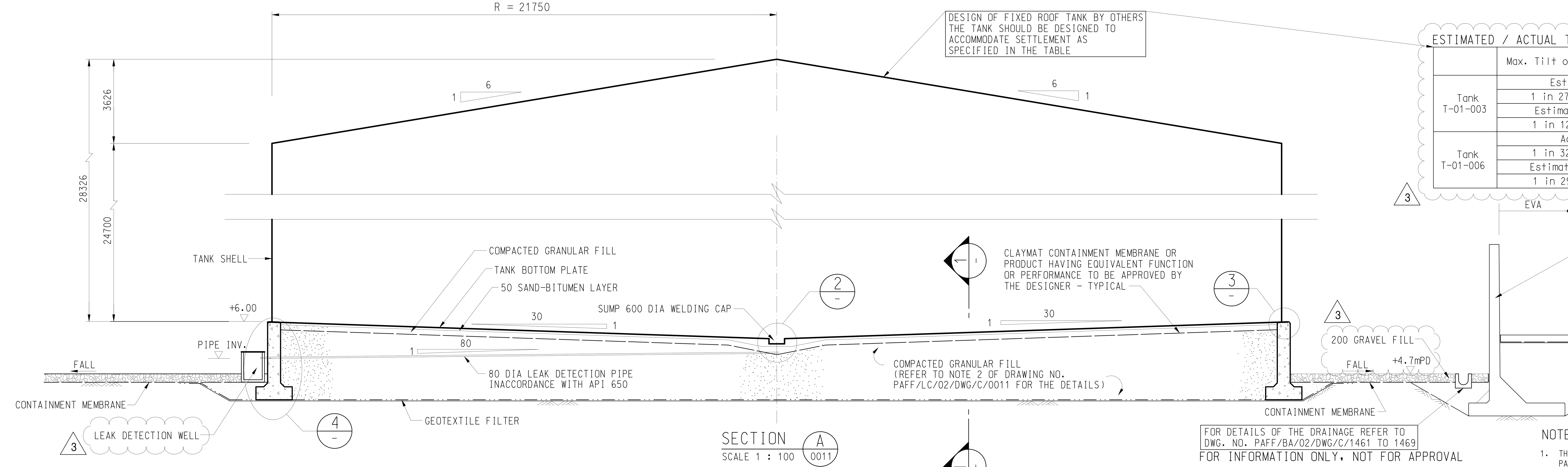
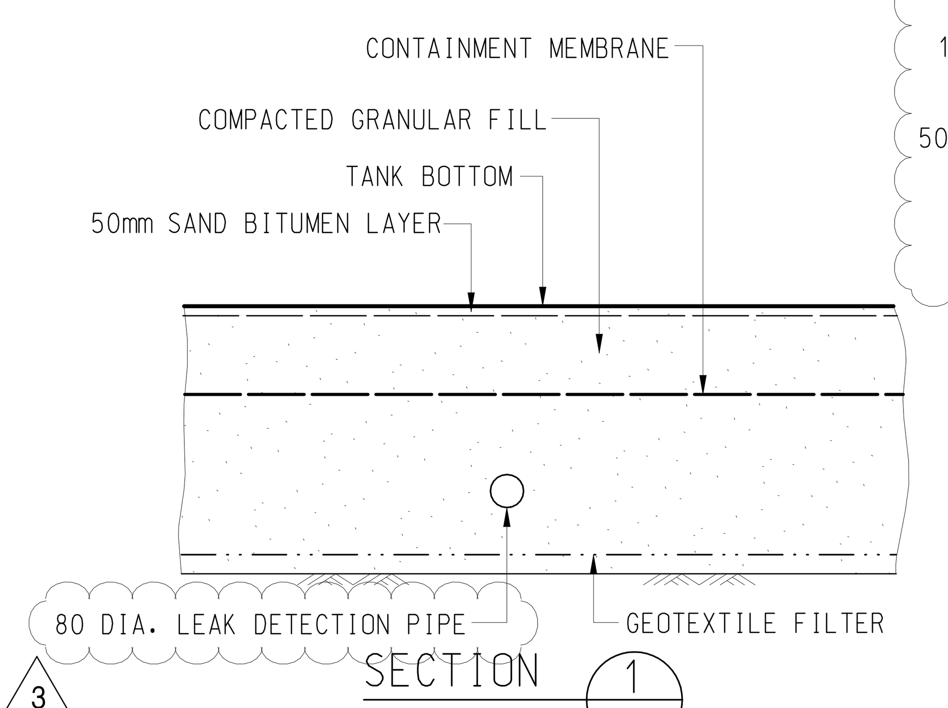


SECTION A
SCALE 1 : 100 (0011)

FOR INFORMATION ONLY, NOT FOR APPROVAL

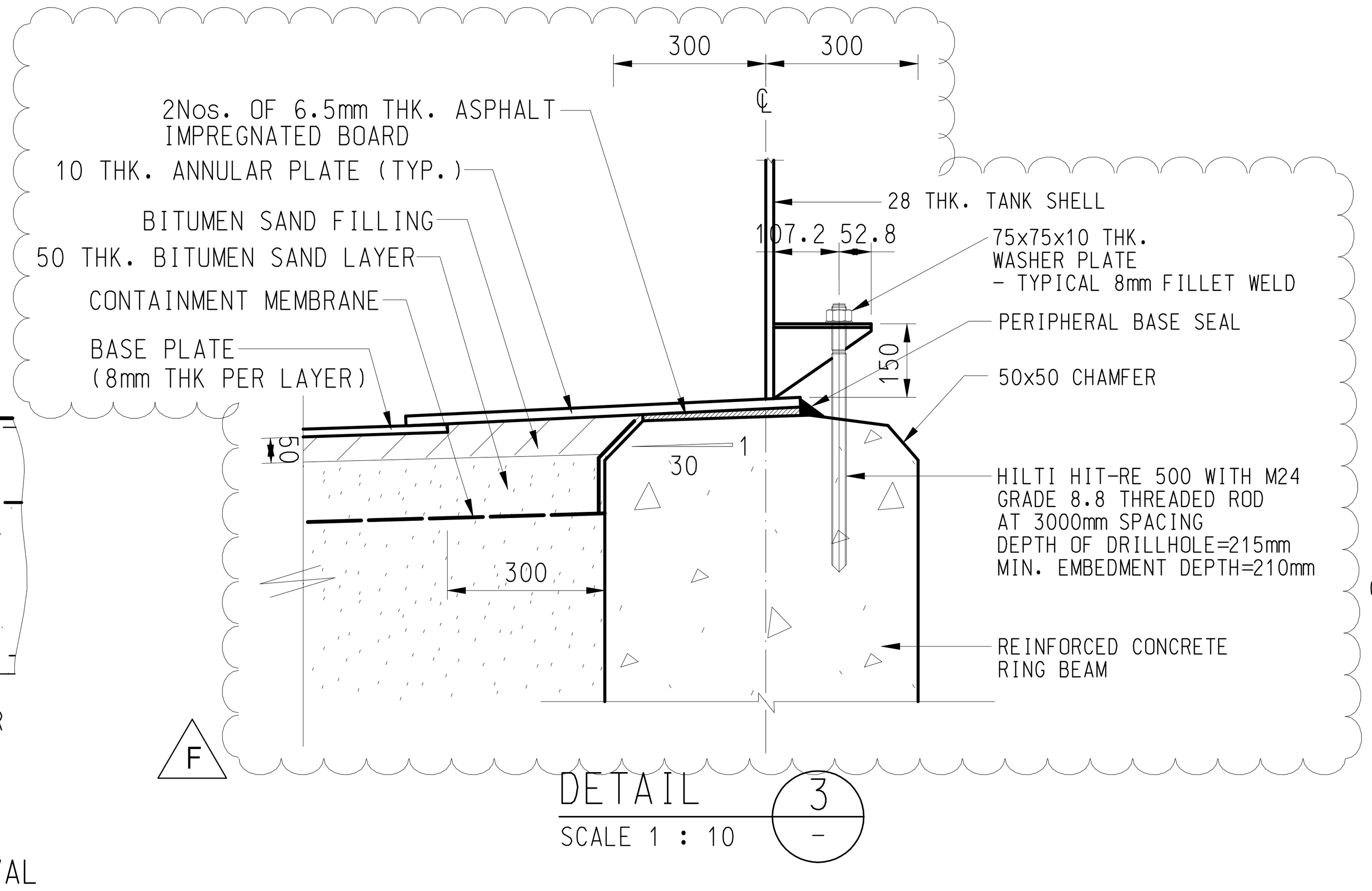
ESTIMATED / ACTUAL TILTING OF TANKS

	Max. Tilt of Tank	Max. Settlement Around Periphery
Tank T-01-003	Estimated on Completion of Water Test	
	1 in 2708	1 in 3275
	Estimated At the End of 50yrs Design Life	
	1 in 1211	1 in 763
Tank T-01-006	Actual on Completion of Water Test	
	1 in 320	1 in 285
	Estimated at the End of 50 yrs Design Life	
	1 in 292	1 in 276

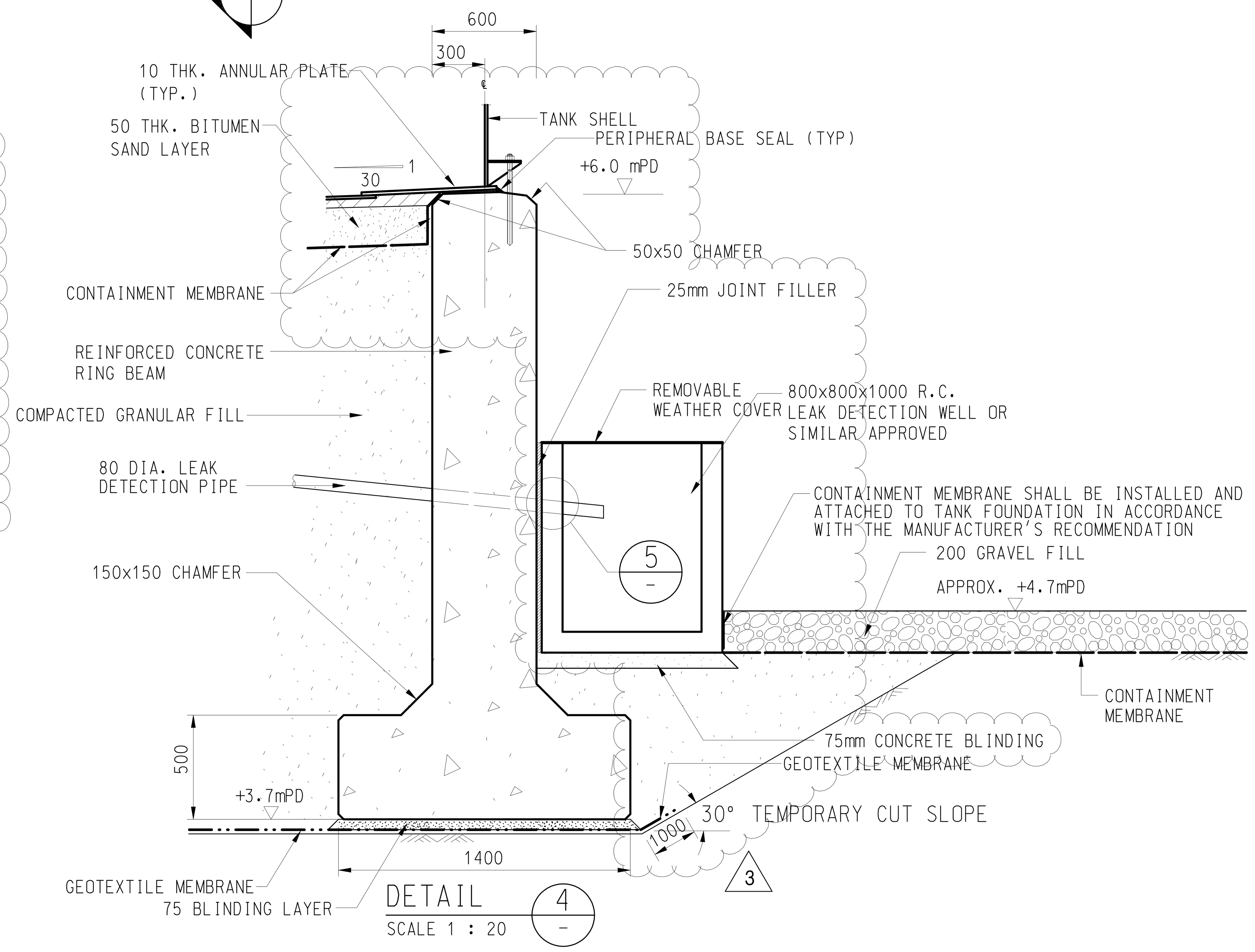


SECTION 1
N.T.S.

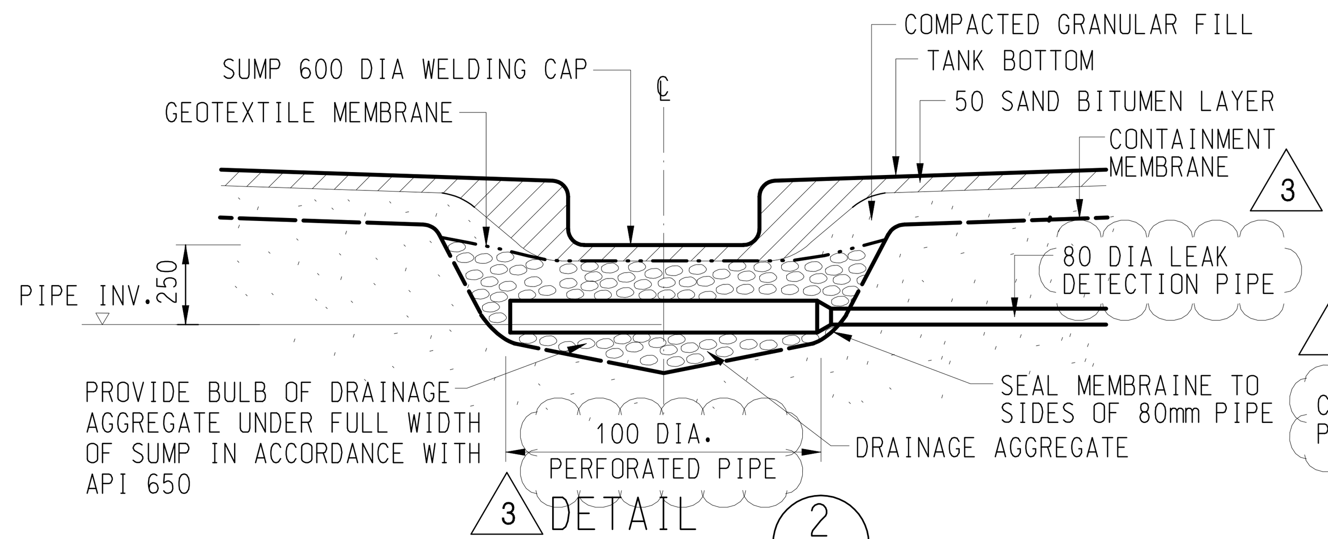
FOR INFORMATION ONLY, NOT FOR APPROVAL



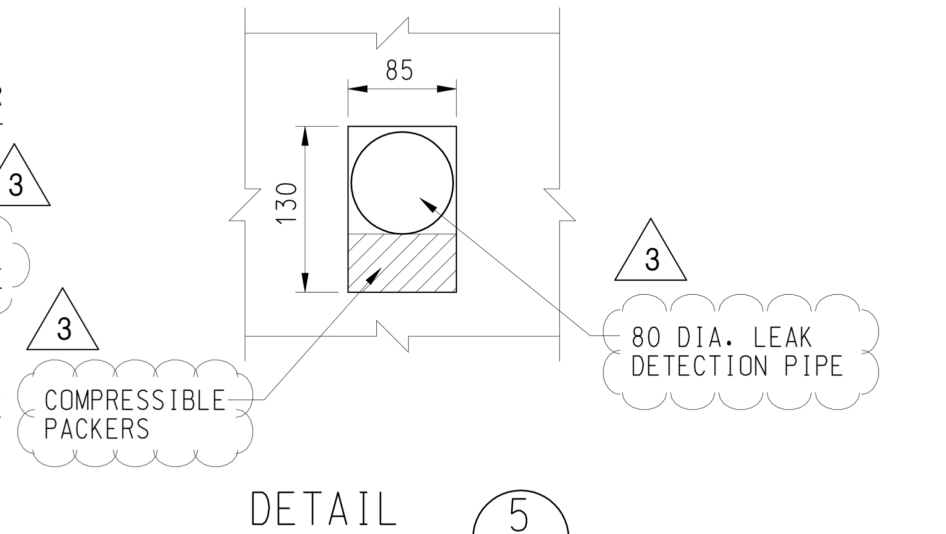
DETAIL 3
SCALE 1 : 10



DETAIL 4
SCALE 1 : 20



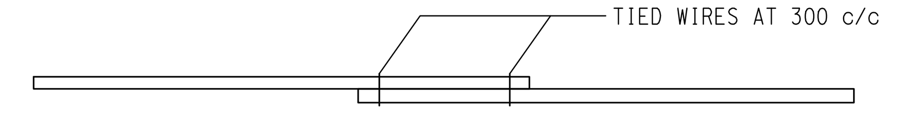
DETAIL 2
N.T.S.



DETAIL 5
SCALE 1 : 5

NOTES :

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NO. PAFF/BA/02/DEG/C/1711.
2. ALL STRUCTURAL CONCRETE SHALL BE A DESIGN MIX OF A GRADE IN ACCORDANCE WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS. DETAILS OF THE DESIGN MIXES TO BE USED ARE GIVEN IN THE PARTICULAR SPECIFICATION.
3. ALL STRUCTURAL CONCRETE SHALL HAVE 40mm COVER.
4. UNLESS OTHERWISE NOTED ALL REINFORCEMENT FOR STRUCTURAL CONCRETE SHALL BE HOT ROLLED HIGH TENSILE STEEL DEFORMED BARS DENOTED BY 'T' WITH MINIMUM YIELD STRENGTH OF NOT LESS THAN 460 N/mm^2.
5. RADII AND BENDS IN REINFORCEMENT TO BE IN ACCORDANCE WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS AND TO BS 8666.
6. WELDING OF REINFORCEMENT IS NOT PERMITTED WITHOUT PRIOR APPROVAL OF THE DESIGNER.
7. WHERE CONCRETE IS TO BE PLACED, ALL SURFACES SHALL BE CLEANED AND ALL STANDING WATER SHALL BE REMOVED IMMEDIATELY BEFORE THE PLACING OF CONCRETE.
8. NO HOLES IN REINFORCED CONCRETE ARE TO BE FORMED OR CUT WITHOUT THE DESIGNER'S PRIOR AGREEMENT.
9. THE POSITIONS AND DETAILS OF ALL CONSTRUCTION JOINTS ARE TO BE AGREED WITH THE DESIGNER BEFORE WORK COMMENCES.
10. UNLESS OTHERWISE STATED ALL LAP LENGTHS AND ANCHORAGE VALUES OF REINFORCEMENT SHALL BE IN ACCORDANCE WITH TABLE 3.27 OF BS8110: PART 1 : 1985.
11. ALL LAPS TO BE STAGGERED LAPS.
12. UNLESS NOTED OTHERWISE ON THE DRAWINGS. ALL NEW CONCRETE WORKS FOR STRUCTURE SHALL BE GRADE 40D/20 DESIGNED MIX AND SHALL HAVE A CHARACTERISTIC STRENGTH OF 40 N/mm^2 AT 28-DAY. FOR DETAILS REFER TO PARTICULAR SPECIFICATION.
13. FOR CONCRETE FINISH REFER TO GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS (1992 EDITION).
14. BARS TIED WITH WIRE :
    a. WIRE SHOULD BE PROVIDED AT THE CROSSING OF ALL BARS AND
    b. LAPPING BARS



15. THE GEOTEXTILES SHOULD BE IN ACCORDANCE WITH WORKS BUREAU TECHNICAL CIRCULAR NO. 10/2001 ON GRANULAR AND GEOTEXTILE FILTERS. THE SIZING OF THE GEOTEXTILE WEAVING MUST ALSO BE COMPATIBLE WITH THE FILL MATERIAL.
16. FOR NOTES ON COMPACTION FILL REFER TO DRAWING NO. PAFF/LC/02/DWG/C/0011.
17. NOT USED
18. THE RING BEAM SHALL BE FOUNDED ON MATERIAL WITH AN ALLOWABLE BEARING CAPACITY OF 250kPa.
19. FOR DETAILS OF REINFORCEMENT REFER TO DRAWING NO. PAFF/BA/02/DWG/C/1711.
20. ALL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH PARTICULAR SPECIFICATION. GENERAL SPECIFICATION AND OTHER CONTRACT DOCUMENTS.
21. THE TANKS SHALL BE LEVELED IF FOUND NECESSARY BY THE SUPPLIER USING SHIMS.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	FEB 2006	TOP OF RING BEAM REVISED	
2	JAN 2007	DRAWING UPDATE AS HIGHLIGHTED	
3	JUL 2009	FOR CONSTRUCTION - LEAK DETECTION WELL ADDED, ESTIMATED/ACTUAL TILTING REVISED	

Scale	Date
AS SHOWN (A1)	JAN 2006

Designed	Drawn	Checked
BW	SKL	AS

Design Team Leader: AS — Date: JAN 2006
Approved: LHS — Date: JAN 2006

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Permanent Aviation Fuel Facility

Title: TANK FARM
FUEL TANK FOUNDATIONS - SECTIONS AND DETAILS OF RING BEAM (SHEET 1 OF 2)

Drawing No. PAFF/BA/02/DWG/C/1705 — Revision 3

DATE : 8/10/2009
TIME : 1:50:28 PM
PLOT DRV: $PLTDRVL$

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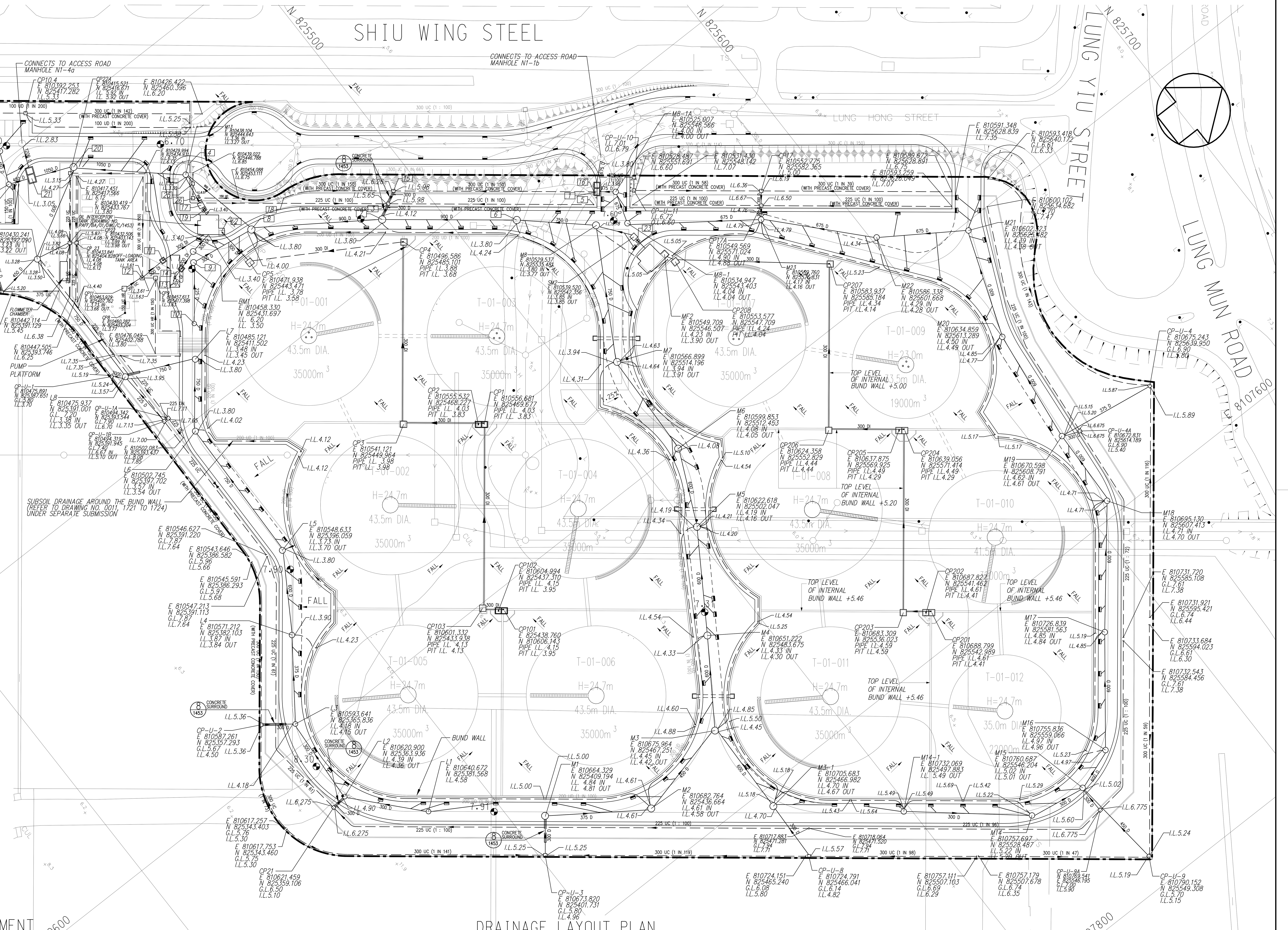
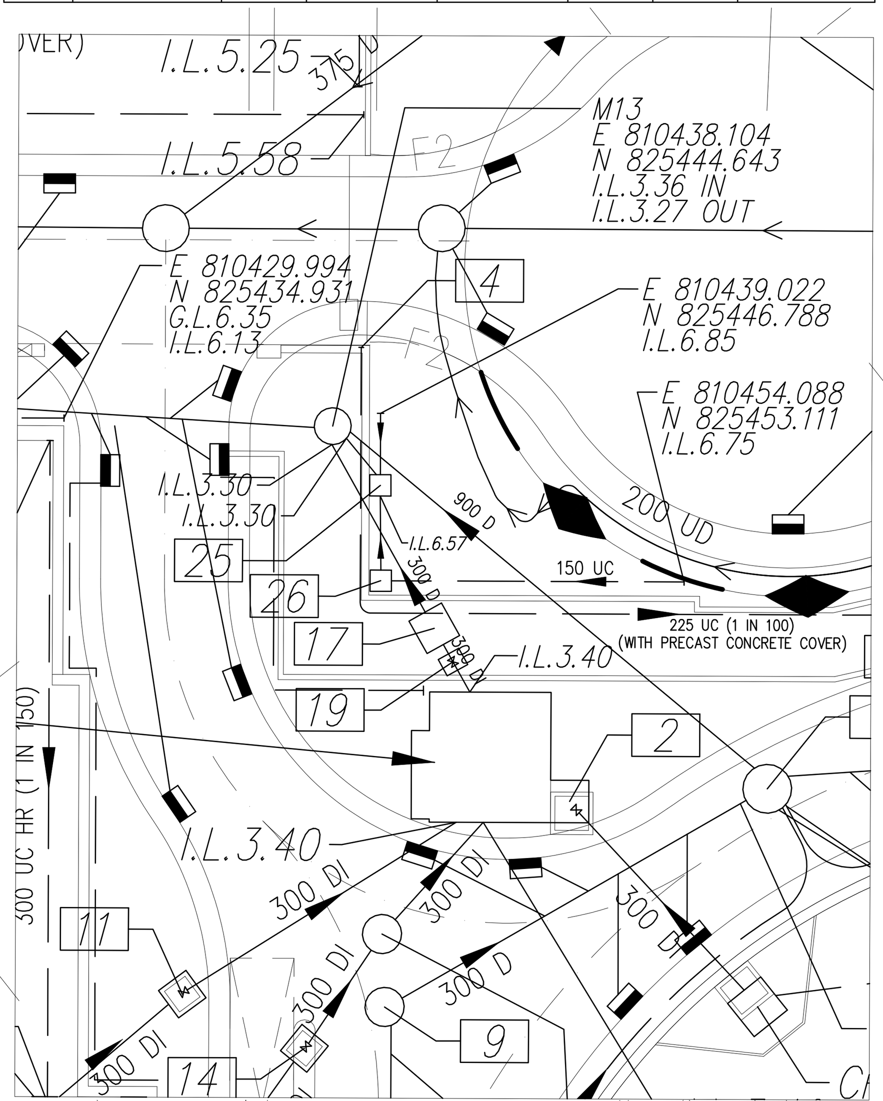


DRAINAGE LAYOUT PLAN

SCALE 1 : 750

COORDINATE TABLE							
No.	MANHOLE No.	GRADE LEVEL	NORTHING	EASTING	INVERT LEVEL		PROFILE OR DETAIL REF.
					OUT	IN	
1	M8-2	7.825	825541.981	810521.373	3.83	3.98	–
3	CP14	6.61	825488.599	810484.167	4.77	5.27	–
4	UC END	6.60	825447.985	810436.022	6.487	–	–
5	UC END	6.85	825538.764	810523.932	6.62	–	–
6	M9	7.45	825516.935	810512.885	3.66	3.69	–
7	M10	7.05	825484.100	810486.861	3.54	3.57	–
8	M11	7.35	825450.173	810464.158	3.43	3.46	–
9	M12	7.50	825443.460	810470.938	4.80	4.83	–
10	M12.1	7.80	825418.094	810476.182	5.10	–	–
12	CP10	4.44	825414.107	810455.005	3.60	3.61	–
13	FLOOR DRAIN	7.60	825422.211	810461.224	6.40	–	–
15	CP15	6.48	825492.376	810482.052	5.30	5.98	–
16	UC END	6.90	825541.248	810520.798	6.60	–	–
17	SM1	6.45	825442.521	810448.539	3.36	3.37	–
18	UC END	6.90	825464.019	810462.778	6.60	–	–
26	CP24	6.90	825441.924	810445.221	6.61	6.61	–
20	L11	5.825	825418.914	810414.356	3.13	3.15	–
21	L10	5.65	825406.253	810409.430	2.90	3.05	–
22	L10.1a	5.65	825399.524	810406.455	3.09	3.12	–
25	CP24A	6.95	825444.681	810441.680	4.40	6.80	–



OIL INTERCEPTOR DRAINAGE ALIGNMENT

SCALE 1 : 375

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
A	11.11.09	FIRST ISSUE					

Scale	Date	
AS SHOWN	11 NOV 2009	
Designed	Drawn	Checked
D.HOLDEN	A.SO	D.HOLDEN
Design Team Leader		Date
Approved		Date
E.ZRAICAT		11 NOV 2009

ECO

Contractor

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Hong Kong SAR
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Fax: 2529 8784

JACOBS
15th Floor, Cornwall House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong
Tel: (852) 2880 9788 E-mail: babtie@babtie.com.hk
Fax: (852) 2565 5561

Permanent Aviation Fuel Facility

Title
TANK FARM
DRAINAGE LAYOUT PLAN

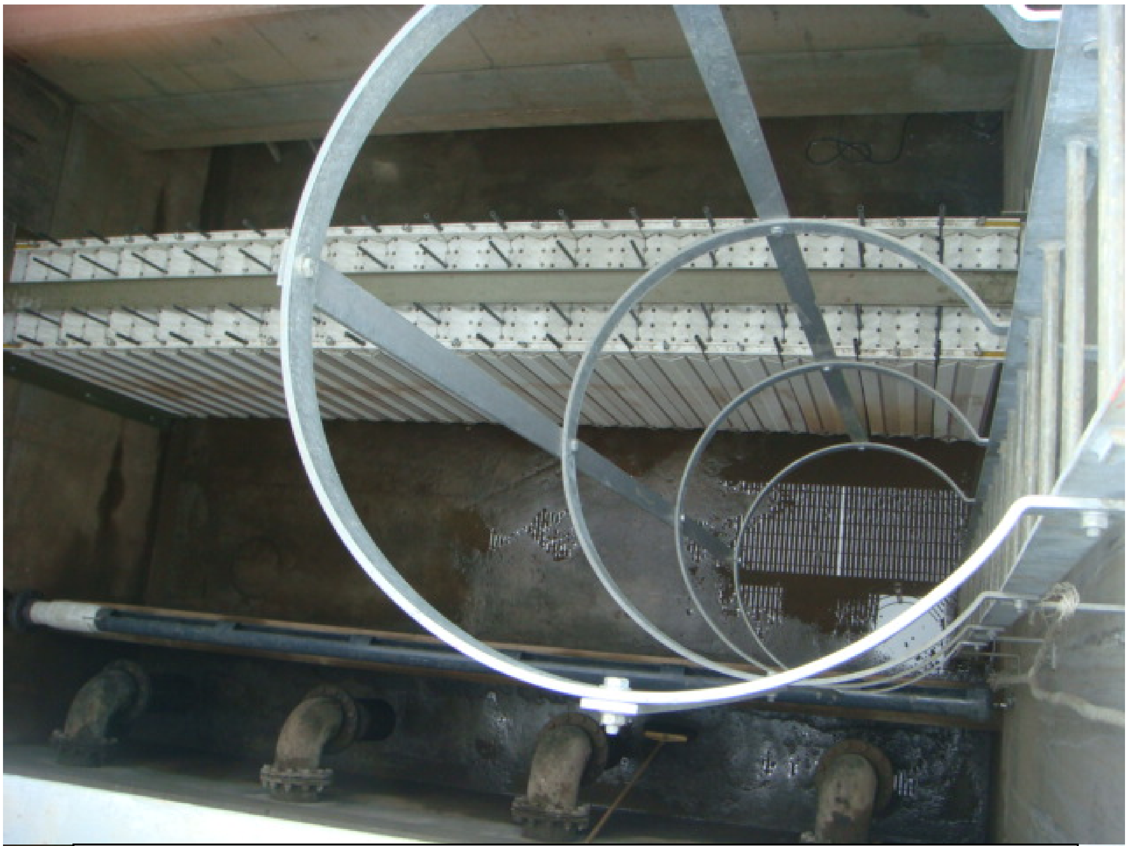
Drawing No.	Project / Originator / Location / Category / Discipline / Number	Revision
	PAFF/LC/02/DWG/C/0885	A

DATE : 18-Nov-09
TIME : 10:32:21 AM

FILENAME : S:\Drawings\DGN\Babtie\20090928\LC02DWGC0885A.dgn

Photographs

Valves inside the stormwater system inside the bunded area of the tank farm



Oil / Water Separator showing the coalescing plates

Sign at the valve pit leading to the oil/water separartor

Installation of the impermeable lining to the tank base.

Penstock at final stormwater manhole

MOV for penstock

Technical Information

Penstock

Biwater

(If you have not received all pages clearly, please contact the sender immediately)

facsimile

To	Gary Chan	Facsimile No	2404 0081
Company	Leighton Contractors (Asia) Ltd.	Date	27 August 2008

SE/K/819 - Permanent Aviation Fuel Facility Area 38, Tuen Mun
Supply & Installation of Ham Baker Penstocks

Coplastix Series 50-40 Penstocks as shown on the contract drawing meet with BS7775 standard and leakage rate of 0.5 litres / minute / seal perimeter in accordance the clause 5.2.2 of BS7775

Item 1 : Location – Manhole M8-2 (type T2)

Product Range	:	700 x 700 Coplastix Series 50-40 Flush Invert Sluice Gate
Frame	:	Fabricated in St St BS EN 10088-2 - 1.4401 (316 suitable for, Wall Mounting at sides and invert. The top of the frame is of a open top design with the thrust taken by the operator.
Door	:	A sandwich construction having carbon steel internal matrix which is totally enclosed and chemically bonded with an outer skin of non carcinogenic compressed composite plastic.
Seals	:	Comprising of a resilient, low friction Polyolefin sealing strip with a backing of expanded closed cell neoprene, bonded to the inside legs of the vertical channel.
Operation	:	By a handwheel mounted on a Ductile Iron floor pillar, acting through a Stainless Steel Gr316 rising stem, including cast iron spindle guide brackets.
Fasteners	:	Construction screws manufactured from Stainless Steel grade A4. Anchor bolts are chemical.
Operating Head	:	3.955 metre on seating pressure, 3.994 metre off seating pressure.
Invert to Coping	:	3.995 metres
Invert to h/wheel Sluice Gate	:	Nominal 4.94 metres
Surface Treatment	:	Natural
Qty	:	1

Biwater

Item 2 : Location ~ Manhole M10 (type T2)

Product Range	:	1200 x 1200 Coplastix Series 50-40 Flush Invert Sluice Gate
Frame	:	Fabricated in St St BS EN 10088-2 - 1.4401 (316 suitable for, Wall Mounting at sides and invert. The top of the frame is of a closed top design with the thrust taken on the frame.
Door	:	A sandwich construction having carbon steel internal matrix which is totally enclosed and chemically bonded with an outer skin of non carcinogenic compressed composite plastic.
Seals	:	Comprising of a resilient, low friction Polyolefin sealing strip with a backing of expanded closed cell neoprene, bonded to the inside legs of the vertical channel.
Operation	:	By a hand operated gearbox mounted direct on the frame with a Ductile Iron pillar, acting through a Stainless Steel Gr316 rising stem.
Fasteners	:	Construction screws manufactured from Stainless Steel grade A4. Anchor bolts are chemical.
Operating Head	:	2.91 metre on seating pressure, 2.91 metre off seating pressure.
Invert to Coping	:	2.91 metres
Invert to h/wheel	:	Nominal 3.52 metres
Sluice Gate		
Surface Treatment	:	Natural
Qty	:	1

Coplastix® Series 50 - 40

DESCRIPTION

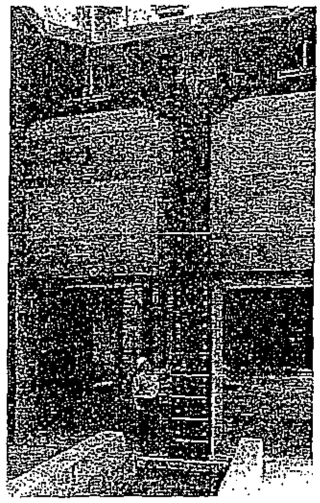
The Coplastix® Series 50-40 is a rectangular faced penstock designed and manufactured to suit modern industrial and domestic effluent environments. Utilisation of the latest synthetic materials for both sealing mechanisms and door construction combined with the use of steel or stainless steel in the construction of the penstock frames ranges.

A range of penstocks suitable for use in most water, sewage and effluent treatment plants. The penstocks are available for wall mounting and can be provided with either manual or power operators, manufactured in sizes ranging from 400mm square to 2000mm square as standard.

MATERIAL SPECIFICATION

Frames

Frames are manufactured from mild steel to BS EN 10025:1993 grade S275 or stainless steel to BS EN 10088:1995 grades 1.4301 (304) or 1.4401 (316). Mild steel frames can be protected to suit sea water, potable or sewage application, stainless steel - natural finish. The penstock frames for both wall and channel mounting (downward closing) have a resilient flush invert seal to allow smooth transmission of the flow through the penstock.



Frame Seals

The sealing arrangements for the Coplastix® Penstocks combine the use of resilient and low friction synthetic materials, which ensures a high degree of sealing with easy movement.

Doors

Doors are manufactured as a composite sandwich construction comprising a lightweight rigid, cellular core with a fully welded steel box section matrix between two other skins of rigid, compressed composite plastic which is asbestos free, ultra violet stabilised, rigid and non toxic. All materials are chemically bonded and sealed. Doors for non-rising spindle penstocks have a stainless steel lining tube inside the central vertical box section of the inner matrix.

Spindles

Rising or non-rising type in stainless steel BS EN 10088:1995 grades 1.4301 (304) or 1.4401 (316) with extension spindles in the same material as standard.

Frame Yokes

Frame yokes form an integral part of the frame and are positioned to allow removal of the door should this be necessary. The yoke material is the same as for the frame.

Fig 1.
SEE TABLE ON PAGE 24.

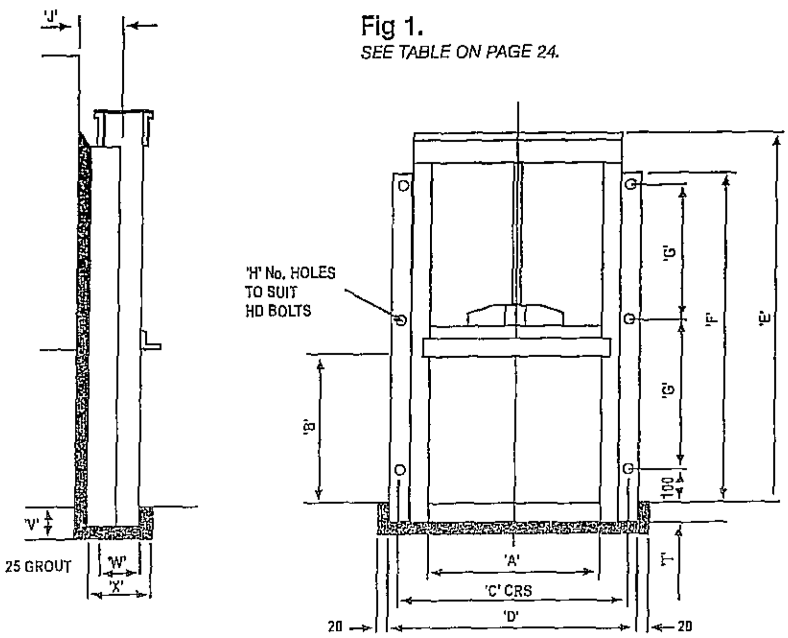


TABLE 1

RANGE	J	T	V	W	X
DIMENSIONS IN MILLIMETRES					
SMALL	104	50	80	165	215
MEDIUM	122	60	80	195	235
LARGE	146	80	100	245	295

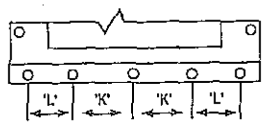
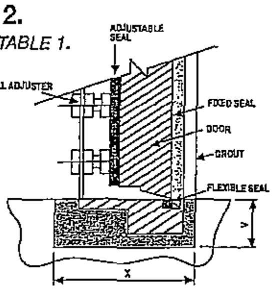
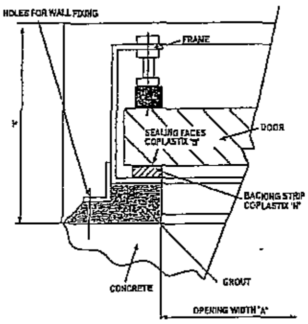


Fig 2.
SEE TABLE 1.

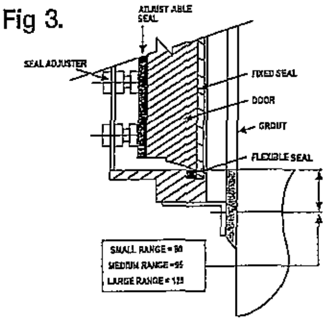


SECTION SHOWING INVERT SEAL ARRANGEMENT FOR WALL PENSTOCK WITH RECESS



SECTION SHOWING SIDE SEAL ARRANGEMENT FOR WALL PENSTOCKS

Fig 3.



SECTION SHOWING INVERT SEAL ARRANGEMENT FOR WALL PENSTOCK WITHOUT RECESS

Stem Nuts

The stem nuts are phosphor bronze to BS 12167:1998. For non-rising stems, the nut is housed in a cast-iron bracket secured to top of the penstock door. For rising stems, the nut is housed in the handwheel.

Fixing Bolts

Can be supplied when requested.

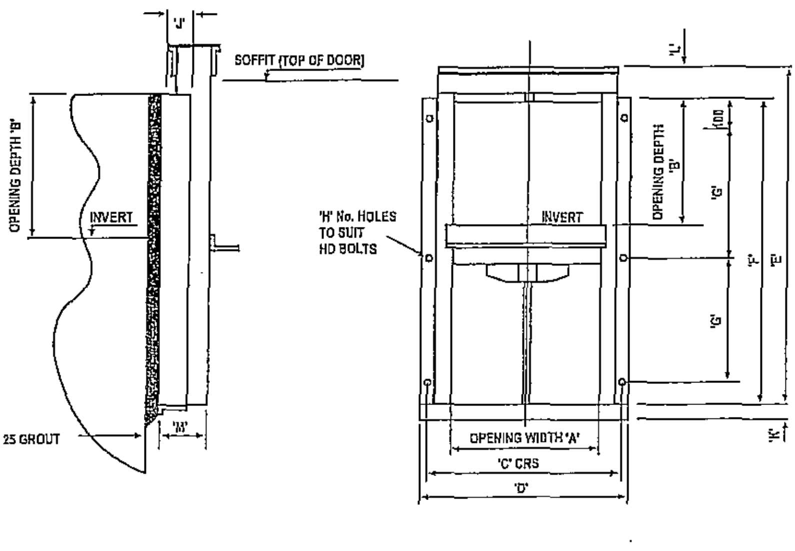
Pressure Pads

Adjustable pressure pads are fitted as standard and pre-set at the works to provide maximum degree of water tightness.

WEIR (Downward Opening)

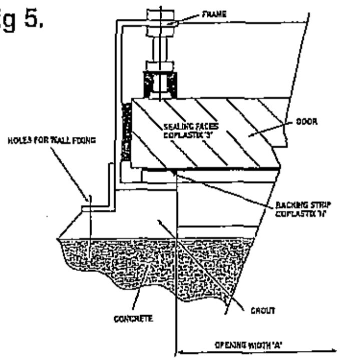
Coplastix® Weir Penstocks are constructed as described for the wall mounted type other than the stem is secured to the lower edge of the penstock door via a cast iron bracket, thus permitting maximum unhibited flow over the upper weir edge of the door. Flush invert does not apply for Weir Penstocks. The sealing arrangements for the Coplastix® Penstocks combine the use of resilient and low friction synthetic materials which ensures a high degree of sealing with easy movement.

Fig 4.
SEE TABLE ON PAGE 25.



OVERALL DIMENSIONS DIAGRAM OF WEIR PENSTOCKS

Fig 5.



SECTION SHOWING SIDE SEALs arrangement for weir products

RANGE	J	K	L	M
DIMENSIONS IN MILLIMETRES				
SMALL	104	50	85	165
MEDIUM	122	68	110	185
LARGE	146	80	160	245

Small Range Fig.1 Wall Mounted Version

WIDTH A	DEPTH B	C	D	E	F	G	H	J	K	L	M
DIMENSIONS IN MILLIMETRES											
400	400	560	600	977	880	370	6	104	-	-	-
450	450	610	650	1077	980	420	6	104	-	-	-
500	500	660	700	1177	1080	470	6	104	-	-	-
600	600	760	800	1377	1280	570	6	104	300	-	-
600	800	760	800	1777	1680	770	6	104	300	-	-
700	700	860	900	1577	1480	670	6	104	350	-	-
800	600	960	1000	1377	1280	570	6	104	400	-	-
800	800	960	1000	1777	1680	385	10	104	400	-	-
800	1000	960	1000	2177	2080	485	10	104	400	-	-
900	900	1060	1000	1977	1880	435	10	104	450	-	-

Medium Range Fig.1 Wall Mounted Version

WIDTH A	DEPTH B	C	D	E	F	G	H	J	K	L	M
DIMENSIONS IN MILLIMETRES											
800	1200	990	1050	2597	2480	585	10	122	400	-	-
1000	600	1190	1250	1397	1280	570	6	122	500	-	-
1000	800	1190	1250	1797	1680	770	6	122	500	-	-
1000	1000	1190	1250	2197	2080	485	10	122	500	-	-
1000	1200	1190	1250	2597	2480	585	10	122	500	-	-
1000	1400	1190	1250	2997	2880	685	10	122	500	-	-
1200	600	1390	1450	1397	1280	570	6	122	300	300	300
1200	800	1390	1450	1797	1680	385	10	122	300	300	300
1200	1000	1390	1450	2197	2080	485	10	122	300	300	300
1200	1200	1390	1450	2597	2480	468	12	122	300	300	300
1200	1400	1390	1450	2997	2880	548	12	122	300	300	300
1200	1600	1390	1450	3397	3280	628	12	122	300	300	300
1200	1800	1390	1450	3797	3680	590	14	122	300	300	300
1400	800	1590	1650	1797	1680	385	10	122	300	400	400
1400	1000	1590	1650	2197	2080	388	12	122	300	400	400
1400	1200	1590	1650	2597	2480	468	12	122	300	400	400
1400	1400	1590	1650	2997	2880	457	14	122	300	400	400

Large Range Fig.1 Wall Mounted Version

WIDTH A	DEPTH B	C	D	E	F	G	H	J	K	L	M
DIMENSIONS IN MILLIMETRES											
1400	1600	1650	1710	3420	3270	780	10	146	300	400	400
1400	1800	1650	1710	3820	3670	587	14	146	300	400	400
1400	2000	1650	1710	4220	4070	653	14	146	300	400	400
1500	1500	1750	1810	3220	3070	487	14	146	450	400	400
1600	800	1850	1910	1820	1670	760	6	146	500	400	400
1600	1000	1850	1910	2220	2070	480	10	146	500	400	400
1600	1200	1850	1910	2620	2470	580	10	146	500	400	400
1600	1400	1850	1910	3020	2870	453	14	146	500	400	400
1600	1600	1850	1910	3420	3270	520	14	146	500	400	400
1600	1800	1850	1910	3820	3670	587	14	146	500	400	400
1600	2000	1850	1910	4220	4070	653	14	146	500	400	400
1800	1000	2050	2110	2220	2070	480	10	146	600	400	400
1800	1200	2050	2110	2620	2470	387	14	146	600	400	400
1800	1400	2050	2110	3020	2870	453	14	146	600	400	400
1800	1600	2050	2110	3420	3270	520	14	146	600	400	400
1800	1800	2050	2110	3820	3670	440	18	146	600	400	400
1800	2000	2050	2110	4220	4070	490	18	146	600	400	400
2000	1000	2250	2310	2220	2070	480	10	146	700	400	400
2000	1200	2250	2310	2620	2470	387	14	146	700	400	400
2000	1400	2250	2310	3020	2870	453	14	146	700	400	400
2000	1600	2250	2310	3420	3270	390	18	146	700	400	400
2000	1800	2250	2310	3820	3670	440	18	146	700	400	400
2000	2000	2250	2310	4220	4070	490	18	146	700	400	400

Biwater

MAJOR SUPPLY REFERENCE LIST FOR HAM BAKER 'COPLASTIX' PENSTOCK

Date : Feb 2007

YEAR	PROJECT	CONSULTANTS / ENDUSER	CONTRACTOR
1979	Yuen Long Sewage Treatment Works	PWD / DSD	Whitehead & Poole
1992	East Kowloon Pollution Control Stage I (DC/91/04)	PHH / DSD	Franki Contractors Ltd.
1993	Tai Po Sewage Treatment Works	DSD	Cho & Partners Engg. Ltd.
1994	Tai Po Sewage Treatment Works Stage IV B (TP/25/93)	Balfour / DSD	Wan Hin / Chevalier
1995	Shek O Sewage Treatment Works	DSD	Ryoden Engg. Ltd.
1996	Sha Tin Sewage Treatment Works (DC/93/08)	DSD	Gammon Construction Ltd.
1998	Aberdeen Preliminary Treatment Works	DSD	Kofull Engg
1998	Sandy Bay Sewage Treatment Work	DSD	KEL
1999	Central, Westerna nd Wanchai West Trunk Sewers	Maunsell / DSD	Gammon Construction Ltd.
2001	Sha Tin Sewage Treatment Works (Term Contract)	DSD	Sum Kee Construction Ltd.
2002	West Kowloon Drainage Improvement (DC/98/20)	Black & Veatch / DSD	China & Road & Bridge Corporation
2002	West Kowloon Drainage Improvement Stage 2 Phase I (DC/98/18)	Black & Veatch / DSD	Shun Yuen Construction Ltd.
2003	West Kowloon Drainage Improvement Stage 2 Phase I (DC/98/19)	Black & Veatch / DSD	Downer Construction Ltd.
2004	Regulation of Shenzhen River Stage III Phase I (DC/2000/19)	DSD	Barican Construction Ltd.
2005	Tolo Harbour Catchment Stage I Phase I D Sewerage (DC/2000/09)	Halcrow-Babtie / DSD	Sum Kee Construction Ltd.
2006	West Kowloon Drainage Improvement Stage 2 Phase 2 (DC/98/21)	DSD	Downer Construction Ltd.
2007	Kwun Tong Intermediate Pumping Station	DSD	Fullink Technologies Ltd.

Biwater

Recommended Instructions For Mixing Grout

GROUT MIX :

50 kg Cement
50 kg Sand
225 g Cebex 100
22~24 litres Water
YIELD – 57 litres

Cebex is a non-shrink additive

Penstock or Flap Valve to be shuttered, sponge rubber placed between wall and wooden shutter to ensure seal.

Cebex 100

Cebex 100
December 2002

formally known as Conbex

Expanding and plasticising grout admixture

Uses

Cebex 100 is an admixture for site batched cementitious grouts where a reduced water/cement ratio and positive expansion is required. Applications include bed grouting, duct grouting, non-shrink infilling and jointing.

Advantages

- Gaseous expansion system compensates for plastic shrinkage and settlement in properly designed cementitious grout.
- Reduced water/cement ratio in the grout mix ensures low permeability and long term durability in service.
- Gives high grout fluidity with low water/cement ratio, thus making placement or injection of the grout easy.
- No metallic iron content to corrode and cause staining or deterioration due to rust expansion in the grout.
- Composition allows high early strength development in grouts, without the use of chlorides.

Standards compliance

Cebex 100 is a suitable pre-stressing grout admixture when complying with BS 8110 Part 1, 1997, Annex A.

Description

Cebex 100 is supplied as a powder admixture. The material is a combination of a plasticising agent and a gas producing expansion medium. The plasticising agent allows the use of a reduced water/cement ratio with consequent increased strengths and durability. The expansive medium counteracts the natural settlement and plastic shrinkage of the grout and aids stability and cohesion.

Sufficient restrained expansion is developed to ensure a high degree of interfacial contact.

Specification clauses

Supplier specification

All grouting (specify details and areas of application) must be carried out using a cement based grout, incorporating Cebex 100 manufactured by Fosroc and applied strictly in accordance with the manufacturer's technical data sheet.

Properties

Chloride content:	Nil to BS 5075
Compressive strength:	The plasticising action of Cebex 100 allows reduction of the water/cement ratio of cementitious grouts whilst maintaining flow properties. This gives improvement in strength and long term durability when cured under restraint.
Setting times:	Cebex 100 does not significantly affect the setting times of cement based grouts.
Expansion characteristics:	The controlled positive expansion in unset grouts incorporating Cebex 100 overcomes plastic settlement when measured in accordance with ASTM C827. An unrestrained expansion of up to 4% is typical.
Time for expansion:	15 minutes to 2 hours. Temperatures above 20°C may slightly reduce these times.
Compatibility:	Cebex 100 is compatible with all types of Portland cement. Cebex 100 may be used in mixes containing certain other Fosroc admixtures. Consult Fosroc for further information.

Instructions for use

Mixing

For best results a mechanically powered grout mixer must be used. For quantities up to 50 kg a slow speed drill fitted with a Conbextra mixing paddle is suitable. Larger quantities will require a high shear vane mixer. It is essential that machine mixing capacity and labour availability is adequate to enable the grouting operation to be carried out continuously. This may require the use of a holding tank with provision for gentle agitation to maintain fluidity. The selected water content should be accurately measured into the mixer. Slowly add the cement (and sand if required) and Cebex 100. Mix continuously for 5 minutes, making sure that a smooth even consistency is obtained.

Application

Areas to be grouted should be prepared to ensure substrates are clean, sound, and then pre-wetted. The unrestrained surface area of the grout must be kept to a minimum. Place the grout within 20 minutes of mixing to gain the full benefit of the expansion process. Adopt usual placing or pumping procedures ensuring a continuous operation.

Curing

On completion of the grouting operation, any exposed areas which are not to be cut back should be thoroughly cured by means of water application, Concure curing membrane or wet hessian.

Cleaning

Grouts mixed with Cebex 100 should be removed from tools and equipment with clean water immediately after use. Remove cured material mechanically or with Fosroc Acid Etch.

Limitations

Cebex 100 is incompatible with High Alumina Cement.

Estimating

Packaging

Cebex 100 is supplied in packs containing 24 x 225 g units.

Dosage

OPC	Concreting sand	Water	Cebex 100	Approx yield
50 kg	—	20 to 22 litres	225 g	36 litres
50 kg	50 kg	22 to 24 litres	225 g	57 litres

Note: For grout, mortar or concrete mixes with an aggregate/cement ratio more than 1, use 4 x 225 g units of Cebex 100 per 100 kg of cement.

Effects of overdosing

Drastic overdosing of Cebex 100 increases expansion and may cause frothing.

Storage

Cebex 100 has a shelf life of 12 months if kept in a dry store in its original packaging. High temperature and humidity storage may reduce this period.

Precautions

Health and safety

When mixing grouts with Cebex 100, avoid inhalation of dust and contact with skin and eyes. Wear suitable protective clothing, gloves, eye protection and respiratory protective equipment. The use of barrier creams provide additional skin protection. In case of contact with skin, rinse with plenty of clean water, then cleanse with soap and water. In case of contact with eyes, rinse immediately with plenty of clean water and seek medical advice. If swallowed, seek medical attention immediately — do not induce vomiting.

For further information see Material Safety Data Sheet.

Fosroc Limited

Coleshill Road
Tamworth
Staffordshire B78 3TL
Tel 01827 262222
Fax 01827 262444
www.fosrocuk.com

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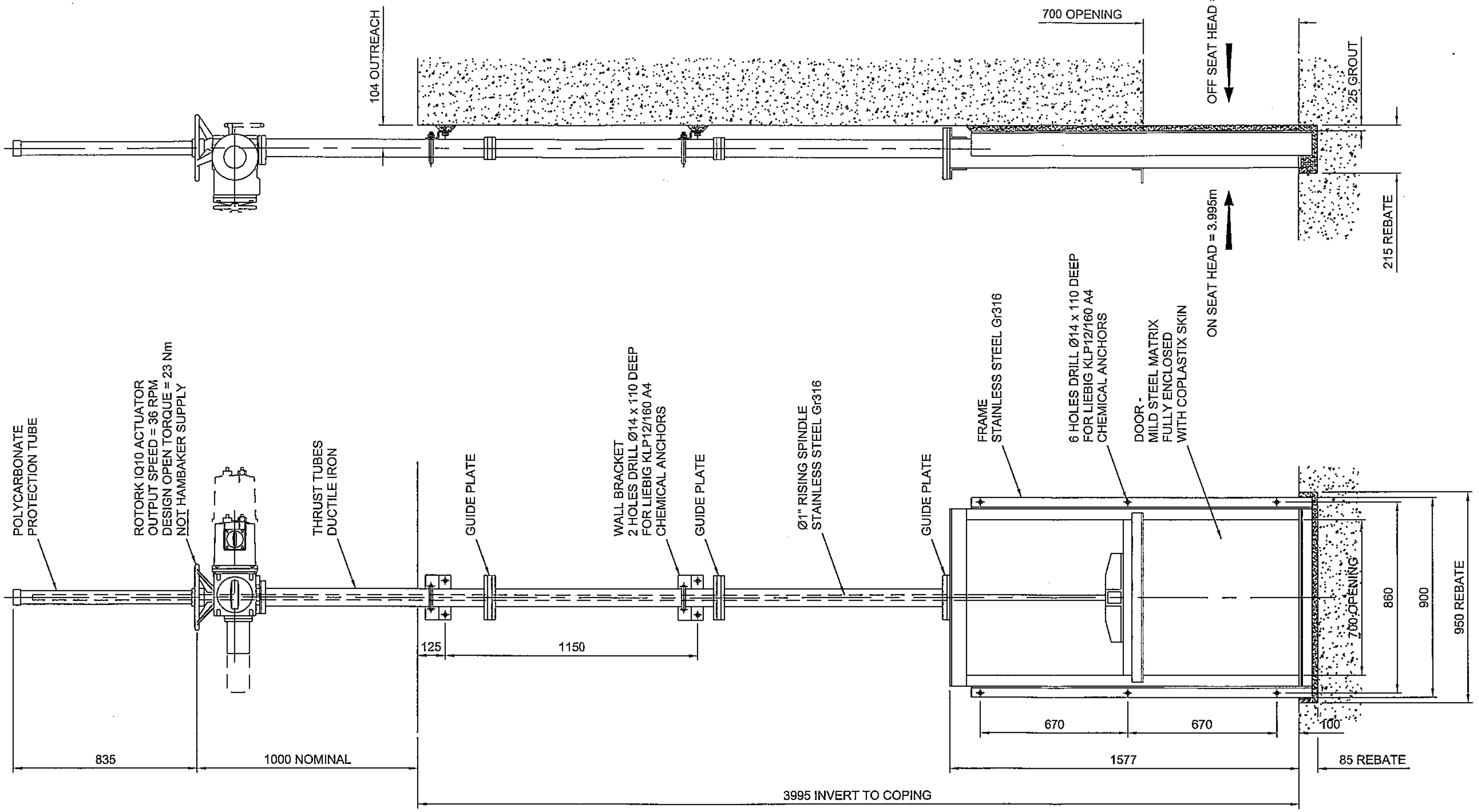
2	H40061907-01	THE DESIGN SHOWN ON THE DRAWING IS THE PROPERTY OF HAM BAKER FLOW CONTROL LTD AND IS NOT TO BE USED, COPIED, DISCLOSED OR COMMUNICATED IN WHOLE OR IN PART, EXCEPT IN ACCORDANCE WITH A CONTRACT, LICENCE OR AGREEMENT IN WRITING WITH HAM BAKER FLOW CONTROL LTD.	Copyright (2005) Ham Baker Flow Control Limited	GENERAL TOLERANCES UNLESS OTHERWISE SPECIFIED CASTING DETAILS: DIMENSIONS <1000mm ±1.5mm DIMENSIONS >1000mm ±2.0mm MACHINED DETAILS: ±1.0mm FABRICATED DETAILS: ± 1.0mm PER STD METRE LENGTH

CLIENT ~ BIWATER MAN LEE
SCHEME ~ TUEN MUN
HBFC ENQUIRY No ~ Q08-3886
HBFC CONTRACT No ~ H40062907
ITEM No ~ S01
QUANTITY ~ 1 OFF
SURFACE TREATMENT ~ NATURAL



2		SCM	MTB	SCM	26/09/08	Changed to rebate invert & direct mount.
1						INITIAL ISSUE
ISS	ECR	BY	CHK	APP	DATE	REVISION

TITLE G.A. 700 x 700 50/40 COPLASTIX PENSTOCK.

Drawn	SCM	25/09/08	Approved	SCM	25/09/08
Checked	MTB	25/09/08	Scale	1:20	Master Size 420x297 (A3)

ISO 9001

HAMBAKER FlowControl

Ham Baker Flow Control Ltd. Stoke-on-Trent Staffordshire ST4 7BH, England Tel: +44 (0) 1782 202300 Fax: +44 (0) 1782 203639

DRAWING NUMBER H40061907-01 ISS 2

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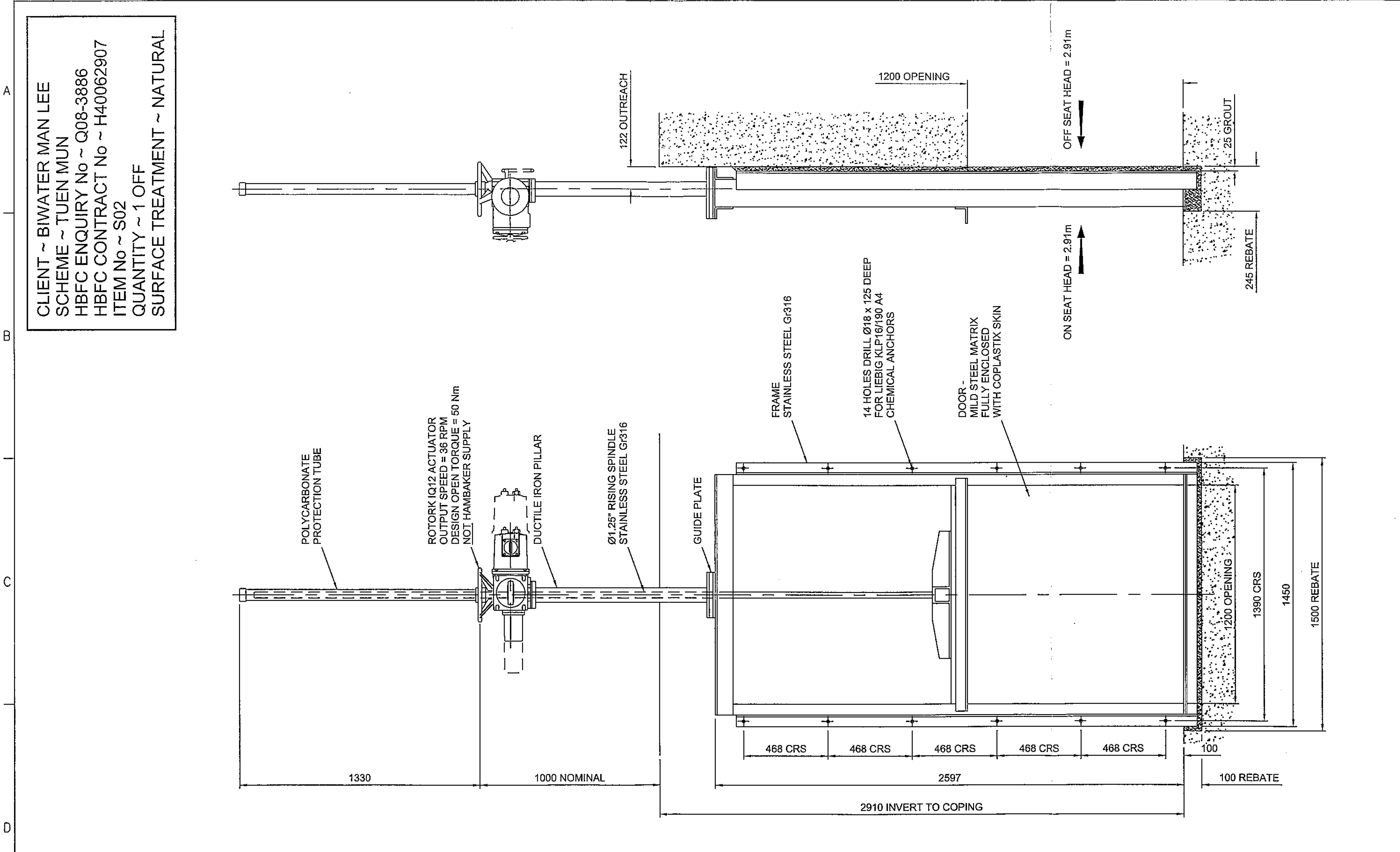
MACHINED DETAILS: ±1.0mm FABRICATED DETAILS: ± 1.0mm PER STD METRE LENGTH



TITLE G.A. 1200 x 1200 50/40 COP' PENSTOCK.

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2		SCM	MTB	SCM	26/09/08	Rebate invert added.
1						INITIAL ISSUE

Drawn	SCM	25/09/08	Approved	SCM	25/09/08
Checked	MTB	25/09/08	Scale	1:20	Master Size 420x297 (A3)

HAMBAKER FlowControl

Ham Baker Flow Control Ltd. Stoke-on-Trent Staffordshire ST4 7BH, England Tel: +44 (0) 1782 202300 Fax: +44 (0) 1782 203639

DRAWING NUMBER H40061907-02 ISS 2

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Containment Lining

LEIGHTON 礼顿

LEIGHTON CONTRACTOR ASIA LIMITED
H2104 - PAFF PERMANENT AVIATION FUEL FACILITIES

MATERIAL SUBMISSION FORM

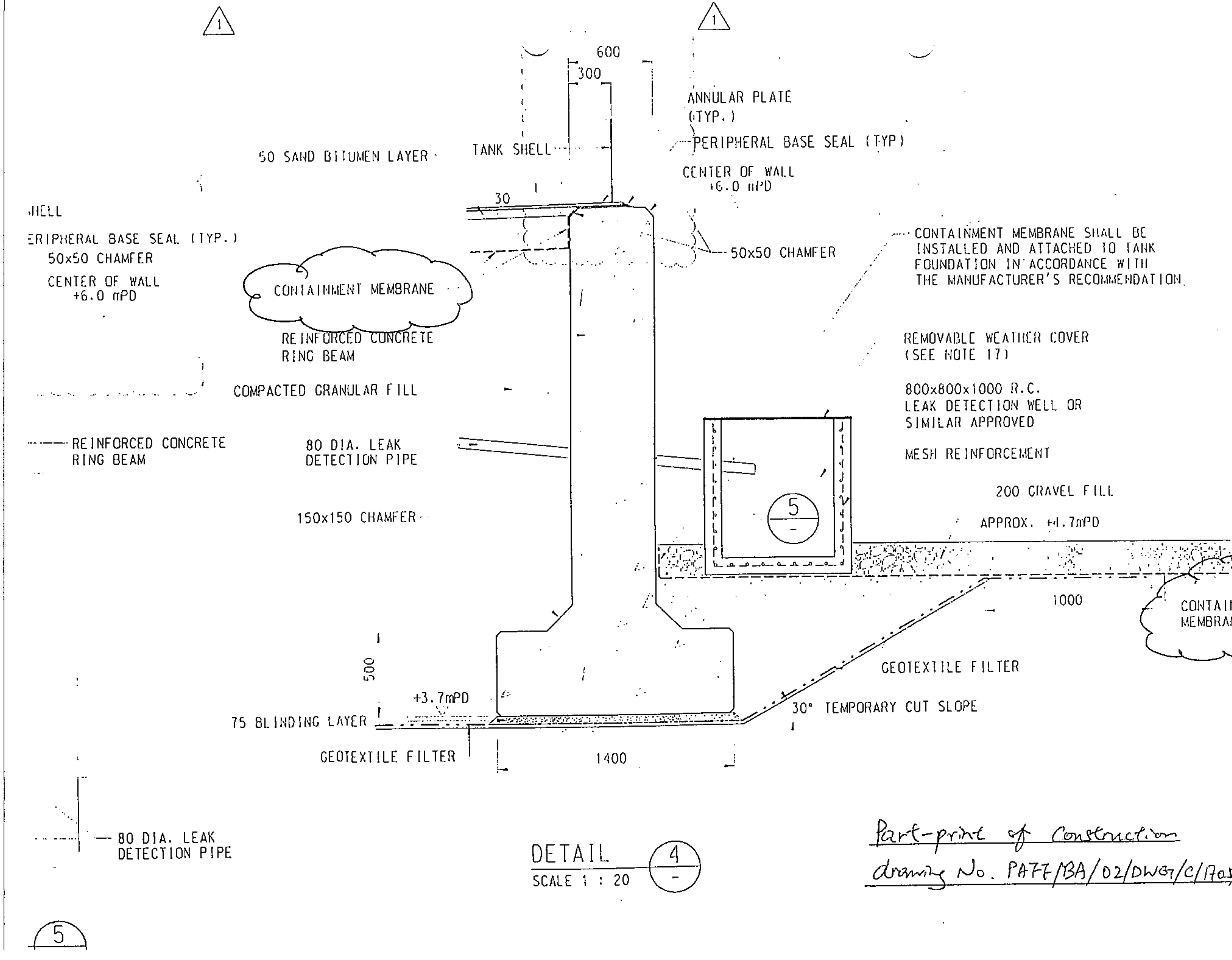
FROM : Project Director Leighton Contractor Asia Limited	TO : Michael Kay - CONSTRUCTION MANAGER Scott Wilson Limited 38/F/ Metroplaza Tower 1 223 Hing Fong Road Kwai Fong, N.T.	MSF NO : H2104/C22/2408/04a FILE REF : SIGNED : DATE : 28-Mar-06

DOCUMENT TITLE	* N / R	DOCUMENT NO	SRF / ERF NO	CONTRACTOR'S COMMENTS
The material described below are being submitted for approval or comment A. Material : - 1.00mm HDPE Containment Membrane B. Model / Selection : - GSE HD 1.00mm HDPE Geomembrane C. Manufacture / Origin : - G & E Company Ltd. , Hong Kong D. Specification Ref. : - Design Premise PAFF/LC/01/DSG/G/0201 rev. D Clause 5.3.4 item 1-5 E. Intended Location / Use : a. TANK FARM (Location as clouded highlighted refer to attached part-print drawing No. PAFF/BA/02/DWG/C/1705/1)		Encl. [x] Data Sheet [x] Catalogue [x] Job Reference [x] Test Report / Certificate [x] Sample [x] Others Method Statement		

REGISTRATION		INTERNAL DISTRIBUTION		EXTERNAL DISTRIBUTION	
CRS Receipt date :					
CRS Registration No :					

* N = New Submission R = Re-submission

Doc. No. H1863/F



Part-print of construction drawing No. PAFF/BA/02/DWG/C/1705/1

ACCORDANCE WITH THE ... REGULATIONS. DETAILS ... IN THE PARTICULAR SPE...

3. ALL STRUCTURAL CONCRE...

4. UNLESS OTHERWISE NOTE... SHALL BE HOT ROLLED ... BY 'T' WITH MINIMUM Y...

5. RADII AND BENDS IN RE... KONG BUILDING (CONSTR...

6. WELDING OF REINFORCEM... THE DESIGNER.

7. WHERE CONCRETE IS TO ... ALL STANDING WATER SH... PLACING OF CONCRETE.

8. NO HOLES IN REINFORCE... DESIGNER'S PRIOR AGRE...

9. THE POSITIONS AND DET... AGREED WITH THE DESIG...

10. UNLESS OTHERWISE STA... REINFORCEMENT SHALL ... BS8110: PART 1 : 1985

11. ALL LAPS TO BE STAGGE...

12. UNLESS NOTED OTHERWIS... STRUCTURE SHALL BE GR... A CHARACTERISTIC STRE... TO PARTICULAR SPECIFI...

13. FOR CONCRETE FINISH F... ENGINEERING WORKS (1S...

14. BARS TIED WITH WIRE ...
a. WIRE SHOULD BE...
b. LAPPING BARS ...

15. THE GEOTEXTILES SHOU... TECHNICAL CIRCULAR N... THE SIZING OF THE GE... THE FILL MATERIAL.

16. FOR NOTES ON COMPACTI... PAFF/LC/02/DWG/C/001...

17. CONTRACTOR TO PROPOS... OF THE DESIGNER.

18. THE RING BEAM SHALL ... BEARING CAPACITY OF ...

19. FOR DETAILS OF REINF... PAFF/BA/02/DWG/C/171...

20. ALL DRAWINGS ARE TO ... SPECIFICATION, GENER...

21. THE TANKS SHALL BE L... USING SHIMS.

Permanent Aviation Fuel Facility

Containment Membrane

Prepared by G and E Co. Ltd.

Permanent Aviation Fuel Facility Area 38, Tuen Mun, N.T., Hong Kong HDPE Containment Membrane to Tank Farm

March 2006

Table of Content

Product Specification

Asian Product Data Sheet

GSE STANDARD PRODUCTS

GSE HD

GSE HD is a smooth, high quality, high density polyethylene (HDPE) geomembrane produced from specially formulated, virgin polyethylene resin. This polyethylene resin is designed specifically for flexible geomembrane applications. It contains approximately 97.5% polyethylene, 2.5% carbon black and trace amounts of antioxidants and heat stabilizers; no other additives, fillers or extenders are used. GSE HD has outstanding chemical resistance, mechanical properties, environmental stress crack resistance, dimensional stability and thermal aging characteristics. GSE HD has excellent resistance to UV radiation and is suitable for exposed conditions. *These product specifications meet or exceed GRI GM13.*

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM VALUE							
Product Code			HDS 030 A00T	HDS 050 A00T	HDS 075 A00T	HDS 100 A00T	HDS 150 A00T	HDS 200 A00T	HDS 250 A00T	HDS 300 A00T
Thickness, mm (mil)	ASTM D 5199	every roll	0.27 (10.8)	0.45 (18)	0.68 (27)	0.9 (36)	1.35 (54)	1.8 (72)	2.25 (90)	2.7 (108)
Density, g/cm³	ASTM D 1505	every 5th roll	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Tensile Properties (each direction)	ASTM D 6693, Type IV	every 5th roll								
Strength at Break, N/mm-width (lb/in)	Dumbell, 2 ipm		8 (46)	14 (80)	21 (122)	28 (162)	43 (243)	57 (324)	71 (405)	85 (486)
Strength at Yield, N/mm-width (lb/in)			5 (29)	8 (46)	11 (63)	15 (84)	23 (130)	30 (173)	38 (216)	45 (257)
Elongation at Break, %	G.L. 51 mm (2.0 in)		600	700	700	700	700	700	700	700
Elongation at Yield, %	G.L. 33 mm (1.3 in)		13	13	13	13	13	13	13	13
Tear Resistance, N (lb)	ASTM D 1004	every 5th roll	40 (9)	65 (15)	93 (21)	125 (28)	187 (42)	249 (56)	311 (70)	373 (84)
Puncture Resistance, N (lb)	ASTM D 4833	every 5th roll	105 (24)	176 (40)	263 (59)	352 (79)	530 (119)	703 (158)	881 (198)	1,059 (238)
Carbon Black Content, %	ASTM D 1603	every 5th roll	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Carbon Black Dispersion	ASTM D 5596	every 5th roll	+Note 1	+Note 1	+Note 1	+Note 1	+Note 1	+Note 1	+Note 1	+Note 1
Notched Constant Tensile Load, hrs	ASTM D 5397, Appendix	90,000 kg	400	400	400	400	400	400	400	400
REFERENCE PROPERTY	**TEST METHOD**	**FREQUENCY**	**NOMINAL VALUE**							
Thickness, mm (mil)	ASTM D 5199	every roll	0.3 (12)	0.5 (20)	0.75 (30)	1.0 (40)	1.5 (60)	2.0 (80)	2.5 (100)	3.0 (120)
Oxidative Induction Time, minutes	ASTM D 3895, 200° C; O_2, 1 atm	90,000 kg	>100	>100	>100	>100	>100	>100	>100	>100
Roll Length (approximate), m (ft)			200 (656)	420 (1,738)	280 (918)	210 (689)	140 (459)	105 (344)	85 (279)	70 (230)
Roll Width, m (ft)			7.1 (23.3)	7.1 (23.3)	7.0 (23)	7.0 (23)	7.0 (23)	7.0 (23)	7.0 (23)	7.0 (23)
Roll Area, m² (ft²)			1,420 (15,284)	2,982 (40,495)	1,960 (21,114)	1,470 (15,847)	980 (10,557)	735 (7,912)	595 (6,417)	490 (5,290)
40' Container, roll			35	16	16	16	16	16	16	16

NOTES:

- +Note 1: Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- GSE HD provided in thicknesses of 0.5 mm to 3.0 mm has an approximate weight of 1,430 kg (3,152 lb). GSE HD 0.3 mm material is provided in rolls weighing approximately 413 kg (910 lb) each.
- All GSE geomembranes have dimensional stability of ±2% when tested with ASTM D 1204 and LTB of <-77° C when tested with ASTM D 746.

DS005 TH R07/12/04

Americas	GSE Lining Technology, Inc.	Houston, Texas	800-435-2008	281-443-8564	Fax: 281-230-8650
Asia/Pacific	GSE Lining Technology Company Ltd.	Bangkok, Thailand		66-2-937-0091	Fax: 66-2-937-0097
Europe/Middle East/Africa	GSE Lining Technology GmbH	Hamburg, Germany		49-40-767420	Fax: 49-40-7674233

This product data sheet is also available on our website at:

www.gseworld.com

Chemical Resistance For GSE Geomembranes

GSE geomembranes are made of high quality, virgin polyethylene which demonstrates excellent chemical resistance. GSE polyethylene geomembranes are resistant to a great number and combinations of chemicals. It is this property of (HDPE) high density polyethylene geomembranes that makes it the lining material of choice.

In order to gauge the durability of a material in contact with a chemical mixture, testing is required in which the material is exposed to the chemical environment in question. Chemical resistance testing is a very large and complex topic because of two factors. First, the number of specific media is virtually endless and second, there are many criteria such as tensile strength, hardness, etc. that may be used to assess a material's resistance to degradation.

The chemical resistance of polyethylene has been investigated by many people over the past few decades. We are able to draw from that work when making statements about the chemical resistance of today's polyethylene geomembranes. In addition to that, many tests have been performed that specifically use geomembranes and certain chemical mixtures. Naturally, however, every mixture of chemicals cannot be tested for. As a result of these factors, GSE published a chemical resistance chart, demonstrating general guidelines.

Polyethylene is, for practical purposes, considered impermeable. Be aware, however, that all materials are permeable to some extent. Permeability varies with concentration, temperature, pressure and type of permeant. The rates of permeation are usually so low, however, that they are insignificant. As a point of reference, polyethylene is commonly used for packaging of several types of materials. These include gasoline, motor oil, household cleaners (i.e. bleach), muratic acid, pesticides, insecticides, fungicides, and other highly concentrated chemicals. Also, you should be aware that there are some chemicals which may be absorbed by the material but only when present at very high concentrations. These include halogenated and/or aromatic hydrocarbons at greater than 50%; their absorption results in swelling and slight changes in physical properties such as increased tensile elongations. This includes many types of fuels and oils. Recognize that this action, however, does not affect the liner's ability to act as a barrier for the material it is containing.

Since polyethylene is a petroleum product, it can absorb other petroleum products. Like a sponge, the material becomes slightly thicker and more flexible but does not produce a hole or void. However, unlike a sponge, this absorption is not immediate. It takes a much longer time for a polyethylene liner to swell than it does for a sponge. The exact time it takes for swelling to occur depends on the particular constituents and concentrations of the contained media. However, a hole would not be produced. Also, this absorption is reversible and the material will essentially return to it's original state when the chemical is no longer in contact with the liner.

With regard to typical municipal landfills in the United States, legally allowable levels of chemicals have been demonstrated to have no adverse affect on polyethylene geomembrane performance. The very low levels of salts, metals and organic compounds do not damage polyethylene. A double-lined containment with a leachate (leak detection) removal system effectively prevents any significant, continuous exposure of the secondary membrane to these materials and for practical purposes makes the total liner system even more impermeable.

TN005 R11/07/02

Americas	GSE Lining Technology, Inc.	Houston, Texas	800-435-2008	281-443-8564	Fax: 281-230-8650
Europe/Middle East/Africa	GSE Lining Technology GmbH	Hamburg, Germany		49-40-767420	Fax: 49-40-7674233
Asia/Pacific	GSE Lining Technology Company Ltd.	Bangkok, Thailand		66-2-937-0091	Fax: 66-2-937-0097

GSE

Technical Note

Chemical Resistance Chart

GSE is the world's leading supplier of high quality, polyethylene geomembranes. GSE polyethylene geomembranes are resistant to a great number and combinations of chemicals. Note that the effect of chemicals on any material is influenced by a number of variable factors such as temperature, concentration, exposed area and duration. Many tests have been performed that use geomembranes and certain specific chemical mixtures. Naturally, however, every mixture of chemicals cannot be tested for, and various criteria may be used to judge performance. Reported performance ratings may not apply to all applications of a given material in the same chemical. Therefore, these ratings are offered as a guide only. This information is provided for reference purposes only and is not intended as a warranty or guarantee. GSE assumes no liability in connection with the use of this information.

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
A			
Acetic acid	100%	S	L
Acetic acid	10%	S	S
Acetic acid anhydride	100%	S	L
Acetone	100%	L	L
Adipic acid	sat. sol.	S	S
Allyl alcohol	96%	S	S
Aluminum chloride	sat. sol.	S	S
Aluminum fluoride	sat. sol.	S	S
Aluminum sulfate	sat. sol.	S	S
Alum	sol.	S	S
Ammonia, aqueous	dil. sol.	S	S
Ammonia, gaseous dry	100%	S	S
Ammonia, liquid	100%	S	S
Ammonium chloride	sat. sol.	S	S
Ammonium fluoride	sol.	S	S
Ammonium nitrate	sat. sol.	S	S
Ammonium sulfate	sat. sol.	S	S
Ammonium sulfide	sol.	S	S
Amyl acetate	100%	S	L
Amyl alcohol	100%	S	L
Aniline	100%	S	L
Antimony trichloride	90%	S	S
Arsenic acid	sat. sol.	S	S
Aqua regia	HCI-HNO3	U	U
B			
Barium carbonate	sat. sol.	S	S
Barium chloride	sat. sol.	S	S
Barium hydroxide	sat. sol.	S	S
Barium sulfate	sat. sol.	S	S
Barium sulfide	sol.	S	S
Benzaldehyde	100%	S	L
Benzene	—	L	L
Benzoic acid	sat. sol.	S	S
Beer	—	S	S
Borax (sodium tetraborate)	sat. sol.	S	S
Boric acid	sat. sol.	S	S
Bromine, gaseous dry	100%	U	U
Bromine, liquid	100%	U	U
Butane, gaseous	100%	S	S
1-Butanol	100%	S	S
Butyric acid	100%	S	L
C			
Calcium carbonate	sat. sol.	S	S
Calcium chlorate	sat. sol.	S	S
Calcium chloride	sat. sol.	S	S
Calcium nitrate	sat. sol.	S	S
Calcium sulfate	sat. sol.	S	S
Calcium sulfide	dil. sol.	L	L
Carbon dioxide, gaseous dry	100%	S	S
Carbon disulfide	100%	L	U
Carbon monoxide	100%	S	S
Chloracetic acid	sol.	S	S
Carbon tetrachloride	100%	L	U
Chlorine, aqueous solution	sat. sol.	L	U
Chlorine, gaseous dry	100%	L	U
Chloroform	100%	U	U
Chromic acid	20%	S	L
Chromic acid	50%	S	L
Citric acid	sat. sol.	S	S

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
Copper chloride	sat. sol.	S	S
Copper nitrate	sat. sol.	S	S
Copper sulfate	sat. sol.	S	S
Cresylic acid	sat. sol.	L	—
Cyclohexanol	100%	S	S
Cyclohexanone	100%	S	L
D			
Decahydronaphthalene	100%	S	L
Dextrine	sol.	S	S
Diethyl ether	100%	L	—
Dioctylphthalate	100%	S	L
Dioxane	100%	S	S
E			
Ethanediol	100%	S	S
Ethanol	40%	S	L
Ethyl acetate	100%	S	U
Ethylene trichloride	100%	U	U
F			
Ferric chloride	sat. sol.	S	S
Ferric nitrate	sol.	S	S
Ferric sulfate	sat. sol.	S	S
Ferrous chloride	sat. sol.	S	S
Ferrous sulfate	sat. sol.	S	S
Fluorine, gaseous	100%	U	U
Fluorosilicic acid	40%	S	S
Formaldehyde	40%	S	S
Formic acid	50%	S	S
Formic acid	98-100%	S	S
Furfuryl alcohol	100%	S	L
G			
Gasoline	—	S	L
Glacial acetic acid	96%	S	L
Glucose	sat. sol.	S	S
Glycerine	100%	S	S
Glycol	sol.	S	S
H			
Heptane	100%	S	U
Hydrobromic acid	50%	S	S
Hydrobromic acid	100%	S	S
Hydrochloric acid	10%	S	S
Hydrochloric acid	35%	S	S
Hydrocyanic acid	10%	S	S
Hydrofluoric acid	4%	S	S
Hydrofluoric acid	60%	S	L
Hydrogen	100%	S	S
Hydrogen peroxide	30%	S	L
Hydrogen peroxide	90%	S	U
Hydrogen sulfide, gaseous	100%	S	S
L			
Lactic acid	100%	S	S
Lead acetate	sat. sol.	S	—
M			
Magnesium carbonate	sat. sol.	S	S
Magnesium chloride	sat. sol.	S	S
Magnesium hydroxide	sat. sol.	S	S
Magnesium nitrate	sat. sol.	S	S
Maleic acid	sat. sol.	S	S
Mercuric chloride	sat. sol.	S	S

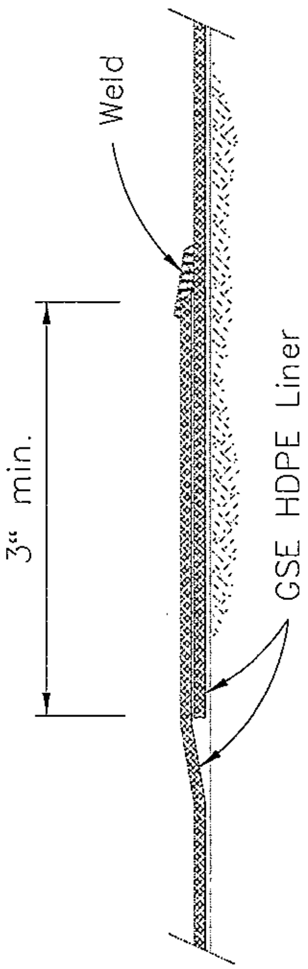
- Continued -

Installation Sketch

GSE

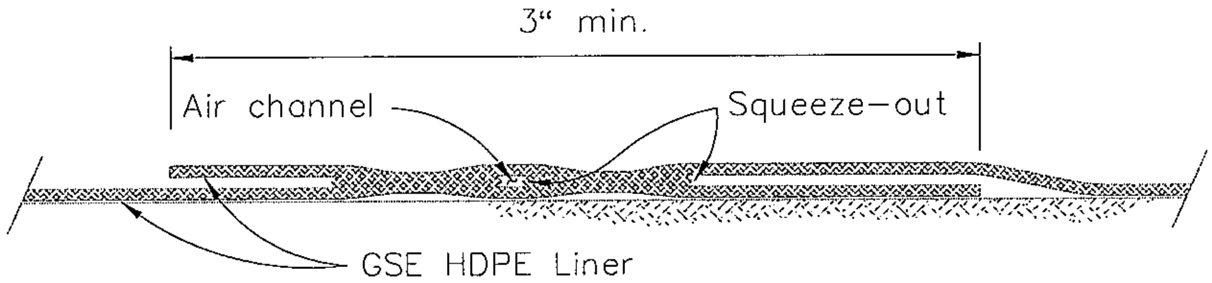
GSE Lining Technology, Inc.
19103 Gundle Road
Houston, Texas 77073-3598
(800)435-2008 / (281)443-8564

DRAWN	DATE	REVISION	DWG. NO.
Don	10/24/97	1	D-WS001



Typical Fillet Extrusion Weld

Not to scale

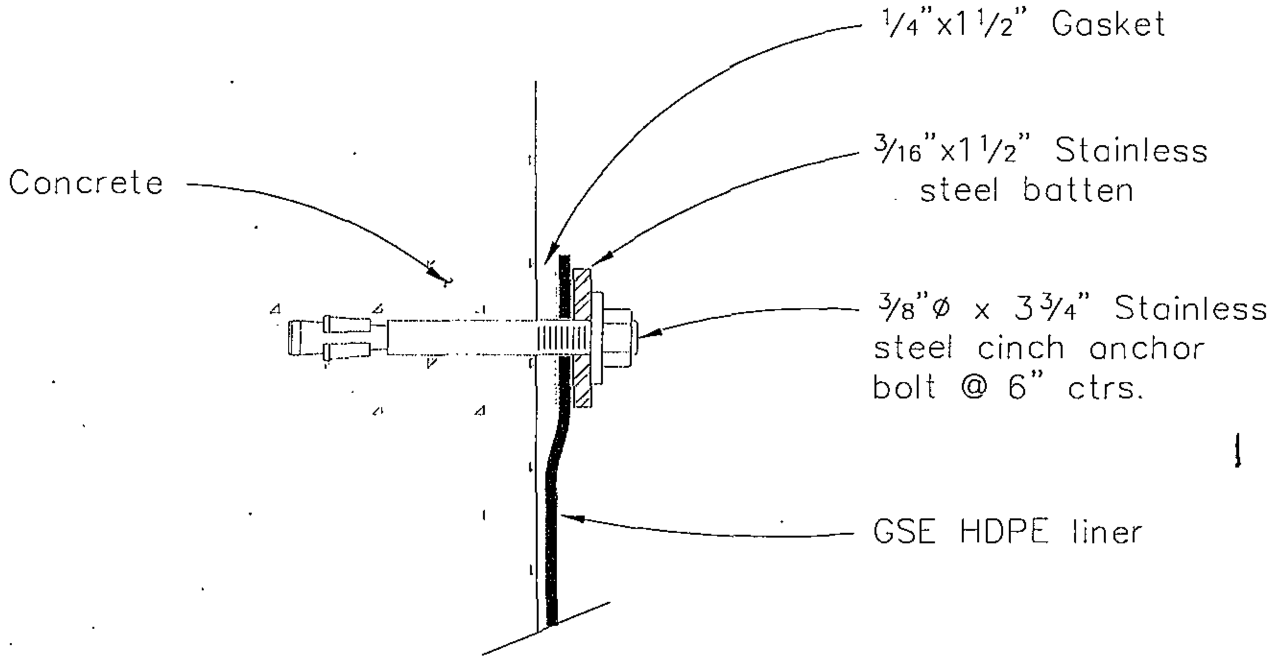


Typical Hot Wedge Double Track Fusion Weld

Not to scale

GSE Lining Technology, Inc.
19103 Gundle Road
Houston, Texas 77073-3598
(800)435-2008 / (281)443-8564

DRAWN	Don
DATE	10/24/97
REVISION	1
DWG. NO.	D-WS002



Concrete Anchor Detail

Not to scale

GSE Lining Technology, Inc.
19103 Gundle Road
Houston, Texas 77073-3598
(800)435-2008 / (713)443-8564

DRAWN

DATE

REVISION

DWG. NO. D-BT002

Installation Quality Assurance

GSE

GSE Geomembranes

Geomembranes ▪ Geonets ▪ Geocomposites ▪ GCLs ▪ Geotextiles ▪ Concrete Protection ▪ Installation Services ▪ Fabrications

Installation Quality Assurance Manual

www.gseworld.com

1.0 Overview

This manual is a guide of the duties and responsibilities for a GSE QA technician.

ASTM Practices that this guide lists include the following and are included separately:

ASTM D-6392 Standard Test Methods For Determining The Integrity Of NonReinforced Geomembrane Seams Produced Using Thermo Fusion Methods

ASTM D-5820 Standard Practice For Pressurized Air Channel Evaluation of Dual Seamed Geomembranes

ASTM D-5641 Standard Practice For Geomembrane Seam Evaluation By Vacuum Chamber

ASTM D-6497 Standard Guide For Mechanical Attachment of Geomembrane to Penetrations or Structures

GRI Standard GM13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

GRI Standard GM14 Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes

GRI Standard GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

2.0 Material Delivery

2.01 Upon arrival on site, the GSE QA will do an inventory of materials on the job site.

2.02 Roll numbers of liner, textile, geonet and composite will be logged on the Inventory Check List and cross-referenced with bills of lading (Materials Supplied by GSE).

2.03 Copies of the Inventory Check List and signed Bill of Ladings should be sent to the home office with the QA retaining the originals.

2.04 Any visible damage to roll materials should be noted on the roll and Inventory Check List.

3.0 Earthwork

3.01 The General Contractor is responsible for preparing and maintaining the subgrade. The subgrade should be prepared and maintained per the individual job specifications.

3.02 Subgrade Surface Acceptance Certificate - The GSE Site Manager shall be responsible for assuring that the subgrade surface has been properly prepared for deployment of geosynthetics. If GSE is required to sign a Subgrade Surface Acceptance Certificate, please use the form provided by GSE. Under no circumstances sign off on subgrade that is not suitable for deployment of geosynthetics. Sign the Subgrade Acceptance Certificate only on areas to be covered in one day, preferably after deployment.

3.03 If the subgrade is unacceptable and the GC/Owner directs GSE to deploy over, the GSE Site Manager must have the Owner's representative sign the Deployment by Owner's Direction Over

Unsuitable Subgrade Certificate which will take the place of the Subgrade acceptance Certificate for the particular area being covered.

3.04 Prior to material installation, whenever possible, the QA should measure the area to be covered and compare it to the area used for the bid. An outline of the area including anchor trenches, top of slopes and toe of slopes will be provided by GSE's Drafting department. Use this outline to log actual on-site conditions, i.e....distances between anchor trenches, length of anchor trenches, top of berms, length of slopes and/or any other relevant distances.

Note: Whenever possible distances will be included on the blank outlines. If actual field dimensions have changed or do not match the GSE outline the QA should notify their Supervisor and then the Project Manager, so that quantities can be reassessed to determine the proper amount of material needed for installation. It is important to establish the limits of deployment with all parties. Any changes must be noted and signed off by the Customer's Representative.

4.0 Panel Placement

4.01 Each panel will be assigned a number as detailed below.

4.01a When there is only one layer, panels may be designated with a number only, i.e.... 1, 2, 3, 4 etc.

4.01b When two or more layers are required use a letter and number, i.e....
Secondary Liner S1, S2, S3, S4 etc...
Primary Liner P1, P2, P3, P4 etc...
Tertiary Liner T1, T2, T3, T4 etc...

4.02 This numbering system should be used whenever possible. Agreement to a panel-numbering system should be made at the pre-construction meeting if possible. However, it is essential that GSE's system and the Owner's Representative/Third Party QA agree. Do not use different systems.

4.03 Panel numbers shall be written in large block letters in the center of each deployed panel. The roll number, date of deployment and length (gross) should be noted below the panel number. All noting should be made so that they are easily visible from a distance. On long panels it is beneficial to write information at both ends.

4.04 Panel Numbers shall be logged on the GSE Panel Placement Log along with the roll number and gross length.

4.05 If there is a partial roll left after deployment it is important to write the last four digits of the roll number several times for future identification, along with the estimated length.

5.0 Trial Welds

5.01 Seaming apparatus shall be allowed to warm up a minimum of 15 minutes before performing trial welds.

5.02 Each seaming apparatus along with GSE Welding Tech will pass a trial weld prior to use. Trial welds to be performed in the morning and afternoon, as a minimum, as well as whenever there is a power shutdown.

5.03 Fusion or wedge welds will always be performed or conducted on samples at least 6' long. Extrusion welds will be done on samples at least 3' long.

Note: Always perform trial welds in the same conditions that exist on the job. Run the trial welds on the ground, not the installed liner. Do not use a wind break unless you are using one on the job.

5.04 Sampling Procedure

5.04a Cut 4 - 1" wide specimens from the trial weld sample. Operating temperatures should be monitored while welding.

5.04b Specimens will always be cut using a 1" die cutter so the peel values may be used for qualitative analysis.

5.04c When cutting coupons from the trial weld samples, the inside and outside tracks on the coupon should be identified to assist in troubleshooting problems in case the weld fails. The outside track will be defined as the track which would be peeled if pulling the overlap exposed in a typical installation, or the seam which is closest to the edge of the top sheet. The inside track is the seam closest to the edge of the bottom sheet.

5.04d Place a small mark on the exposed (Top) overlap to denote the outside track prior to testing trial welds.

5.05 Die Cutter

5.05a Only cut one sample at a time to avoid damaging the die cutter.

5.05b Samples should be free of sand and grit prior to cutting sample.

5.05c Inspect the die edge weekly for nicks, dents or signs of dullness. Dullness of the cutting edge may damage the units.

5.05d Remove die when edge has been dulled and lightly reshape it with a medium hand file. When wear is excessive return it for a replacement die.

5.05e When the cutting board becomes deeply scored and/or interferes with coupon cutting it should be replaced.

5.05d To adjust the depth of the die cut into the cutting board, after replacing the cutting board or sharpening the die, 0.015" washer shims can be added or removed between the cutting ram and the ram extension. Only add shims when cutting is difficult due to lack of depth of cut.

5.06 Trial Weld Testing

5.06a Allow coupons to cool prior to testing. Avoid separating the coupons while hot as failure of the sheet may be initiated and false readings indicated.

5.06b In extreme heat the coupons may need to be cooled, using water or an insulated cooler prior to peel testing. Lab conditions specify 70 degrees (plus or minus 4 degrees) Fahrenheit. Coupon temperatures greater than 70 degrees may result in lowered strengths.

5.06c Visually inspect the coupons for squeeze-out, footprint, pressure and general appearance.

5.06d Each of the 4 coupons will be tested in peel on the field tensiometer at a separation rate of 2" per minute (for HDPE). Shear tests, in addition to the peel tests, will be performed if required by a site-specific QA. Plan.

5.07 Pass/Fail Criteria

5.07a Criteria for passing trial welds will be as follows:

1) Seam must exhibit film tear bond (FTB). Trial welds should have no incursion into the weld.
2) Peel and shear values shall meet or exceed the values listed below for HDPE smooth or textured sheet (@ 2"/min.):

Material (Mil)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40	81	65	52
60	121	98	78
80	162	130	104
100	203	162	130

3) Peel and shear values shall meet or exceed the values listed below for LLDPE smooth or textured sheet (@ 20"/min.):

Material (Mil)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40	60	50	48
60	90	75	72
80	120	100	96
100	150	125	120

5.07b Both tracks of fusion welded samples must pass for the trial weld to be considered acceptable. If any of the four coupons fail either due to seam incursion (no FTB) or low strength values, the trial weld must be re-done.

5.07c The GSE QA will give approval to proceed with welding after observing and recording all trial welds.

5.08 Trial Weld Documentation

5.08a All trial weld data will be logged on the GSE Trial Weld log

5.08b When logging fusion welded peel values on the GSE Trial Weld log indicate the values for the outside track first, followed by the inside track

5.08c Speed and temperature settings will be recorded for each machine's trial weld

6.0 Geomembrane Field Seaming

6.01 The seam number takes the identity of the panels on each side. The seam between panels 1 & 2 becomes Seam 1/2. These lengths and seam numbers shall be recorded in the GSE Seam Log.

6.02 Welding Technicians will mark their initials/employee number, machine number, date and time at the start of every seam. Technician should also periodically mark temperatures along the seam and at the end of the seam.

6.03 Approved processes for field seaming and repairing are extrusion welding and fusion welding. All welding equipment shall have accurate temperature monitoring devices installed and working to ensure proper measurement.

6.04 Extrusion welding shall be used primarily for repairs, patching and special detail fabricating and may be used for seaming. The GSE Site Manager shall verify that:

1) equipment in use is functioning properly
2) welding personnel are purging the machine of heat degraded extrudate prior to actual use
3) all work is performed on clean surfaces and done in a professional manner
4) no seaming will be performed in adverse weather conditions

6.05 Fusion welding, shall be used for seaming panels together and is not used for patching or detail work. The GSE Site Manager shall verify that:

1) the equipment used is functioning properly
2) seaming personnel are working in a professional manner and are attentive to their duties
3) no seaming will be performed in adverse weather conditions

6.06 Seam preparation, the welding technician shall verify that:

1) prior to seaming, the seaming area is free of moisture, dust, dirt, sand or debris of any nature
2) the seam is overlapped properly for fusion welding
3) the seam is overlapped or extended beyond damaged areas at least 4" when extrusion welding
4) the seam is properly heat tacked and abraded when extrusion welding
5) seams are welded with fewest number of unmatched wrinkles or "fishmouths"

6.07 No seaming will be performed in ambient air temperatures or adverse weather conditions that would jeopardize the integrity of the liner installation.

7.0 Field Destructive Testing

7.01 Destructive seam tests shall be performed to evaluate bonded seam strength. The frequency of sample removal shall be one sample per 500' of seam, unless specific site specifications differ. Location of the destructive samples will be selected and marked by the QA Technician or third party QA. Field testing should take place as soon as possible after seam is completed.

7.02 Samples should be labeled in numerical order, I.e. DS-1, DS-2 etc....This should carry thru any layers and or multiple ponds, do not start numbering from 1 again. (This is the preferred method)

7.03 The size of samples and distribution should be approximately 12" x 39"(size may vary dependent on Job requirements) and distributed as follows:

7.03a 12" x 12" piece given to QA Technician for field testing.
7.03b 12" x 12" piece sent to Home Office for testing, if required.
7.03c 12" x 12" piece given to third party for independent testing, or archiving.

NOTE: All samples will be labeled showing test number, seam number, machine number, job number, date welded and welding tech number.

7.04 The sample given to the QA Technician in the field shall have ten coupons cut and be tested with a tensiometer adjusted to a pull rate as shown below. All tests shall meet or be greater than the values listed below.

1) Seam must exhibit film tear bond (FTB). Trial welds should have no incursion into the weld.
2) Peel and shear values shall meet or exceed the values listed below for HDPE smooth or textured sheet (@ 2"/min.):

Material (Mil)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40	81	65	52
60	121	98	78
80	162	130	104
100	203	162	130

3) Peel and shear values shall meet or exceed the values listed below for LLDPE smooth or textured sheet (@ 20"/min.):

Material (Mil)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40	60	50	48
60	90	75	72
80	120	100	96
100	150	125	120

7.05 All trial weld destructive test data will be logged on the GSE Destructive test log.

7.06 When logging fusion welded peel values on the GSE Destructive Test Log, indicate the values for the outside track first, followed by the inside track.

7.08 Test results will be noted in the GSE Destructive Test Log as P (pass) or F (fail).

7.09 If test fails, additional samples will be cut, approximately 10' on each side of the failed test, and retested. These will be labeled A (after) & B (before). This procedure will repeat itself until a sample passes. Then the area of failed seam between the two tests that pass will be capped or reconstructed.

7.10 In lieu of taking an excessive number of samples, the GSE Site Manager may opt to extrusion weld the flap or cap the entire seam and then non-destructively test according to Section 8.0.

8.0 Non-Destructive Testing

8.01 GSE shall non-destructively test all seams their full length using an air pressure or vacuum test. The purpose of this test is to check the continuity of the seam.

8.02 Air testing; the following procedures are applicable to those seams welded with a double-seam fusion welder.

8.02a The equipment used shall consist of an air tank or pump capable of producing a minimum 35 psi and a sharp needle with a pressure gauge attached to insert into the air chamber.

8.02b Seal both ends of the seam by heating and then squeezing together. Insert the needle with the gauge into the air channel, it may be necessary to heat the liner to make this easier. Pressurize the air channel to 30psi. Note time test starts and wait a minimum of 5 minutes to check. If pressure after five minutes has dropped less than 2 psi then the test is successful (Thickness of material may cause variance).

8.02c Cut opposite seam end and listen for pressure release to verify full seam has been tested.

8.02d If the test fails, follow these procedures.

a) While channel is under pressure walk the length of the seam listening for a leak.
b) While channel is under pressure apply a soapy solution to the seam edge and look for bubbles formed by air escaping.
c) Re-test the seam in smaller increments until the leak is found.

8.02e Once the leak is found using one of the proceedures above, cut out the leak area and retest the portions of the seams between the leak areas as per 8.02a to 8.02c above. Continue this proceedure until all sections of the seam pass the pressure test.

8.02f Repair the leak with a patch and vacuum test again.

8.02g All non-destructive tests will be noted in the GSE Non-Destructive Test/Repair log.

8.03 Vacuum testing; the following procedures are applicable to those seams welded with a extrusion welder.

8.03a The equipment used shall consist of an vacuum pumping device, a vacuum box and a foaming agent in solution.

8.03b Wet a section with the foaming agent, place vacuum box over wetted area. Evacuate air from the vacuum box to a pressure suitable to affect a seal between the box and geomembrane. Observe the seam through the viewing window for the presence of soap bubbles emitting from the seam.

8.03c If no bubbles are observed, move box to the next area for testing. If bubbles are observed, mark the area of the leak for repair as per Section 10.0 and retest as per Section 8.03.

Note: If vacuum testing fusion welded seams, the overlap flap must be cut off to perform the tests.

9.0 Defects and Repairs

9.01 Identification; all seams and non-seam areas of the geomembrane lining system shall be examined for defects in the seam and sheet.

9.02 Identification of the defect should be made using the following procedures:

9.02a For any defect in the seam or sheet that is an actual breach (hole) in the liner, installation personnel shall circle the defect and mark with the letter "P" along side the circle. The letter "P" indicates a patch is required.

9.02b For any defect that is not an actual hole, installation personnel shall only circle the defect indicating that the repair method may be only an extruded bead and that a patch is not required.

9.02c Each suspect area that has been identified as needing repair shall be repaired in accordance with this section and Non-Destructively tested as per Section 8.0. After all work is complete, the GSE Site Manager will conduct a final walk-through to confirm all repairs have been completed and debris removed. Only after this final evaluation by GSE's Site Manager and Owner/Agent shall any material be placed over the installed liner.

10.0 Repair Procedures

10.01 Any Portion of the Geomembrane liner system exhibiting a defect which has been marked for repair may be repaired with any one or combination of the following procedures:

1) Patching - used to repair holes, tears, undispersed raw materials in the sheet and dented areas.
2) Grind and Reweld - used to repair small sections of extruded seams.
3) Spot Welding - Used to repair small minor, localized flaws.
4) Flap Welding - Used to extrusion weld the flap of a fusion weld in lieu of a full cap.
5) Capping - Used to repair failed seams.

6) Topping - Application of extrudate bead directly to existing seams.

10.02 The following conditions shall apply to the above methods:

1) surfaces of the geomembrane which are to be repaired shall be roughened
2) all surfaces must be clean and dry at the time of the repair
3) all seaming equipment used in repairing procedures shall be qualified
4) all patches and caps shall extend at least 4" beyond the edge of the defect, and all patches must have rounded corners
5) all cut out holes in liner must have rounded corners, 3" min. radius

11.0 As-Built Drawing Procedures

11.01 Liner Layout

11.01a Submitted As-built Drawings should always be on blank outlines supplied by GSE's Drafting Department. (Phone 281-230-2518 Don Sharkey). When outlines are not available plain paper may be used, but only after permission from GSE's Drafting Department.

11.01b Accuracy to the way seams fit or join.

11.01c Using different colors makes information easier to see. Drawings may be done in ink or pencil, but writing must be neat.

11.01d Do not write so small that it is hard to read.

11.01e Suggested scale is 1" = 40' (Other scales may be used if required).

11.02 Anchor Trenches

11.02a The amount of liner actually in the trench should be noted on the drawing. If amount differs, show all differences and approximate locations.

11.02b If anchor trench is larger than shown on GSE's construction drawings then a written approval should be obtained from the Owner/Agent representative. This should be included in the as-built package.

11.03 Panel & Roll Numbers

11.03a Each panel will be assigned a number as detailed below. When there is only one layer panels may be designate with a number only, i.e.... 1, 2, 3, 4 etc.

11.03b When two or more layers are required use a letter and number, i.e....

Secondary Liner S1, S2, S3, S4 etc...
Primary Liner P1, P2, P3, P4 etc...
Tertiary Liner T1, T2, T3, T4 etc...

11.03c This numbering system should be used whenever possible. Agreement to a panel numbering system should be made at the pre-construction meeting if possible. However, it is essential that GSE's system and the Owner's Representative/Third Party QA agree. Do not use different systems.

11.03d Panel numbers shall be written in large block letters in the center of each deployed panel. The roll number, date of deployment and gross length should be noted below the panel number. All notations should be made so that they are easily visible from a distance. On long panels it is beneficial to write information at both ends.

11.03e Panel Numbers shall be logged on the Daily Report Forms along with the roll number and gross length.

11.03f Whenever possible, roll numbers should be placed next to panel numbers on the field copies of the as-built drawing.

11.04 Seam Lengths

11.04a Every seam length that is not a cross-seam must be noted. This includes rectangles, squares, pies and any other shape (See Fig. A).

11.04b GSE assumes that all regular cross-seams are either 22' or 34' wide, unless they are not full width panels they do not have to be noted on the drawing. Panel widths are measured perpendicularly across the panels.

11.04c All dimensions should be called out in tenths of a foot.

11.05 Tests

11.05a All test markings should conform to the "Legend" on the blank outline.

11.05b It can be assumed that all seam junctions will have a patch, therefore, it is only necessary to note if they don't.

11.06 Seam Numbers

11.06a Since the seam number is drawn from the adjoining panels (I.e. 1/2, 10/11 etc.) there is no need to call out seam numbers on the drawings.

11.06b Each seam must be logged in the Daily Report.

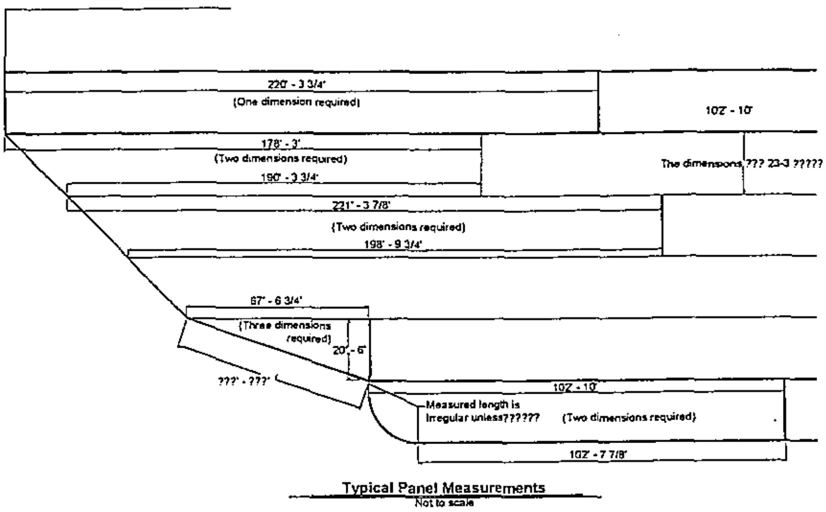


Fig A

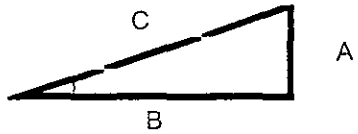
11.07 Miscellaneous

11.07a QA's name should be on all drawings and paperwork.

11.07b Any questions arising in the field about reporting issues may be handled by calling Don Sharkey at 800-435-2008, ext 2518 or 281-230-2518.

12.0 Formulas

12.01 Here are some procedures using trig formulas to enable you to deal with slope corrections concerning seam lengths on as-built drawings in order to do these calculations you will need a calculator that performs trigonomic functions.



A = Rise
B = Base
C = Slope

Welding of HDPE Membrane

Extrusion Welding

Extrusion welding is necessary for non-linear seams, roll ends, pipe penetrations, patches or anywhere that it is impra~~cti~~cal to use a wedge welder. At the sheet overlap, the extrusion welder integrates molten polyethylene onto the prepared geomembrane seam to create a permanent weld. The result is a continuous connection of the adjacent panels through the seam. The extruded welding material is manufactured from the same resin as in the geomembrane itself and therefore exhibits the same chemical resistance and physical properties.

An extruder with a screw of 20 mm diameter and an effective length / diameter ratio (L/D) of 9:1 is driven by a commercially available electric drill.

A high pressure blower provides cooling air for the feedzone. The preheated air passes through a hearing cartridge, to be brought to the correct temperature in order to pre-heat the surface of the base material in the immediate weld area to the required welding temperature.

The heating collar of the extruder cylinder (barrel) provides the energy required to plasticize the material at start-up and during the extrusion process.

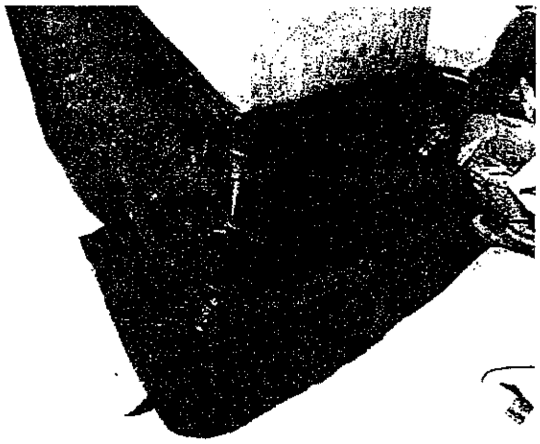
A welding die made of Telflon (PTFE) with the configuration of the finished weld seam guides the plasticized mass (extrudate) onto the pre-heated based material (sheet). The required press on is provided by the hand welder's own weight.

The weld speed is achieved by the repulsion effect of the specially designed welding die. A loop-shaped handles serves as a support rest, provides good handling, also allows vertical welding with two people.

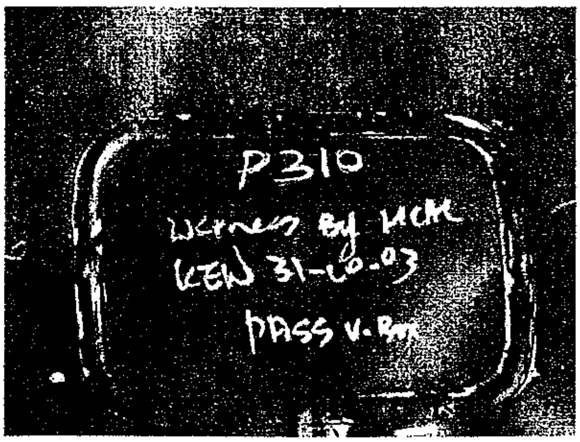
The area of the HDPE sheet, where the extrudate will make the initial contact, should be pre-heated with the hot air stream of the extruder pre-heater. This should be done with a slight pendulum-like movement, without contacting the sheet.

Extrusion Welding

Extrusion welding operation



Extrusion welding seam



Patch repair using extrusion welding

Wedge Welding

Wedge welding is the primary method for joining two adjacent, overlapped geomembranes.—The wedge welder creates a fusion weld by heating the facing overlapping surfaces and then pressing them together while in a molten state. The result is a permanent bond. The wedge welding method is fast and consistent. In addition, wedge welders produce a double-tract weld. Between these two weld tracts is an air channel which is used to non-destructively air pressure test the integrity the of seam.

Wedge welder utilizes an electrically heated 4 cm wide copper or polymer wedge, controlled by a programmable controller, with an audible off-temperature alarm and a variable speed drive unit which can operate between 0.3 to 5.0 meter/minute. The heated wedge passes between the overlapped edges of the liner and the overlap is about 100 mm. Two part of 4 cm (including a 1.2 cm gap in the middle of each roller) press the heated liner together and also provides propulsion for the machine. The welder can be configured in the field to operate on either 110 volt or 220 volt (at both 50 and 60 Hz) electrical current with only one component requiring replacement. The welder can operate properly with up to 60 m of electrical extension cord.

The wedge has two weld-contact with a machined-out space, 1.2 cm in the middle. This creates a double weld with an air space between the welds. This air space is subsequently used to air pressure test the seam in a non-destructive manner.

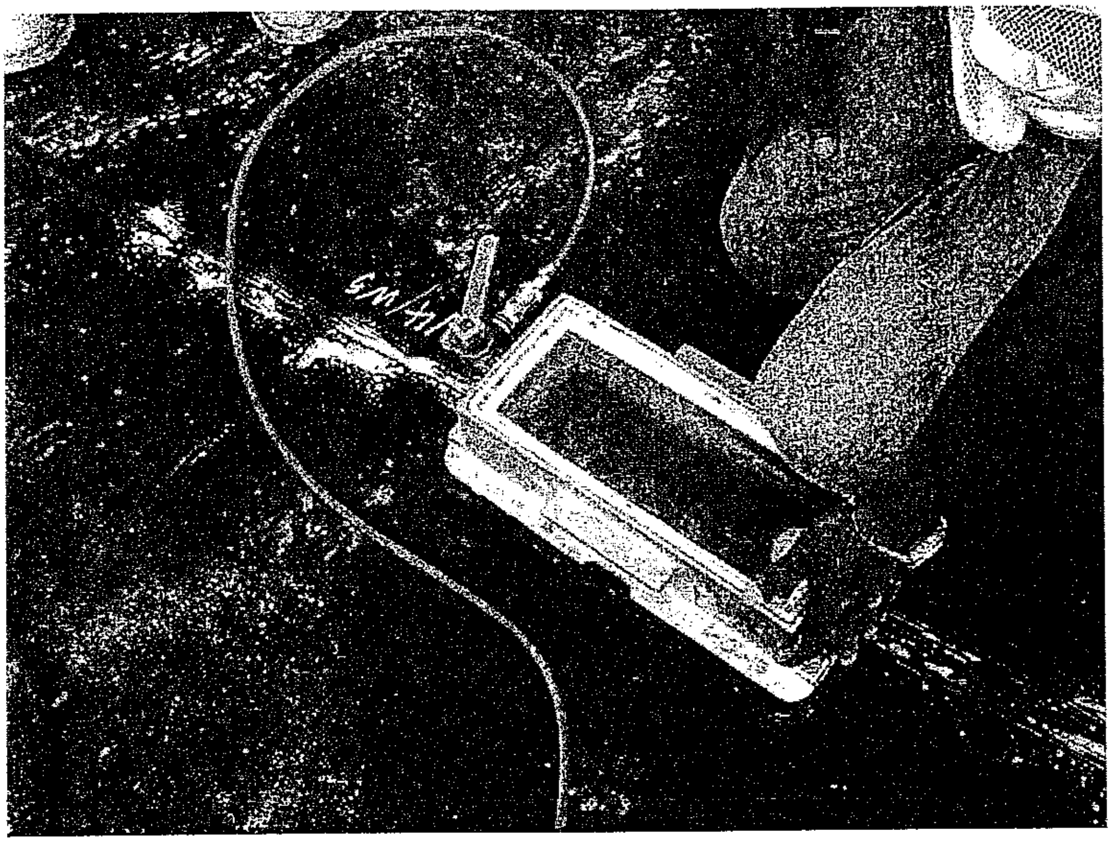
Waterproofing Installation

Penny Bay – Artificial Lake
Disney Hong Kong

Wedge Welding

Waterproofing Installation

Penny Bay – Artificial Lake
Disney Hong Kong



Vacuum Box Test

Waterproofing Installation

Contract HCC300&HCC302
KCRC East Rail Extensions

Air Pressure Test

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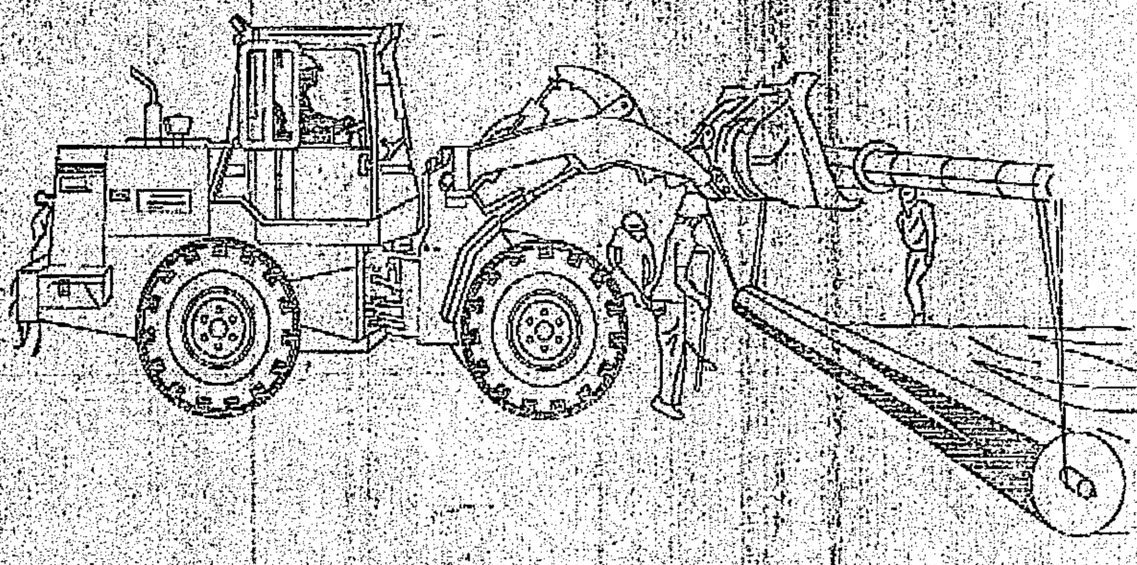
Qualification and Certification

GSE Lining Technology, Inc.

1996

GSE Agent



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Valid through December 31, 2005

John K. Robinson
President, IAGI

Laurie Honnigford
Managing Director, IAGI

Project Reference

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Geomembrane Supply / Installation

Date	Project	Client	Consultant	Application
Mar-86	Toxic & Hazard~~ous~~ Waste Disposal Project	Hong Kong Environmental Protection Agency	Hong Kong Government	Experimental waste tip
Jun-86	Gas Production Plant GP II Naphtha Tank Farm Lining	The Hong Kong & China Gas Company Ltd	-	Tank lining
Feb-89	Junk Bay Landfill Stage II, Phase II	Civil Engineering Services Department	Civil Engineering Department	Landfill lining
Feb-91	Junk Bay Landfill Stage II, Phase II, Expansion Project	Civil Engineering Services Department	Civil Engineering Department	Landfill lining
Dec-92	CV/89/16 Shuen Wan Landfill Contract H	China Harbour Engineering Company	Civil Engineering Department	Sanitary landfill lining
Oct-93	Penfold Garden Shatin	The Royal Hong Kong Jockey Club	Client	Pond lining
Dec-93	CV/91/06 Tseung Kwan O Landfill Stage III	China Harbour Engineering Company	Civil Engineering Department	Leachate collection trench lining
Jan-94	West New Territories Landfill	Swire BFI Waste Services Limited	Binnie & Partners Ltd	Sanitary landfill waste lagoon
May-94	CV/93/10 Gin Drinker's Bay Landfill Restoration Advance Works	Hong Kong & Macau Scent On Engineering Ltd	Civil Engineering Department	Leachate trench protection
Aug-94	Black Point Power Station	China Light & Power Ltd	Maunsell Geotechnical Services Ltd	Leak detection lining
Sep-94	Chinese Permanent Cemetery Yau Tong Service Reservoir	Hsin Chong Construction Ltd	Maunsell Geotechnical Services Ltd Ng Chun Man & Associates	Reservoir lining
Nov-94	CV/92/07 Shuen Wan Landfill Contract J	China Harbour Engineering Company	Civil Engineering Department	Sanitary landfill waste lagoon
Nov-94	CRC Oil Terminal Tsing Yi Depot Phase I&II	China Resources Petroleum & Chemical Company Limited	JGC Corporation	Leak detection lining

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Mar-95	MTRC 509 Kwai Chung Park Viaduct	r,c	GTM-Wan Hin-CEF JV Roundel Co Ltd	Babtie Oakervee MTR Corporation	Pile protection lining T-grip
Apr-95	MTRC 509 Kwai Chung Park Viaduct	r,c	GTM-Wan Hin-CEF JV China Harbour Engineering Company Pacific Island Engineering Ltd	Babtie Oakervee MTR Corporation	Waste containment capping
Aug-95	Shuen Wan Landfill		Wai Lung Engineering Co Ltd	Civil Engineering Department	Structure Waterproofing
Sep-95	Fuel Oil Tank Foundation at Tap Shek Kok		Shun Yip Construction Co Ltd	China Light & Power Ltd	Leak detection liner
Dec-95	Contract 401 Chek Lap Kok Airport Airfield works	r	Airfield Works JV	Provisional Airport Authority	Water lagoon supplying pugmill
Jan-96	CV/93/06 Pillar Point Valley Landfill Contract F	r	Sang Hing Civil Contractors Co Ltd	Civil Engineering Department	Landfill leachate trench
Oct-96	CRC Oil Terminal Tsing Yi Depot Phase III	r	Pollard Construction Ltd	JGC Corporation	Leak detection lining
Mar-97	Wong's Circuits (PTH) Ltd Factory at Tseung Kwan O, TL39	r	Chinney Construction Ltd	Esteem Design Ltd EHS Consultants Ltd	Landfill gas barrier
Mar-97	Reconstruction of Pond at Driving Range Clearwater Bay Golf & Country Club	r	Concord Rise Construction Co Ltd	BMMK Ratcliffe, Hoare & Co Ltd	Pond lining
Apr-97	MTRC 501A Central Subway	r*	Kier - SFK Joint Venture	MTR Corporation	Tunnel lining T-grip
May-97	EP/SP/10/91 SENT Landfill Tseung Kwan O	r	Green Valley Landfill Ltd	Rust Asia Pacific Ltd	Temporary leachate lagoon lining
Jul-97	EP/SP/27/95 Shuen Wan Landfill Restoration	r*	Hong Kong Landfill Restoration Group Ltd	Babtie BMT Golder & Associates	Landfill capping
Jan-98	Seawall & Reclamation for Proposed Residential Development at Areas 50 & 51, Tseung Kwan O	r	Geoworks Equipment Co Ltd	Maunsell Geotechnical Services Ltd EHS Consultants Ltd	Landfill gas barrier

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Feb-98	EP/SP/28/95 Ma Yau Tong West Landfill Restoration	r	Hong Kong Landfill Restoration Group Ltd	Babtie BMT Golder & Associates	Landfill capping
Feb-98	Tin Shui Wai Development	r	Yick Hing Construction Company	Binnie & Partners Ltd	Infiltration tank waterproofing
Feb-98	Concrete Batching Plant Tseung Kwan O		Edwin Lai & Co Ltd	-	Foundation waterproofing
Mar-98	EP/SP/29/95 Tseung Kwan O Landfill Restoration	r	Chun Wo Construction & Engineering Co Ltd Swire BFI Waste Services Limited	Binnie Consultant Ltd Mouchel Asia Limited	Landfill capping
May-98	Shuen Lee Tsuen Recreation Ground	r	Architectural Services Department	Taoho Design Architects	Gas barrier
May-98	Proposed Development at Ngau Chi Wan NKIL6217	r	Sun Hung Kai Properties Group	Kwan & Associates Architect Ltd EHS Consultants Ltd	Gas barrier
Jun-98	Proposed Development at Tseung Kwan O Area 50 & 51	r	Sun Hung Kai Properties Group	LCT Associates EHS Consultants Ltd	Gas barrier
Jul-98	Reconstruction of Pond No. 4 Clearwater Bay Golf Course	r	Concord Rise Construction Co Ltd	P Y Leung & Associates Ltd	Pond waterproofing
Sep-98	Meizhou Wan Power Station, Fujian, PRC	r	Fujian Pacific Electric Co Ltd	Bechtel Overseas Corporation	Raw water pond & oil fuel tank
Oct-98	Fairview Park Mini Golf		Mr Bruce Derek	-	Golf ground
Dec-98	Chevron China Polystyrene Project, Zhangjiagang, Shanghai	r	Chevron Chemical (Zhangjiagang) Co Ltd	Fluor Daniel PRC Ltd	Tank leakage detection system
Jul-99	Relining to Pond Adjacent to 10 Hole New Course	r	Hong Kong Golf Club	-	Pond waterproofing
Jul-00	MTRC612 Eastern Harbour Crossing / Lam Tin Tunnels	r*	Gammon-CHEC Joint Venture Wah Keung - Man Chuen Joint Venture	Hyder Consulting Ltd	Tunnel lining
Nov-00	CWB G&CC: Structural Repair to 11 pond	*	Kwan On Construction Co. Ltd.	BMMK Ratcliffe, Hoare & Co Ltd	Pond lining
Jan-01	Motorola Factory, Tai Po Industrial Estate	r	May's Construction Limited	EHS Consultants Ltd	Gas Barrier

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Mar-01	Clearwater Bay Golf & Country Club	r*	Univic Engineering Ltd	BMMK Ratcliffe, Hoare & Co Ltd	Pond lining
May-01	Water Feature and Rockscape Works at Discovery Bay North Areas N1F and N1G and The Central Park		Artscapes D. Brumit & Associates (HK) Ltd	CYS Associates (HK) Ltd	Pond lining
Sep-01	7/WSD/96 Butterfly Valley Primary Service Reservoir	r*	Gammon Construction Ltd	Binnie Consultants Limited	Waterproofing
Jan-02	Contract HCC300 & HCC302 KCRC East Rail Extensions	r*	Stress (Far East) Limited	Ove Arup & Partner	Tunnel Waterproofing
Apr-02	DC/99/10 Outlying Islands Sewerage - Stage 1 Phase 1C Upgrading of Siu Ho Wan Sewage Treatment Plant - Civil Works	*	China State Construction Engrg (Hong Kong) Ltd	Maunsell Consultants Asia Ltd	Studliner concrete protection
Apr-02	Clearwater Bay Golf & Country Club		The Clearwater Bay Golf & Country Club	BMMK Ratcliffe, Hoare & Co Ltd	Pond lining
Jul-02	FL/26/01 River Training for Upper Indus - Completion of the Remaining Works between Man Kam to Road and KCRC Bridges	r	Sun Fook Kong (Civil) Ltd	Maunsell Consultants Asia Ltd	Waterproofing barrier
Sep-02	FL/27/02 Completion of the Remaining River Training Works for Upper River Indus between Man Kam To Road and San Wai	r*	Bilfinger Berger AG	Maunsell Consultants Asia Ltd	Filter barrier
Oct-02	CV/2001/10 Infrastructure for Penny's Bay Development, Contract 2	r	Leighton Contractors (Asia) Ltd China State Construction Engrg. (Hong Kong) Ltd	Civil Engineering Department	Temporary water storage Biopile base liner Protection to historical relics
Dec-02	EP/SP/28/95 Jordan Valley Landfill Restoration		Hong Kong Landfill Restoration Group	Environmental Protection Department	Sewage tank liner repair
Jan-03	KTIL 750 Development 416-424 Kwun Tong Road	r	Yee Fai Construction Co Ltd	Allied Environmental Consultants Ltd	Contamination containment

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Jan-03	DC/96/04 Sham Tseng Sewage Pumping Station Sewage Treatment Works & Submarine Outfall		Tai Shing Engineering Ltd	Mott Connell Ltd	Structure separation layer
Jan-03	KCRC Contract CC-610 West Rail Habitat Compensation	r*	Surtech Engineering Development Ltd	Kowloon-Canton Railway Corp	Wetland creation
Mar-03	11/WSD/01 Water Supply to South East Kowloon Development, Stage 1 Construction of Diamond Hill No. 2 Fresh Water Service Reservoir and Laying of Fresh Water and Salt Water Mains	*	Nishimatsu Construction Co Ltd	Hyder Consulting Ltc	Structure separation layer
Apr-03	Braemar Hill Mansion		Yan Kee Construction Co Ltd Chuen Kee Construction Co Ltd	Mouchel Asia Ltd	Tank lining waterproofing
Jul-03	CV/2000/09 Infrastructure for Penny's Bay Development, Contract I	r*	China State Construction Engrg. Corporation	Maunsell Consultants Asia Ltd	Water recreation waterproofing
Sep-03	Hong Kong Disneyland Resort - Disney's Hollywood Hotel		Sun Fook Kong Construction Limited	HK International Theme Park Ltd	Foundation waterproofing
Dec-03	HK/10/2000 Northern Access Road for Cyberport Development at Telegraph Bay		China Harbour Engineering Co (Group)	Babtie Asia Ltd	Water barrier to reinforced wall
Aug-04	NWNT Landfills & Gin Drinkers Bay Landfill Restoration		Swire Sita Waste Services Ltd		Repair storage treatment plant
Mar-05	HY/2003/19 Improvement to Tung Chung Road between Lung Tseng Tau and Cheung Sha		Yuk Shing Engineering Co Ltd	Mott Connell Ltd	temporary water collection system
Mar-05	DC/2001/09 Construction of the San Tin Eastern Main Drainage Channel	*	Hsin Chong Construction Co Ltd	Drainage Services Department	storage pond
May-05	P337 Skypier People Mover Tunnel Works	r*	Chun Wo - Fujita JV Sheung Moon Construction Ltd	Airport Authority Hong Kong	Waterproofing

G AND E COMPANY LIMITED

G & E ENGINEERING

Rm. B, 13/F Cheung Lee Ind. Bldg.
9 Cheung Lee Street
Chai Wan, Hong Kong
Tel: 2508 0058 / 2570 0103 Fax: 2570 0089

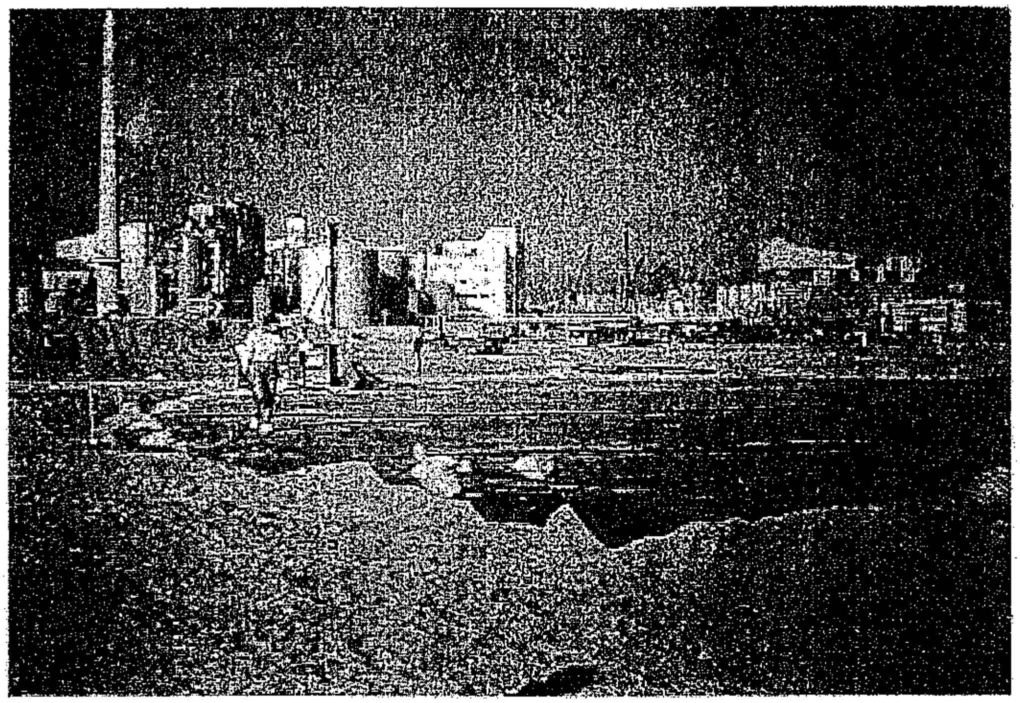
Jul-05	EP/SP/12/92 North East New Territories (NENT) Landfill	Rankine Engineering Co.Ltd	Halcrow China Ltd	Ground cover
Aug-05	Vaccum preloading field test set up	Ocean East Engineering (Macau) Ltd	The University of Hong Kong	Air tightness application
Sep-05	Colombo, Sri Lanka	China Geo-Engineering Corporation		Seperation layer
Sep-05	Cleaning of Sediments on Bottom of Lakes, Penfold Park, STRC	Tri Build Masonry & Engineering Ltd	Hong Kong Jockey Club	Waterproofing
ov-05	P313 West Quay AFS Upgrading Works	Kier Hong Kong Limited	Airport Authority Hong Kong	Contamination seperation
Dec-05	SS N314 The Construction of a Secondary in Area 50, Tseung Kwan O, NT	Maeda Corporation	Architectural Services Department	Gas membrane
Jan-06	KL 39/03 South East Kowloon Development Site Preparation and Drainage Works at North Apron Area of Kai Tak Airport	Kin Shing Construction Co Ltd	Ove Arup & Partner	Biopile system for contaminated soil
Jan-06	Clearwater Bay Golf & Country Club - Highland Pond 4 Reconstruction Work	Environmental Seal Corporation Limited	Thomson Perrett	Pond Lining
eb-06	KDB200 - West Kowloon Station and Tunnels Jordan Road to ETS Station	Link 200 Joint Venture	Maunsell Consultants Asia Ltd	Temporary storage of contaminats

Feb 28, 2006

Photo Reference

G AND E COMPANY LIMITED

Unit 6, 17th Floor, Technology Plaza,
651 King's Road, North Point, Hong Kong
Tel. 2508 0028 / 25700103 Fax: 2570 0089

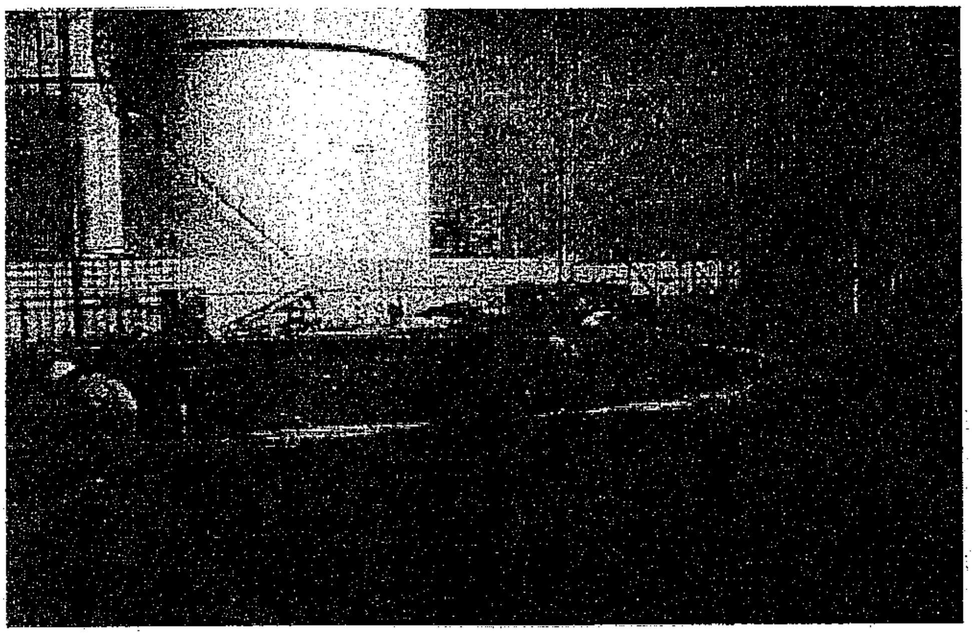


Date	October, 1994
Project	CRC Oil Terminal
Client	China Resources Petrochems (Group) Co Ltd
Consultant	JGC Corporation
Main Contractor	Shimizu Corporation
Works	Leakage detection lining system
Size	18,000 sqm

G AND E COMPANY LIMITED

G & E ENGINEERING

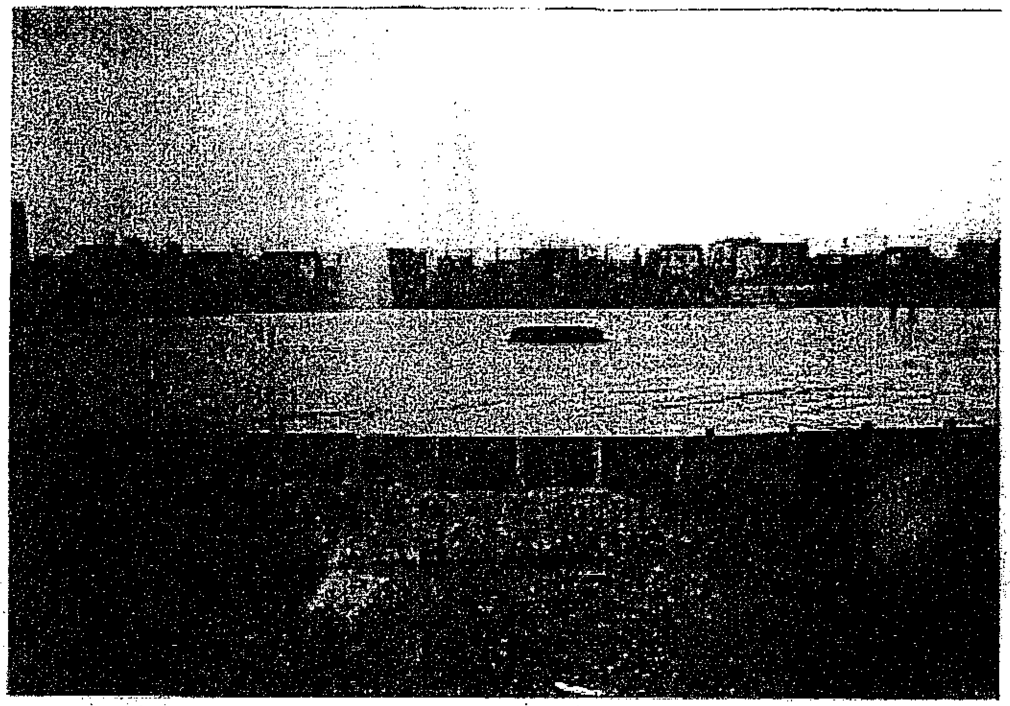
Rm. 8, 13/F. Cheung Lee Ind. Bldg.
9 Cheung Lee Street
Chai Wan, Hong Kong
Tel: 2508 0028 / 2570 0103 Fax: 2570 0089



Date	October, 1996
Project	CRC South Oil Terminal
Client	China Resources Petrochems (Group) Co. Ltd.
Consultant	JGC Corporation
Main Contractor	Pollard Construction Co. Ltd.
Works	Leakage detection lining system
Size	2,000 sqm

G AND E COMPANY LIMITED

G & E ENGINEERING
Unit 5, 17th Floor, Technology Plaza,
651 King's Road, North Point, Hong Kong
Tel: 2508 0028 / 25700103   Fax. 2570 0689

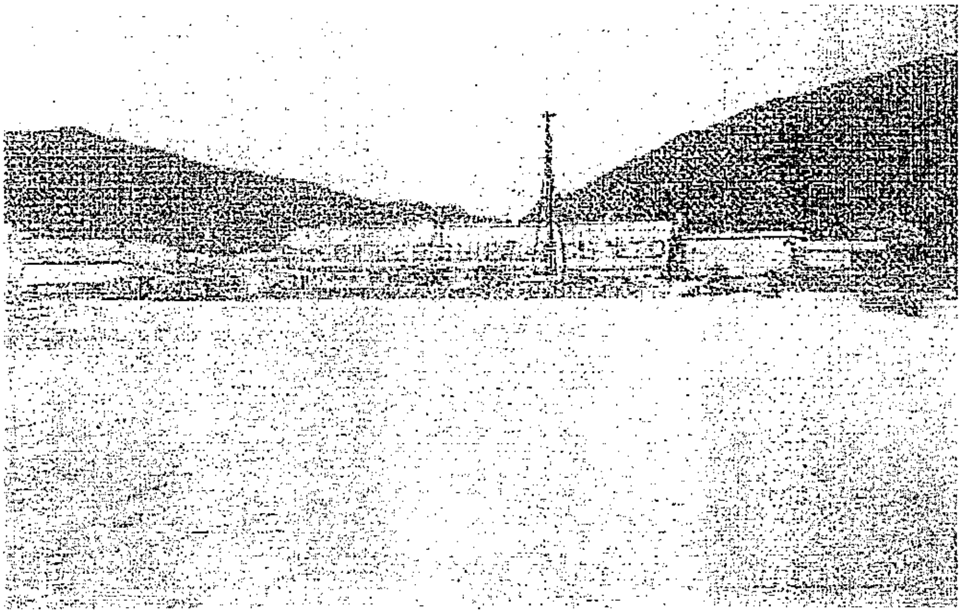


Date	February 1999
Project	Chevron PS Project, Shanghai, PRC
Client	Chevron Chemical (Zhangjiagang) Co Ltd
Consultant	Fluor Daniel PRC Ltd
Works	Tank liner and leak detection sump
Size	2,000 sqm
Materials	2.5 mm thick HDPE geomembrane and HDPE sump & observation well

G AND E COMPANY LIMITED

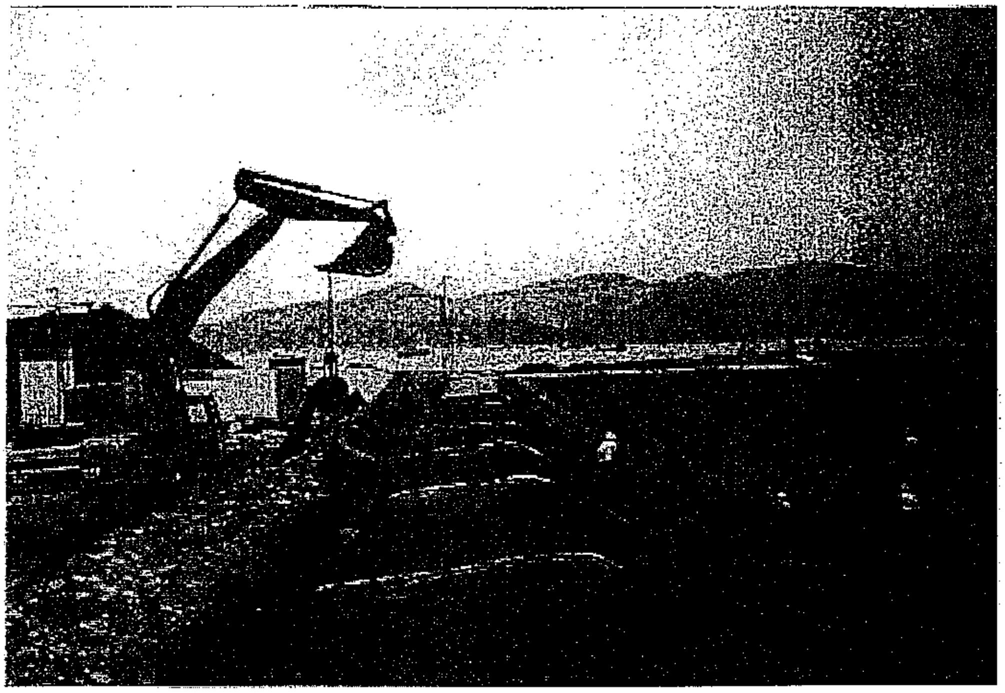
G & E ENGINEERING

Flat C, 3/F., Tung Kin Fty. Bldg.,
196-198 Tsat Tsz Mui Road,
North Point, Hong Kong.
Tel: 2508 0028 / 2570 0103 Fax: 2570 0089



Date	October 2002
Project	Contract No. CV/2001/10 Penny Bay Contract II
Client	Civil Engineering Department
Consultant	Maunsell Environmental Management Consultants Ltd
Main Contractor	Leighton Contractors (Asia) Ltd China State Construction Engrg. Corp
Works	Temporary Storage Tank Lining

G AND E COMPANY LIMITED
Unit 6, 17th Floor, Technology Plaza,
651 King's Road, North Point, Hong Kong
Tel 2508 0028 / 25700103 Fax. 2570 0089

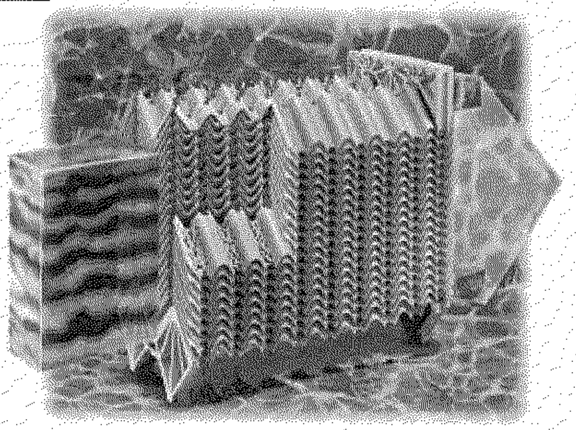


Date	June, 1997
Project	SENT Landfill
Client	Environmental Protection Department
Consultant	Rust Asia Pacific Limited
Main Contractor	Green Valley Landfill, Ltd
Works	Leachate lagoon lining system
Size	5,000 sqm

Coalescing Plates

MPak® Coalescing Plates

Description



Facet's new high-performance MPak® coalescing plates provide superior performance in real-world environmental clean-up.

Facet's patented MPak® coalescing plates are designed to separate oil and solids from water using the differences in their specific gravities. They are provided with integral moldings that ensure the spacings are accurately controlled while at the same time promoting the transfer of solids to the bottom of the installation.

The plates can be assembled into packs which are securely held together by molded polypropylene supports with either stainless steel wires or rods. The pack modules are designed to be supported in such a way as to provide integral sumps for solids retention. This construction makes them eminently suitable for use in retrofit as well as new applications.

Features

- Performance guarantee - reduces oil contamination to limits as low as 5 ppm
- Most efficient oil removal available
- Virtually self-cleaning — solids fall to the bottom, oil weeps to the top
- Modular construction — retrofits existing API separators and tanks
- New support system — allows access for solids removal
- 1/4", 1/2" and 3/4" spacing — most efficient oil removal available
- Computer sizing — guarantees effluent quality

Standard Design Features

- pH range from 2 to 12
- Oleophilic material
- Surface area per 2 ft^3: 186 ft^2 (0.056 m^3: 17.27 m^2) is greater than any competitor
- Choice of spacing available using the same plate design.

Applications

Facet's MPak® coalescing plates have hundreds of environmental applications, including:

- Rainwater run-off clean-up
- Maintenance washdown clean-up
- Heavy equipment and transportation washdown facilities
- Groundwater remediation clean-up
- Machine tool coolant recovery
- Manufacturing facility effluent water
- Oil refinery/storage terminal effluent water
- Offshore and onshore oil production facilities
- Marine applications
- General industry

Top

BY HAND
17 MAY 2007

LEIGHTON
禮頓

Leighton Contractors (Asia) Limited

39/F Sun Hung Kai Centre
30 Harbour Road
Hong Kong
t: +852 2823 1111
f: +852 2529 8784
e: info@leightonasia.com

www.leightonasia.com

Site Tel: 2404 8900
Site Fax: 2404 0081

By Hand

Our Ref: H2104/C22/5156/BG/SKT/EC/pl

16 May 2007

5156

H2104	File: C22
Action:	/
Circulation:	Y / N
Copies:	/
Date:	17 MAY 2007
Response To:	
Keys:	MAT / OK
* = Without Attachments	

Scott Wilson Limited
(Site Office)
Lung Hong Street
Lung Mun Road
Tuen Mun Area 38
Tap Shek Kok
New Territories

Attn: Mr. Michael Kay

Dear Sir,

PERMANENT AVIATION FUEL FACILITY
MATERIAL SUBMISSION – FILTER SS SEPARATOR PACKS FOR OIL INTERCEPTOR

Please find attached the datasheet and shop drawing for the proposed filter separator packs of the oil interceptor for your acceptance.

Yours faithfully
LEIGHTON CONTRACTORS (ASIA) LIMITED

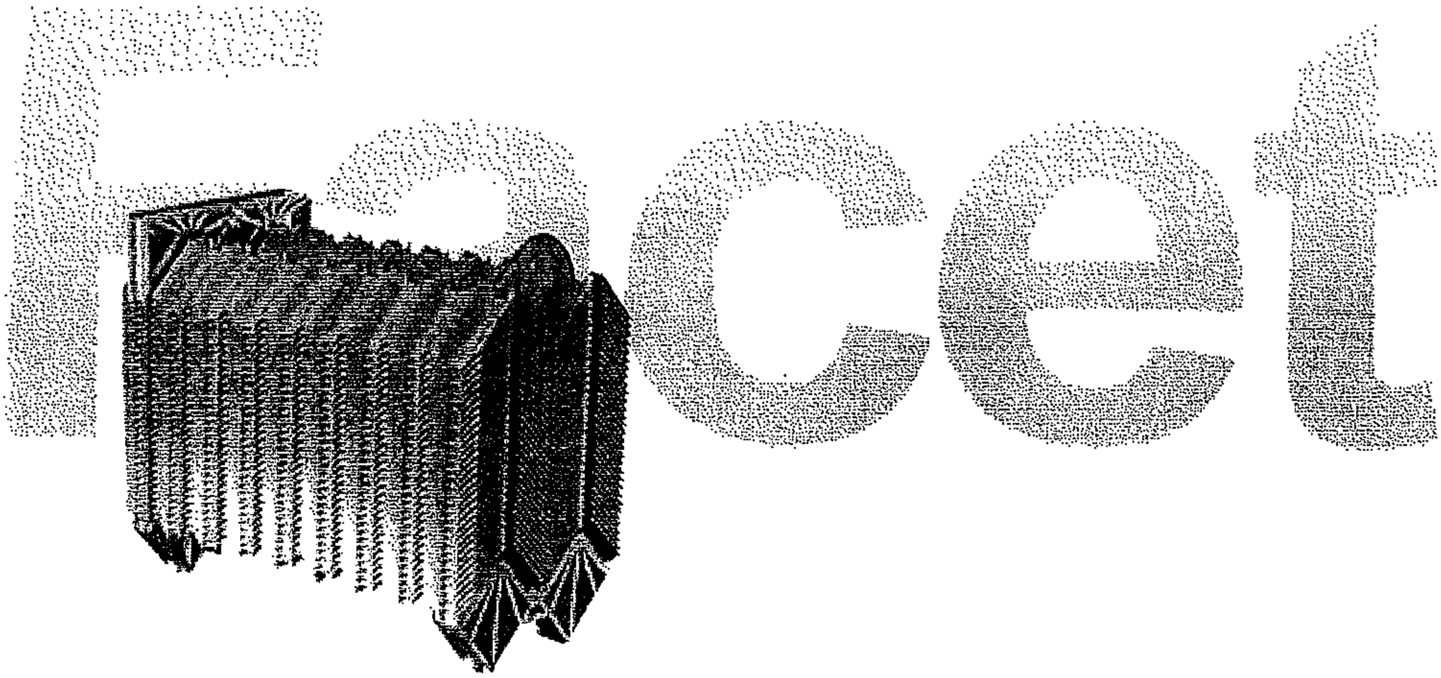
BRIAN GILLON
PROJECT DIRECTOR

Encl. – 1. Datasheet (A4 x 1 sheet)
2. Part print of Drawing No. PAFF/BA/02/DWG/C/1453 Rev. 1 (A4 x 1 sheet)
3. Facet Drawing No. F7700 Rev. C (A3 x 1 sheet)

c.c. ECO – Mr. Tommy Siu (w/encl.) **(By Hand)**
Jacobs China – Mr. Leslie Swann (w/encl.) **(By Hand)**

bcc: DL, EC (w/encl.)

MPak® Coalescing Plates



Facet's High-Performance MPAK Coalescing Plates Provide Superior Performance In Real-World Environmental Clean-Up

Facet's patented MPak coalescing plates are designed to separate oil and solids from water using the differences in their specific gravities. As the oil/water/solids mixture travels through the plates, oil rises to the top and solids drop to the bottom through dedicated surfaces and weep holes. Plate supports at the bottom allow for easy removal of the solids that collect beneath the plates. And, because of the steep angles and short travel distances, oils and solids are quickly released, making the media virtually self-cleaning.

Applications

Facet's MPak coalescing plates have hundreds of environmental applications, including:

- Rainwater run-off clean up
- Maintenance washdown clean-up
- Heavy equipment and transportation washdown facilities
- Groundwater remediation clean-up
- Machine tool coolant recovery
- Manufacturing facility effluent water
- Oil refinery/storage terminal effluent water
- Offshore and onshore oil production facilities
- Marine applications
- General industry

Features

- Performance guarantee—reduces oil contamination to limits as low as 10ppm
- Most efficient oil removal available
- Virtually self-cleaning—solids fall to the bottom oil rises to the top
- Modular construction—retrofits existing API separators and tanks
- Support system—allows access for solids removal
- 1/4", 1/2" and 3/4" (6.25, 12.5 and 19.1 mm) nominal spacing—most efficient oil removable available
- Computer sizing—The "MPak Quality Prediction Program" provides a written ***guarantee*** of your effluent quality based on influent conditions.

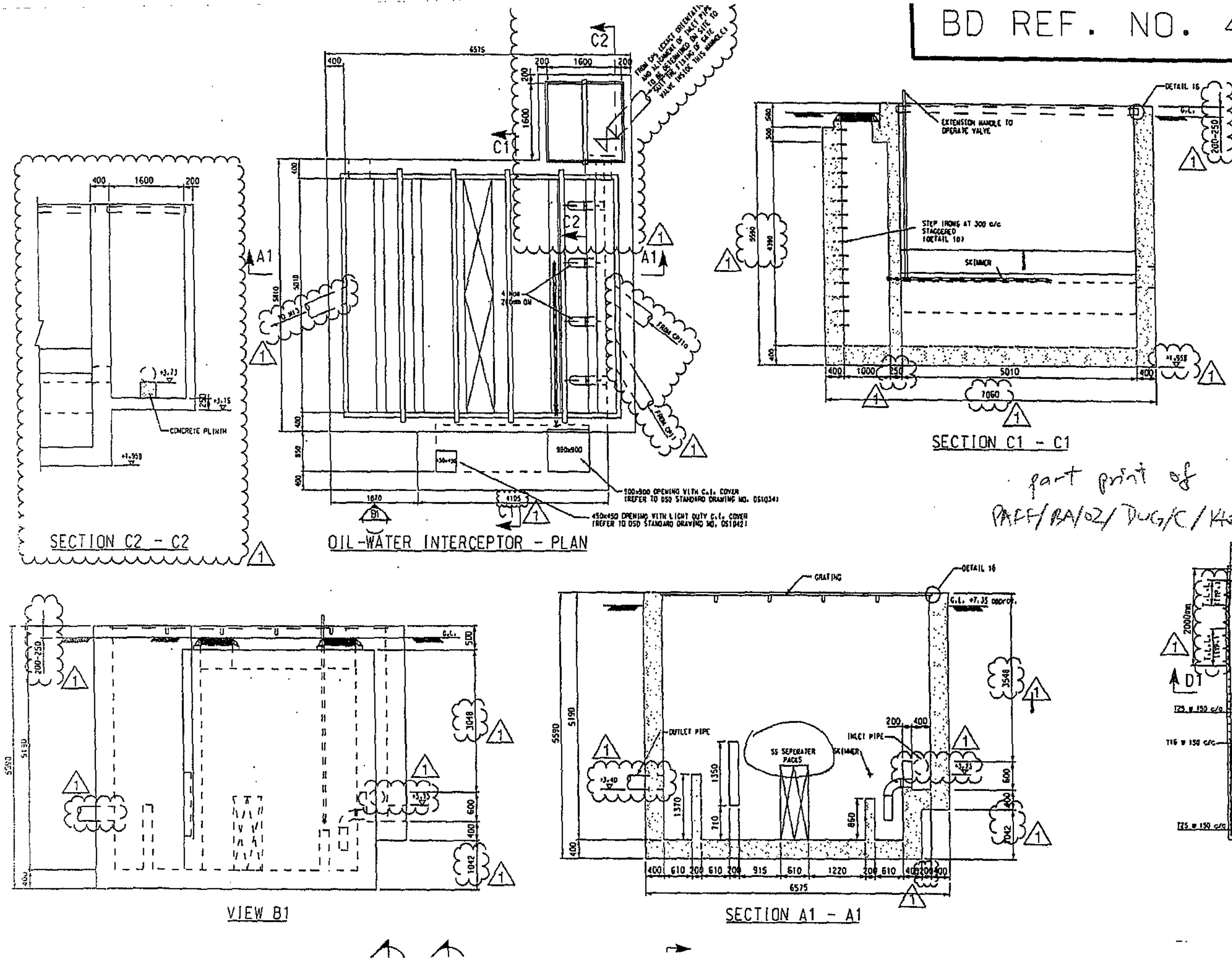
Standard Design Features

- Operating temperature 40°F to 180°F (4.4°C to 82.2°C)
  Formulations available to 300°F (150°C).
- pH range from 2 to 12
- Oleophilic material
- Surface area per 2 ft^3 (0.056 m^3):
  1/4" (6.25 mm) nominal—210 ft^2 (19.51 m^2)
  1/2" (12.5 mm) nominal—120 ft^2 (13.01 m^2)
  3/4" (19.1 mm) nominal—84 ft^2 (7.80 m^2)
  Greater coalescing surface area than any competitor
- Choice of spacing available using the same plate design

Facet International
a CLARCOR company

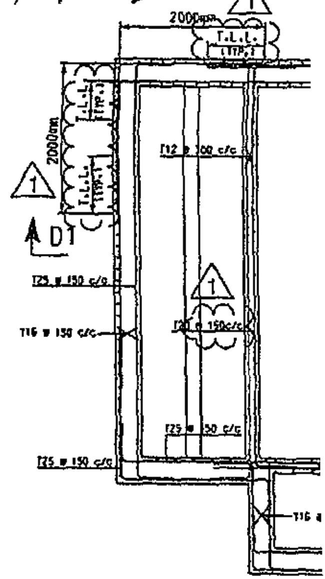
F005701

BD REF. NO. 4/000

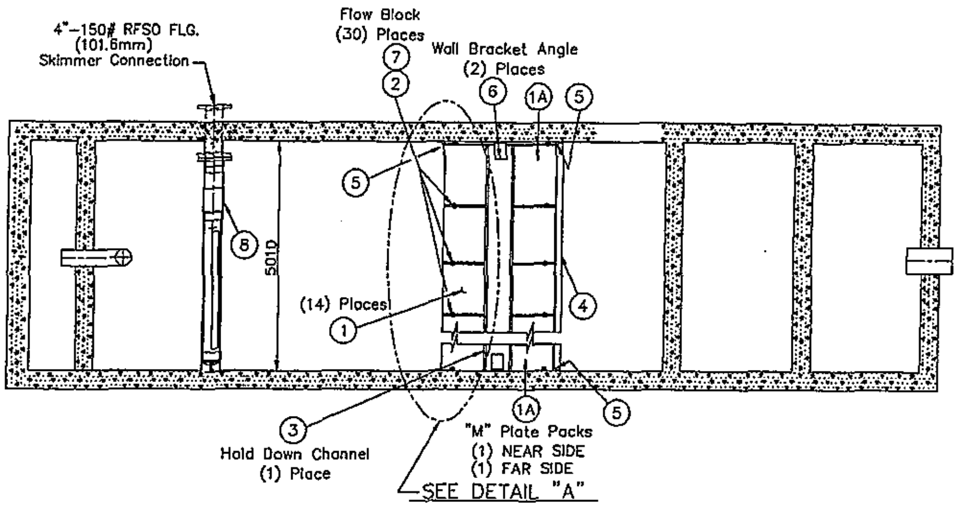


NOTES FOR OIL-WA

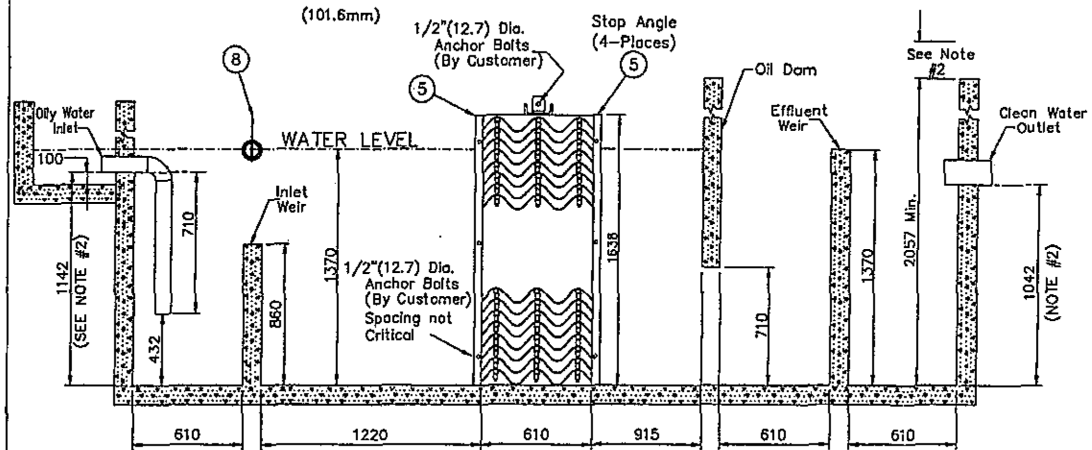
1. FOR GENERAL NOTES.
2. THE CONTRACTOR SHAL DIMENSIONS IN ADVAN TO THE PROJECT MANA
3. ALL WORK SHALL BE C BUILDING AND CONSTR
4. ALL CONCRETE WORK S REGULATION 1990 AND BS8110 & BS8007.
5. CONCRETE STRENGTH C
6. COVER: NOMINAL COVE
7. REINFORCEMENT IS TO STRESS=460N/mm FOR STRESS=425N/mm FOR
8. WELDING OF REINFORC OF THE ARCHITECT.
9. UNLESS NOTED OTHERW SHALL BE 460.
10. ALL ARISES SHALL H
11. MINIMUM BEARING CA



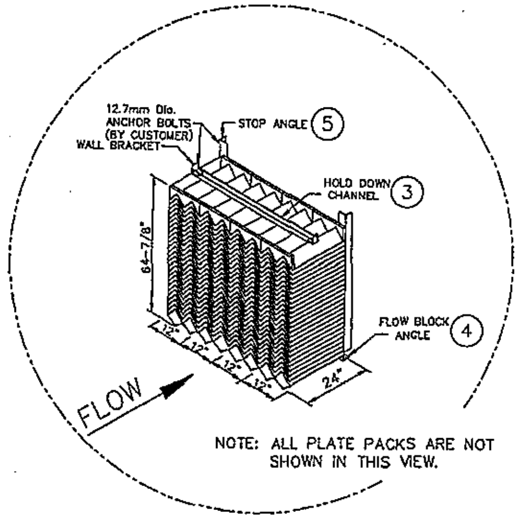
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROV.
	A	REVISED PER CUSTOMER APPROVAL	10/17/06	MW
	B	REVISED PER CUSTOMER APPROVAL	1/23/07	MW
	C	REVISED PER CUSTOMER APPROVAL	4/24/07	MW



TOP VIEW OF VAULT



SIDE VIEW OF VAULT



DETAIL "A"

NOTES:

1. ITEMS NORMALLY FURNISHED BY FACET INTERNATIONAL INCLUDE FIBERGLASS ANGLE, CHANNEL AND CLIPS AS WELL AS PVC SPACERS AND PLATE PACK ASSEMBLIES.
2. PIT EXTENSION SHOULD BE ADDED TO HEIGHT DIM. TO ADJUST FOR LOCAL CONDITIONS SUCH AS POSITION (DEPTH) OF INLET & OUTLET PIPING. INLET ELEV. HEIGHT GENERALLY SHOULD BE AT OR ABOVE WATER LEVEL, HOWEVER; THE KEY FACTOR IS HAVING AT LEAST A TWO FOOT HEAD OF WATER AT THE INLET NOZZLE.
3. CONCRETE THK. TO BE DESIGNED BY CUST., CONSULTING ENGINEER, AND/OR CONTRACTOR. PROPER REINFORCING MUST BE PROVIDED.
4. OIL REMOVAL SYSTEM INCLUDING SEPARATOR MONITORING SYSTEM NOT SHOWN OR PROVIDED WITH THIS UNIT.
5. DIMENSIONS IN (xxx) ARE IN MILIMETERS.
6. USE EITHER FLOW BLOCKS ITEM #2 OR #7 OR A COMBINATION TO MAKE UP PACKS TIGHT IN VAULT. TWO SIZES PROVIDED TO ACCOUNT FOR VARIATIONS IN VAULT WIDTH.
7. COVER BY CUSTOMER (NOT SHOWN).

ITEM No.	QTY	DESCRIPTION	MATERIAL PART/ DWG No.
10	30	Flow Block 1/2"(12.7) Dia. Sch.80 x 71"(1803.4) Lg. Bevel One End 15°	PVC Pipe
9	1	Cleaning Wand Assembly	6051764
8	1	Rotary Skimmer Assembly 4"(101.6) Per Drawing	B6052145
7	30	Flow Block 1/2"(12.7) Dia. Sch.80 x 71"(1803.4) Lg. Bevel One End 15°	PVC Pipe
6	2	Wall Bracket Angle 4" x 4" x 1/4" Thk.(101.6 x 101.6 x 6.35) Cut To 4"(101.6) Length	Fiberglass
5	4	Stop Angle 4" x 4" x 1/4" Thk.(101.6 x 101.6 x 6.35) Cut To 64-1/2"(1638.3) Length	Fiberglass
4	1	Flow Block Angle 3" x 3" x 1/4" Thk.(76.2 x 76.2 x 6.35) Cut To 197"(5003.8) Length	Fiberglass
3	1	Hold Down Channel 6" x 1-5/8" (152.4 x 41.3) Cut To 197"(5003.8) Length	Fiberglass
2	30	Flow Block 3/8"(9.5) Dia. Sch.80 x 71"(1803.4) Lg. Bevel One End 15°	PVC Pipe
1A	2	"M" Plate Packs 1/2"(12.7) Sp. x 57"(1447.8) Ht. W/ Tygon & w/ Top And Bottom Supports Per Drawing	C6051984
1	14	"M" Plate Packs 1/2"(12.7) Sp. x 57"(1447.8) Ht. No Tygon w/ Top And Bottom Supports Per Drawing	C6051985

Bill Of Material

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND TOLERANCES ARE AS FOLLOWS: .XX=±.03, .XXX=±.010, ANGLES = ±1° FRACTIONAL = ±1/8" FAB. VESSELS PER DWG.#695958 IAW FWI-74-01-1

SIGNATURES	MO	DAY	YR
DRAWN Boehler	6	26	06
CHECKED BY CB	6	26	06
APPROVED			

MATERIAL–

Facet

RETRO-FIT KIT
INSTALLATION FOR "M" PLATE PACKS

SIZE	FSCM NO.	DRAWING NUMBER	REV
C	87405	F7700	C

SCALE None — SHEET 1 of 1

Valves for Stormwater System

LEIGTON CONTRACTORS (ASIA) LIMITED
PERMANENT AVIATION FUEL FACILITY

MATERIAL SUBMISSION FORM

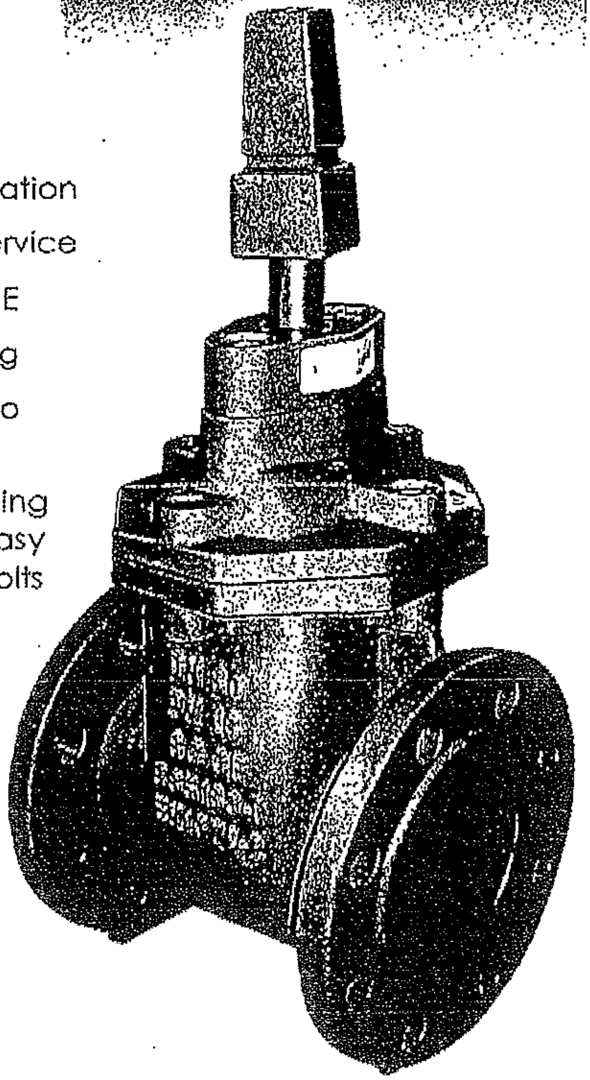
FROM : PROJECT MANAGER LEIGHTON CONTRACTORS ASIA LIMITED	TO : Michael Kay SCOTT WILSON	FILE REF: ____ SIGN : ____ DATE : ____

DOCUMENT TITLE	*N/R	DOCUMENT NO.	CONTRACTOR'S COMMENTS
A Material:			
i) Metal Seated Wedge Gate Valve (DN 300)	N	Enlc. Catatpgue Job Reference	
B Suppliers			
i) BIS Hua Wei Pipelines & Steel Structure Eng. Co.	N		
	N		
	N		
	N		
C Intended Location / Use	N		
i) Drainage system in Phase 1b	N		
	N		
	N		
	N		

* N = New submission R = Re-submission

Metal Seated Wedge Gate Valve

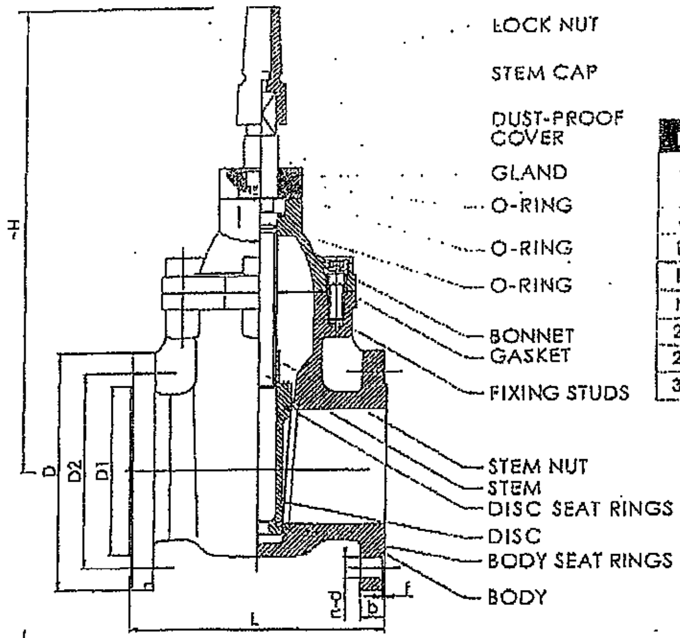
BS 5163-1&2
BS EN1074-1&2



* Stem Cap Operation
* Underground Service
* Clockwise CLOSE
* Life Long Sealing
* Epoxy Coating To BS6920
* Gland Bolt Housing arranged for easy removal of the bolts
* Service Areas:
  Waterworks
  Drainage
  Sewage
  Sea water
  Potable water
  Alkalies acids
  Dilute acids
  etc.

* Stem Cap:
  Shear device to prevent overtorque
* Body:
  Minimal height for strength and rigidity
* Seats:
  Hydraulically pressed into body
* Spindle:
  Non-rising type with strong square thread
* Flange Drilling:
  BS EN1092-2 PN16

SPECIFICATIONS



DN	L	H	D	D2	D1	n-d	b	f
50	178	326	165	125	98	4-19	19	3
65	190	364	185	145	118	4-19	19	3
80	203	386	200	160	132	8-19	19	3
100	229	420	220	180	156	8-19	19	3
125	254	490	250	210	182	8-19	19	3
150	267	517	285	240	211	8-23	19	3
200	292	604	340	295	266	12-23	20	3
250	330	705	405	355	319	12-28	22	3
300	356	785	460	410	370	12-28	24.5	4

All dimension in mm

BODY MARKING
DN___ PREMIER
SG CF *2007
PN16
BS5163-1
EN1074-2
*Year of manufacture.

COMPONENT	MATERIAL
BODY	SG CAST IRON BS EN1563-EN-GJS-500/7
BODY SEAT RINGS	COPPER ALLOY BS EN1982-CC491K
DISC	SG CAST IRON BS EN1563-EN-GJS-500/7
DISC SEAT RINGS	COPPER ALLOY BS EN1982-CC491K
STEM	STAINLESS STEEL BS970-431S29
STEM NUT	COPPER ALLOY BS EN1982-CC491K
FIXING STUDS	STAINLESS STEEL BS970-304
GASKET	EPDM or NBR BS EN681-1
BONNET	SG CAST IRON BS EN1563-EN-GJS-500/7
O-RING	EPDM or NBR BS EN681-1
GLAND	SG CAST IRON BS EN1563-EN-GJS-500/7
DUST-PROOF COVER	EPDM or NBR BS EN681-1
STEM CAP	CAST IRON BS EN1561-EN-GJL250
LOCK NUT	STAINLESS STEEL BS970-304

#Alternative materials available on request

TESTING

All valves are machine tested on each face to the nominal pressure and on the body to the test pressure in accordance with BS5163-1&2, BS EN1074-1&2, BS EN12266-1

Working Pressure	16 Bars
Body Test Pressure	25 Bars
Seat Test Pressure	17.6 Bars

PREMIER VALVES (Pty) Ltd.

Water Supplies Department
水務署

Replacement and Rehabilitation of Water Mains
Stage 1 Phase 2, Mains on Hong Kong Island

Engineer's Representative's Office
6/F Nan Dao Commercial Building
359-361 Queen's Road Central
Sheung Wan, Hong Kong
Tel: 2544 3620 Fax: 2890 9331

04 JUL 2007
LETTER IN
No. 00262

Our Ref. : (3/WSD/06)/M25/400/137
Your Ref. : CRBC/3WSD06/S200(06)/031

4 July 2007

By Fax : 8208 1339 & By Hand

REFERENCE ONLY

China Road and Bridge Corporation
Units 5110-12,
51/F, The Centre,
99 Queen's Road Central,
Hong Kong.

Attn.: Mr. W K Leung

Dear Mr. Leung,

Contract No. 3/WSD/06
Replacement and Rehabilitation of Water Mains, Stage 1 Phase 2
Mains along Connaught Road
Material Submission – Valves

We refer to the submission of "Premier" valve manufacture by "Tianjin Yinhe Valve Co., Ltd." and supplied by "BIS Hua Wei Pipelines & Steel Structure Engineering Co. Ltd." covered under your letters of 16 April 2007, 30 May 2007 and 14 June 2007.

Your proposal is in-principle acceptable for use of "Premier" valve in this Contract subjected to the compliance of Appendix 23.08 of Particular Specification and the satisfactory performance after installation. Prior to installation, you should submit to us independent inspection agent (IIA) reports to demonstrate that the stem cap complies with the minimum strength torque requirements as specified in Table B.1, Annex B of BS EN 1074-2:2000 and Clause 4.3 of BS 5163-2:2004 as stipulated in PS Appendix 23.08 Clause 5.2.3.

We also have no objection to your proposed "ETS-Testconsult Limited" as the IIA. In light of your proposed IIA's representative, Mr. Lam Ming Wah, Mr. Chan Him Yik, Mr. Ngai Kei and Mr. Yu Chee Keung for performing the inspection of valves and Mr. Wong Yiu Keung, Tony for signing the inspection report, we have no objection subject to the satisfactory performance of material inspection. The acceptance notes and IIA inspection reports should be submitted prior to the delivery of the valves pursuant to PS Clause 23.30(13).

Please be reminded to submit the test certificate for every valve in its delivery state, showing compliance with the requirement in accordance with to Clauses 6.1 to 6.3 and Table 2 of BS EN 1074-2:2000 and the on-site test arrangement without delay.

Yours faithfully,

C K Ng
Engineer's Representative

CKN/SKT/JYPC/vl

ATKINS

15 June 2006

MAJV - CIE's Office
Ma Fat Kwang Street
& Chung Hau Street
(opp. to K. Fai House)
Homantin, Kowloon

Tel: 2762-7111
Fax: 2715-9088

RECEIVED
15 JUN 2006
BY:

Lam Woo – Preussag Joint Venture
11/F., Chevalier Engineering Service Centre
21 Sheung Yuet Road
Kowloon Bay
Hong Kong

Attn.: Mr. Keni Wong – Site Agent

Dear Sirs,

Contract No. 22/WSD/02
Replacement and Rehabilitation of Water Mains, Stage 1 Phase 1
Mains in Cheung Sha Wan, Kwai Chung and Tsing Yi
Material Submission – Alternative Supplier for D.I. Metal Seated Gate Valves (DN80 – DN700)

We refer to your above letters dated 7, 8 and 11 June 2006 respectively regarding the proposed alternative supplier and manufacturer for D.I. Metal Seated Gated Valves as follows:-

- Brand : Premier
- Supplier : BIS – Hua Wei Pipeline & Steel Structure Eng. Co. Ltd.
- Manufacturer : Tianjin Boha Valve Group (Licensed by Premier Valves (Pty) Ltd.)
- ILA : ETS – Test Consult Limited

Please be informed that we have no objection to your proposed DN300, DN450, DN600 and DN700 Gate Valves provided that the materials fully comply with the requirements of the Contract.

Yours faithfully,

Wong W K, Chris
Engineer's Representative

CW/TL/ms

MWH 美华集团 JOINT VENTURE ATKINS

MWH Office Address: Unit 1712, Tower II, Grand Central Plaza, 138 Shatin Rural Committee Rd., Shatin, N.T. Tel (852) 2639 2800 Fax (852) 2690 0901
Atkins Office Address: 15th Floor Miramar Tower, 132 Nathan Road, Tsim Sha Tsui, Kowloon, Hong Kong Tel (852) 2972 1000 Fax (852) 2890 6343

RECEIVED 27 AUG 2007

Ref.: 4912/(20/WSD/06)/M25/120/L100117 BY:

Page: 1

CONTRACT NO. 20/WSD/06
REPLACEMENT AND REHABILITATION OF WATERMAINS
STAGE 2
– MAINS IN SHA TIN AND SHAP SZE HEUNG

TO : Lam Woo & Company Limited

Attn : Mr. Darvin Lo

ENGINEER'S REPRESENTATIVE'S REPLY TO CONTRACTOR'S SUBMISSION

Title of Submission : Proposed Supplier for Double Flanged Key-Operated Cast Iron Valves – BIS Hua Wei Pipelines & Steel Structure Engineering Co., Ltd.

Submission Identification Number : LW/(20/WSD/06)/CS/MS8/002 and 003

Response to Submission for :

Approval - A – Approved ☐
B – Approved subject to comments, please resubmit ☑
C – Not approved, please resubmit ☐

Information - I – Submission Acknowledged (no re-submission required) ☐

Record - R – Submission Acknowledge (no re-submission required) ☐

Comments :

I refer to your submissions of the particulars of the Double Flanged Key-Operated Cast Iron Valves dated 21 July 2007 and the supplementary information dated 6 August 2007.

I have no objection in principle on your proposal of adopting the Double Flanged Key-Operated Cast Iron Valves manufactured by Premeir Valve (Pty) Ltd. and supplied by BIS Hua Wei Pipelines & Steel Structure Engineering Co. Ltd. subject to my comments as attached.

I have no objection to your proposal of inviting ETS-Testconsult Ltd. to be the IIB for inspecting the Double Flanged Key-Operated Cast Iron Valves.

From : Engineer's Representative
Name : Mr. S. W. Wong

Signature : Wong

Date : 24 August 2007

BL/SW/ET/ph

Encl.

FORM ER-04

Design Calculation for Stormwater Drainage for EVA and Tank Farm

15104.
31/7/08

JACOBS

15th Floor, Cornwall House, Taikoo Place
979 King's Road, Quarry Bay
Hong Kong, China
852.2880.9788 Fax 852.2565.5561

30 July 2008

Our ref.: G2511/60/X05080

Buildings Department
12-15/F Pioneer Centre
750 Nathan Road
Mongkok
Kowloon

Dear Sirs,

Permanent Aviation Fuel Facility at Tuen Mun Area 38
Fifth Amendment Submission for Drainage (EVA and Tank Farm)
BD Ref. No. BD4/0001/02

We would like to submit the following documents regarding the captioned for your consideration and approval.

1. Two duly signed copies of the amended drawing no. PAFF/BA/02/DWG/C/1452 Rev N and four additional copies for your reference.

2. One duly signed copy of the calculation report "Supplementary Design Calculation for Stormwater Drainage System for EVA and Tank Farm" Ref. R/2511/043/1 Issue 6 and one additional copy for your reference.

Should you have any queries, please do not hesitate to contact the undersigned or our Paul Chong at **2738 3823**.

Yours faithfully
for and on behalf of Jacobs China Ltd

Chui Chung Lai
Authorized Person

DC/BW/PC/cyy

cc: Leighton – Mr. Boyd Merrett (Fax No. 2404 0081) (w/encl.)
JB – Site Staff (Fax No. 2404 0081) (w/encl.)

JACOBS

Report No.
R/2511/043/1
Issue 6
July 2008

Leighton Contractors (Asia) Limited

Permanent Aviation Fuel Facility at Tuen Mun Area 38

Supplementary Design Calculation for Stormwater Drainage System for EVA and Tank Farm

July 2008

For and on behalf of
Jacobs China Ltd

Chiu Chung Lai
AUTHORISED PERSON

Client:

Leighton Contractors (Asia) Ltd
39/F Sun Hung Kai Centre
30 Harbour Road
Wanchai
HONG KONG

Consulting Engineers:

Jacobs China Ltd
15/F, Cornwall House
Taikoo Place, 979 King's Road
Quarry Bay
HONG KONG

Babtie Asia		**CALCULATION CONTROL SHEET** Form QP209/F2 Issue 3

15/F Cornwall House
Taikoo Place, 979 King's Road
Quarry Bay, Hong Kong

Tel : 2880 9788
Fax : 2565 5561
E-mail : babtie@babtie.com.hk

PROJECT TITLE	Permanent Aviation Fuel Facility at Tuen Mun Area 38	Job No. :	2511
SECTION	Drainage (EVA and Tank Farm)	Sub Job No :	--

Calc Package No : R/2511/129/1 Number of Sheets : --

Subject: Supplementary Design Calculation for Stormwater Drainage System for EVA and Tank Farm (5th Amendment)

List of Engineers Preparing : the Calculations	(Print Name)	(Signature)	(Initial)
	Paul Chong	PC	PC

Category of Check : 2A Checked by : Patrick Ng Pat Date : 23/07/08

Assumptions Verified by : Bella Wong (Design Team Leader) Date : 23/07/08

Internal independent review by : (For check cat. 3A, 3B or 3C) Date :

No. of Independent Calculation Sheets :

Remarks:

REVISIONS	Page Nos.			Revised		Checked	
Reason for Revision	Revised	Added	Deleted	By	Date	By	Date

N.B. Mark superseded (replaced/deleted) on calculation sheet originals and kept at the back of the calculation package.

Distribution : Calculation File Page of

JACOBS

DOCUMENT CONTROL SHEET

(Form QP203/F9 Issue 3)

Distribution : Original to document master in Project File

Client : Leighton Contractors (Asia) Ltd.

Client Contract No : Job No : 2511

Project Title : **Permanent Aviation Fuel Facility at Tuen Mun Area 38**

Document Title : Supplementary Design Calculation for Stormwater Drainage System for EVA and Tank Farm

Document No :

R/2511/043/1 Issue 6

This Document has been prepared by: Paul Chong

Status and Approval Schedule

Issue No.	Status	Description of Amendment	Prepared by		Project Manager		Project Director	
			Initials	Date	Initials	Date	Initials	Date
1	Final		CKY VS	Oct 04	AS	Oct 04	LHS	Oct 04
2	Final		CKY VS	14 Oct 04	AS	14 Oct 04	LHS	14 Oct 04
3	Final	BD 2nd Amendment	CKY FT	26 May 06	AS	26 May 06	LHS	26 May 06
4	Final	BD 3rd Amendment	FT	8 Jun 07	BW	8 Jun 07	LHS	8 Jun 07
5	Final	BD 3rd Amendment	FT	20 Jun 07	BW	20 Jun 07	LHS	20 Jun 07
6	Final	BD 5th Amendment	PC	23 July 08	BW	23 July 08	LHS	July 08

Distribution : Client, Project File

CONTENTS

APPENDIX

1.0 Introduction

This report contains the hydraulic design of the main drainage systems proposed for the Tank Farm of the Permanent Aviation Fuel Facility (PAFF). The main drainage pipes convey drainage along the EVA and collect all runoff from the proposed PAFF to the Government drainage system (Manhole number N1-1b and N1-4a) in the access road. The proposed PAFF site has a total area approx. 70,000m^2.

In this revision, consideration has been taken for the amount of stormwater flows discharged from Terminal Manholes M8-2 and L-10 within the proposed PAFF site into the public access road manholes N1-1b and N1-4a respectively. Pipe strength calculation and revised drawing no. PAFF/BA/02/DWG/C/1451 showing the proposed type of bedding are also incorporated in this submission.

The Hydrological and Hydraulic models by HydroWorks were used to simulate the proposed drainage system. As the future development of PAFF will connect to the above drainage system, design catchment will include the overall site area.

2.0 Design Rainstorm

Synthetic rainstorm events were generated by Hydroworks in accordance with Section 4.3.4, DSD's Stormwater Drainage Manual (SDM). Gumbel solution was used. The estimated rainstorm duration is less than 15 minutes. Therefore rainstorm events with 30-minute duration (and 1 minute time step) were used to ensure that peak flow is reached.

3.0 Catchment

Catchment for each of the manholes is as shown in Drawing no. PAFF/BA/02/DWG/C/1450 rev. G (attached in Appendix A). Runoff coefficient C is assumed to be 1.0 and 0.35 for paved area and unpaved area respectively. Details of the runoff parameter file for HydroWorks are attached in the Appendix C and D.

4.0 Design Sea level

The system was designed to discharge into the Government manholes N1-1b and N1-4a and eventually to the Outfall.

Sea level as a boundary condition of the model is represented by the .lev file. Extreme sea levels at Tuen Mun (from Drainage Master Plan for Tuen Mun) as shown in the following table are adopted for the design of sea levels at the Outfall.

Return Period T (year)	Extreme Sea level at Government Access Road Outfall
10	+3.25 mPD
50	+3.50 mPD

Referring to Table 11 of the Stormwater Drainage Manual, the following combination of rainfall and tidal events are to be adopted:

Flood level return period	Case I	Case II
50	50-year rain + 10-year sea level	10-year rain + 50-year sea level

5.0 Freeboard

According to Stormwater Design Manual, 300mm minimum will be provided for every manhole.

6.0 Roughness coefficient

Roughness for concrete pipe Ks = 0.6mm and 1.5mm are to be adopted for the upper and bottom part respectively as recommended in Table 14 of Stormwater Drainage Manual. Conservation has been taken account in these roughness coefficients as we have already assumed the pipe internal surface would be in poor condition in future.

Manhole details will follow the DSD Standard Drawings.

7.0 Results and discussion

The results of HydroWorks are summarized in Table 1. Further detail such as maximum water level is attached in Appendix C and D.

Table 1 Summary of Drainage System within the Tank Farm

Node Ref.	Ground Level	Water Level (mPD)		Freeboard (m)	
		50 Rainfall + 10 Tide	10 Rainfall + 50 Tide	50 Rainfall + 10 Tide	10 Rainfall + 50 Tide
M1	8.100	5.079	5.046	3.021	3.054
M2	7.900	4.888	4.850	3.012	3.050
M3	7.700	4.819	4.778	2.881	2.922
M3-1	6.000	4.880	4.861	1.120	1.139
M4	7.450	4.725	4.676	2.725	2.774
M5	7.150	4.634	4.573	2.516	2.577
M6	7.200	4.548	4.486	2.652	2.714
M7	7.450	4.420	4.367	3.030	3.083
M8	7.550	4.342	4.289	3.208	3.261
M9	7.450	4.231	4.187	3.219	3.263
M10	7.080	4.135	4.085	2.945	2.995
M11	7.350	4.032	3.981	3.318	3.369
M12	7.500	4.922	4.915	2.578	2.585
M13	6.490	3.935	3.887	2.555	2.603
M8-1	7.500	4.663	4.599	2.837	2.901
M8-2	7.820	4.458	4.362	3.362	3.458
M12-1	7.800	5.258	5.242	2.542	2.558
L1	7.750	4.845	4.731	2.905	3.019
L2	7.950	4.816	4.647	3.134	3.303

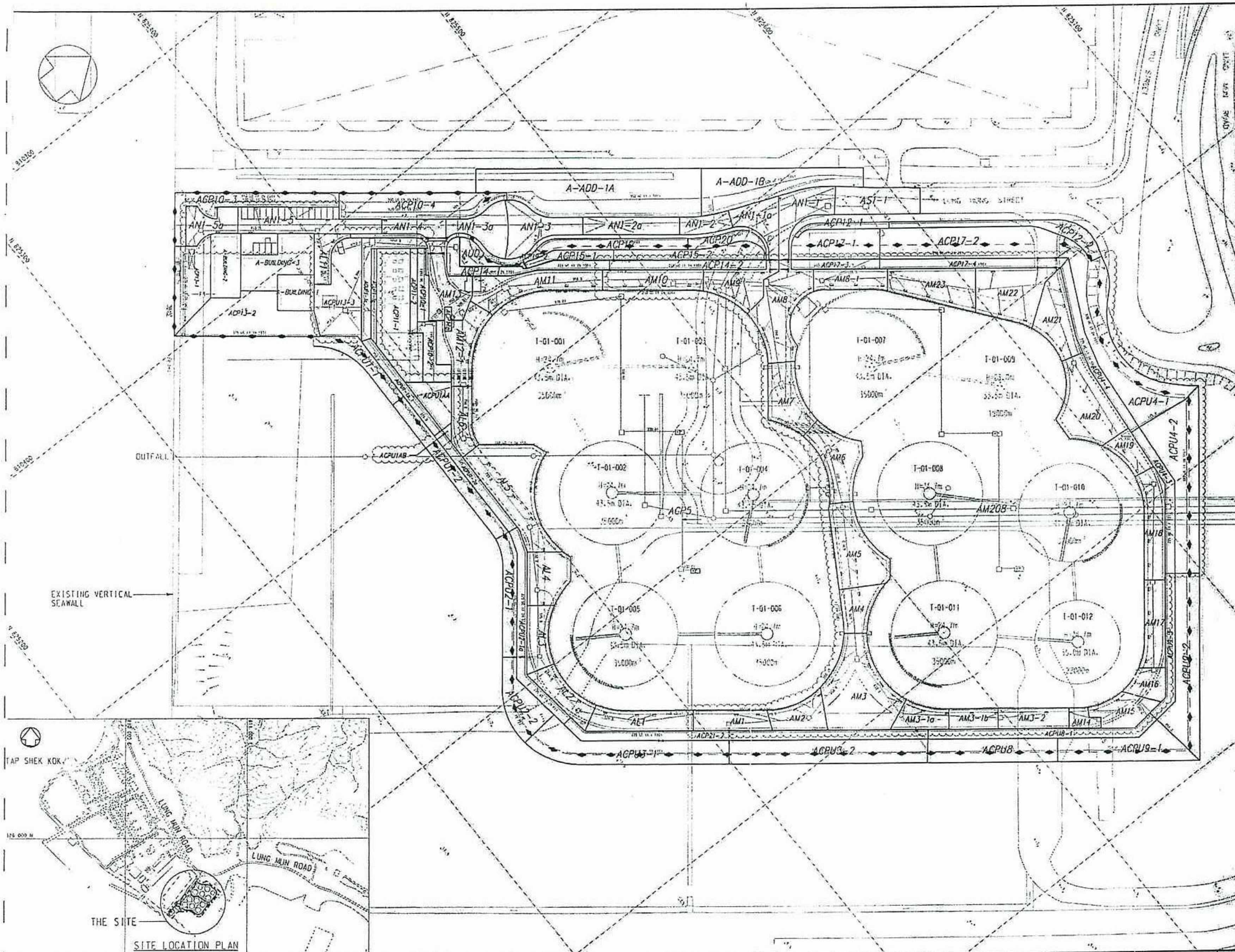
Table 1 Summary of Drainage System within the Tank Farm (Cond.)

Node Ref.	Ground Level	Water Level (mPD)		Freeboard (m)	
		50 Rainfall + 10 Tide	10 Rainfall + 50 Tide	50 Rainfall + 10 Tide	10 Rainfall + 50 Tide
L3	8.200	4.457	4.416	3.743	3.784
L4	8.100	4.156	4.134	3.944	3.966
L5	7.900	4.075	4.048	3.825	3.852
L6	7.850	3.967	3.918	3.883	3.932
L7	7.880	3.943	3.883	3.937	3.997
L8	6.400	3.929	3.870	2.471	2.530
L9	7.200	3.895	3.842	3.305	3.358
L10	5.810	3.754	3.730	2.056	2.080
L11	5.820	3.868	3.821	1.952	1.999
L10.1	5.640	4.171	4.056	1.469	1.584
L10.2	5.900	4.292	4.143	1.608	1.757
*CP5	5.000	5.690	5.630	-0.690	-0.630
MF1	7.320	5.046	4.987	2.274	2.333
*CP10	4.100	5.031	4.985	-0.931	-0.885
M14-1	7.750	5.611	5.604	2.139	2.146
M14	7.950	5.372	5.359	2.578	2.591
M15	7.850	5.315	5.289	2.535	2.561
M16	7.750	5.281	5.252	2.469	2.498
M17	7.800	5.212	5.157	2.588	2.643
M18	7.900	5.180	5.082	2.720	2.818
M19	7.750	5.157	5.054	2.593	2.696
M20	7.850	5.070	4.970	2.780	2.880
M21	7.750	4.917	4.840	2.833	2.910
M22	7.750	4.859	4.771	2.891	2.979
M23	7.850	4.776	4.689	3.074	3.161
*CP208	5.000	6.261	6.13	-1.261	-1.130

* For the catch pits CP5, CP10 and CP208, they were designed to be flooded during the rainstorm events. The flow was controlled by valves that were installed at the outlet pipe of the catch pits. During rainstorm, all runoff was stored inside the bund wall with the valves closed. The valves would be opened when the rainstorm ended. Runoff from that catch pits was then discharged into the manhole MF1 or MF2 which was an oil interceptor.

The HydroWorks results showed that the drainage system meets the 50 years design standard and provided adequate freeboards.

APPENDIX A CATCHMENT PLAN



CATCHMENT AREA TABLE

CATCHMENT AREA NO.	AREA (m²)
AS1-1	398
AN1-1	355
AN1-1a	284
AN1-2	156
AN1-2a	254
AN1-3	399
AN1-3a	329
AN1-4	188
AN1-5	511
AN1-5a	254
AM1	269
AM2	267
AM3	887
AM4	245
AM5	577
AM6	438
AM7	389
AM8	674
AM9	364
AM10	307
AM11	598
AM12-1	439
AM13	430
AL1	383
AL2	279
AL3	254
AL4	352
AL5	837
AL6	246
AL11	111
ACPU1-1	306
ACPU1-1a	151
ACPU13-3	657
ACPU1-1b	86
ACPU1-1c	270
ACPU1-2	418
ACPU1-2a	298
ACPU1AA	230
ACPU1AB	17
ACPU2-1	306
ACPU2-1a	354
ACPU2-2	364
~~ACPU3-1~~	~~885~~
ACPU3-2	806
ACPU4-1	1058
ACPU4-2	978
ACPU4-3	258
ACPU4-4	306
ACPU8	520
ACPU8-1	380
ACPU9-1	581
ACPU9-2	781
ACPU9-3	250

CATCHMENT AREA TABLE

CATCHMENT AREA NO.	AREA (m²)
ACP5	20201
ACP10-3	535
ACP10-4	710
ACP12-1	99
ACP12-2	332
ACP13-1	466
ACP13-2	776
ACP14-1	289
ACP14-2	244
ACP15-1	141
ACP15-2	318
ACP17-1	152
ACP17-2	968
ACP17-3	147
ACP17-4	302
ACP19	310
ACP20	145
ACP21-1	197
ACP21-2	606
AUD	121
A-ADD-1A	1691
A-ADD-1B	806
A-BUILDING-1	725
A-BUILDING-2	330
A-BUILDING-3	486
ACP10-1	130
ACP10-2	197
ACP11-1	195
ACP11-2	108
ACP11a	30
AM3-1a	212
AM3-1b	170
AM3-2	242
AM14	91
AM15	287
AM16	179
AM17	325
AM18	410
AM19	186
AM20	638
AM21	405
AM22	593
AM23	503
AM8-1	266
AM208	20707

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Rev.	Date	Description	Checked
A	APR 2004	FIRST ISSUE	
B	OCT 2005	CATCHMENT AREAS ADDED	
C	FEB 2006	CATCHMENT AREAS REVISED	
D	MAY 2006	CATCHMENT AREAS AND TABLE REVISED	
E	MAY 2006	CATCHMENT AREAS AND TABLE REVISED	
F	DEC 2006	CATCHMENT AREAS AND TABLE REVISED	
G	MAY 2008	CATCHMENT AREAS AND TABLE REVISED	

Scale 1:350 (A1) | Date OCT 2002

Designed | Drawn JL | Checked
Design Team Leader | Date Jul 08
Approved LHS | Date Jul 08

ECO

Contractor: LEIGHTON CONTRACTORS (ASIA) LIMITED

JACOBS

Permanent Aviation Fuel Facility

Title: TANK FARM
CATCHMENT PLAN FOR
STORMWATER DRAINAGE

Drawing No. PAFF/BA/02/DWG/C/1450 | Revision G

APPENDIX B CALCULATION FOR PROPOSED PIPE & U-CHANNEL CAPACITY and PIPE STRENGTH CALCULATION

Checking for pipe capacity

Calculating velocity
(by Colebrook-white equation stated in Sewerage Manual Part 1 cl 5.2.1 (I))

v = velocity (by Colebrook-white equation)

$v = -((8gDs)^{1/2} \times LOG(k_s/(3.7D)+(2.51v)/(D(2gDs)^{1/2}))$

where

g (m/s^2) =	9.81
k_s (m) UPVC =	0.00006
k_s (m) concrete =	0.00150
v (m^2/s) =	0.000001

t_f = time of travel estimated from length/velocity
$t_c = t_0 + t_f$
v = velocity (by Colebrook-white equation)

Estimating the rainfall intensity
(refer to cl 4.3.2 of Stormwater Drainage Manual)

$$i = \frac{a}{(t_f + b)^c}$$

where

t_f = time of travel estimated from length/velocity
$t_c = t_0 + t_f$

	t_0 (min) =	2.00	for urban / paved area
For 1 in 50 Return Period			
	a =	687.00	
	b =	4.20	
	c =	0.42	
	C =	0.95	for Asphalt surface

Estimating the peak runoff

$$Q_p = 0.278CiA$$

where

i = intensity that estimated from above equation
A = Area of catchment

	C =	0.95	for Asphalt surface
adopt	C =	1.00	in Hydrowork model for conservative approach
	C =	0.35	from stormwater drainage manual

Estimating the longest travel time from catchment to outfall

the longest route = travel from (A-Future-2+AAD10+AS1-1+AN1-1+AN1-2+AN1-3+AN1-4+AN1-5)
= (33+29+54+32+35+37+61+21+17+27+37+72+43+93+15)/60   assume v=1m/s
= 606/60
= 10.1mins

while t_0 (min) = 2.00
therefore t_c = 12.1 mins

Tanker Berth and Fuel Farm Facilities (Tuen Mun Area 38)

Prepared By: 23/7/08
Checked By :

Manhole number	Catchment Area (Paved)(m^2)	Catchment Area (Unpaved)(m^2)	Cumulative Catchment Area (Paved)(m^2)	Cumulative Catchment Area (Unpaved)(m^2)	Pipe Diameter (m)	t_f (min)	t_c (min)	Intensity I (mm/hr)	Pipe Length (m)	Invert Out (m)	Invert In at next Manhole (m)	Gradient		Pipe Velocity v (ms^{-1})	Pipe Capacity Q (max) (m^3/s)	Total flow (m^3/s)	Check for Gradient	Check for length
													1 in					
						t_e (min) =	2.0											
M1	269	1693	269	1693	0.375	0.0	2.0	319.3	35.00	4.810	4.610	0.006	175	1.21	0.134	0.075	OK	OK
M2	267	0	536	1693	0.450	0.5	2.5	309.4	28.00	4.580	4.450	0.005	215	1.23	0.195	0.095	OK	OK
M3	1078	520	1614	2213	0.600	0.4	2.9	302.3	28.00	4.420	4.330	0.003	311	1.23	0.347	0.194	OK	OK
M4	245	0	1859	2213	0.600	0.4	3.2	295.7	34.00	4.300	4.190	0.003	309	1.23	0.348	0.209	OK	OK
M5	577	0	2436	2213	0.600	0.5	3.7	288.3	25.00	4.160	4.080	0.003	313	1.23	0.346	0.248	OK	OK
M6	438	0	2874	2213	0.600	0.3	4.0	283.3	33.00	4.050	3.940	0.003	300	1.25	0.354	0.276	OK	OK
M7	389	0	3263	2213	0.750	0.4	4.5	277.2	43.00	3.910	3.800	0.003	391	1.26	0.558	0.299	OK	OK
M8	624	0	3887	2213	0.750	0.6	5.0	269.9	25.00	3.770	3.690	0.003	313	1.41	0.624	0.335	OK	OK
M9	364	0	4251	2213	0.900	0.3	5.3	266.4	41.00	3.660	3.570	0.002	456	1.31	0.835	0.356	OK	OK
M10	307	992	4558	3205	0.900	0.5	5.9	260.5	35.00	3.540	3.460	0.002	438	1.34	0.852	0.395	OK	OK
M11	1037	0	5595	3205	0.900	0.4	6.3	255.9	26.50	3.430	3.360	0.003	379	1.44	0.916	0.458	OK	OK
M13	1260	0	6855	3205	1.050	0.3	6.6	252.8	34.50	3.270	3.150	0.003	288	1.82	1.578	0.537	OK	OK
L11						0.3	6.9											

						t_e (min) =	2.0											
CP-U-3	0	1693	0	1693	0.300	0.0	2.0	319.3	11.00	4.960	4.840	0.011	92	1.45	0.102	0.053	OK	OK
M1																		

						t_e (min) =	2.0											
CP-U-8	0	520	0	520	0.300	0.0	2.0	319.3	18.00	4.820	4.700	0.007	150	1.13	0.080	0.016	OK	OK
M3-1	191	0	191	520	0.600	0.3	2.3	313.7	31.00	4.670	4.450	0.007	141	1.83	0.517	0.032	OK	OK
M3																		

						t_e (min) =	2.0											
CP17	0	1420	0	1420	0.300	0.0	2.0	319.3	3.00	5.000	4.900	0.033	30	2.54	0.179	0.044	OK	OK
CP17A	0	449	0	1869	0.300	0.0	2.0	318.8	3.00	4.880	4.760	0.040	25	2.78	0.196	0.058	OK	OK
M23																		

						t_e (min) =	2.0											
CP15	0	459	0	459	0.300	0.0	2.0	319.3	3.50	5.300	5.270	0.009	117	1.28	0.091	0.014	OK	OK
CP14	0	533	0	992	0.300	0.0	2.0	318.3	3.50	4.770	4.120	0.186	5	5.99	0.424	0.031	OK	OK
M10																		

						t_e (min) =	2.0											
M12-1	439	0	439	0	0.225	0.0	2.0	319.3	19.00	5.100	4.830	0.014	70	1.37	0.054	0.037	OK	OK
M12	0	0	439	0	0.300	0.2	2.2	314.4	21.00	4.800	4.000	0.038	26	2.71	0.192	0.036	OK	OK
M11																		

Prepared By: ______
Checked By : ______ 23/7/08

Manhole number	Catchment Area (Paved)(m^2)	Catchment Area (Unpaved)(m^2)	Cumulative Catchment Area (Paved)(m^2)	Cumulative Catchment Area (Unpaved)(m^2)	Pipe Diameter (m)	t_f (min)	t_c (min)	Intensity I (mm/hr)	Pipe Length (m)	Invert Out (m)	Invert In at next Manhole (m)	Gradient		Pipe Velocity v (ms^{-1})	Pipe Capacity Q (max) (m^3/s)	Total flow (m^3/s)	Check for Gradient	Check for length
						t_e (min) =	2.0											
L1	383	0	383	0	0.300	0.0	2.0	319.3	25.00	4.580	4.390	0.008	132	1.21	0.085	0.032	OK	OK
L2	279	960	662	960	0.300	0.3	2.3	312.1	26.00	4.360	4.180	0.007	144	1.15	0.082*	0.084	OK	OK
L3	254	670	916	1630	0.375	0.4	2.7	304.9	26.00	4.150	3.870	0.011	93	1.66	0.184	0.122	OK	OK
L4	352	0	1268	1630	0.600	0.3	3.0	300.2	24.50	3.840	3.730	0.004	223	1.45	0.411	0.148	OK	OK
L5	837	0	2105	1630	0.750	0.3	3.3	295.4	44.00	3.700	3.570	0.003	338	1.36	0.600	0.211	OK	OK
L6	246	0	2351	1630	0.750	0.5	3.8	286.8	20.50	3.540	3.480	0.003	342	1.35	0.597	0.224	OK	OK
L7	0	0	2351	1630	0.750	0.3	4.1	283.1	21.00	3.450	3.380	0.003	300	1.44	0.637	0.221	OK	OK
L8	0	1396	2351	3026	0.750	0.2	4.3	279.7	44.00	3.350	3.230	0.003	367	1.30	0.576	0.256	OK	OK
L9	225	2250	2576	5276	0.900	0.6	4.9	272.2	28.00	3.220	3.150	0.003	400	1.40	0.891	0.325	OK	OK
L11	7473	3205	10049	8481	1.050	0.3	5.2	268.1	11.00	3.130	3.050	0.007	138	2.64	2.283		OK	OK
L10	1581	1416	11630	9897	1.200	0.1	5.3	267.3	6.50	2.900	2.830	0.011	93	3.49	3.948	1.078	OK	OK
N1-4a						0.0	5.3											
						t_e (min) =	2.0											
CP21	0	960	0	960	0.300	0.0	2.0	319.3	3.50	5.100	4.900	0.057	18	3.32	0.235	0.030	OK	OK
L2																		
						t_e (min) =	2.0											
CP-U-2	0	670	0	670	0.300	0.0	2.0	319.3	10.00	4.500	4.180	0.032	31	2.49	0.176	0.021	OK	OK
L3																		
						t_e (min) =	2.0											
CP-U-1	0	724	0	724	0.300	0.0	2.0	319.3	3.00	3.700	3.570	0.043	23	2.89	0.204	0.022	OK	OK
L8																		
						t_e (min) =	2.0											
CP-U-1A	0	247	0	247	0.225	0.0	2.0	319.3	1.50	6.700	6.670	0.020	50	1.63	0.065	0.008	OK	OK
CP-U-1B	0	425	0	672	0.225	0.0	2.0	318.9	17.00	5.100	3.950	0.068	15	2.99	0.119	0.021	OK	OK
L8																		
						t_e (min) =	2.0											
Building 1	225	0	225	0	0.225	0.0	2.0	319.3	11.50	4.090	3.930	0.014	72	1.35	0.054	0.019	OK	OK
CP13	0	1894	225	1894	0.450	0.1	2.1	316.3	13.50	3.900	3.280	0.046	22	3.87	0.616	0.077	OK	OK
L9																		
						t_e (min) =	2.0											
CP23	0	86	0	86	0.225	0.0	2.0	319.3	2.00	4.080	3.990	0.045	22	2.44	0.097	0.003	OK	OK
CP22	0	270	0	356	0.225	0.0	2.0	319.0	8.00	3.980	3.820	0.020	50	1.63	0.065	0.011	OK	OK

Manhole number	Catchment Area (Paved)(m^2)	Catchment Area (Unpaved)(m^2)	Cumulative Catchment Area (Paved)(m^2)	Cumulative Catchment Area (Unpaved)(m^2)	Pipe Diameter (m)	t_f (min)	t_c (min)	Intensity I (mm/hr)	Pipe Length (m)	Invert Out (m)	Invert In at next Manhole (m)	Gradient		Pipe Velocity v (ms^{-1})	Pipe Capacity Q (max) (m^3/s)	Total flow (m^3/s)	Check for Gradient	Check for length
L9																		
						t_c (min) =	2.0											
CP10.3	0	1245	0	1245	0.300	0.0	2.0	319.3	11.00	4.000	3.530	0.043	23	2.87	0.203	0.039	OK	OK
L10.2	584	0	584	1245	0.450	0.1	2.1	317.9	47.00	3.500	3.230	0.006	174	1.37	0.217	0.088	OK	OK
L10.1	997	0	1581	1245	0.450	0.6	2.6	306.4	9.50	3.200	3.120	0.008	119	1.66	0.263	0.165	OK	OK
L10.1a	0	171	1581	1416	0.450	0.1	2.7	304.6	5.50	3.090	3.050	0.007	138	1.54	0.245	0.169	OK	OK
L10						0.1	2.8											
						t_c (min) =	2.0											
Building 2	330	0	330	0	0.225	0.0	2.0	319.3	10.00	4.170	3.680	0.049	20	2.55	0.101	0.028	OK	OK
L10.2																		
						t_c (min) =	2.0											
Building 3	486	0	486	0	0.150	0.0	2.0	319.3	3.00	4.020	3.730	0.097	10	2.73	0.048	0.041	OK	OK
L10.1																		
						t_c (min) =	2.0											
M14-1	191		191	0	0.300	0.0	2.0	319.3	40.00	5.49	5.22	0.007	148	1.14	0.080	0.016	OK	OK
M14	333		524	0	0.300	0.6	2.6	307.4	11.50	5.20	5.02	0.016	64	1.74	0.123	0.043	OK	OK
M15	287	1992	811	1992	0.600	0.1	2.1	316.9	12.00	5.01	4.97	0.003	300	1.25	0.354	0.129	OK	OK
M16	179		990	1992	0.600	0.2	2.3	313.6	35.00	4.96	4.85	0.003	318	1.21	0.343	0.143	OK	OK
M17	325		1315	1992	0.600	0.5	2.8	304.3	39.00	4.84	4.71	0.003	300	1.25	0.354	0.165	OK	OK
M18	410		1725	1992	0.600	0.5	3.3	295.2	23.00	4.70	4.62	0.003	288	1.28	0.361	0.192	OK	OK
M19	186	2600	1911	4592	0.600	0.3	3.6	290.4	34.00	4.61	4.50	0.003	309	1.23	0.348	0.276	OK	OK
M20	638		2549	4592	0.600	0.5	4.0	283.5	32.00	4.49	4.39	0.003	320	1.21	0.342	0.317	OK	OK
M21	405		2954	4592	0.675	0.4	4.5	277.3	27.00	4.38	4.29	0.003	300	1.35	0.483	0.340	OK	OK
M22	593		3547	4592	0.675	0.3	4.8	273.0	34.50	4.280	4.170	0.003	314	1.32	0.472	0.378	OK	OK
M23	503	1869	4050	6461	0.675	0.4	5.2	267.6	37.00	4.160	4.040	0.003	308	1.33	0.476	0.454	OK	OK
M8-1	266		4316	6461	0.675	0.5	5.7	262.2	18.00	4.040	3.980	0.003	300	1.35	0.483	0.464	OK	OK
M8-2	0	0	4316	6461	0.675	0.2	5.9	259.8	6.50	3.830	3.800	0.005	217	1.59	0.568	0.459	OK	OK
N1-1b						0.1	6.0											
						t_c (min) =	2.0											
CP-U-4	0	2036	0	2036	0.375	0.0	2.0	319.3	31.50	5.800	5.150	0.021	48	2.31	0.255	0.063	OK	OK
M19																		
						t_c (min) =	2.0											
CP-U-4A	0	564	0	564	0.300	0.0	2.0	319.3	4.50	5.400	5.200	0.044	23	2.93	0.207	0.018	OK	OK
M19																		
						t_c (min) =	2.0											

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Manhole number	Catchment Area (Paved)(m^2)	Catchment Area (Unpaved)(m^2)	Cumulative Catchment Area (Paved)(m^2)	Cumulative Catchment Area (Unpaved)(m^2)	Pipe Diameter (m)	t_f (min)	t_c (min)	Intensity I (mm/hr)	Pipe Length (m)	Invert Out (m)	Invert In at next Manhole (m)	Gradient		Pipe Velocity v (ms^{-1})	Pipe Capacity Q (max) (m^3/s)	Total flow (m^3/s)	Check for Gradient	Check for length
CP-U-9A	0	630	0	630	0.300	0.0	2.0	319.3	7.60	5.900	5.600	0.039	25	2.76	0.195	0.020	OK	OK
M15																		
						t_c (min) =	2.0											
CP-U-9	0	1362	0	1362	0.450	0.0	2.0	319.3	28.00	5.150	5.020	0.005	215	1.23	0.195	0.042	OK	OK
M15																		

N.B. * - For the 300mm dia. pipe between L2 and L3, the total flow is greater than the pipe capicity; however, refer to the result of HydroWorks, it showed that manholes L2 and L3 can provide adequate freeboards (min. 300mm) which mean the drainage system is still up to the standard.

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Catchment Area ACPU1-1

A = 306.0 m^2
= 0.0003 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.2 min.

L = 5 m
Average slope H = 100 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 370.1 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.011 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 150
Size = 300 mm
Q = 6000 ℓ/min.
= 0.100 m^3/s > Peak runoff 0.011 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU1-1

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Date: 23/7/08

Catchment Area ACPU1-1a

A = 137.0 m^2
= 0.0001 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465{*}L / (H^{0.2}{*}A^{0.1})$
= 0.2 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 368.3 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.005 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
= 0.053 m^3/s > Peak runoff 0.005 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU1-1a

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Date: 24/1/08

Catchment Area ACPU1AA

$A = 230.0\ m^2$
$= 0.0002\ km^2$

Run off coeff.

$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465{*}L / (H^{0.2}{*}A^{0.1})$
$= 0.2$ min.

$L = 4$ m
Average slope $H = 12.5$ m per 100m
$td = 0.2$ min.

Intensity

$a = 687$
$b = 4.2$
$c = 0.42$
$i = a / (td + b)^c$
$= \underline{368.6}$ mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$= \underline{0.008}\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
$= \underline{0.053}\ m^3/s$ > Peak runoff $0.008\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU1AA

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Date: 23/7/08

Catchment Area ACPU1AB

A = 17.0 m^2
= 0.0000 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

t_0 = 0.14465*L / ($H^{0.2}$*$A^{0.1}$)
= 0.3 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.3 min.

Intensity

a = 687
b = 4.2
c = 0.42
i = a / (td + b)^c
= 366.5 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.001 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 l/min.
= 0.053 m^3/s > Peak runoff 0.001 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU1AB

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Date: 23/7/08

Catchment Area ACPU1-2a

A = 288.0 m^2
= 0.0003 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.2 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 368.8 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.010 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
= 0.053 m^3/s > Peak runoff 0.010 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU1-2a

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Date: 23/7/08

Catchment Area ACPU1-2

$A =$ 418.0 m^2
$=$ 0.0004 km^2

Run off coeff.

$c =$ 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
$=$ 0.0 min.

$L =$ 1 m
Average slope $H =$ 100 m per 100m
$td =$ 0.0 min.

Intensity

$a =$ 687
$b =$ 4.2
$c =$ 0.42
$i = a / (td + b)^c$
$=$ 374.8 mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$=$ 0.015 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 150
Size = 300 mm
Q = 6000 ℓ/min.
$=$ 0.100 m^3/s > Peak runoff 0.015 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU1-2

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU2-1a

A = 354.0 m^2
= 0.0004 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.2 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 368.9 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 cIA
= 0.013 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
= 0.053 m^3/s > Peak runoff 0.013 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU2-1a

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Date: 23/7/08

Catchment Area ACP 21-2

$A = 606.0\ m^2$
$= 0.0006\ km^2$

Run off coeff.

$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
$= 0.2$ min.

$L = 4$ m
Average slope $H = 12.5$ m per 100m
$td = 0.2$ min.

Intensity

$a = 687$
$b = 4.2$
$c = 0.42$
$i = a / (td + b)^c$
$= \underline{369.3}$ mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$= \underline{0.022}\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
$= \underline{0.053}\ m^3/s$ > Peak runoff $0.022\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU21-2

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU2-1

A = 306.0 m^2
= 0.0003 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
= 0.0 min.

L = 1 m
Average slope H = 100 m per 100m
td = 0.0 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 374.8 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.011 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 150
Size = 300 mm
Q = 6000 ℓ/min.
= 0.100 m^3/s > Peak runoff 0.011 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU2-1

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Date: 23/7/08

Catchment Area ACPU2-2

A = 364.0 m^2
= 0.0004 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.0 min.

L = 1 m
Average slope H = 100 m per 100m
td = 0.0 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 374.8 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.013 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 73
Size = 300 mm
Q = 8500 ℓ/min.
= 0.142 m^3/s > Peak runoff 0.013 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU2-2

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Date: 23/7/08

Catchment Area ACPU3-1

$A =$ 885.0 m^2
$=$ 0.0009 km^2

Run off coeff.

$c =$ 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465{*}L / (H^{0.2}{*}A^{0.1})$
$=$ 0.0 min.

L = 1 m
Average slope H = 100 m per 100m
td = 0.0 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
$=$ 374.9 mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ cIA$
$=$ 0.032 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 141
Size = 300 mm
Q = 6200 ℓ/min.
$=$ 0.103 m^3/s > Peak runoff 0.032 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU3-1

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Catchment Area ACPU3-2

A = 808.0 m^2
= 0.0008 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
= 0.0 min.

L = 1 m
Average slope H = 100 m per 100m
td = 0.0 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 374.9 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.029 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 119
Size = 300 mm
Q = 6800 l/min.
= 0.113 m^3/s > Peak runoff 0.029 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU3-2

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Catchment Area ACPU8

A = 520.0 m^2
= 0.0005 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_o = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.0 min.

L = 1 m
Average slope H = 100 m per 100m
td = 0.0 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 374.9 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.019 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 98
Size = 300 mm
Q = 7500 ℓ/min.
= 0.125 m^3/s > Peak runoff 0.019 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU8

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Catchment Area ACPU8-1

A = 380.0 m^2
= 0.0004 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil; DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465{*}L / (H^{0.2}{*}A^{0.1})$
= 0.2 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 369.0 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.014 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 150
Size = 225 mm
Q = 6000 ℓ/min.
= 0.100 m^3/s > Peak runoff 0.014 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU8-1

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU9-1

A = 581.0 m^2
= 0.0006 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.0 min.

L = 1 m
Average slope H = 100 m per 100m
td = 0.0 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 374.9 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.021 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 47
Size = 300 mm
Q = 10000 ℓ/min.
= 0.167 m^3/s > Peak runoff 0.021 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU9-1

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU9-2

$A = 781.0\ m^2$
$= 0.0008\ km^2$

Run off coeff.

$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
$= 0.0$ min.

L = 1 m
Average slope H = 100 m per 100m
td = 0.0 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
$=$ 374.9 mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$= 0.028\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 59
Size = 300 mm
Q = 9500 l/min.
$= 0.158\ m^3/s$ > Peak runoff $0.028\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU9-2

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU9-3

$A = 250.0\ m^2$
$= 0.0003\ km^2$

Run off coeff.

$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465{*}L / (H^{0.2}{*}A^{0.1})$
$= 0.2$ min.

$L = 4$ m
Average slope $H = 12.5$ m per 100m
$td = 0.2$ min.

Intensity

$a = 687$
$b = 4.2$
$c = 0.42$
$i = a / (td + b)^c$
$= \underline{368.7}$ mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$= \underline{0.009}\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
$= \underline{0.053}\ m^3/s$ > Peak runoff $0.009\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU9-3

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU4-1

A = 1058.0 m^2
= 0.0011 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
= 0.1 min.

L = 3 m
Average slope H = 50 m per 100m
td = 0.1 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 372.3 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.038 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 143
Size = 300 mm
Q = 6000 ℓ/min.
= 0.100 m^3/s > Peak runoff 0.038 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU4-1

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU4-2

$A = 978.0\ m^2$
$= 0.0010\ km^2$

Run off coeff.

$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
$= 0.1$ min.

L = 3 m
Average slope H = 50 m per 100m
td = 0.1 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 372.3 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.035 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 116
Size = 300 mm
Q = 7000 ℓ/min.
= 0.117 m^3/s > Peak runoff 0.035 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU4-2

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU4-3

$A = 258.0\ m^2$
$= 0.0003\ km^2$

Run off coeff.

$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
$= 0.2$ min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 368.7 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
$= 0.009\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
$= 0.053\ m^3/s$ > Peak runoff $0.009\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU4-3

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACPU4-4

A = 306.0 m^2
= 0.0003 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

t_0 = 0.14465*L / ($H^{0.2}$*$A^{0.1}$)
= 0.2 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
i = a / (td + b)^c
= 368.8 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.011 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 l/min.
= 0.053 m^3/s > Peak runoff 0.011 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACPU4-4

Prepare by: [signature]
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Date: 23/7/18

Catchment Area ACP17-1

A = 452.0 m^2
= 0.0005 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.1 min.

L = 4 m
Average slope H = 50 m per 100m
td = 0.1 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 370.7 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.016 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 58
Size = 300 mm
Q = 9000 ℓ/min.
= 0.150 m^3/s > Peak runoff 0.016 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP17-1

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACP17-2

A = 968.0 m^2
= 0.0010 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.1 min.

L = 3 m
Average slope H = 50 m per 100m
td = 0.1 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 372.3 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.035 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 39
Size = 300 mm
Q = 11000 ℓ/min.
= 0.183 m^3/s > Peak runoff 0.035 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP17-2

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACP17-3

A = 147.0 m^2
= 0.0001 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
= 0.2 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= <u>368.3</u> mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= <u>0.005</u> m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
= <u>0.053</u> m^3/s > Peak runoff 0.005 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP17-3

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACP17-4

A = 302.0 m^2
= 0.0003 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_o = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.2 min.

L = 4 m
Average slope H = 12.5 m per 100m
td = 0.2 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 368.8 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.011 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
= 0.053 m^3/s > Peak runoff 0.011 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP17-4

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACP14-1

A = 289.0 m^2
= 0.0003 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 2.1 min.

L = 22 m
Average slope H = 0.5 m per 100m
td = 2.1 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 317.7 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.009 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
= 0.053 m^3/s > Peak runoff 0.009 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP14-1

Prepare by: [signature]
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Date: 23/7/18

Catchment Area ACP14-2

A = 244.0 m^2
= 0.0002 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.3 min.

L = 5.5 m
Average slope H = 5.5 m per 100m
td = 0.3 min.

Intensity

a = 687
b = 4.2
c = 0.42
$I = a / (td + b)^c$
= 364.4 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.009 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 l/min.
= 0.053 m^3/s > Peak runoff 0.009 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP14-2

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Date: 23/7/08

Catchment Area AUD

A = 121.0 m^2
= 0.0001 km^2

Run off coeff.

c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
= 0.5 min.

L = 6 m
Average slope H = 7.5 m per 100m
td = 0.5 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= <u>359.3</u> mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= <u>0.004</u> m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 150 mm
Q = 1200 l/min.
= <u>0.020</u> m^3/s > Peak runoff 0.004 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area AUD

Prepare by: [signature]
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Date: 23/1/08

Catchment Area ACPU15-1

$A = 141.0\ m^2$
$= 0.0001\ km^2$

Run off coeff.
$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
$= 0.2$ min.

$L = 4.5$ m
Average slope $H = 65$ m per 100m
$td = 0.2$ min.

Intensity

$a = 687$
$b = 4.2$
$c = 0.42$
$i = a / (td + b)^c$
$= \underline{369.7}$ mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$= \underline{0.005}\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 150
Size = 300 mm
Q = 6000 ℓ/min.
$= \underline{0.100}\ m^3/s$ > Peak runoff $0.005\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP15-1

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACP15-2

$A =$	318.0	m^2
$=$	0.0003	km^2

Run off coeff.

$c =$ 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$

$=$ 0.2 min.

$L =$	4.5	m
Average slope $H =$	65	m per 100m
$td =$	0.2	min.

Intensity

$a =$	687
$b =$	4.2
$c =$	0.42

$i = a / (td + b)^c$

$=$ 370.2 mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$

$=$ 0.011 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient =	1	in	150
Size =	300	mm	
$Q =$	6000	ℓ/min.	

$=$ 0.100 m^3/s > Peak runoff 0.011 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP15-2

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACP10-1

$A = 130.0\ m^2$
$= 0.0001\ km^2$

Run off coeff.

$c = 1.00$ (for Paved area: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
$= 0.4$ min.

L = 5 m
Average slope H = 2.2 m per 100m
td = 0.4 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 362.6 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
$= 0.013\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 150
Size = 300 mm
Q = 6000 ℓ/min.
$= 0.100\ m^3/s$ > Peak runoff $0.013\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP10-1

Prepare by: [signature]
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Date: 23/7/08

Catchment Area ACP10-2

A = 197.0 m^2
= 0.0002 km^2

Run off coeff.

c = 1.00 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
= 0.4 min.

L = 5 m
Average slope H = 2.2 m per 100m
td = 0.4 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 363.1 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.020 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 150
Size = 300 mm
Q = 6000 ℓ/min.
= 0.100 m^3/s > Peak runoff 0.020 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP10.2

Prepare by: [signature]
Checked by: [signature]
Date: 23/7/08

Catchment Area ACP10-3

A = 535.0 m^2
= 0.0005 km^2

Run off coeff.
c = 0.35 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.6 min.

L = 11 m
Average slope H = 6.5 m per 100m
td = 0.6 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 356.0 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.019 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 142
Size = 300 mm
Q = 6200 ℓ/min.
= 0.103 m^3/s > Peak runoff 0.019 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP10-3

Prepare by: [signature]
Checked by: [signature]
Date: 23/7/08

Catchment Area ACP10-4

$A = 710.0\ m^2$
$= 0.0007\ km^2$

Run off coeff.

$c = 0.35$ (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
$= 0.5$ min.

$L = 11$ m
Average slope $H = 11$ m per 100m
$td = 0.5$ min.

Intensity

$a = 687$
$b = 4.2$
$c = 0.42$
$i = a / (td + b)^c$
$= \underline{358.3}$ mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$= \underline{0.025}\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 142
Size = 300 mm
Q = 6200 ℓ/min.
$= \underline{0.103}\ m^3/s$ > Peak runoff $0.025\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP10-4

Prepare by: [signature]
Checked by: [signature]
Date: 23/7/08

Catchment Area ACP1-1c

A = 270.0 m^2
= 0.0003 km^2

Run off coeff.

c = 1.00 (for Paved area: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_o = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.2 min.

L = 3 m
Average slope H = 1 m per 100m
td = 0.2 min.

Intensity

a = 637
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 367.1 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.028 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 l/min.
= 0.053 m^3/s > Peak runoff 0.028 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP1-1c

Prepare by: [signature]
Checked by: [signature]
Date: 25/7/08

Catchment Area ACP1-1b

$A = 86.0\ m^2$
$= 0.0001\ km^2$

Run off coeff.

$c = 1.00$ (for Paved area: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
$= 0.2$ min.

$L = 3$ m
Average slope $H = 2.2$ m per 100m
$td = 0.2$ min.

Intensity

$a = 687$
$b = 4.2$
$c = 0.42$
$i = a / (td + b)^c$
$= \underline{367.4}$ mm/hr (for 1 in 50 years)

Peak runoff

$Q = 0.278\ ciA$
$= \underline{0.009}\ m^3/s$

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 100
Size = 225 mm
Q = 3200 ℓ/min.
$= \underline{0.053}\ m^3/s$ > Peak runoff $0.009\ m^3/s$

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP1-1b

Prepare by: [signature]
Checked by: [signature]
Date: 23/7/08

Catchment Area ACP13-1

A = 466.0 m^2
= 0.0005 km^2

Run off coeff.

c = 1.00 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 0.9 min.

L = 13 m
Average slope H = 1.5 m per 100m
td = 0.9 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 345.5 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.045 m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 180
Size = 375 mm
Q = 11000 ℓ/min.
= 0.183 m^3/s > Peak runoff 0.045 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP13-1

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Checked by: [signature]
Date: 23/7/08

Catchment Area ACP13-2

A = 776.0 m^2
= 0.0008 km^2

Run off coeff.

c = 1.00 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465*L / (H^{0.2}*A^{0.1})$
= 1.4 min.

L = 19.5 m
Average slope H = 1 m per 100m
td = 1.4 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= <u>332.0</u> mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= <u>0.072</u> m^3/s

Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 180
Size = 375 mm
Q = 11000 ℓ/min.
= <u>0.183</u> m^3/s > Peak runoff 0.072 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP13-2

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Checked by: [signature]
Date: 23/7/08

Catchment Area ACP13-3

A = 652.0 m^2
= 0.0007 km^2

Run off coeff.

c = 1.00 (for grassland, heavy soil: DSD Stormwater Drainage Manual Section 7.5.2)

Time of concentration

Inlet time (by Brandsby William's Equation)

$t_0 = 0.14465 * L / (H^{0.2} * A^{0.1})$
= 1.3 min.

L = 17 m
Average slope H = 1 m per 100m
td = 1.3 min.

Intensity

a = 687
b = 4.2
c = 0.42
$i = a / (td + b)^c$
= 336.1 mm/hr (for 1 in 50 years)

Peak runoff

Q = 0.278 ciA
= 0.061 m^3/s

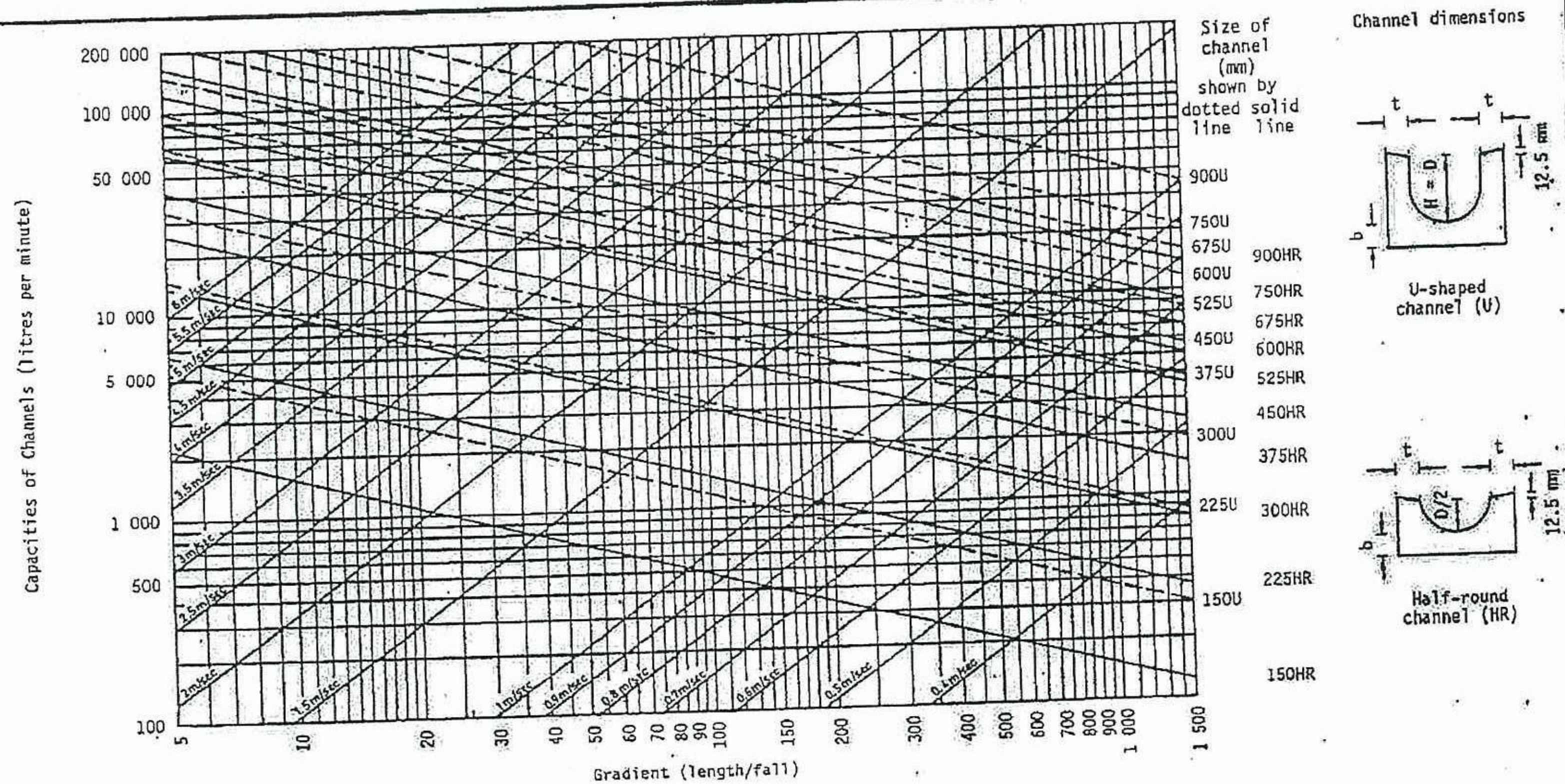
Capacity of Proposed U-Channel

From Figure 8.7 (Geotechnical Manual for Slopes)

Gradient = 1 in 180
Size = 375 mm
Q = 11000 ℓ/min.
= 0.183 m^3/s > Peak runoff 0.061 m^3/s

Conclusion

Capacity of Proposed U-Channel is adequate for the Peak Runoff at Catchment area ACP13-3



DESIGN METHOD USING CHART

(a) Normal channel
Solution

1. Runoff
2. Gradient
3. Channel size
4. Velocity

Example :

1. Enter Runoff = 4 000 litre/min.
2. Enter Gradient = 1 in 40
3. Read channel required = 225 U or 300HR
4. Read velocity = 2.2 m/sec. (<4 m/sec. ∴OK)

(b) Stepped channel
Solution

1. Velocity
2. Runoff
3. Channel size
4. Gradient

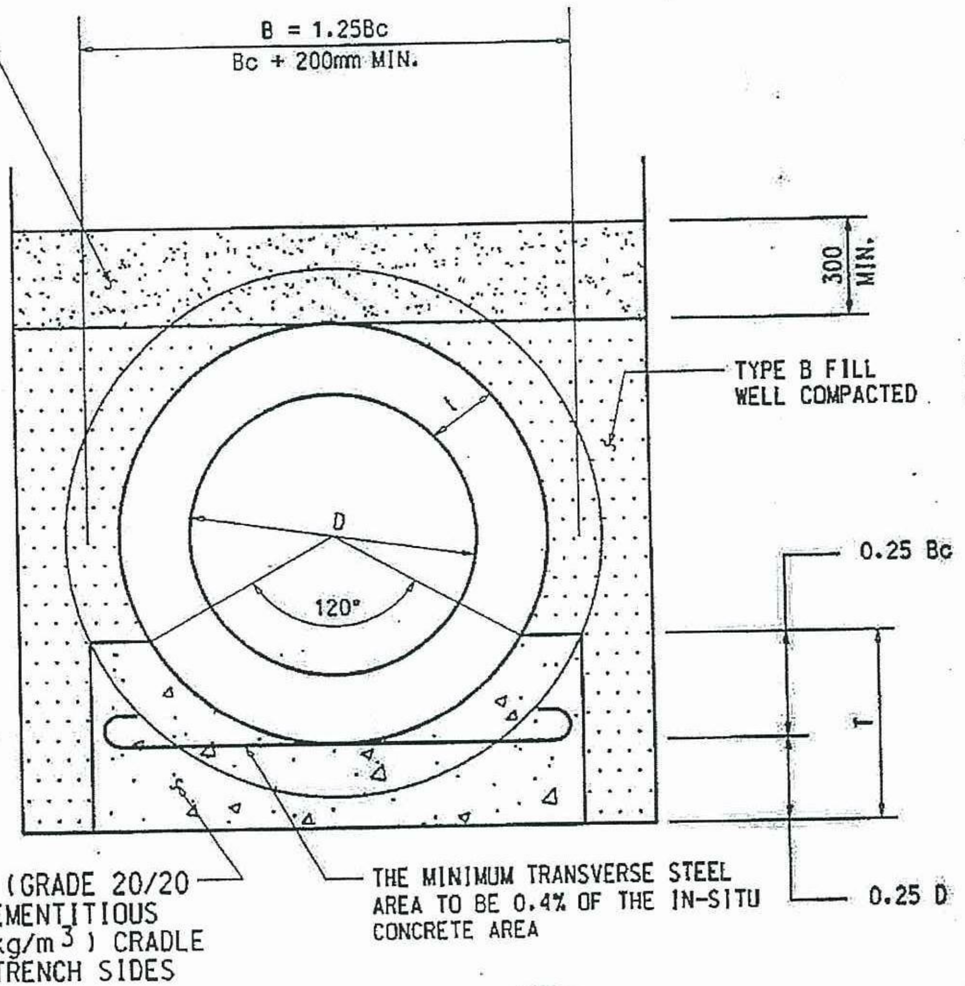
Example :

1. Enter Velocity = 5 m/sec.
2. Enter Runoff = 20 000 litre/min.
3. Read required channel size = 300U
4. Read required gradient = 1 in 14

Figure 8.7 - Chart for the Rapid Design of Channels

RANGE OF GRADING OF TYPE B MATERIALS

BS TEST SIEVE	PERCENTAGE BY MASS PASSING
METRIC	TYPE B
63 mm	100
37.5 mm	85 - 100
20 mm	0 - 20
10 mm	0 - 5
3.35 mm	-
600 µm	-
75 µm	-



TYPICAL PIPE BEDDING DETAIL 7

SCALE : 1 : 50

Calculation for buried rigid pipes (DN1050 Pipe from N1-1a to N1-4)

1. Input data for pipe

Nominal size of pipe	DN	=	1050	mm
Pipe outside diameter	B_c	=	1300	mm
Assumed trench width	B_d	=	2050	mm

Crushing test loads (kN/m of effective length)		*Works proof load*	*Maximum load*
Class	*L*	51	64
	M	76	95
	H	96	120

Bedding factor F_m = 3.4

Cover depth H = 3.40 m

2. Fill Load

a. Wide Trench Condition

$$W_c = C_c\, w\, B_c^2$$

(para. 10.5.3, Stormwater Drainage Manual)

$K\mu'$ = 0.19

H = 3.40 m

B_c = 1.30 m

H/B_c = 2.62

$r_{sd} \cdot P$ = 0.70

C_c = 4.25

w = 19.0 kN/m³

(Fig 12, Stormwater Drainage Manual)

⇒ W_c = 136.42 kN/m

3. Water Load (For pipe > 600mm dia.)

$$W_w = 9.81\,(3\pi/4)\,(D^2/4)$$

(para. 10.5.5, Stormwater Drainage Manual)

D = 1.05 m

⇒ W_w = 6.37 kN/m

4. Traffic Load (Surcharge Load)

$$p = (3L/2\pi)\,(H^3/H_s^5)\,\alpha$$

(Para. 10.5.4, Stormwater Drainage Manual)

L = 90 kN (load per wheel)

H = 3.40 m

α = 1.3 (for construction vehicle wheels load)

r_1 =	0.0 m	H_{s1} =	3.4 m	p_1 =	4.83 kN/m²
r_2 =	1.8 m	H_{s2} =	3.8 m	p_2 =	2.61 kN/m²
r_3 =	7.8 m	H_{s3} =	8.5 m	p_3 =	0.05 kN/m²
r_4 =	9.6 m	H_{s4} =	10.2 m	p_4 =	0.02 kN/m²
r_5 =	3.0 m	H_{s5} =	4.5 m	p_5 =	1.15 kN/m²
r_6 =	3.50 m	H_{s6} =	4.9 m	p_6 =	0.79 kN/m²
r_7 =	8.36 m	H_{s7} =	9.0 m	p_7 =	0.04 kN/m²

r_8 =	10.06	m	H_{s8} =	10.6	m	p_8 =	0.02	kN/m^2

$W_p = \Sigma\, pB_c$

B_c = 1.3 m

⇒ W_p = 12.35 kN/m

$\sigma = (3P/2\pi H^2)\,[1/(1+(r/H)^2)]^{5/2}$

(Appendix 2, A guide to design loadings for buried rigid pipes)

H = 3.40 m
P = 90 kN

r_1 =	0.0 m	σ_1 =	3.72	kN/m^2
r_2 =	1.8 m	σ_2 =	2.00	kN/m^2
r_3 =	7.8 m	σ_3 =	0.04	kN/m^2
r_4 =	9.6 m	σ_4 =	0.02	kN/m^2
r_5 =	3.0 m	σ_5 =	0.88	kN/m^2
r_6 =	3.50 m	σ_6 =	0.61	kN/m^2
r_7 =	8.36 m	σ_7 =	0.03	kN/m^2
r_8 =	10.06 m	σ_8 =	0.01	kN/m^2

$W_{csu} = \Sigma\, \sigma B_c$

B_c = 1.3 m

⇒ W_{csu} = 9.50 kN/m

W_{csu} = PsBc = σB_c = 8 * Bc

W_{csu} = 10.40 kN/m

(from Cl. NA 4.1.4 & Fig. NA. 6, BS EN 1295-1 : 1998)

5. Total External Load

We = Wc (Narrow or Wide Trench) + Ww + Wp (or Wcsu)

⇒ W_e = 155.14 kN/m

6. Required Maximum Crushing Test Load of Pipe

$W_{T(max)} = F_{s(max)} W_e / F_m$

$F_{s(max)}$ = 1.25
F_m = 3.4

$W_{T(max)}$ = 57.04 kN/m

⇒ ** Min. Pipe Class = L*

7. Required Works Proof Test Strength of Pipe

$W_{T(proof)} = F_{s(proof)} W_e / F_m$

$F_{s(proof)}$ = 1.1
F_m = 3.4

$W_{T(proof)}$ = 50.19 kN/m

⇒ ** Min. Pipe Class = L*

Calculation for buried rigid pipes (DN1200 Pipe from L10 to N1-4a)

1. Input data for pipe

Nominal size of pipe	DN	=	1200	mm
Pipe outside diameter	B_c	=	1490	mm
Assumed trench width	B_d	=	2300	mm

Crushing test loads (kN/m of effective length)		*Works proof load*	*Maximum load*
Class	*L*	58	72
	M	87	109
	H	110	138

Bedding factor F_m = 3.4
Cover depth H = 1.60 m

2. Fill Load

a. Wide Trench Condition

$$W_c = C_c\, w\, B_c^2$$ (para. 10.5.3, Stormwater Drainage Manual)

$K\mu'$ = 0.19
H = 1.60 m
B_c = 1.49 m
H/B_c = 1.07
$r_{sd} \cdot P$ = 0.70

C_c = 1.80 (Fig 12, Stormwater Drainage Manual)
w = 19.0 kN/m^3

⇒ W_c = 75.82 kN/m

3. Water Load (For pipe > 600mm dia.)

$$W_w = 9.81\,(3\pi/4)\,(D^2/4)$$ (para. 10.5.5, Stormwater Drainage Manual)

D = 1.2 m

⇒ W_w = 8.32 kN/m

4. Traffic Load (Surcharge Load)

$$p = (3L/2\pi)\,(H^3/H_s^5)\,\alpha$$ (Para. 10.5.4, Stormwater Drainage Manual)

L = 90 kN (load per wheel)
H = 1.60 m
α = 1.3 (for construction vehicle wheels load)

r_1 =	0.0	m	H_{s1} =	1.6	m	p_1 =	21.82	kN/m^2
r_2 =	1.8	m	H_{s2} =	2.4	m	p_2 =	2.82	kN/m^2
r_3 =	7.8	m	H_{s3} =	8.0	m	p_3 =	0.01	kN/m^2
r_4 =	9.6	m	H_{s4} =	9.7	m	p_4 =	0.00	kN/m^2
r_5 =	3.0	m	H_{s5} =	3.4	m	p_5 =	0.50	kN/m^2
r_6 =	3.50	m	H_{s6} =	3.8	m	p_6 =	0.27	kN/m^2

r_7 =	8.36	m	H_{s7} =	8.5	m	p_7 =	0.01	kN/m²
r_8 =	10.06	m	H_{s8} =	10.2	m	p_8 =	0.00	kN/m²

$W_p = \Sigma\, pB_c$

B_c = 1.49 m

⇒ $\boxed{W_p = 37.90 \text{ kN/m}}$

$\sigma = (3P/2\pi H^2)\,[1/(1+(r/H)^2)]^{5/2}$ (Appendix 2, A guide to design loadings for buried rigid pipes)

H = 1.60 m
P = 90 kN

r_1 =	0.0 m	σ_1 =	16.79	kN/m²
r_2 =	1.8 m	σ_2 =	2.17	kN/m²
r_3 =	7.8 m	σ_3 =	0.01	kN/m²
r_4 =	9.6 m	σ_4 =	0.00	kN/m²
r_5 =	3.0 m	σ_5 =	0.39	kN/m²
r_6 =	3.50 m	σ_6 =	0.21	kN/m²
r_7 =	8.36 m	σ_7 =	0.00	kN/m²
r_8 =	10.06 m	σ_8 =	0.00	kN/m²

$W_{csu} = \Sigma\, \sigma B_c$

B_c = 1.49 m

⇒ $\boxed{W_{csu} = 29.16 \text{ kN/m}}$

W_{csu} = PsBc = σB_c = 33 * Bc $\boxed{W_{csu} = 49.17 \text{ kN/m}}$

(from Cl. NA.4.1.4 & Fig. NA. 6, BS EN 1295-1 : 1998)

5. Total External Load

We = Wc (Narrow or Wide Trench) + Ww + Wp (or Wcsu)

⇒ $\boxed{W_e = 133.31 \text{ kN/m}}$

6. Required Maximum Crushing Test Load of Pipe

$W_{T(max)} = F_{s(max)} W_e / F_m$

$F_{s(max)}$ = 1.25
F_m = 3.4

$\boxed{W_{T(max)} = 49.01 \text{ kN/m}}$

⇒ ***Min. Pipe Class = L***

7. Required Works Proof Test Strength of Pipe

$W_{T(proof)} = F_{s(proof)} W_e / F_m$

$F_{s(proof)}$ = 1.1
F_m = 3.4

$\boxed{W_{T(proof)} = 43.13 \text{ kN/m}}$

⇒ ***Min. Pipe Class = L***

Calculation for buried rigid pipes (DN1500 Pipe from N1-4 to Outfall)

1. Input data for pipe

Nominal size of pipe	DN	=	1500	mm
Pipe outside diameter	B_c	=	1830	mm
Assumed trench width	B_d	=	2700	mm

Crushing test loads (kN/m of effective length)		*Works proof load*	*Maximum load*
Class	*L*	69	87
	M	104	130
	H	132	165

Bedding factor F_m = 3.4
Cover depth H = 2.50 m

2. Fill Load

a. Wide Trench Condition

$$W_c = C_c\, w\, B_c^{\,2}$$

(para. 10.5.3, Stormwater Drainage Manual)

$K\mu'$ = 0.19
H = 2.50 m
B_c = 1.83 m
H/B_c = 1.37
$r_{sd} \cdot P$ = 0.70

C_c = 2.26
w = 19.0 kN/m^3

(Fig 12, Stormwater Drainage Manual)

⇒ W_c = 143.94 kN/m

3. Water Load (For pipe > 600mm dia.)

$$W_w = 9.81\ (3\pi/4)\ (D^2/4)$$

(para. 10.5.5, Stormwater Drainage Manual)

D = 1.5 m

⇒ W_w = 13.00 kN/m

4. Traffic Load (Surcharge Load)

$$p = (3L/2\pi)\ (H^3/H_s^{\,5})\ \alpha$$

(Para. 10.5.4, Stormwater Drainage Manual)

L = 90 kN (load per wheel)
H = 2.50 m
α = 1.3 (for construction vehicle wheels load)

r_1	=	0.0	m	H_{s1}	=	2.5	m	p_1	=	8.94	kN/m^2
r_2	=	1.8	m	H_{s2}	=	3.1	m	p_2	=	3.15	kN/m^2
r_3	=	7.8	m	H_{s3}	=	8.2	m	p_3	=	0.02	kN/m^2
r_4	=	9.6	m	H_{s4}	=	9.9	m	p_4	=	0.01	kN/m^2
r_5	=	3.0	m	H_{s5}	=	3.9	m	p_5	=	0.96	kN/m^2
r_6	=	3.50	m	H_{s6}	=	4.3	m	p_6	=	0.59	kN/m^2

r_7 =	8.36	m	H_{s7} =	8.7	m	p_7 =	0.02	kN/m^2
r_8 =	10.06	m	H_{s8} =	10.4	m	p_8 =	0.01	kN/m^2

$W_p = \Sigma\, pB_c$

B_c = 1.83 m

⇒ | W_p = 25.08 kN/m |

$\sigma = (3P/2\pi H^2)\,[1/(1+(r/H)^2)]^{5/2}$ (Appendix 2, A guide to design loadings for buried rigid pipes)

H = 2.50 m
P = 90 kN

r_1 =	0.0 m	σ_1 =	6.88	kN/m^2
r_2 =	1.8 m	σ_2 =	2.42	kN/m^2
r_3 =	7.8 m	σ_3 =	0.02	kN/m^2
r_4 =	9.6 m	σ_4 =	0.01	kN/m^2
r_5 =	3.0 m	σ_5 =	0.74	kN/m^2
r_6 =	3.50 m	σ_6 =	0.46	kN/m^2
r_7 =	8.36 m	σ_7 =	0.01	kN/m^2
r_8 =	10.06 m	σ_8 =	0.01	kN/m^2

$W_{csu} = \Sigma\, \sigma B_c$

B_c = 1.83 m

⇒ | W_{csu} = 19.28 kN/m |

W_{csu} = PsBc = σB_c = 15 * Bc | W_{csu} = 27.45 kN/m |

(from Cl. NA 4.1.4 & Fig. NA. 6, BS EN 1295-1 : 1998)

5. Total External Load

We = Wc (Narrow or Wide Trench) + Ww + Wp (or Wcsu)

⇒ | W_e = 184.39 kN/m |

6. Required Maximum Crushing Test Load of Pipe

$W_{T(max)} = F_{s(max)} W_e / F_m$

$F_{s(max)}$ = 1.25
F_m = 3.4

| $W_{T(max)}$ = 67.79 kN/m |

⇒ | ***Min. Pipe Class = L*** |

7. Required Works Proof Test Strength of Pipe

$W_{T(proof)} = F_{s(proof)} W_e / F_m$

$F_{s(proof)}$ = 1.1
F_m = 3.4

| $W_{T(proof)}$ = 59.66 kN/m |

⇒ | ***Min. Pipe Class = L*** |

** Table 7 Crushing test loads in kN/m (BS 5911:Part 100:1988 Section 4)*

Nominal size of pipe DN	Class L		Class M		Class H	
	Works proof load	Maximum load	Works proof load	Maximum load	Works proof load	Maximum load
150	20	25	23	29	-	-
225	20	25	23	29	-	-
300	20	25	23	29	-	-
375	20	25	31	39	36	45
450	20	25	35	44	41	52
525	20	25	38	48	46	58
600	20	25	46	58	54	68
675	20	25	50	63	60	75
750	38	48	53	67	65	81
825	41	52	58	72	69	86
900	46	58	67	84	85	106
975	48	60	72	90	91	114
1050	51	64	76	95	96	120
1125	53	67	82	103	106	133
1200	58	72	87	109	110	138
1350	63	79	96	120	122	153
1500	69	87	104	130	132	165
1650	75	94	116	145	146	183
1800	82	103	124	155	158	198
1950	88	110	135	169	169	212
2100	96	120	146	183	184	230
2250	102	128	155	194	195	244
2400	108	135	165	207	210	263
2550	116	145	177	222	223	279
2700	124	155	186	233	235	294
2850	130	163	195	244	251	314
3000	135	169	207	259	260	326

Table 4 Outside diameter and trench
(A guide to loadings for buried rigid pipe

Nominal Pipe Dia. DN (mm)	Pipe Outside Dia. B_c (mm)	Overall Trench Width B_d (mm)
100	130	550
150	190	600
225	280	670
300	380	750
375	500	1050
450	580	1150
525	670	1200
600	790	1350
675	880	1450
750	950	1500
825	1040	1600
900	1120	1900
975	1200	2000
1050	1300	2050
1125	1390	2200
1200	1490	2300
1350	1650	2500
1500	1830	2700
1650	2010	2800
1800	2240	3100
1950	2350	3200
2100	2550	3400
2250	2700	3500
2400	2880	3700
2550	3060	3900
2700	3240	4100
2850	3420	4300
3000	3600	4500

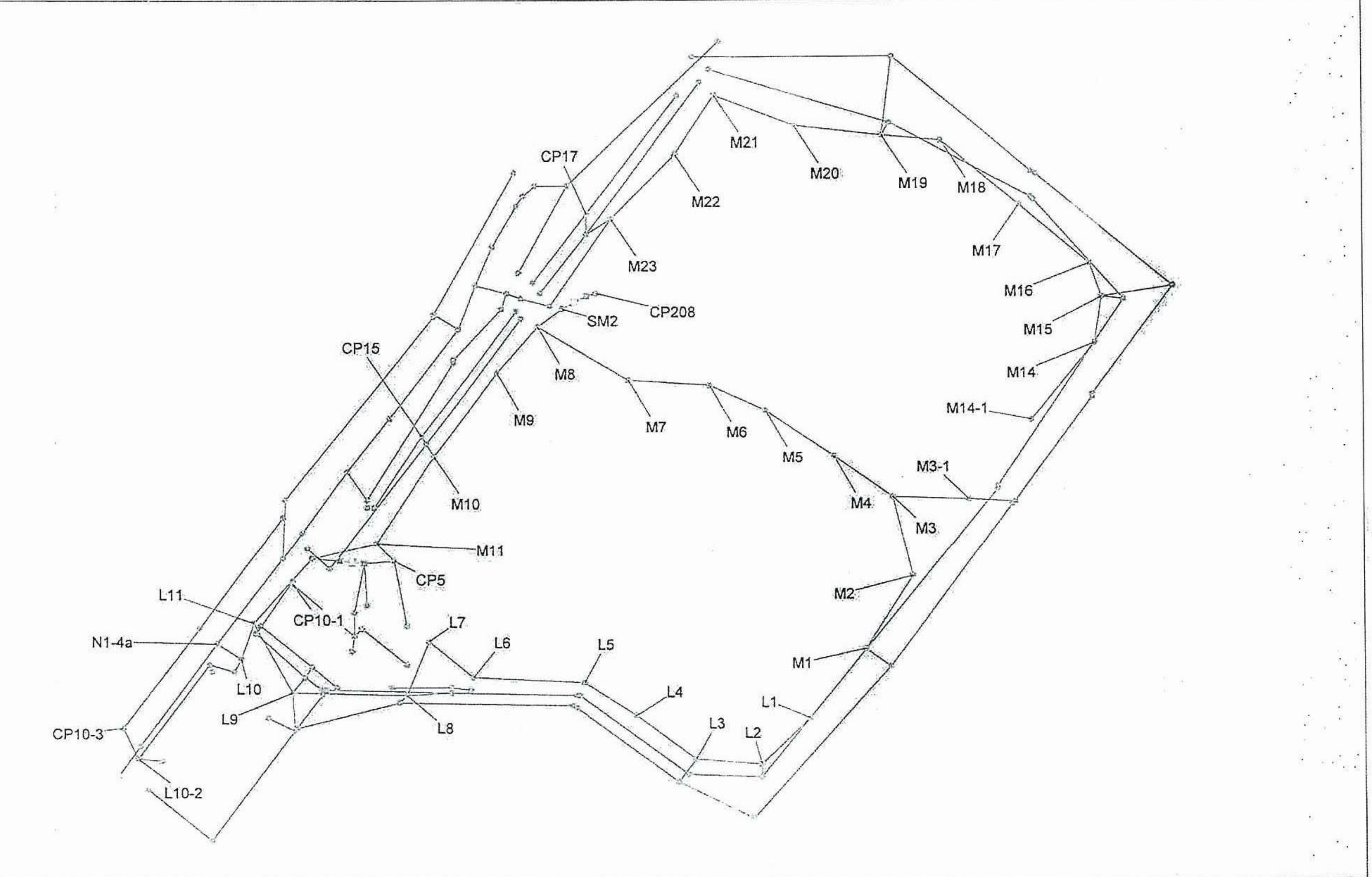
Class of precast concrete pipes

Nominal Pipe Dia. DN (mm)	Assumed Outside Dia. B_c (mm)	Assumed Trench Width B_d (mm)	Bedding Factor F_m	Class of Precast Concrete pipes to BS 5911:Part 100:1988 for Cover Depth in meters													
				0.9	1.2	1.5	1.8	2.4	3.0	4.6	5.0	5.5	6.0	6.5	7.0	7.5	8.0
150	*190*	*600*	*1.9*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	L	L	L	L	L	L	L
225	*280*	*670*	*1.9*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	L	L	L	L	L	L	L
300	*380*	*750*	*1.9*	*M*	*M*	*M*	*L*	*L*	*M*	*M*	L	L	L	L	L	L	L
375	*500*	*1050*	*1.9*	*M*	*M*	*M*	*M*	*M*	*M*	*H*	M	M	M	M	H	H	H
450	*580*	*1150*	*1.9*	*M*	*M*	*M*	*M*	*M*	*H*	*H*	M	M	H	H	H	H	H
600	*790*	*1350*	*1.9*	*M*	*M*	*M*	*M*	*M*	*M*	*H*	M	H	H	H	H	H	H
750	*950*	*1500*	*1.9*	*H*	*M*	*M*	*M*	*M*	*M*	*H*	H	H	H	H	H	H	H
900	*1120*	*1900*	*1.9*	*M*	*M*	*M*	*M*	*M*	*H*	*H*	H	H	H	H	*	*	*
1050	*1300*	*2050*	*1.9*	*M*	*M*	*M*	*M*	*M*	*H*	*H*	H	H	H	H	*	*	*
1200	*1490*	*2300*	*1.9*	*M*	*M*	*M*	*M*	*M*	*M*	*H*	H	H	H	*	*	*	*
1350	**1650**	**2500**	**1.9**	*	H	M	M	M	M	H	H	H	H	*	*	*	*
1500	**1830**	**2700**	**1.9**	*	H	M	M	M	M	H	H	H	*	*	*	*	*
1650	**2010**	**2800**	**1.9**	*	H	M	M	M	M	H	H	H	H	*	*	*	*
1800	**2240**	**3100**	**1.9**	*	H	M	M	M	M	H	H	*	*	*	*	*	*
1950	**2350**	**3200**	**1.9**	*	H	M	M	M	M	H	H	H	*	*	*	*	*
2100	**2550**	**3400**	**1.9**	*	H	M	M	M	M	H	H	H	*	*	*	*	*

Note : * Bedding to be revised

APPENDIX C HydroWorks INPUT DATA AND RESULTS FOR CASE 1

File : c:\hkg00189\2511\trunk7\trunk8.dsd



HydroWorks(tm) SIM

Summary output from pre-processor

Version 5.1.074 dated September 2000

Licence Number - WS04260001PM

Produced from file ...\trunk8.dsd
Land use definitions from ...\default.lud

Total contributing area (ha)	7.9
Total pipe length (m)	4277
Number of computational nodes	1002
Number of int. nodes / ponds	143
Number of outfalls	1
Number of links	143

******** Land use data ********

Land use Index	Population Density (person/ha)	DWF Index	Infiltration Flow Index	Connectivity (%)	< Surface 1 > Runoff Index	Pollut Index	< Surface 2 > Runoff Index	Pollut Index	< Surface 3 > Runoff Index	Pollut Index
1	50	1	0	100	10	1	20	1	21	1
2	50	2	0	100	10	2	20	2	21	2
3	100	3	0	100	10	3	20	3	21	3
4	100	4	0	100	10	4	20	4	21	4
5	150	5	0	100	10	5	20	5	21	5
6	150	6	0	100	10	6	20	6	21	6
7	150	7	0	100	10	7	20	7	21	7
8	150	8	0	100	10	8	20	8	21	8
9	0	9	0	100	10	9	20	9	21	9
10	0	10	0	100	10	10	20	10	21	10
11	100	11	0	100	10	11	20	11	21	11
12	100	12	0	100	10	12	20	12	21	12
99	0	0	-1	0	10	1	20	1	21	1

********** Node data **********

Node Ref	Map Reference	Ground Level (m AD)	Area (ha)	Connection Density	Floor Level (m AD)	Chamber Area (m2)	Roof Level (m AD)	Shaft Area (m2)	Flood Type	< Flood Area 1> Level (m AD)	Area (ha)	< Flood Area 2> Level (m AD)	Area (ha)
E1	1052925590	6.58	0.020	0.0	4.140	1.8	4.470	0.3	1	7.58	0.00	105.58	0.02
E2	1052425586	6.64	0.010	0.0	4.080	1.8	4.380	0.3	1	7.64	0.00	105.64	0.01
E3	1052125582	6.69	0.010	0.0	3.980	1.8	4.280	0.3	1	7.69	0.00	105.69	0.01
M8-2	1052325546	7.82	0.000	0.0	3.830	1.8	4.655	0.3	1	8.82	0.00	106.82	0.00
CP-U-4	1067525640	6.90	0.102	0.0	5.800	1.0	6.190	1.0	1	7.90	0.01	105.90	0.10
CPU-4A	1067425614	6.85	0.028	0.0	5.400	0.9	6.425	0.9	1	7.85	0.00	105.85	0.03
CPC1	1073225585	7.61	0.013	0.0	7.380	0.8	7.605	0.8	1	8.61	0.00	106.61	0.01
CPL1	1060025635	7.70	0.015	0.0	7.470	0.8	7.695	0.8	1	8.70	0.00	106.70	0.01
CP-U-9	1079025550	5.70	0.068	0.0	5.150	1.2	5.600	1.2	1	6.70	0.01	104.70	0.07
CPU-9A	1077025545	7.00	0.032	0.0	5.900	0.9	6.200	0.9	1	8.00	0.00	106.00	0.03
CPK1	1071825472	7.94	0.019	0.0	7.710	0.8	7.935	0.8	1	8.94	0.00	106.94	0.02
CPD1	1073325584	7.61	0.013	0.0	7.380	0.8	7.605	0.8	1	8.61	0.00	106.61	0.01
CPC	1073225595	6.74	0.049	0.0	6.440	0.9	6.740	0.9	1	7.74	0.00	105.74	0.05
CPD	1073425594	6.61	0.039	0.0	6.300	0.9	6.600	0.9	1	7.61	0.00	105.61	0.04
CPK	1075725508	6.74	0.029	0.0	6.350	0.9	6.650	0.9	1	7.74	0.00	105.74	0.03
CPL	1059325640	6.66	0.053	0.0	6.330	0.9	6.630	0.9	1	7.66	0.01	105.66	0.05
N1-1	1051125566	6.96	0.036	0.0	3.824	2.3	4.724	0.7	1	7.96	0.00	105.96	0.04
N1-1a	1050425551	7.39	0.028	0.0	3.732	2.3	4.782	0.7	1	8.39	0.00	106.39	0.03
N1-1b	1051725548	7.25	0.000	0.0	3.795	1.6	4.700	1.6	1	8.25	0.00	106.25	0.00
N1-2	1049725534	7.94	0.016	0.0	3.593	3.2	4.934	0.7	1	8.94	0.00	106.94	0.02
N1-2a	1046925499	7.79	0.029	0.0	3.399	3.2	4.469	0.7	1	8.79	0.00	106.79	0.03
N1-3	1045225478	7.37	0.040	0.0	3.239	1.8	4.318	0.3	1	8.37	0.00	106.37	0.04
N1-3a	1043425454	6.97	0.045	0.0	3.115	1.8	4.175	0.3	1	7.97	0.00	105.97	0.05
N1-4	1042625444	6.63	0.000	0.0	3.005	2.3	4.505	0.7	1	7.63	0.00	105.63	0.00
N1-4a	1039925411	5.61	0.000	0.0	2.826	2.3	4.327	0.7	1	6.61	0.00	104.61	0.00
N1-5	1036825371	5.88	0.000	0.0	1.901	2.3	4.131	0.7	1	6.88	0.00	104.88	0.00
CP-U-3	1067425402	5.80	0.085	0.0	4.960	0.9	5.540	0.9	1	6.80	0.01	104.80	0.09
M1	1066425409	8.10	0.027	0.0	4.810	1.8	5.185	0.3	1	9.10	0.00	107.10	0.03
M2	1068325437	7.90	0.027	0.0	4.580	1.8	5.030	0.3	1	8.90	0.00	106.90	0.03
M3	1067525468	7.70	0.089	0.0	4.420	2.3	5.050	0.7	1	8.70	0.01	106.70	0.09
CP-U-8	1072525466	6.08	0.026	0.0	4.820	0.9	5.870	0.9	1	7.08	0.00	105.08	0.03
M3-1	1070625467	6.00	0.038	0.0	4.670	2.3	5.270	0.7	1	7.00	0.00	105.00	0.04
M4	1065125484	7.45	0.025	0.0	4.300	2.3	4.930	0.7	1	8.45	0.00	106.45	0.03
M5	1062325502	7.15	0.058	0.0	4.160	2.3	4.790	0.7	1	8.15	0.01	106.15	0.06
M6	1060025512	7.20	0.044	0.0	4.050	3.2	4.680	0.7	1	8.20	0.00	106.20	0.04
M7	1056725514	7.45	0.039	0.0	3.910	3.2	4.660	0.7	1	8.45	0.00	106.45	0.04
M8	1053025535	7.55	0.062	0.0	3.770	3.2	4.550	0.7	1	8.55	0.01	106.55	0.06
M9	1051325517	7.45	0.036	0.0	3.660	3.2	4.560	0.7	1	8.45	0.00	106.45	0.04
CP20A	1049525522	8.19	0.007	0.0	7.890	0.9	8.190	0.9	1	9.19	0.00	107.19	0.01
CP20	1051525542	7.34	0.007	0.0	5.090	0.9	7.300	0.9	1	8.34	0.00	106.34	0.01
CP15B	1052125541	6.90	0.016	0.0	6.600	0.9	6.900	0.9	1	7.90	0.00	105.90	0.02
CP19A	1049525521	8.19	0.013	0.0	7.890	0.9	8.190	0.9	1	9.19	0.00	107.19	0.01
CP19B	1046025464	7.14	0.005	0.0	6.840	0.9	7.140	0.9	1	8.14	0.00	106.14	0.00
CP19	1046025467	7.32	0.013	0.0	5.400	0.9	7.240	0.9	1	8.32	0.00	106.32	0.01
CP15A	1046325464	6.72	0.007	0.0	6.420	0.9	6.720	0.9	1	7.72	0.00	105.72	0.01
CP15	1048225492	6.48	0.023	0.0	5.300	0.9	6.480	0.9	1	7.48	0.00	105.48	0.02
CP14	1048425489	6.50	0.022	0.0	4.770	0.9	6.205	0.9	1	7.50	0.00	105.50	0.02
M10	1048725484	7.08	0.031	0.0	3.540	3.2	4.470	0.7	1	8.08	0.00	106.08	0.03
M11	1046425450	7.35	0.060	0.0	3.430	3.2	4.360	0.7	1	8.35	0.01	106.35	0.06
M12	1047125443	7.50	0.000	0.0	4.800	3.2	5.100	0.7	1	8.50	0.00	106.50	0.00
M12-1	1047625418	7.80	0.044	0.0	5.100	1.8	5.325	0.3	1	8.80	0.00	106.80	0.04
M8-1	1053525543	7.50	0.027	0.0	4.040	1.8	4.715	0.3	1	8.50	0.00	106.50	0.03
CP12A	1052225556	6.80	0.005	0.0	6.500	0.9	6.800	0.9	1	7.80	0.00	105.80	0.00

Node Ref	Map Reference	Ground Level (m AD)	Area (ha)	Connection Density	Floor Level (m AD)	Chamber Area (m2)	Roof Level (m AD)	Shaft Area (m2)	Flood Type	< Flood Area 1> Level (m AD)	Area (ha)	< Flood Area 2> Level (m AD)	Area (ha)
CP12B	1060425646	6.73	0.017	0.0	6.430	0.9	6.730	0.9	1	7.73	0.00	105.73	0.02
CP12	1054225590	6.65	0.022	0.0	5.360	0.9	6.530	0.9	1	7.65	0.00	105.65	0.02
CP17	1055025579	5.40	0.071	0.0	5.000	0.9	5.400	0.9	1	6.40	0.01	104.40	0.07
CP17A	1055025571	8.03	0.022	0.0	4.880	0.9	6.625	0.9	1	9.03	0.00	107.03	0.02
CP17-1A	1053125548	8.03	0.007	0.0	7.450	0.8	7.675	0.8	1	9.03	0.00	107.03	0.01
CP17-2A	1059625630	8.03	0.015	0.0	7.450	0.8	7.675	0.8	1	9.03	0.00	107.03	0.01
SM1	1044925443	6.45	0.000	0.0	3.360	0.9	3.700	0.9	1	7.45	0.00	105.45	0.00
M13	1043825444	6.49	0.012	0.0	3.270	3.2	4.320	0.7	1	7.49	0.00	105.49	0.01
CP13A	1039725334	5.75	0.062	0.0	5.200	1.0	5.575	1.0	1	6.75	0.01	104.75	0.06
CP13B	1037125354	5.75	0.023	0.0	5.370	1.0	5.745	1.0	1	6.75	0.00	104.75	0.02
CP13C	1044225391	5.75	0.050	0.0	5.450	1.0	5.825	1.0	1	6.75	0.00	104.75	0.05
CPU-1-1	1043225378	5.75	0.015	0.0	5.440	0.9	5.740	0.9	1	6.75	0.00	104.75	0.01
CPU-1-2	1054425387	5.97	0.021	0.0	5.662	0.9	5.962	0.9	1	6.97	0.00	104.97	0.02
CP-U-1A	1049425394	8.00	0.012	0.0	6.700	0.8	7.825	0.8	1	9.00	0.00	107.00	0.01
CPU1AA	1050225393	8.10	0.011	0.0	7.800	0.8	8.025	0.8	1	9.10	0.00	107.10	0.01
CPU1AB	1047025394	7.20	0.002	0.0	7.200	0.8	7.575	0.8	1	8.20	0.00	106.20	0.00
CP-U-1B	1049425392	7.34	0.018	0.0	5.100	0.8	7.325	0.8	1	8.34	0.00	106.34	0.02

CP-U-1B2	1054625391	7.94	0.014	0.0	7.640	0.8	7.865	0.8	1	8.94	0.00	106.94	0.01
CPU-1C	1044425393	7.55	0.010	0.0	7.550	0.8	7.825	0.8	1	8.55	0.00	106.55	0.01
CPU2A	1054625386	5.98	0.015	0.0	5.680	0.9	5.980	0.9	1	6.98	0.00	104.98	0.01
CPU2B	1061725343	5.76	0.018	0.0	5.300	0.9	5.600	0.9	1	6.76	0.00	104.76	0.02
CPU3A	1061825343	5.75	0.044	0.0	5.300	0.9	5.600	0.9	1	6.75	0.00	104.75	0.04
CPU3B	1072425465	6.10	0.040	0.0	5.800	0.9	6.100	0.9	1	7.10	0.00	105.10	0.04
CPU8B	1075725507	6.69	0.026	0.0	6.290	0.9	6.590	0.9	1	7.69	0.00	105.69	0.03
L1	1064125382	7.75	0.038	0.0	4.580	1.8	4.880	0.3	1	8.75	0.00	106.75	0.04
L2	1062125364	7.95	0.028	0.0	4.360	1.8	5.200	0.3	1	8.95	0.00	106.95	0.03
L3	1059425366	8.20	0.025	0.0	4.150	1.8	4.525	0.3	1	9.20	0.00	107.20	0.03
CP-U-2	1058725357	5.67	0.034	0.0	4.500	0.9	5.440	0.9	1	6.67	0.00	104.67	0.03
L4	1057025383	8.10	0.035	0.0	3.840	1.8	4.440	0.3	1	9.10	0.00	107.10	0.04
L5	1054925396	7.90	0.084	0.0	3.700	1.8	4.450	0.3	1	8.90	0.01	106.90	0.08
L6	1050325398	7.85	0.025	0.0	3.540	1.8	4.320	0.3	1	8.85	0.00	106.85	0.03
L7	1048525412	7.88	0.000	0.0	3.450	1.8	4.230	0.3	1	8.88	0.00	106.88	0.00
L8	1047625391	6.40	0.000	0.0	3.350	1.8	4.175	0.3	1	7.40	0.00	105.40	0.00
CP-U-1	1047325388	5.80	0.036	0.0	3.700	0.9	5.540	0.9	1	6.80	0.00	104.80	0.04
L9	1043025392	7.20	0.000	0.0	3.220	1.8	4.120	0.3	1	8.20	0.00	106.20	0.00
CP22	1043525398	7.30	0.014	0.0	3.980	0.9	6.225	0.9	1	8.30	0.00	106.30	0.01
CP22B	1043025435	7.30	0.004	0.0	6.120	0.8	6.345	0.8	1	8.30	0.00	106.30	0.00
CP22A	1041525415	7.30	0.004	0.0	5.870	0.8	6.115	0.8	1	8.30	0.00	106.30	0.00
CP22C	1044225393	7.30	0.007	0.0	6.120	0.8	6.345	0.8	1	8.30	0.00	106.30	0.01
CP23	1043825402	7.30	0.010	0.0	4.080	0.8	6.145	0.8	1	8.30	0.00	106.30	0.01
CP23A	1041725418	7.30	0.005	0.0	6.070	0.8	6.295	0.8	1	8.30	0.00	106.30	0.00
CP23B	1044825394	7.30	0.005	0.0	6.070	0.8	6.295	0.8	1	8.30	0.00	106.30	0.00
CP13	1043125377	5.60	0.072	0.0	3.900	1.2	5.575	1.2	1	6.60	0.01	104.60	0.07
BU1	1042025382	5.90	0.023	0.0	4.090	0.8	4.315	0.8	1	6.90	0.00	104.90	0.02
L10	1040925405	5.81	0.000	0.0	2.900	1.8	4.100	0.3	1	6.81	0.00	104.81	0.00
L11	1041425419	5.82	0.062	0.0	3.130	1.8	4.200	0.3	1	6.82	0.01	104.82	0.06
L10-1	1039625403	5.64	0.100	0.0	3.200	1.8	3.880	0.3	1	6.64	0.01	104.64	0.10
BU3	1039725400	6.05	0.049	0.0	4.020	0.7	4.170	0.7	1	7.05	0.00	105.05	0.05
L10-2	1036725366	5.90	0.025	0.0	3.500	1.8	3.950	0.3	1	6.90	0.00	104.90	0.03
BU2	1037725365	5.90	0.033	0.0	4.170	0.8	4.395	0.8	1	6.90	0.00	104.90	0.03
CP10-3	1036125378	5.10	0.027	0.0	4.000	0.9	4.700	0.9	1	6.10	0.00	104.10	0.03
CP5	1047125443	5.00	2.021	0.0	3.780	0.9	4.080	0.9	1	6.00	2.02	8.00	2.02
MF1	1045925442	7.32	Pond										
			Level 1 =	2.360 m AD, Area 1 =			27.5 m2						
			Level 2 =	7.300 m AD, Area 2 =			27.5 m2						

Node Ref	Map Reference	Ground Level (m AD)	Area (ha)	Connection Density	Floor Level (m AD)	Chamber Area (m2)	Roof Level (m AD)	Shaft Area (m2)	Flood Type	< Flood Area 1> Level (m AD)	Area (ha)	< Flood Area 2> Level (m AD)	Area (ha)
UC-A-1	1048725539	6.22	0.085	0.0	5.919	0.9	6.219	0.9	1	7.22	0.01	105.22	0.09
UC-A-2	1052025595	6.90	0.040	0.0	6.588	0.9	6.888	0.9	1	7.90	0.00	105.90	0.04
CP-A-1	1042725467	5.60	0.085	0.0	5.091	1.0	5.466	1.0	1	6.60	0.01	104.60	0.09
CP-A-2	1048725540	6.10	0.040	0.0	5.550	0.9	5.980	0.9	1	7.10	0.00	105.10	0.04
CP21-1	1059125360	6.81	0.011	0.0	6.570	0.8	6.795	0.8	1	7.81	0.00	105.81	0.01
CP21-1A	1054725391	7.87	0.011	0.0	7.640	0.8	7.865	0.8	1	8.87	0.00	106.87	0.01
CP21-2	1071825471	7.94	0.030	0.0	7.710	0.8	7.935	0.8	1	8.94	0.00	106.94	0.03
CP21	1062125359	6.81	0.037	0.0	5.100	0.9	6.445	0.9	1	7.81	0.00	105.81	0.04
CP17-1	1052825552	6.00	0.023	0.0	5.700	0.9	6.000	0.9	1	7.00	0.00	105.00	0.02
CP17-2	1058725625	6.90	0.048	0.0	6.600	0.9	6.900	0.9	1	7.90	0.00	105.90	0.05
CP14-1	1044525440	7.00	0.010	0.0	6.120	0.8	6.375	0.8	1	8.00	0.00	106.00	0.01
CP14-2	1052325538	7.00	0.012	0.0	6.770	0.8	6.995	0.8	1	8.00	0.00	106.00	0.01
CP14-3	1043625448	6.50	0.009	0.0	6.270	0.8	6.495	0.8	1	7.50	0.00	105.50	0.01
CP9	1045825417	3.90	0.010	0.0	3.630	0.9	3.880	0.9	1	4.90	0.01	6.90	0.01
CP11	1045425408	4.10	0.090	0.0	3.660	0.9	3.960	0.9	1	5.10	-0.09	7.10	0.09
CP10-1	1043025434	4.00	0.007	0.0	3.800	0.9	4.000	0.9	1	5.00	0.01	7.00	0.01
CP10	1045525414	4.10	0.016	0.0	3.600	0.9	3.910	0.9	1	5.10	0.02	7.10	0.02
CP10-2	1047625403	4.00	0.010	0.0	3.800	0.9	4.000	0.9	1	5.00	0.01	7.00	0.01
G1	1045525423	7.55	0.000	0.0	3.500	0.9	3.850	0.9	0	7.55	0.00	107.55	0.00
G2	1046025426	7.47	0.003	0.0	5.500	0.9	5.800	0.9	1	8.47	0.00	106.47	0.00
CP10-4	1039225417	5.40	0.062	0.0	4.800	0.9	5.100	0.9	1	6.40	0.01	104.40	0.06
CP10-4a	1042625460	5.70	0.036	0.0	5.200	0.9	5.500	0.9	1	6.70	0.00	104.70	0.04
L10-1a	1040625400	5.65	0.017	0.0	3.090	1.2	3.570	1.2	1	6.65	0.00	104.65	0.02
M14	1075825528	7.95	0.009	0.0	5.200	0.9	5.520	0.9	1	8.95	0.00	106.95	0.01
M15	1076125546	7.85	0.029	0.0	5.010	1.5	5.900	1.5	1	8.85	0.00	106.85	0.03
M16	1075625559	7.75	0.018	0.0	4.960	1.5	5.570	1.5	1	8.75	0.00	106.75	0.02
M17	1072725582	7.80	0.033	0.0	4.840	1.5	5.450	1.5	1	8.80	0.00	106.80	0.03
M18	1069525607	7.90	0.041	0.0	4.700	1.5	5.310	1.5	1	8.90	0.00	106.90	0.04
M19	1067125609	7.75	0.019	0.0	4.610	1.5	5.525	1.5	1	8.75	0.00	106.75	0.02
M20	1063525613	7.85	0.064	0.0	4.490	1.5	5.100	1.5	1	8.85	0.01	106.85	0.06
M21	1060225625	7.75	0.041	0.0	4.380	1.6	5.055	1.6	1	8.75	0.00	106.75	0.04
M22	1058625602	7.75	0.059	0.0	4.280	1.6	4.965	1.6	1	8.75	0.01	106.75	0.06
M23	1056025577	7.85	0.050	0.0	4.160	1.6	4.985	1.6	1	8.85	0.00	106.85	0.05
M14-1	1073225498	7.75	0.019	0.0	5.490	0.9	5.790	0.9	1	8.75	0.00	106.75	0.02
SM2	1054025542	7.70	0.000	0.0	3.840	0.9	4.150	0.9	1	8.70	0.00	106.70	0.00
CP208	1055425548	5.00	2.021	0.0	4.240	0.9	4.540	0.9	1	6.00	0.20	104.00	2.02
MF2	1055025547	7.32	Pond										
			Level 1 =	2.360 m AD, Area 1 =			27.5 m2						
			Level 2 =	7.300 m AD, Area 2 =			27.5 m2						
OUT*	1035925359	7.20											

Nodes marked '*' are outfalls

******** Catchment data *******

Node Ref	Area (ha)	Land Use	Population	Soil Class	DWF Idx	<Infiltration> Flow (m3/s)	Index	Rain Prof	< Surface 1 > Area (ha)	Run	Pol	< Surface 2 > Area (ha)	Run	Pol	< Surface 3 > Area (ha)	Run	Pol	Conn (%)
E1	0.020	99	0	1	0	0.00000	-1	1	0.020	10	1	0.000	20	1	0.000	21	1	0
E2	0.010	99	0	1	0	0.00000	-1	1	0.010	10	1	0.000	20	1	0.000	21	1	0
E3	0.010	99	0	1	0	0.00000	-1	1	0.010	10	1	0.000	20	1	0.000	21	1	0
M8-2	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
CP-U-4	0.102	99	0	1	0	0.00000	-1	1	0.025	10	1	0.000	20	1	0.076	21	1	0
CPU-4A	0.028	99	0	1	0	0.00000	-1	1	0.007	10	1	0.000	20	1	0.021	21	1	0
CPC1	0.013	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.010	21	1	0
CPL1	0.015	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.011	21	1	0
CP-U-9	0.068	99	0	1	0	0.00000	-1	1	0.017	10	1	0.000	20	1	0.051	21	1	0
CPU-9A	0.032	99	0	1	0	0.00000	-1	1	0.008	10	1	0.000	20	1	0.024	21	1	0
CPK1	0.019	99	0	1	0	0.00000	-1	1	0.005	10	1	0.000	20	1	0.014	21	1	0
CPD1	0.013	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.010	21	1	0
CPC	0.049	99	0	1	0	0.00000	-1	1	0.012	10	1	0.000	20	1	0.037	21	1	0
CPD	0.039	99	0	1	0	0.00000	-1	1	0.010	10	1	0.000	20	1	0.029	21	1	0
CPK	0.029	99	0	1	0	0.00000	-1	1	0.007	10	1	0.000	20	1	0.022	21	1	0
CPL	0.053	99	0	1	0	0.00000	-1	1	0.013	10	1	0.000	20	1	0.040	21	1	0
N1-1	0.036	99	0	1	0	0.00000	-1	1	0.036	10	1	0.000	20	1	0.000	21	1	0
N1-1a	0.028	99	0	1	0	0.00000	-1	1	0.028	10	1	0.000	20	1	0.000	21	1	0
N1-1b	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
N1-2	0.016	99	0	1	0	0.00000	-1	1	0.016	10	1	0.000	20	1	0.000	21	1	0
N1-2a	0.029	99	0	1	0	0.00000	-1	1	0.029	10	1	0.000	20	1	0.000	21	1	0
N1-3	0.040	99	0	1	0	0.00000	-1	1	0.040	10	1	0.000	20	1	0.000	21	1	0
N1-3a	0.045	99	0	1	0	0.00000	-1	1	0.045	10	1	0.000	20	1	0.000	21	1	0
N1-4	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
N1-4a	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
N1-5	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
CP-U-3	0.085	99	0	1	0	0.00000	-1	1	0.021	10	1	0.000	20	1	0.064	21	1	0
M1	0.027	99	0	1	0	0.00000	-1	1	0.027	10	1	0.000	20	1	0.000	21	1	0
M2	0.027	99	0	1	0	0.00000	-1	1	0.027	10	1	0.000	20	1	0.000	21	1	0
M3	0.089	99	0	1	0	0.00000	-1	1	0.089	10	1	0.000	20	1	0.000	21	1	0
CP-U-8	0.026	99	0	1	0	0.00000	-1	1	0.007	10	1	0.000	20	1	0.020	21	1	0
M3-1	0.038	99	0	1	0	0.00000	-1	1	0.038	10	1	0.000	20	1	0.000	21	1	0
M4	0.025	99	0	1	0	0.00000	-1	1	0.025	10	1	0.000	20	1	0.000	21	1	0
M5	0.058	99	0	1	0	0.00000	-1	1	0.058	10	1	0.000	20	1	0.000	21	1	0
M6	0.044	99	0	1	0	0.00000	-1	1	0.044	10	1	0.000	20	1	0.000	21	1	0
M7	0.039	99	0	1	0	0.00000	-1	1	0.039	10	1	0.000	20	1	0.000	21	1	0
M8	0.062	99	0	1	0	0.00000	-1	1	0.062	10	1	0.000	20	1	0.000	21	1	0
M9	0.036	99	0	1	0	0.00000	-1	1	0.036	10	1	0.000	20	1	0.000	21	1	0
CP20A	0.007	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.005	21	1	0
CP20	0.007	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.005	21	1	0
CP15B	0.016	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.012	21	1	0
CP19A	0.013	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.010	21	1	0
CP19B	0.005	99	0	1	0	0.00000	-1	1	0.001	10	1	0.000	20	1	0.004	21	1	0
CP19	0.013	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.010	21	1	0
CP15A	0.007	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.005	21	1	0
CP15	0.023	99	0	1	0	0.00000	-1	1	0.006	10	1	0.000	20	1	0.017	21	1	0
CP14	0.022	99	0	1	0	0.00000	-1	1	0.005	10	1	0.000	20	1	0.016	21	1	0
M10	0.031	99	0	1	0	0.00000	-1	1	0.031	10	1	0.000	20	1	0.000	21	1	0
M11	0.060	99	0	1	0	0.00000	-1	1	0.060	10	1	0.000	20	1	0.000	21	1	0
M12	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
M12-1	0.044	99	0	1	0	0.00000	-1	1	0.044	10	1	0.000	20	1	0.000	21	1	0
M8-1	0.027	99	0	1	0	0.00000	-1	1	0.027	10	1	0.000	20	1	0.000	21	1	0
CP12A	0.005	99	0	1	0	0.00000	-1	1	0.001	10	1	0.000	20	1	0.004	21	1	0

Node Ref	Area (ha)	Land Use	Population	Soil Class	DWF Idx	<Infiltration> Flow (m3/s)	Index	Rain Prof	< Surface 1 > Area (ha)	Run	Pol	< Surface 2 > Area (ha)	Run	Pol	< Surface 3 > Area (ha)	Run	Pol	Conn (%)
CP12B	0.017	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.013	21	1	0
CP12	0.022	99	0	1	0	0.00000	-1	1	0.005	10	1	0.000	20	1	0.016	21	1	0
CP17	0.071	99	0	1	0	0.00000	-1	1	0.018	10	1	0.000	20	1	0.053	21	1	0
CP17A	0.022	99	0	1	0	0.00000	-1	1	0.005	10	1	0.000	20	1	0.016	21	1	0
CP17-1A	0.007	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.005	21	1	0
CP17-2A	0.015	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.011	21	1	0
SM1	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
M13	0.012	99	0	1	0	0.00000	-1	1	0.012	10	1	0.000	20	1	0.000	21	1	0
CP13A	0.062	99	0	1	0	0.00000	-1	1	0.062	10	1	0.000	20	1	0.000	21	1	0
CP13B	0.023	99	0	1	0	0.00000	-1	1	0.023	10	1	0.000	20	1	0.000	21	1	0
CP13C	0.050	99	0	1	0	0.00000	-1	1	0.013	10	1	0.000	20	1	0.038	21	1	0
CPU-1-1	0.015	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.011	21	1	0
CPU-1-2	0.021	99	0	1	0	0.00000	-1	1	0.005	10	1	0.000	20	1	0.016	21	1	0
CP-U-1A	0.012	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.009	21	1	0
CPU1AA	0.011	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.008	21	1	0
CPU1AB	0.002	99	0	1	0	0.00000	-1	1	0.001	10	1	0.000	20	1	0.002	21	1	0
CP-U-1B	0.018	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.013	21	1	0

CP-U-1B2	0.014	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.010	21	1	0
CPU-1C	0.010	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.007	21	1	0
CPU2A	0.015	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.011	21	1	0
CPU2B	0.018	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.013	21	1	0
CPU3A	0.044	99	0	1	0	0.00000	-1	1	0.011	10	1	0.000	20	1	0.033	21	1	0
CPU3B	0.040	99	0	1	0	0.00000	-1	1	0.010	10	1	0.000	20	1	0.030	21	1	0
CPU8B	0.026	99	0	1	0	0.00000	-1	1	0.007	10	1	0.000	20	1	0.020	21	1	0
L1	0.038	99	0	1	0	0.00000	-1	1	0.038	10	1	0.000	20	1	0.000	21	1	0
L2	0.028	1	0	1	1	0.00000	0	1	0.028	10	1	0.000	20	1	0.000	21	1	100
L3	0.025	99	0	1	0	0.00000	-1	1	0.025	10	1	0.000	20	1	0.000	21	1	0
CP-U-2	0.034	99	0	1	0	0.00000	-1	1	0.009	10	1	0.000	20	1	0.026	21	1	0
L4	0.035	99	0	1	0	0.00000	-1	1	0.035	10	1	0.000	20	1	0.000	21	1	0
L5	0.084	99	0	1	0	0.00000	-1	1	0.084	10	1	0.000	20	1	0.000	21	1	0
L6	0.025	99	0	1	0	0.00000	-1	1	0.025	10	1	0.000	20	1	0.000	21	1	0
L7	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
L8	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
CP-U-1	0.036	99	0	1	0	0.00000	-1	1	0.009	10	1	0.000	20	1	0.027	21	1	0
L9	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
CP22	0.014	99	0	1	0	0.00000	-1	1	0.004	10	1	0.000	20	1	0.010	21	1	0
CP22B	0.004	99	0	1	0	0.00000	-1	1	0.001	10	1	0.000	20	1	0.003	21	1	0
CP22A	0.004	99	0	1	0	0.00000	-1	1	0.001	10	1	0.000	20	1	0.003	21	1	0
CP22C	0.007	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.005	21	1	0
CP23	0.010	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.007	21	1	0
CP23A	0.005	99	0	1	0	0.00000	-1	1	0.001	10	1	0.000	20	1	0.004	21	1	0
CP23B	0.005	99	0	1	0	0.00000	-1	1	0.001	10	1	0.000	20	1	0.004	21	1	0
CP13	0.072	99	0	1	0	0.00000	-1	1	0.072	10	1	0.000	20	1	0.000	21	1	0
BU1	0.023	99	0	1	0	0.00000	-1	1	0.023	10	1	0.000	20	1	0.000	21	1	0
L10	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
L11	0.062	99	0	1	0	0.00000	-1	1	0.062	10	1	0.000	20	1	0.000	21	1	0
L10-1	0.100	99	0	1	0	0.00000	-1	1	0.100	10	1	0.000	20	1	0.000	21	1	0
BU3	0.049	99	0	1	0	0.00000	-1	1	0.049	10	1	0.000	20	1	0.000	21	1	0
L10-2	0.025	99	0	1	0	0.00000	-1	1	0.025	10	1	0.000	20	1	0.000	21	1	0
BU2	0.033	99	0	1	0	0.00000	-1	1	0.033	10	1	0.000	20	1	0.000	21	1	0
CP10-3	0.027	99	0	1	0	0.00000	-1	1	0.027	10	1	0.000	20	1	0.000	21	1	0
CP5	2.021	99	0	1	0	0.00000	-1	1	2.021	10	1	0.000	20	1	0.000	21	1	0
MF1	0.000	1	0	1	0	0.00000	0	1	0.000	10	1	0.000	20	1	0.000	21	1	0

Node Ref	Area (ha)	Land Use	Population	Soil Class	DWF Idx	<Infiltration> Flow (m3/s)	Index	Rain Prof	< Surface 1 > Area (ha)	Run	Pol	< Surface 2 > Area (ha)	Run	Pol	< Surface 3 > Area (ha)	Run	Pol	Conn (%)
UC-A-1	0.085	99	0	1	0	0.00000	-1	1	0.021	10	1	0.000	20	1	0.064	21	1	0
UC-A-2	0.040	99	0	1	0	0.00000	-1	1	0.010	10	1	0.000	20	1	0.030	21	1	0
CP-A-1	0.085	99	0	1	0	0.00000	-1	1	0.085	10	1	0.000	20	1	0.000	21	1	0
CP-A-2	0.040	99	0	1	0	0.00000	-1	1	0.040	10	1	0.000	20	1	0.000	21	1	0
CP21-1	0.011	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.008	21	1	0
CP21-1A	0.011	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.008	21	1	0
CP21-2	0.030	99	0	1	0	0.00000	-1	1	0.007	10	1	0.000	20	1	0.022	21	1	0
CP21	0.037	99	0	1	0	0.00000	-1	1	0.009	10	1	0.000	20	1	0.028	21	1	0
CP17-1	0.023	99	0	1	0	0.00000	-1	1	0.006	10	1	0.000	20	1	0.017	21	1	0
CP17-2	0.048	99	0	1	0	0.00000	-1	1	0.012	10	1	0.000	20	1	0.036	21	1	0
CP14-1	0.010	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.007	21	1	0
CP14-2	0.012	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.009	21	1	0
CP14-3	0.009	99	0	1	0	0.00000	-1	1	0.002	10	1	0.000	20	1	0.007	21	1	0
CP9	0.010	99	0	1	0	0.00000	-1	1	0.010	10	1	0.000	20	1	0.000	21	1	0
CP11	0.090	99	0	1	0	0.00000	-1	1	0.090	10	1	0.000	20	1	0.000	21	1	0
CP10-1	0.007	99	0	1	0	0.00000	-1	1	0.007	10	1	0.000	20	1	0.000	21	1	0
CP10	0.016	99	0	1	0	0.00000	-1	1	0.016	10	1	0.000	20	1	0.000	21	1	0
CP10-2	0.010	99	0	1	0	0.00000	-1	1	0.010	10	1	0.000	20	1	0.000	21	1	0
G1	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
G2	0.003	99	0	1	0	0.00000	-1	1	0.003	10	1	0.000	20	1	0.000	21	1	0
CP10-4	0.062	99	0	1	0	0.00000	-1	1	0.015	10	1	0.000	20	1	0.046	21	1	0
CP10-4a	0.036	99	0	1	0	0.00000	-1	1	0.009	10	1	0.000	20	1	0.027	21	1	0
L10-1a	0.017	99	0	1	0	0.00000	-1	1	0.017	10	1	0.000	20	1	0.000	21	1	0
M14	0.009	99	0	1	0	0.00000	-1	1	0.009	10	1	0.000	20	1	0.000	21	1	0
M15	0.029	99	0	1	0	0.00000	-1	1	0.029	10	1	0.000	20	1	0.000	21	1	0
M16	0.018	99	0	1	0	0.00000	-1	1	0.018	10	1	0.000	20	1	0.000	21	1	0
M17	0.033	99	0	1	0	0.00000	-1	1	0.033	10	1	0.000	20	1	0.000	21	1	0
M18	0.041	99	0	1	0	0.00000	-1	1	0.041	10	1	0.000	20	1	0.000	21	1	0
M19	0.019	99	0	1	0	0.00000	-1	1	0.019	10	1	0.000	20	1	0.000	21	1	0
M20	0.064	99	0	1	0	0.00000	-1	1	0.064	10	1	0.000	20	1	0.000	21	1	0
M21	0.041	99	0	1	0	0.00000	-1	1	0.041	10	1	0.000	20	1	0.000	21	1	0
M22	0.059	99	0	1	0	0.00000	-1	1	0.059	10	1	0.000	20	1	0.000	21	1	0
M23	0.050	99	0	1	0	0.00000	-1	1	0.050	10	1	0.000	20	1	0.000	21	1	0
M14-1	0.019	99	0	1	0	0.00000	-1	1	0.019	10	1	0.000	20	1	0.000	21	1	0
SM2	0.000	99	0	1	0	0.00000	-1	1	0.000	10	1	0.000	20	1	0.000	21	1	0
CP208	2.021	99	0	1	0	0.00000	-1	1	2.021	10	1	0.000	20	1	0.000	21	1	0
MF2	0.000	1	0	1	0	0.00000	0	1	0.000	10	1	0.000	20	1	0.000	21	1	0

Total population	0
Total infiln. flow (m3/s)	0.00000
Total area surface 1 (ha)	6.682
Total area surface 3 (ha)	1.250

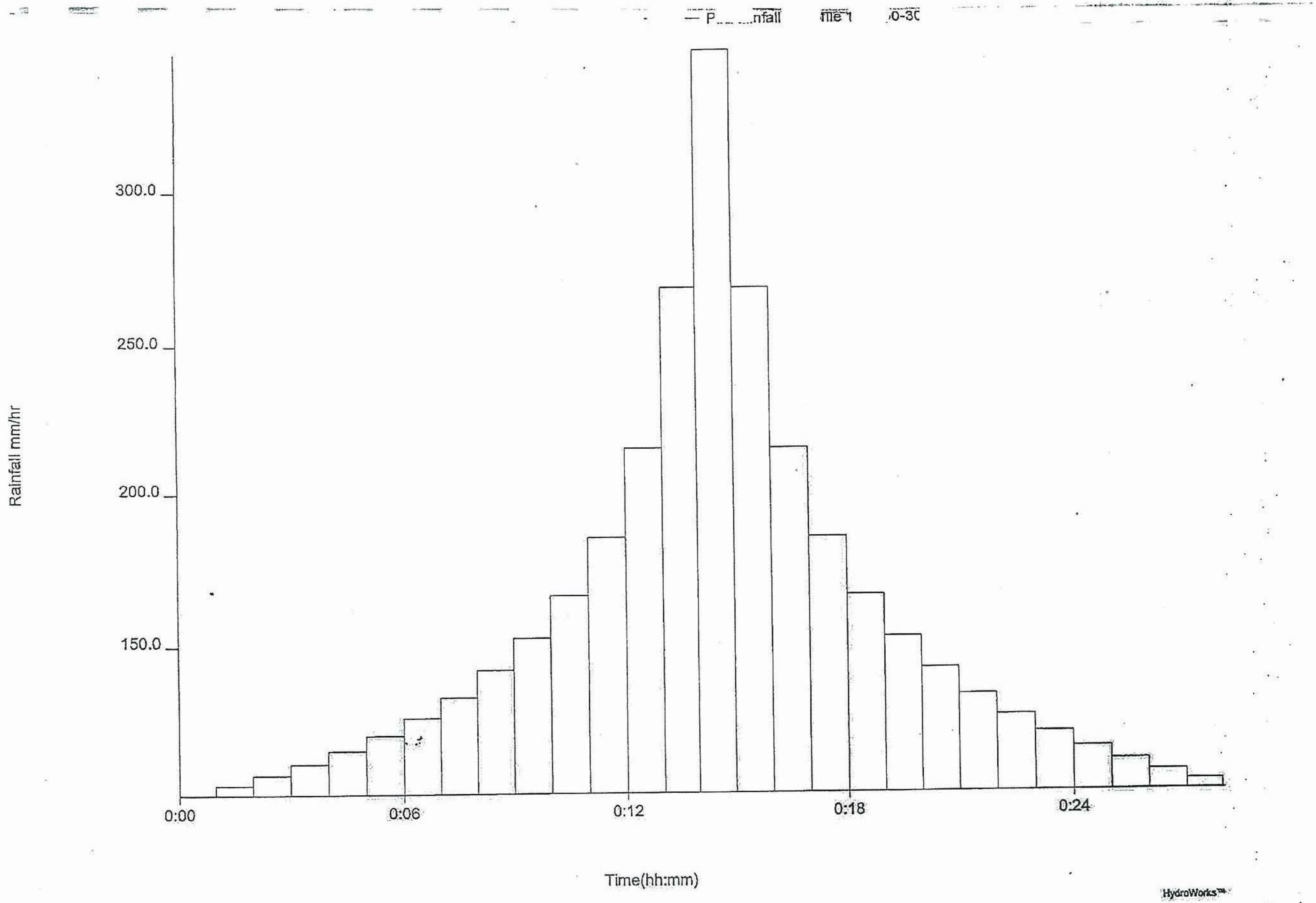
********** Link data **********

Link Reference	D/S Node	Conduit Len (m)	Conduit Shape	Conduit Width (mm)	Conduit Hgt (mm)	Roughness Bottom	Roughness Top	Sed Dpth (mm)	Sed Ty	Upstream Invert (m AD)	Upstream Loss T	Upstream Loss Coeff	Upstream Set Eff	Downstream Invert (m AD)	Downstream Loss T	Downstream Loss Coeff	Downstream Set Eff	Slope	Conduit Cap (m3/s)	No. Comp Node	S M
CPK.1	CP-U-9	52	OU	300	300	1.50	0.60	48	0	6.350	1	1.00	0	5.190	1	8.00	0	0.0223	0.190	10	0
CPD.1	CP-U-9	70	OU	300	300	1.50	0.60	48	0	6.300	1	1.00	0	5.240	1	8.00	0	0.0151	0.157	13	0
CPK1.1	CPU-9A	95	OU	225	225	1.50	0.60	48	0	7.710	1	1.00	0	5.920	1	6.60	0	0.0188	0.076	22	0
CPD1.1	CPU-9A	58	OU	225	225	1.50	0.60	48	0	7.380	1	1.00	0	5.920	1	6.60	0	0.0252	0.088	14	0
CPC.1	CP-U-4	70	OU	300	300	1.50	0.60	48	0	6.440	1	1.00	0	5.890	1	8.00	0	0.0079	0.113	13	0
CPL.1	CP-U-4	90	OU	300	300	1.50	0.60	48	0	6.330	1	1.00	0	5.870	1	8.00	0	0.0051	0.091	16	0
CPC1.1	CPU-4A	66	OU	225	225	1.50	0.60	48	0	7.380	1	1.00	0	5.820	1	6.60	0	0.0236	0.085	16	0
CPL1.1	CPU-4A	68	OU	225	225	1.50	0.60	48	0	7.470	1	1.00	0	6.200	1	6.60	0	0.0187	0.076	16	0
E1.1	E2	6	CIRC	300	300	1.50	0.60	48	0	4.140	1	6.00	0	4.080	1	3.30	0	0.0100	0.089	5	0
E2.1	E3	5	CIRC	300	300	1.50	0.60	48	0	4.080	1	3.30	0	3.980	1	1.00	0	0.0200	0.126	5	0
E3.1	N1-1	19	CIRC	300	300	1.50	0.60	48	0	3.980	1	1.00	0	3.830	1	3.30	0	0.0079	0.079	5	0
N1-1.1	N1-1a	12	CIRC	900	900	1.50	0.60	144	0	3.824	1	3.30	0	3.761	1	1.00	0	0.0052	1.169	5	0
N1-1a.1	N1-2	21	CIRC	1050	1050	1.50	0.60	165	0	3.732	1	1.00	0	3.642	1	3.30	0	0.0043	1.588	5	0
N1-2.1	N1-2a	42	CIRC	1050	1050	1.50	0.60	165	0	3.593	1	6.60	0	3.419	1	1.00	0	0.0041	1.562	5	0
N1-2a.1	N1-3	26	CIRC	1050	1050	1.50	0.60	165	0	3.399	1	1.00	0	3.268	1	1.00	0	0.0050	1.723	5	0
N1-3.1	N1-3a	28	CIRC	1050	1050	1.50	0.60	165	0	3.239	1	1.00	0	3.125	1	1.00	0	0.0041	1.548	5	0
N1-3a.1	N1-4	10	CIRC	1050	1050	1.50	0.60	165	0	3.115	1	3.30	0	3.039	1	1.00	0	0.0076	2.118	5	0
N1-4.1	N1-4a	45	CIRC	1500	1500	1.50	0.60	235	0	3.005	1	6.00	0	2.827	1	1.00	0	0.0040	3.889	5	0
N1-4a.1	N1-5	45	CIRC	1500	1500	1.50	0.60	235	0	2.826	1	6.60	0	2.631	1	1.00	0	0.0043	4.071	5	0
N1-5.1	OUT	14	CIRC	1500	1500	1.50	0.60	235	0	1.901	1	1.00	0	0.155	1	1.00	0	0.1247	21.907	5	0
CP-U-3.1	M1	11	CIRC	300	300	1.50	0.60	36	0	4.960	1	6.60	0	4.840	1	6.60	0	0.0109	0.099	5	0
M1.1	M2	35	CIRC	375	375	1.50	0.60	60	0	4.810	1	6.60	0	4.610	1	3.30	0	0.0057	0.122	6	0
M2.1	M3	28	CIRC	450	450	1.50	0.60	72	0	4.580	1	3.30	0	4.450	1	3.30	0	0.0046	0.177	5	0
M3.1	M4	28	CIRC	600	600	1.50	0.60	94	0	4.420	1	3.30	0	4.330	1	1.00	0	0.0032	0.316	5	0
CP-U-8.1	M3-1	18	CIRC	300	300	1.50	0.60	72	0	4.820	1	6.00	0	4.700	1	1.00	0	0.0067	0.063	5	0
M3-1.1	M3	31	CIRC	600	600	1.50	0.60	94	0	4.670	1	8.00	0	4.450	1	3.30	0	0.0071	0.471	5	0
M4.1	M5	34	CIRC	600	600	1.50	0.60	94	0	4.300	1	1.00	0	4.190	1	3.30	0	0.0032	0.317	5	0
M5.1	M6	25	CIRC	600	600	1.50	0.60	94	0	4.160	1	3.30	0	4.080	1	3.30	0	0.0032	0.315	5	0
M6.1	M7	33	CIRC	600	600	1.50	0.60	94	0	4.050	1	3.30	0	3.940	1	3.30	0	0.0033	0.322	5	0
M7.1	M8	43	CIRC	750	750	1.50	0.60	118	0	3.910	1	3.30	0	3.800	1	6.60	0	0.0026	0.506	5	0
M8.1	M9	25	CIRC	750	750	1.50	0.60	118	0	3.770	1	6.60	0	3.690	1	1.00	0	0.0032	0.566	5	0
M9.1	M10	41	CIRC	900	900	1.50	0.60	144	0	3.660	1	1.00	0	3.570	1	1.00	0	0.0022	0.754	5	0
M10.1	M11	35	CIRC	900	900	1.50	0.60	144	0	3.540	1	6.60	0	3.460	1	3.30	0	0.0023	0.769	5	0
M12.1	M11	21	CIRC	300	300	1.50	0.60	47	0	4.800	1	6.00	0	4.000	1	8.00	0	0.0381	0.176	5	0
M12-1.1	M12	19	CIRC	225	225	1.50	0.60	36	0	5.100	1	1.00	0	4.830	1	6.00	0	0.0142	0.050	5	0
CP17.1	CP17A	3	CIRC	300	300	1.50	0.60	60	0	5.000	1	8.00	0	4.900	1	3.30	0	0.0333	0.153	5	0
CP17-1A.1	CP17A	40	OU	225	225	1.50	0.60	48	0	7.450	1	0.00	0	6.400	1	8.00	0	0.0262	0.090	10	0
CP17-2A.1	CP17A	60	OU	225	225	1.50	0.60	48	0	7.450	1	0.00	0	6.400	1	8.00	0	0.0175	0.073	14	0
CP17A.1	M23	3	CIRC	225	225	1.50	0.60	48	0	4.880	1	8.00	0	4.760	1	6.00	0	0.0400	0.077	5	0
M8-2.1	N1-1b	6	CIRC	675	675	1.50	0.60	108	0	3.830	1	6.60	0	3.800	1	1.00	0	0.0050	0.535	5	0
CP12.1	E1	12	CIRC	300	300	1.50	0.60	48	0	5.360	1	8.00	0	4.170	1	6.00	0	0.0992	0.282	5	0
CP12B.1	CP12	89	OU	300	300	1.50	0.60	48	0	6.430	1	1.00	0	5.910	1	6.00	0	0.0058	0.097	16	0
CP12A.1	CP12	40	OU	300	300	1.50	0.60	48	0	6.500	1	1.00	0	6.230	1	8.00	0	0.0067	0.104	8	0
CP19A.1	CP19	65	OU	300	300	1.50	0.60	48	0	7.890	1	1.00	0	6.940	1	6.00	0	0.0146	0.154	12	0
CP19B.1	CP19	4	OU	300	300	1.50	0.60	48	0	6.840	1	1.00	0	6.930	1	8.00	0	-0.0225	-0.191	5	0
CP19.1	N1-3	11	CIRC	300	300	1.50	0.60	48	0	5.400	1	8.00	0	3.840	1	3.30	0	0.1418	0.338	5	0
CP20A.1	CP20	32	OU	300	300	1.50	0.60	48	0	7.890	1	1.00	0	7.000	1	6.60	0	0.0278	0.213	6	0
CP20.1	N1-1b	4	CIRC	300	300	1.50	0.60	48	0	5.090	1	6.60	0	4.400	1	6.60	0	0.1725	0.373	5	0
N1-1b.1	N1-1a	8	CIRC	675	675	1.50	0.60	108	0	3.795	1	6.60	0	3.760	1	6.60	0	0.0044	0.501	5	0
CP15B.1	CP15	58	OU	300	300	1.50	0.60	48	0	6.600	1	1.00	0	6.180	1	6.60	0	0.0072	0.108	11	0
CP15A.1	CP15	35	OU	300	300	1.50	0.60	48	0	6.420	1	1.00	0	6.180	1	6.60	0	0.0069	0.105	7	0
CP15.1	CP14	4	CIRC	300	300	1.50	0.60	48	0	5.300	1	6.60	0	5.270	1	1.00	0	0.0075	0.077	5	0
CP14.1	M10	4	CIRC	300	300	1.50	0.60	48	0	4.770	1	1.00	0	4.120	1	6.60	0	0.1625	0.362	5	0

Link Reference	D/S Node	Conduit Len (m)	Conduit Shape	Conduit Width (mm)	Conduit Hgt (mm)	Roughness Bottom	Roughness Top	Sed Dpth (mm)	Sed Ty	Upstream Invert (m AD)	Upstream Loss T	Upstream Loss Coeff	Upstream Set Eff	Downstream Invert (m AD)	Downstream Loss T	Downstream Loss Coeff	Downstream Set Eff	Slope	Conduit Cap (m3/s)	No. Comp Node	S M
SM1.1	M13	4	CIRC	300	300	1.50	0.60	48	0	3.360	1	1.00	0	3.300	1	6.60	0	0.0150	0.109	5	0
MF1.1	SM1	Orifice											100				100				
		Discharge coefficient =				1.00															
		Invert level =				3.400 m AD															
		Diameter =				0.300 m															
		Limiting discharge =				0.108 m3/s															
CP5.1	MF1	11	CIRC	300	300	0.60	0.30	48	0	3.780	1	6.00	0	3.730	1	6.00	0	0.0045	0.066	5	0
CP208.1	MF2	5	CIRC	300	300	0.60	0.30	48	10	4.240	1	6.00	0	4.230	1	6.00	0	0.0020	0.044	5	0
MF2.1	SM2	Orifice											100				100				
		Discharge coefficient =				1.00															
		Invert level =				3.850 m AD															
		Diameter =				0.300 m															
		Limiting discharge =				0.108 m3/s															
SM2.1	M8	10	CIRC	300	300	1.50	0.60	48	0	3.850	1	1.00	0	3.780	1	1.00	0	0.0070	0.075	5	0
CP13B.1	CP13A	30	OU	375	375	1.50	0.60	60	0	5.370	1	1.00	0	5.200	1	6.60	0	0.0057	0.172	5	0
CP13C.1	CP13	17	OU	375	375	1.50	0.60	60	0	5.450	1	1.00	0	5.200	1	3.30	0	0.0147	0.278	5	0
CP13A.1	CP13	48	OU	375	375	1.50	0.60	60	0	5.200	1	6.60	0	4.930	1	3.30	0	0.0056	0.172	7	0

CPU-1-2.1	CP-U-1	70	OU	300	300	1.50	0.60	48	0	5.662	1	1.00	0	5.240	1	6.00	0	0.0060	0.099	13	0
CPU-1-1.1	CP-U-1	45	OU	300	300	1.50	0.60	48	0	5.440	1	1.00	0	5.190	1	8.00	0	0.0056	0.095	9	0
CPU1AA.1	CP-U-1A	8	OU	225	225	1.50	0.60	48	0	7.800	1	1.00	0	7.600	1	6.60	0	0.0250	0.088	5	0
CPU1AB.1	CP-U-1A	24	OU	225	225	1.50	0.60	48	0	7.350	1	1.00	0	7.100	1	6.60	0	0.0104	0.057	6	0
CP-U-1A.1	CP-U-1B	5	CIRC	225	225	1.50	0.60	48	0	6.700	1	1.00	0	6.670	1	6.60	0	0.0060	0.029	5	0
CPU-1C.1	CP-U-1B	52	OU	225	225	1.50	0.60	48	0	7.600	1	1.00	0	6.800	1	6.60	0	0.0154	0.069	13	0
CP-U-1B2.1	CP-U-1B	51	OU	225	225	1.50	0.60	48	0	7.640	1	1.00	0	7.100	1	8.00	0	0.0106	0.057	12	0
CP-U-1B.1	L8	17	CIRC	225	225	1.50	0.60	48	0	5.100	1	8.00	0	3.950	1	6.00	0	0.0676	0.100	5	0
CPU2A.1	CP-U-2	50	OU	300	300	1.50	0.60	48	0	5.680	1	1.00	0	5.100	1	6.60	0	0.0116	0.137	9	0
CPU2B.1	CP-U-2	29	OU	300	300	1.50	0.60	48	0	5.300	1	1.00	0	5.140	1	6.60	0	0.0055	0.094	6	0
CPU3A.1	CP-U-3	72	OU	300	300	1.50	0.60	48	0	5.300	1	1.00	0	5.020	1	6.60	0	0.0039	0.079	13	0
CPU3B.1	CP-U-3	71	OU	300	300	1.50	0.60	48	0	5.800	1	1.00	0	5.240	1	6.60	0	0.0079	0.113	13	0
CPU8B.1	CP-U-8	45	OU	300	300	1.50	0.60	48	0	6.290	1	1.00	0	5.570	1	6.00	0	0.0160	0.161	9	0
L1.1	L2	26	CIRC	300	300	1.50	0.60	48	0	4.580	1	1.00	0	4.390	1	3.30	0	0.0073	0.076	5	0
L2.1	L3	27	CIRC	300	300	1.50	0.60	48	0	4.360	1	6.60	0	4.180	1	3.30	0	0.0067	0.073	6	0
L3.1	L4	26	CIRC	375	375	1.50	0.60	60	0	4.150	1	8.00	0	3.870	1	1.00	0	0.0108	0.167	5	0
L4.1	L5	25	CIRC	600	600	1.50	0.60	96	0	3.840	1	1.00	0	3.730	1	3.30	0	0.0044	0.368	5	0
L5.1	L6	44	CIRC	750	750	1.50	0.60	120	0	3.700	1	3.30	0	3.570	1	3.30	0	0.0030	0.542	5	0
L6.1	L7	21	CIRC	750	750	1.50	0.60	120	0	3.540	1	3.30	0	3.480	1	6.60	0	0.0029	0.533	5	0
L7.1	L8	21	CIRC	750	750	1.50	0.60	120	0	3.450	1	6.60	0	3.380	1	6.00	0	0.0033	0.576	5	0
L8.1	L9	44	CIRC	750	750	1.50	0.60	120	0	3.350	1	6.00	0	3.230	1	3.30	0	0.0027	0.521	5	0
L9.1	L11	28	CIRC	900	900	1.50	0.60	141	0	3.220	1	8.00	0	3.150	1	8.00	0	0.0025	0.809	5	0
L10.1	N1-4a	11	CIRC	1200	1200	1.50	0.60	192	0	2.900	1	6.60	0	2.830	1	6.60	0	0.0064	2.738	5	0
L10-2.1	L10-1	47	CIRC	450	450	1.50	0.60	71	0	3.500	1	8.00	0	3.230	1	6.60	0	0.0057	0.198	6	0
BU3.1	L10-1	3	CIRC	150	150	1.50	0.60	24	0	4.020	1	1.00	0	3.730	1	8.00	0	0.0967	0.044	5	0
CP10-3.1	L10-2	11	CIRC	300	300	1.50	0.60	48	0	4.000	1	6.60	0	3.530	1	6.60	0	0.0427	0.185	5	0
BU2.1	L10-2	10	CIRC	225	225	1.50	0.60	36	0	4.170	1	1.00	0	3.680	1	8.00	0	0.0490	0.093	5	0
L11.1	L10	16	CIRC	1050	1050	1.50	0.60	168	0	3.130	1	8.00	0	3.050	1	6.60	0	0.0050	1.709	5	0
CP-U-2.1	L3	10	CIRC	300	300	1.50	0.60	48	0	4.500	1	6.60	0	4.180	1	6.60	0	0.0320	0.160	5	0
BU1.1	CP13	11	CIRC	225	225	1.50	0.60	36	0	4.090	1	1.00	0	3.930	1	6.60	0	0.0145	0.050	5	0
CP-U-1.1	L8	5	CIRC	300	300	1.50	0.60	36	0	3.700	1	8.00	0	3.570	1	6.00	0	0.0260	0.153	5	0
CP13.1	L9	14	CIRC	450	450	1.50	0.60	71	0	3.900	1	6.60	0	3.280	1	8.00	0	0.0443	0.552	5	0
CP23A.1	CP23	25	OU	225	225	1.50	0.60	36	0	6.070	1	1.00	0	5.820	1	1.00	0	0.0100	0.060	7	0
CP23B.1	CP23	12	OU	225	225	1.50	0.60	36	0	6.070	1	1.00	0	5.920	1	1.00	0	0.0125	0.067	5	0

Link Reference	D/S Node	Conduit Len (m)	Conduit Shape	Conduit Width (mm)	Conduit Hgt (mm)	Roughness Bottom	Roughness Top	Sed Dpth (mm)	Sed Ty	Upstream Invert (m AD)	Upstream Loss T	Upstream Loss Coeff	Upstream Set Eff	Downstream Invert (m AD)	Downstream Loss T	Downstream Loss Coeff	Downstream Set Eff	Slope	Conduit Cap (m3/s)	No. Comp Node	S M
CP23.1	CP22	5	CIRC	225	225	1.50	0.60	36	0	4.080	1	1.00	0	3.990	1	1.00	0	0.0180	0.056	5	0
CP22B.1	CP22A	24	OU	225	225	1.50	0.60	36	0	6.120	1	1.00	0	5.890	1	1.00	0	0.0096	0.058	6	0
CP22A.1	CP22	25	OU	225	225	1.50	0.60	36	0	5.870	1	1.00	0	5.600	1	1.00	0	0.0108	0.062	7	0
CP22C.1	CP22	8	OU	225	225	1.50	0.60	36	0	6.120	1	1.00	0	6.000	1	1.00	0	0.0150	0.073	5	0
CP22.1	L9	6	CIRC	300	300	1.50	0.60	36	0	3.980	1	1.00	0	3.820	1	1.00	0	0.0267	0.155	5	0
UC-A-1.1	CP-A-1	95	OU	300	300	1.50	0.60	48	0	5.919	1	1.00	0	5.100	1	6.60	0	0.0086	0.118	17	0
CP-A-1.1	N1-4	20	CIRC	375	375	1.50	0.60	59	0	5.091	1	6.00	0	3.456	1	6.00	0	0.0817	0.464	5	0
UC-A-2.1	CP-A-2	65	OU	300	300	1.50	0.60	48	0	6.588	1	1.00	0	5.680	1	6.60	0	0.0140	0.151	12	0
CP-A-2.1	N1-2	8	CIRC	225	225	1.50	0.60	36	0	5.550	1	6.60	0	4.709	1	6.60	0	0.1051	0.136	5	0
CP10-4a.1	CP10-4	55	OU	300	300	1.50	0.60	48	0	5.200	1	1.00	0	4.800	1	1.00	0	0.0073	0.108	10	0
CP10-4.1	CP10-3	55	OU	300	300	1.50	0.60	48	0	4.800	1	1.00	0	4.400	1	6.60	0	0.0073	0.108	10	0
L10-1.1	L10-1a	9	CIRC	450	450	1.50	0.60	71	0	3.200	1	6.60	0	3.120	1	6.60	0	0.0089	0.246	5	0
L10-1a.1	L10	5	CIRC	450	450	1.50	0.60	71	0	3.090	1	6.60	0	3.050	1	6.60	0	0.0080	0.234	5	0
G2.1	MF1	12	CIRC	300	300	0.60	0.30	16	0	5.500	1	1.00	0	3.400	1	6.00	0	0.1750	0.476	5	0
CP11.1	CP10	5	CIRC	300	300	0.60	0.30	32	0	3.660	1	8.00	0	3.610	1	1.00	0	0.0100	0.107	5	0
CP10.1	G1	6	CIRC	300	300	0.60	0.30	32	0	3.600	1	8.00	0	3.550	1	1.00	0	0.0083	0.097	5	0
G1.1	MF1	13	CIRC	300	300	0.60	0.30	48	0	3.500	1	1.00	0	3.400	1	6.00	0	0.0077	0.087	5	0
CP10-1.1	CP10	30	OU	300	200	1.50	0.60	48	0	3.800	1	1.00	0	3.610	1	8.00	0	0.0063	0.052	9	0
CP9.1	CP10	5	OU	300	250	1.50	0.60	48	0	3.630	1	6.60	0	3.610	1	8.00	0	0.0040	0.060	5	0
CP10-2.1	CP9	20	OU	300	200	1.50	0.60	48	0	3.800	1	1.00	0	3.630	1	6.60	0	0.0085	0.060	6	0
CP14-3.1	CP14-1	12	OU	225	225	1.50	0.60	48	0	6.270	1	1.00	0	6.150	1	8.00	0	0.0100	0.055	5	0
CP14-1.1	CP14	65	OU	225	225	1.50	0.60	36	0	6.120	1	1.00	0	5.530	1	8.00	0	0.0091	0.057	15	0
CP14-2.1	CP14	62	OU	225	225	1.50	0.60	36	0	6.770	1	1.00	0	5.980	1	6.60	0	0.0127	0.067	15	0
M11.1	M13	26	CIRC	900	900	1.50	0.60	144	0	3.430	1	6.60	0	3.360	1	3.30	0	0.0027	0.835	5	0
M13.1	L11	35	CIRC	1050	1050	1.50	0.60	168	0	3.270	1	6.60	0	3.150	1	3.30	0	0.0034	1.414	5	0
CP17-1.1	CP17	40	OU	300	300	1.50	0.60	48	0	5.700	1	1.00	0	5.100	1	8.00	0	0.0150	0.156	8	0
CP17-2.1	CP17	52	OU	300	300	1.50	0.60	48	0	6.600	1	1.00	0	5.100	1	3.30	0	0.0288	0.217	10	0
CP21-1.1	CP21	31	OU	225	225	1.50	0.60	48	0	6.570	1	1.00	0	6.220	1	6.60	0	0.0113	0.059	8	0
CP21-1A.1	CP21-1	60	OU	225	225	1.50	0.60	48	0	7.640	1	1.00	0	6.570	1	1.00	0	0.0178	0.074	14	0
CP21-2.1	CP21	150	OU	225	225	1.50	0.60	48	0	7.710	1	1.00	0	5.510	1	6.60	0	0.0147	0.067	34	0
CP21.1	L2	3	CIRC	300	300	1.50	0.60	48	0	5.100	1	1.00	0	4.900	1	6.60	0	0.0667	0.231	5	0
M14-1.1	M14	40	CIRC	300	300	1.50	0.60	48	0	5.490	1	1.00	0	5.220	1	1.00	0	0.0067	0.073	8	0
M14.1	M15	11	CIRC	300	300	1.50	0.60	94	0	5.200	1	3.30	0	5.020	1	3.30	0	0.0164	0.085	5	0
CP-U-9.1	M15	28	CIRC	450	450	1.50	0.60	71	0	5.150	1	6.00	0	5.020	1	3.30	0	0.0046	0.178	5	0
CPU-9A.1	M15	7	CIRC	300	300	1.50	0.60	48	0	5.900	1	3.30	0	5.600	1	3.30	0	0.0429	0.185	5	0
M15.1	M16	12	CIRC	600	600	1.50	0.60	94	0	5.010	1	6.00	0	4.970	1	6.00	0	0.0033	0.322	5	0
M16.1	M17	35	CIRC	600	600	1.50	0.60	94	0	4.960	1	1.00	0	4.850	1	1.00	0	0.0031	0.312	5	0
M17.1	M18	39	CIRC	600	600	1.50	0.60	94	0	4.840	1	1.00	0	4.710	1	1.00	0	0.0033	0.322	5	0
M18.1	M19	23	CIRC	600	600	1.50	0.60	94	0	4.700	1	6.00	0	4.620	1	1.00	0	0.0035	0.329	5	0
M19.1	M20	34	CIRC	600	600	1.50	0.60	94	0	4.610	1	1.00	0	4.500	1	6.00	0	0.0032	0.317	5	0
M20.1	M21	32	CIRC	600	600	1.50	0.60	94	0	4.490	1	6.00	0	4.390	1	6.00	0	0.0031	0.311	5	0
M21.1	M22	27	CIRC	675	675	1.50	0.60	94	0	4.380	1	3.30	0	4.290	1	1.00	0	0.0033	0.450	5	0
M22.1	M23	34	CIRC	675	675	1.50	0.60	94	0	4.280	1	1.00	0	4.170	1	1.00	0	0.0032	0.443	5	0
M23.1	M8-1	26	CIRC	675	675	1.50	0.60	94	0	4.160	1	1.00	0	4.040	1	1.00	0	0.0046	0.530	5	0
M8-1.1	M8-2	37	CIRC	675	675	1.50	0.60	94	0	4.040	1	1.00	0	3.980	1	1.00	0	0.0016	0.313	5	0
CP-U-4.1	M19	32	CIRC	375	375	1.50	0.60	48	0	5.800	1	6.00	0	5.150	1	6.00	0	0.0203	0.241	5	0
CPU-4A.1	M19	5	CIRC	300	300	1.50	0.60	48	0	5.400	1	6.00	0	5.200	1	6.00	0	0.0400	0.179	5	0



— P... nfall ... file ... 0-30
Rainfall mm/hr
300.0
250.0
200.0
150.0
0:00
0:06
0:12
0:18
0:24
Time(hh:mm)
HydroWorks™

Start of run configured for MS Windows Produced on 23/07/2008 at 10:13

HydroWorks(tm) SIM

Summary results from Simulation

Version 5.1.075 dated September 2000

Licence Number - WS04260001PM

Message 253: Run finished for event 1.

Manhole data for PAFF Event - 1 WS04260001PM Produced 23/07/2008 Pg 1

Summary results for event 1 -

Started at 00000000000000. Run for 120.00 min. (Requested simulation time 120.00 min)

Files used:

Network:	...\trunk8.dsd	Manhole data for PAFF
State:		
Runoff:	...\pavement.rpf	Pavement Type
Rainfall:	...\1-50-30.red	1 in 50 year storm [M50-30 (1)]
DWF:		
Inflows:		
Levels:	...\1-10.lev	1 in 10 year Tide Level (Lok On Pai)
RTC:		
Results:	...\r0000061.spr	

Using Wallingford Procedure runoff routing model.

Total rainfall	=	5866.0 m3
Total runoff	=	5265.1 m3
Total inflow	=	5265.1 m3
Total outflow	=	3668.3 m3
Total lost	=	0.0 m3

********** Node data **********

Node Reference	Ground Level (m AD)	Max Level (m AD)	Flood Volume (m3)	Flood Depth (m)	Flood Area (m2)	Max Stored (m3)	Inflow (m3)	Vol Balance (m3)
E1	6.580	4.330	0.0	0.000	0.0	0.3	14.7	0.000
E2	6.640	4.312	0.0	0.000	0.0	0.4	7.4	0.000
E3	6.690	4.297	0.0	0.000	0.0	0.6	7.4	0.000
M8-2	7.820	4.458	0.0	0.000	0.0	1.1	0.0	0.000
CP-U-4	6.900	5.976	0.0	0.000	0.0	0.2	38.0	0.000
CPU-4A	6.850	5.508	0.0	0.000	0.0	0.1	10.6	0.000
CPC1	7.610	7.465	0.0	0.000	0.0	0.1	4.8	0.000
CPL1	7.700	7.559	0.0	0.000	0.0	0.1	5.8	0.000
CP-U-9	5.700	5.370	0.0	0.000	0.0	0.3	25.6	0.000
CPU-9A	7.000	6.010	0.0	0.000	0.0	0.1	12.1	0.000
CPK1	7.940	7.804	0.0	0.000	0.0	0.1	7.3	0.000
CPD1	7.610	7.464	0.0	0.000	0.0	0.1	4.8	0.000
CPC	6.740	6.568	0.0	0.000	0.0	0.1	18.4	0.000
CPD	6.610	6.412	0.0	0.000	0.0	0.1	14.8	0.000
CPK	6.740	6.449	0.0	0.000	0.0	0.1	10.8	0.000
CPL	6.660	6.473	0.0	0.000	0.0	0.1	19.9	0.000
N1-1	6.960	4.243	0.0	0.000	0.0	1.0	26.5	0.000
N1-1a	7.390	4.241	0.0	0.000	0.0	1.2	20.6	0.000
N1-1b	7.250	4.362	0.0	0.000	0.0	0.9	0.0	0.000
N1-2	7.940	4.125	0.0	0.000	0.0	1.7	11.8	0.000
N1-2a	7.790	3.937	0.0	0.000	0.0	1.7	21.3	0.000
N1-3	7.370	3.836	0.0	0.000	0.0	1.1	29.4	0.000
N1-3a	6.970	3.763	0.0	0.000	0.0	1.2	33.1	0.000
N1-4	6.630	3.738	0.0	0.000	0.0	1.7	0.0	0.000
N1-4a	5.610	3.695	0.0	0.000	0.0	2.0	0.0	0.000
N1-5	5.880	3.294	0.0	0.000	0.0	3.2	0.0	0.000
CP-U-3	5.800	5.185	0.0	0.000	0.0	0.2	31.9	0.000
M1	8.100	5.079	0.0	0.000	0.0	0.5	19.9	0.000
M2	7.900	4.888	0.0	0.000	0.0	0.6	19.9	0.000
M3	7.700	4.819	0.0	0.000	0.0	0.9	65.5	0.000
CP-U-8	6.080	4.981	0.0	0.000	0.0	0.2	10.3	0.000
M3-1	6.000	4.880	0.0	0.000	0.0	0.5	28.0	0.000
M4	7.450	4.725	0.0	0.000	0.0	1.0	18.4	0.000
M5	7.150	4.634	0.0	0.000	0.0	1.1	42.7	0.000
M6	7.200	4.548	0.0	0.000	0.0	1.6	32.4	0.000
M7	7.450	4.420	0.0	0.000	0.0	1.6	28.7	0.000
M8	7.550	4.342	0.0	0.000	0.0	1.8	45.7	0.000
M9	7.450	4.231	0.0	0.000	0.0	1.8	26.5	0.000
CP20A	8.190	7.970	0.0	0.000	0.0	0.1	2.8	0.000
CP20	7.340	5.169	0.0	0.000	0.0	0.1	2.8	0.000
CP15B	6.900	6.695	0.0	0.000	0.0	0.1	6.0	0.000
CP19A	8.190	7.979	0.0	0.000	0.0	0.1	4.8	0.000
CP19B	7.140	7.019	0.0	0.000	0.0	0.2	1.8	0.000
CP19	7.320	5.485	0.0	0.000	0.0	0.1	4.8	0.000
CP15A	6.720	6.502	0.0	0.000	0.0	0.1	2.8	0.000
CP15	6.480	5.428	0.0	0.000	0.0	0.1	8.8	0.000
CP14	6.500	4.873	0.0	0.000	0.0	0.1	7.8	0.000
M10	7.080	4.135	0.0	0.000	0.0	1.9	22.8	0.000
M11	7.350	4.032	0.0	0.000	0.0	1.9	44.2	0.000
M12	7.500	4.922	0.0	0.000	0.0	0.4	0.0	0.000
M12-1	7.800	5.258	0.0	0.000	0.0	0.3	32.4	0.000
M8-1	7.500	4.663	0.0	0.000	0.0	1.1	19.9	0.000
CP12A	6.800	6.578	0.0	0.000	0.0	0.1	1.8	0.000

Node Reference	Ground Level (m AD)	Max Level (m AD)	Flood Volume (m3)	Flood Depth (m)	Flood Area (m2)	Max Stored (m3)	Inflow (m3)	Vol Balance (m3)
CP12B	6.730	6.528	0.0	0.000	0.0	0.1	6.3	0.000
CP12	6.650	5.451	0.0	0.000	0.0	0.1	7.8	0.000
CP17	5.400	5.471	0.1	0.071	2.3	0.5	26.9	0.000
CP17A	8.030	5.370	0.0	0.000	0.0	0.5	7.8	0.000
CP17-1A	8.030	7.527	0.0	0.000	0.0	0.1	2.8	0.000
CP17-2A	8.030	7.539	0.0	0.000	0.0	0.1	5.8	0.000
SM1	6.450	4.037	0.0	0.000	0.0	0.7	0.0	0.000
M13	6.490	3.935	0.0	0.000	0.0	2.1	8.8	0.000
CP13A	5.750	5.423	0.0	0.000	0.0	0.2	45.7	0.000
CP13B	5.750	5.508	0.0	0.000	0.0	0.1	16.9	0.000
CP13C	5.750	5.579	0.0	0.000	0.0	0.1	19.4	0.000
CPU-1-1	5.750	5.536	0.0	0.000	0.0	0.1	5.8	0.000
CPU-1-2	5.970	5.765	0.0	0.000	0.0	0.1	7.8	0.000
CP-U-1A	8.000	6.821	0.0	0.000	0.0	0.1	4.5	0.000
CPU1AA	8.100	7.883	0.0	0.000	0.0	0.1	4.3	0.000
CPU1AB	7.200	7.425	0.2	0.225	1.0	0.2	1.3	0.000
CP-U-1B	7.340	5.210	0.0	0.000	0.0	0.1	6.3	0.000
CP-U-1B2	7.940	7.734	0.0	0.000	0.0	0.1	5.5	0.000
CPU-1C	7.550	7.682	0.1	0.132	1.0	0.1	3.3	0.000
CPU2A	5.980	5.773	0.0	0.000	0.0	0.1	5.8	0.000
CPU2B	5.760	5.399	0.0	0.000	0.0	0.1	6.3	0.000
CPU3A	5.750	5.441	0.0	0.000	0.0	0.1	16.6	0.000
CPU3B	6.100	5.920	0.0	0.000	0.0	0.1	15.1	0.000

CPU8B	6.690	6.392	0.0	0.000	0.0	0.1	10.3	0.000
L1	7.750	4.845	0.0	0.000	0.0	0.5	28.0	0.000
L2	7.950	4.816	0.0	0.000	0.0	0.8	20.6	0.000
L3	8.200	4.457	0.0	0.000	0.0	0.6	18.4	0.000
CP-U-2	5.670	4.618	0.0	0.000	0.0	0.1	13.3	0.000
L4	8.100	4.156	0.0	0.000	0.0	0.6	25.8	0.000
L5	7.900	4.075	0.0	0.000	0.0	0.7	61.9	0.000
L6	7.850	3.967	0.0	0.000	0.0	0.8	18.4	0.000
L7	7.880	3.943	0.0	0.000	0.0	0.9	0.0	0.000
L8	6.400	3.929	0.0	0.000	0.0	1.0	0.0	0.000
CP-U-1	5.800	3.937	0.0	0.000	0.0	0.2	13.6	0.000
L9	7.200	3.895	0.0	0.000	0.0	1.2	0.0	0.000
CP22	7.300	4.079	0.0	0.000	0.0	0.1	5.5	0.000
CP22B	7.300	6.185	0.0	0.000	0.0	0.1	1.5	0.000
CP22A	7.300	5.942	0.0	0.000	0.0	0.1	1.5	0.000
CP22C	7.300	6.189	0.0	0.000	0.0	0.1	2.8	0.000
CP23	7.300	4.162	0.0	0.000	0.0	0.1	3.3	0.000
CP23A	7.300	6.137	0.0	0.000	0.0	0.1	1.8	0.000
CP23B	7.300	6.136	0.0	0.000	0.0	0.1	1.8	0.000
CP13	5.600	4.118	0.0	0.000	0.0	0.3	53.0	0.000
BU1	5.900	4.209	0.0	0.000	0.0	0.1	16.9	0.000
L10	5.810	3.754	0.0	0.000	0.0	1.5	0.0	0.000
L11	5.820	3.868	0.0	0.000	0.0	1.3	45.7	0.000
L10-1	5.640	4.171	0.0	0.000	0.0	1.6	73.7	0.000
BU3	6.050	4.497	0.0	0.000	0.0	0.5	36.1	0.000
L10-2	5.900	4.292	0.0	0.000	0.0	1.2	18.4	0.000
BU2	5.900	4.353	0.0	0.000	0.0	0.2	24.3	0.000
CP10-3	5.100	4.436	0.0	0.000	0.0	0.4	19.9	0.000
CP5	5.000	5.690	1128.6	0.690	4835.0	1129.8	1488.8	-6.240
MF1	7.320	5.046	0.0	0.000	0.0	73.9	0.0	0.000

Node Reference	Ground Level (m AD)	Max Level (m AD)	Flood Volume (m3)	Flood Depth (m)	Flood Area (m2)	Max Stored (m3)	Inflow (m3)	Vol Balance (m3)
UC-A-1	6.220	6.077	0.0	0.000	0.0	0.2	32.0	0.000
UC-A-2	6.900	6.702	0.0	0.000	0.0	0.1	15.1	0.000
CP-A-1	5.600	5.248	0.0	0.000	0.0	0.2	62.6	0.000
CP-A-2	6.100	5.667	0.0	0.000	0.0	0.1	29.4	0.000
CP21-1	6.810	6.674	0.0	0.000	0.0	0.1	4.3	0.000
CP21-1A	7.870	7.725	0.0	0.000	0.0	0.1	4.3	0.000
CP21-2	7.940	7.817	0.0	0.000	0.0	0.1	10.8	0.000
CP21	6.810	5.212	0.0	0.000	0.0	0.1	13.8	0.000
CP17-1	6.000	5.799	0.0	0.000	0.0	0.1	8.8	0.000
CP17-2	6.900	6.709	0.0	0.000	0.0	0.1	18.1	0.000
CP14-1	7.000	6.209	0.0	0.000	0.0	0.1	3.3	0.000
CP14-2	7.000	6.848	0.0	0.000	0.0	0.1	4.5	0.000
CP14-3	6.500	6.356	0.0	0.000	0.0	0.1	3.3	0.000
CP9	3.900	5.031	50.1	1.131	100.0	50.4	7.4	-0.024
CP11	4.100	5.030	251.6	0.930	782.6	252.1	66.3	-0.427
CP10-1	4.000	5.031	28.7	1.031	70.0	28.9	5.2	-0.029
CP10	4.100	5.031	47.6	0.931	140.4	48.1	11.8	-0.068
CP10-2	4.000	5.031	40.1	1.031	100.0	40.3	7.4	-0.044
G1	7.550	5.035	0.0	0.000	0.0	1.5	0.0	0.000
G2	7.470	5.547	0.0	0.000	0.0	0.0	2.2	0.000
CP10-4	5.400	4.973	0.0	0.000	0.0	0.2	22.9	0.000
CP10-4a	5.700	5.318	0.0	0.000	0.0	0.1	13.6	0.000
L10-1a	5.650	3.966	0.0	0.000	0.0	1.0	12.5	0.000
M14	7.950	5.372	0.0	0.000	0.0	0.2	6.6	0.000
M15	7.850	5.315	0.0	0.000	0.0	0.4	21.4	0.000
M16	7.750	5.281	0.0	0.000	0.0	0.5	13.3	0.000
M17	7.800	5.212	0.0	0.000	0.0	0.5	24.3	0.000
M18	7.900	5.180	0.0	0.000	0.0	0.7	30.2	0.000
M19	7.750	5.157	0.0	0.000	0.0	0.8	14.0	0.000
M20	7.850	5.070	0.0	0.000	0.0	0.8	47.1	0.000
M21	7.750	4.917	0.0	0.000	0.0	0.9	30.2	0.000
M22	7.750	4.859	0.0	0.000	0.0	0.9	43.5	0.000
M23	7.850	4.776	0.0	0.000	0.0	1.0	36.8	0.000
M14-1	7.750	5.611	0.0	0.000	0.0	0.1	14.0	0.000
SM2	7.700	4.520	0.0	0.000	0.0	0.7	0.0	0.000
CP208	5.000	6.261	1219.6	1.261	2044.3	1220.3	1488.3	-0.769
MF2	7.320	6.045	0.0	0.000	0.0	101.3	0.0	0.000

A %% indicates water lost from the system.

********** Link data **********

Link Reference	D/S Node	Pipe Len (m)	Pipe Hgt (mm)	Sed Dpth (mm)	P.Full Flow (m3/s)	< Upstream Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3) >	< Downstream Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3) >
CPK.1	CP-U-9	52	300	48	0.190	6.350	0.099	0.012	0.921	10.8	5.190	0.180	0.012	0.320	10.8
CPD.1	CP-U-9	70	300	48	0.157	6.300	0.112	0.016	0.976	14.8	5.240	0.130	0.016	0.952	14.9
CPK1.1	CPU-9A	95	225	48	0.076	7.710	0.094	0.008	0.841	7.3	5.920	0.090	0.008	0.961	7.3
CPD1.1	CPU-9A	58	225	48	0.088	7.380	0.084	0.005	0.714	4.8	5.920	0.090	0.005	0.610	4.8
CPC.1	CP-U-4	70	300	48	0.113	6.440	0.128	0.019	0.904	18.4	5.890	0.128	0.019	0.895	18.4
CPL.1	CP-U-4	90	300	48	0.091	6.330	0.143	0.021	0.816	19.9	5.870	0.139	0.021	0.830	19.9
CPC1.1	CPU-4A	66	225	48	0.085	7.380	0.085	0.005	0.705	4.8	5.820	0.084	0.005	0.700	4.8
CPL1.1	CPU-4A	68	225	48	0.076	7.470	0.089	0.006	0.746	5.8	6.200	0.089	0.006	0.739	5.8
E1.1	E2	6	300	48	0.089	4.140	0.188	0.031	0.983	30.6	4.080	0.232	0.031	0.812	30.6
E2.1	E3	5	300	48	0.127	4.080	0.229	0.038	1.011	38.0	3.980	0.317	0.038	0.627	38.0x
E3.1	N1-1	19	300	48	0.079	3.980	0.314	0.045	0.751	45.3x	3.830	0.415	0.045	0.673	45.1x
N1-1.1	N1-1a	12	900	144	1.169	3.824	0.419	0.072	0.441	71.4	3.761	0.480	0.070	0.262	71.4
N1-1a.1	N1-2	21	1050	165	1.589	3.732	0.509	0.578	1.756	642.7	3.642	0.509	0.578	1.755	642.8
N1-2.1	N1-2a	42	1050	165	1.562	3.593	0.532	0.629	1.786	699.2	3.419	0.532	0.628	1.779	699.4
N1-2a.1	N1-3	26	1050	165	1.723	3.399	0.538	0.646	1.814	720.7	3.268	0.568	0.643	1.649	720.9
N1-3.1	N1-3a	28	1050	165	1.548	3.239	0.596	0.681	1.632	761.6	3.125	0.638	0.676	1.457	761.8
N1-3a.1	N1-4	10	1050	165	2.118	3.115	0.645	0.705	1.498	794.9	3.039	0.699	0.703	1.338	794.9
N1-4.1	N1-4a	45	1500	235	3.889	3.005	0.733	0.792	1.178	889.4	2.827	0.868	0.783	0.888	888.0
N1-4a.1	N1-5	45	1500	235	4.071	2.826	0.859	2.141	2.465	3669.1	2.631	0.859	2.135	2.456	3668.3
N1-5.1	OUT	14	1500	235	21.909	1.901	1.385	2.135	1.397	3668.3	0.155	3.097	2.135	1.257	3668.3x
CP-U-3.1	M1	11	300	36	0.099	4.960	0.208	0.066	1.405	63.7	4.840	0.241	0.066	1.187	63.7
M1.1	M2	35	375	60	0.122	4.810	0.258	0.087	1.265	83.6	4.610	0.279	0.085	1.133	83.6
M2.1	M3	28	450	72	0.177	4.580	0.305	0.106	1.108	103.5	4.450	0.370	0.104	0.843	103.6
M3.1	M4	28	600	94	0.316	4.420	0.395	0.222	1.326	217.7	4.330	0.395	0.218	1.330	217.8
CP-U-8.1	M3-1	18	300	72	0.063	4.820	0.161	0.022	0.871	20.6	4.700	0.180	0.022	0.713	20.6
M3-1.1	M3	31	600	94	0.471	4.670	0.210	0.052	0.929	48.6	4.450	0.369	0.049	0.317	48.6
M4.1	M5	34	600	94	0.317	4.300	0.423	0.237	1.311	236.2	4.190	0.445	0.231	1.207	236.3
M5.1	M6	25	600	94	0.315	4.160	0.463	0.273	1.362	279.1	4.080	0.469	0.271	1.315	279.2
M6.1	M7	33	600	94	0.322	4.050	0.482	0.301	1.425	311.6	3.940	0.481	0.300	1.408	311.7
M7.1	M8	43	750	118	0.506	3.910	0.506	0.326	1.222	340.4	3.800	0.543	0.322	1.081	339.2
M8.1	M9	25	750	118	0.567	3.770	0.547	0.472	1.579	1148.4	3.690	0.541	0.470	1.587	1146.3
M9.1	M10	41	900	144	0.754	3.660	0.570	0.494	1.392	1172.4	3.570	0.565	0.487	1.380	1168.9
M10.1	M11	35	900	144	0.769	3.540	0.585	0.543	1.476	1227.8	3.460	0.572	0.538	1.524	1224.8
M12.1	M11	21	300	47	0.176	4.800	0.122	0.035	1.769	32.4	4.000	0.122	0.035	1.773	32.4
M12-1.1	M12	19	225	36	0.050	5.100	0.156	0.036	1.407	32.4	4.830	0.155	0.035	1.396	32.4
CP17.1	CP17A	3	300	60	0.153	5.000	0.391	0.053	3.800	53.8x	4.900	0.474	0.054	1.662	53.8x
CP17-1A.1	CP17A	40	225	48	0.090	7.450	0.077	0.003	0.492	2.8	6.400	0.078	0.003	0.494	2.8
CP17-2A.1	CP17A	60	225	48	0.073	7.450	0.089	0.006	0.717	5.8	6.400	0.089	0.006	0.716	5.8
CP17A.1	M23	3	225	48	0.077	4.880	0.194	0.071	2.385	70.2	4.760	0.194	0.071	2.388	70.2
M8-2.1	N1-1b	6	675	108	0.535	3.830	0.560	0.490	1.745	545.4	3.800	0.563	0.489	1.736	545.4
CP12.1	E1	12	300	48	0.282	5.360	0.091	0.016	1.500	15.9	4.170	0.160	0.016	0.949	15.9
CP12B.1	CP12	89	300	48	0.097	6.430	0.098	0.007	0.524	6.3	5.910	0.097	0.006	0.515	6.3
CP12A.1	CP12	40	300	48	0.104	6.500	0.078	0.002	0.261	1.8	6.230	0.078	0.002	0.258	1.8
CP19A.1	CP19	65	300	48	0.154	7.890	0.089	0.005	0.520	4.8	6.940	0.088	0.005	0.513	4.8
CP19B.1	CP19	4	300	48	-0.191	6.840	0.179	0.002	0.054	1.7	6.930	0.091	0.002	0.180	1.7
CP19.1	N1-3	11	300	48	0.338	5.400	0.085	0.012	1.328	11.3	3.840	0.085	0.012	1.329	11.3
CP20A.1	CP20	32	300	48	0.213	7.890	0.080	0.003	0.391	2.8	7.000	0.080	0.003	0.383	2.8
CP20.1	N1-1b	4	300	48	0.373	5.090	0.079	0.006	0.806	5.5	4.400	0.079	0.006	0.805	5.5
N1-1b.1	N1-1a	8	675	108	0.501	3.795	0.513	0.494	1.939	550.9	3.760	0.500	0.494	1.997	550.8
CP15B.1	CP15	58	300	48	0.108	6.600	0.095	0.007	0.551	6.0	6.180	0.094	0.006	0.541	6.0
CP15A.1	CP15	35	300	48	0.105	6.420	0.082	0.003	0.354	2.8	6.180	0.082	0.003	0.350	2.8
CP15.1	CP14	4	300	48	0.077	5.300	0.128	0.019	0.874	17.6	5.270	0.128	0.019	0.874	17.6
CP14.1	M10	4	300	48	0.362	4.770	0.103	0.039	2.722	36.5	4.120	0.103	0.039	2.722	36.5

Link Reference	D/S Node	Pipe Len (m)	Pipe Hgt (mm)	Sed Dpth (mm)	P.Full Flow (m3/s)	< Upstream Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3) >	< Downstream Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3) >
SM1.1	M13	4	300	48	0.109	3.360	0.655	0.108	1.635	764.7x	3.300	0.652	0.108	1.632	764.4x
MF1.1	SM1					3.400	1.646	0.108		765.0	3.400	0.637	0.108		765.0
CP5.1	MF1	11	300	48	0.066	3.780	1.558	0.222	3.226	1153.8+	3.730	1.336	0.222	3.712	1153.1+
CP208.1	MF2	5	300	48	0.044	4.240	1.883	0.210	3.125	818.8+	4.230	1.829	0.209	3.504	818.4+
MF2.1	SM2					3.850	2.195	0.108		765.2	3.850	0.670	0.108		765.2
SM2.1	M8	10	300	48	0.075	3.850	0.647	0.108	1.632	764.8+	3.780	0.565	0.108	1.786	764.2+
CP13B.1	CP13A	30	375	60	0.172	5.370	0.138	0.018	0.714	16.9	5.200	0.223	0.018	0.327	17.0
CP13C.1	CP13	17	375	60	0.278	5.450	0.129	0.021	0.952	19.4	5.200	0.129	0.021	0.943	19.4
CP13A.1	CP13	48	375	60	0.172	5.200	0.221	0.066	1.175	62.6	4.930	0.220	0.065	1.168	62.7
CPU-1-2.1	CP-U-1	70	300	48	0.099	5.662	0.103	0.008	0.586	7.8	5.240	0.102	0.008	0.577	7.8
CPU-1-1.1	CP-U-1	45	300	48	0.095	5.440	0.096	0.006	0.496	5.8	5.190	0.095	0.006	0.498	5.8
CPU1AA.1	CP-U-1A	8	225	48	0.088	7.800	0.083	0.005	0.667	4.3	7.600	0.083	0.005	0.664	4.3
CPU1AB.1	CP-U-1A	24	225	48	0.057	7.350	0.075	0.001	0.255	1.3	7.100	0.075	0.001	0.251	1.3
CP-U-1A.1	CP-U-1B	5	225	48	0.029	6.700	0.121	0.011	0.712	10.0	6.670	0.120	0.011	0.719	10.0
CPU-1C.1	CP-U-1B	52	225	48	0.069	7.600	0.082	0.004	0.507	3.3	6.800	0.082	0.003	0.505	3.3
CP-U-1B2.1	CP-U-1B	51	225	48	0.057	7.640	0.094	0.006	0.634	5.5	7.100	0.094	0.006	0.629	5.5
CP-U-1B.1	L8	17	225	48	0.100	5.100	0.109	0.027	2.081	25.1	3.950	0.109	0.027	2.085	25.1
CPU2A.1	CP-U-2	50	300	48	0.137	5.680	0.093	0.006	0.552	5.8	5.100	0.093	0.006	0.548	5.8
CPU2B.1	CP-U-2	29	300	48	0.094	5.300	0.099	0.007	0.519	6.3	5.140	0.098	0.007	0.524	6.3

CPU3A.1	CP-U-3	72	300	48	0.079	5.300	0.141	0.018	0.701	16.6	5.020	0.165	0.018	0.770	16.6
CPU3B.1	CP-U-3	71	300	48	0.113	5.800	0.120	0.016	0.844	15.1	5.240	0.120	0.016	0.833	15.1
CPU8B.1	CP-U-8	45	300	48	0.161	6.290	0.102	0.011	0.826	10.3	5.570	0.101	0.011	0.820	10.3
L1.1	L2	26	300	48	0.076	4.580	0.264	0.030	0.932	28.0	4.390	0.427	0.029	0.502	28.0x
L2.1	L3	27	300	48	0.073	4.360	0.321	0.079	1.280	81.9+	4.180	0.279	0.079	1.398	81.9
L3.1	L4	26	375	60	0.167	4.150	0.267	0.124	1.703	125.7	3.870	0.286	0.123	1.554	125.7
L4.1	L5	25	600	96	0.368	3.840	0.315	0.150	1.234	151.5	3.730	0.345	0.148	1.069	151.6
L5.1	L6	44	750	120	0.542	3.700	0.374	0.213	1.230	213.4	3.570	0.397	0.205	1.233	213.5
L6.1	L7	21	750	120	0.533	3.540	0.426	0.224	1.179	232.0	3.480	0.464	0.215	1.142	232.0
L7.1	L8	21	750	120	0.576	3.450	0.490	0.215	0.973	232.0	3.380	0.549	0.210	0.808	232.1
L8.1	L9	44	750	120	0.521	3.350	0.572	0.259	0.883	284.4	3.230	0.665	0.255	0.714	283.4
L9.1	L11	28	900	141	0.809	3.220	0.665	~~0.416~~	0.998	453.2	3.150	0.719	0.407	0.870	450.8
L10.1	N1-4a	11	1200	192	2.738	2.900	0.828	1.365	1.940	2781.7	2.830	0.867	1.362	1.817	2781.2
L10-2.1	L10-1	47	450	71	0.198	3.500	0.746	0.101	1.000	99.1x	3.230	0.944	0.099	0.648	99.2x
BU3.1	L10-1	3	150	24	0.044	4.020	0.433	0.038	2.641	36.1x	3.730	0.475	0.038	2.639	36.1x
CP10-3.1	L10-2	11	300	48	0.185	4.000	0.369	0.057	1.989	56.4x	3.530	0.767	0.058	0.868	56.4x
BU2.1	L10-2	10	225	36	0.093	4.170	0.182	0.025	1.780	24.3	3.680	0.615	0.025	1.556	24.3x
L11.1	L10	16	1050	168	1.709	3.130	0.701	1.157	2.230	2562.7	3.050	0.706	1.157	2.241	2560.7
CP-U-2.1	L3	10	300	48	0.160	4.500	0.118	0.027	1.488	25.4	4.180	0.278	0.027	0.463	25.4
BU1.1	CP13	11	225	36	0.050	4.090	0.119	0.019	1.096	16.9	3.930	0.188	0.019	0.605	16.9
CP-U-1.1	L8	5	300	36	0.153	3.700	0.234	0.027	1.051	27.2	3.570	0.360	0.027	0.899	27.2x
CP13.1	L9	14	450	71	0.552	3.900	0.217	0.160	2.760	151.9	3.280	0.624	0.159	1.061	151.9x
CP23A.1	CP23	25	225	36	0.060	6.070	0.067	0.002	0.326	1.8	5.820	0.066	0.002	0.326	1.8
CP23B.1	CP23	12	225	36	0.067	6.070	0.066	0.002	0.338	1.8	5.920	0.066	0.002	0.339	1.8
CP23.1	CP22	5	225	36	0.056	4.080	0.082	0.007	0.804	6.8	3.990	0.089	0.007	0.684	6.8
CP22B.1	CP22A	24	225	36	0.058	6.120	0.065	0.002	0.291	1.5	5.890	0.065	0.002	0.291	1.5
CP22A.1	CP22	25	225	36	0.062	5.870	0.072	0.003	0.461	3.0	5.600	0.072	0.003	0.458	3.0
CP22C.1	CP22	8	225	36	0.073	6.120	0.069	0.003	0.467	2.8	6.000	0.069	0.003	0.468	2.8
CP22.1	L9	6	300	36	0.155	3.980	0.099	0.019	1.233	18.1	3.820	0.099	0.019	1.233	18.1
UC-A-1.1	CP-A-1	95	300	48	0.118	5.919	0.157	0.035	1.146	32.0	5.100	0.156	0.034	1.128	32.0
CP-A-1.1	N1-4	20	375	59	0.464	5.091	0.157	0.101	3.118	94.5	3.456	0.283	0.100	2.795	94.5
UC-A-2.1	CP-A-2	65	300	48	0.151	6.588	0.114	0.017	0.962	15.1	5.680	0.113	0.016	0.955	15.1
CP-A-2.1	N1-2	8	225	36	0.136	5.550	0.114	0.049	3.070	44.5	4.709	0.114	0.049	3.067	44.5
CP10-4a.1	CP10-4	55	300	48	0.108	5.200	0.118	0.015	0.792	13.6	4.800	0.173	0.014	0.429	13.6

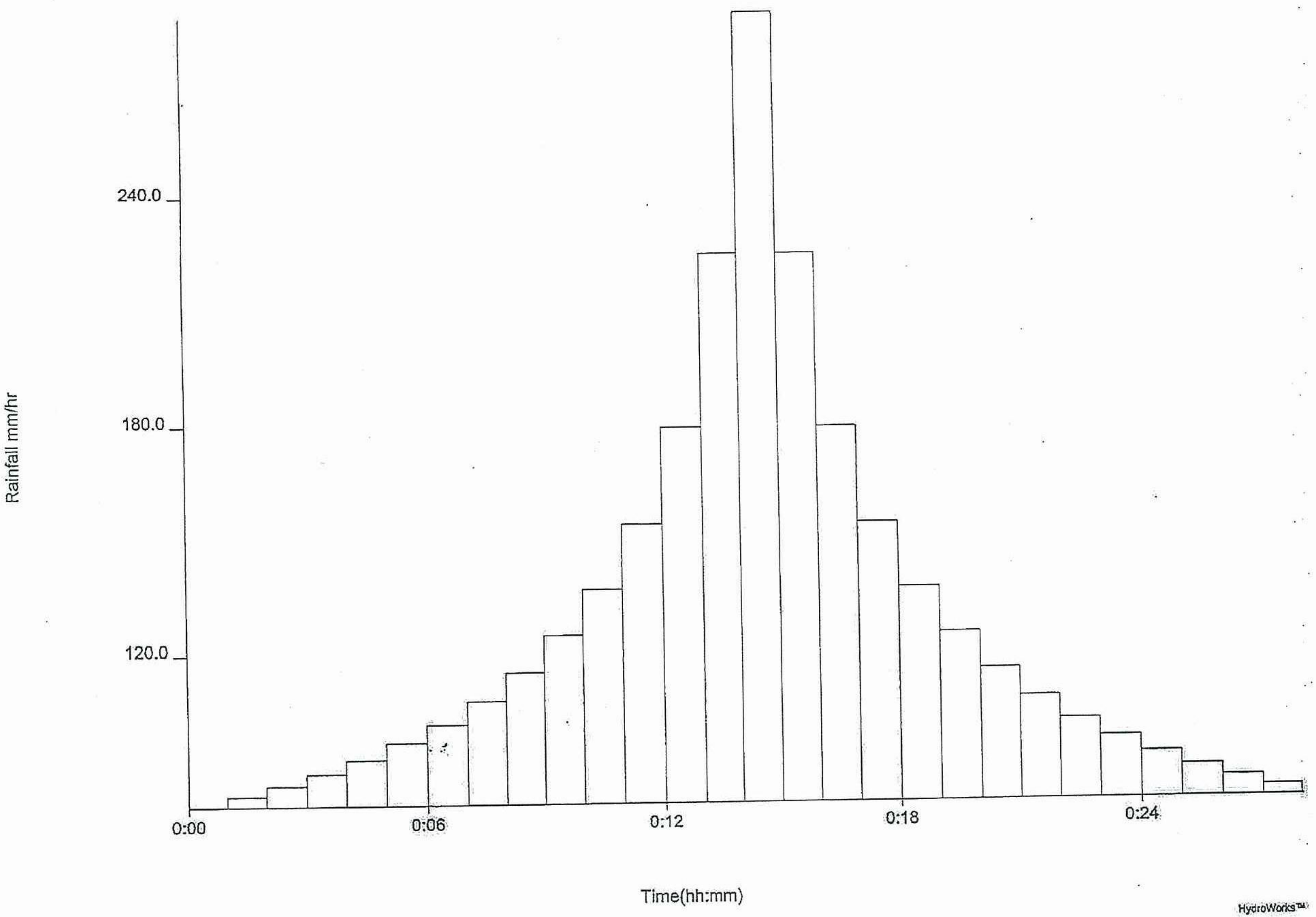
						<		Upstream	>		<		Downstream		>
Link Reference	D/S Node	Pipe Len (m)	Pipe Hgt (mm)	Sed Dpth (mm)	P.Full Flow (m3/s)	Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3)	Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3)
CP10-4.1	CP10-3	55	300	48	0.108	4.800	0.172	0.039	1.116	36.5	4.400	0.171	0.038	1.108	36.5
L10-1.1	L10-1a	9	450	71	0.246	3.200	0.844	0.214	1.405	208.9x	3.120	0.862	0.214	1.404	208.7x
L10-1a.1	L10	5	450	71	0.234	3.090	0.716	0.226	1.499	221.2x	3.050	0.722	0.226	1.499	221.1x
G2.1	MF1	12	300	16	0.475	5.500	0.047	0.002	0.430	2.2	3.400	1.646	-0.002	-0.050	1.7x
CP11.1	CP10	5	300	32	0.107	3.660	1.370	-0.038	0.708	-185.3x	3.610	1.421	-0.038	0.591	-185.6x
CP10.1	G1	6	300	32	0.097	3.600	1.432	-0.068	-0.919	-341.6x	3.550	1.484	-0.068	-0.914	-342.1x
G1.1	MF1	13	300	48	0.087	3.500	1.535	-0.068	-0.953	-343.5x	3.400	1.640	-0.068	-0.941	-344.4x
CP10-1.1	CP10	30	200	48	0.052	3.800	1.231	-0.006	0.183	-23.6x	3.610	1.421	-0.025	-0.308	-34.7x
CP9.1	CP10	5	250	48	0.060	3.630	1.401	-0.028	-0.237	-83.2x	3.610	1.421	-0.030	-0.327	-85.1x
CP10-2.1	CP9	20	200	48	0.060	3.800	1.231	-0.008	0.241	-32.9x	3.630	1.401	-0.015	-0.243	-40.2x
CP14-3.1	CP14-1	12	225	48	0.055	6.270	0.086	0.004	0.479	3.3	6.150	0.085	0.004	0.473	3.3
CP14-1.1	CP14	65	225	36	0.057	6.120	0.089	0.007	0.675	6.6	5.530	0.089	0.007	0.665	6.6
CP14-2.1	CP14	62	225	36	0.067	6.770	0.078	0.005	0.612	4.5	5.980	0.077	0.005	0.605	4.5
M11.1	M13	26	900	144	0.835	3.430	0.589	0.608	1.655	1301.0	3.360	0.575	0.602	1.752	1298.9
M13.1	L11	35	1050	168	1.414	3.270	0.657	0.717	1.556	2071.3	3.150	0.718	0.718	1.448	2066.5
CP17-1.1	CP17	40	300	48	0.156	5.700	0.099	0.010	0.749	8.8	5.100	0.371	0.012	0.630	8.8x
CP17-2.1	CP17	52	300	48	0.217	6.600	0.109	0.020	1.281	18.1	5.100	0.371	0.019	1.053	18.1x
CP21-1.1	CP21	31	225	48	0.059	6.570	0.104	0.009	0.783	8.5	6.220	0.103	0.009	0.779	8.6
CP21-1A.1	CP21-1	60	225	48	0.074	7.640	0.085	0.005	0.625	4.3	6.570	0.104	0.005	0.399	4.3
CP21-2.1	CP21	150	225	48	0.067	7.710	0.107	0.012	0.943	10.8	5.510	0.106	0.011	0.929	10.9
CP21.1	L2	3	300	48	0.231	5.100	0.112	0.034	2.041	33.2	4.900	0.112	0.034	2.042	33.2
M14-1.1	M14	40	300	48	0.073	5.490	0.121	0.015	0.782	14.0	5.220	0.152	0.015	0.522	14.0
M14.1	M15	11	300	94	0.085	5.200	0.171	0.022	0.982	20.6	5.020	0.295	0.022	0.420	20.6
CP-U-9.1	M15	28	450	71	0.178	5.150	0.220	0.055	0.932	51.3	5.020	0.295	0.055	0.579	51.3
CPU-9A.1	M15	7	300	48	0.185	5.900	0.110	0.026	1.589	24.2	5.600	0.110	0.026	1.591	24.2
M15.1	M16	12	600	94	0.322	5.010	0.304	0.125	1.090	117.4	4.970	0.311	0.124	1.051	117.4
M16.1	M17	35	600	94	0.312	4.960	0.320	0.138	1.112	130.7	4.850	0.362	0.133	0.978	130.7
M17.1	M18	39	600	94	0.322	4.840	0.372	0.158	1.126	155.0	4.710	0.470	0.144	0.833	155.1
M18.1	M19	23	600	94	0.329	4.700	0.472	0.175	0.997	185.3	4.620	0.537	0.166	0.790	185.4
M19.1	M20	34	600	94	0.317	4.610	0.542	0.281	1.302	296.9	4.500	0.574	0.271	1.135	297.0
M20.1	M21	32	600	94	0.311	4.490	0.537	0.318	1.420	344.2	4.390	0.531	0.311	1.390	344.3
M21.1	M22	27	675	94	0.450	4.380	0.527	0.340	1.363	374.5	4.290	0.569	0.335	1.215	374.6
M22.1	M23	34	675	94	0.443	4.280	0.574	0.375	1.373	418.1	4.170	0.606	0.374	1.268	418.2
M23.1	M8-1	26	675	94	0.530	4.160	0.607	0.474	1.578	525.2	4.040	0.624	0.474	1.502	525.4
M8-1.1	M8-2	37	675	94	0.313	4.040	0.614	0.492	1.578	545.2	3.980	0.488	0.490	1.987	545.4
CP-U-4.1	M19	32	375	48	0.241	5.800	0.176	0.080	1.862	76.3	5.150	0.176	0.080	1.862	76.3
CPU-4A.1	M19	5	300	48	0.179	5.400	0.108	0.023	1.471	21.1	5.200	0.107	0.023	1.469	21.1

\+ after total flow indicates a pipe/channel surcharged by flow and depth at that end.
x after total flow indicates a pipe/channel surcharged by depth only at that end.

NOTE :
(i) maximum elevations, depths, volumes, velocities and discharges are selected from the values at each time increment and will be in general more extreme than the maximum values in the hydrograph files.
(ii) maximum elevations, velocities and discharges are not necessarily calculated at the same time.
(iii) max. velocity is not calculated for a pipe if either the water level does not exceed 5% of the pipe depth or the discharge is less than 0.001 m3/s.

End of run 0 mins (elapsed) Produced on 23/07/2008 Last page

APPENDIX D HydroWorks INPUT DATA AND RESULTS FOR CASE 2



240.0
180.0
120.0
Rainfall mm/hr
0:00
0:06
0:12
0:18
0:24
Time(hh:mm)
HydroWorks™

Start of run configured for MS Windows Produced on 23/07/2008 at 10:13

HydroWorks(tm) SIM

Summary results from Simulation

Version 5.1.075 dated September 2000

Licence Number - WS04260001PM

Message 253: Run finished for event 1.
Manhole data for PAFF Event - 1 WS04260001PM Produced 23/07/2008 Pg 1

Summary results for event 1 -
Started at 00000000000000. Run for 120.00 min. (Requested simulation time 120.00 min)

```
Files used:
Network:  ...\trunk8.dsd       Manhole data for PAFF
State:
Runoff:   ...\pavement.rpf     Pavement Type
Rainfall: ...\1-10-30.red      1 in 10 year 30 min [M10-30 (1)]
DWF:
Inflows:
Levels:   ...\1-50.lev         1 in 50 years Tide Level (Lok On Pai)
RTC:
Results:  ...\r0000062.spr
```

Using Wallingford Procedure runoff routing model.

```
Total rainfall  =   4783.5 m3
Total runoff    =   4293.5 m3
Total inflow    =   4293.5 m3
Total outflow   =   3278.2 m3
Total lost      =      0.0 m3
```

********** Node data **********

Node Reference	Ground Level (m AD)	Max Level (m AD)	Flood Volume (m3)	Flood Depth (m)	Flood Area (m2)	Max Stored (m3)	Inflow (m3)	Vol Balance (m3)
E1	6.580	4.290	0.0	0.000	0.0	0.3	12.0	0.000
E2	6.640	4.263	0.0	0.000	0.0	0.3	6.0	0.000
E3	6.690	4.248	0.0	0.000	0.0	0.5	6.0	0.000
M8-2	7.820	4.362	0.0	0.000	0.0	1.0	0.0	0.000
CP-U-4	6.900	5.963	0.0	0.000	0.0	0.2	31.0	0.000
CPU-4A	6.850	5.503	0.0	0.000	0.0	0.1	8.6	0.000
CPC1	7.610	7.462	0.0	0.000	0.0	0.1	3.9	0.000
CPL1	7.700	7.556	0.0	0.000	0.0	0.1	4.7	0.000
CP-U-9	5.700	5.351	0.0	0.000	0.0	0.2	20.9	0.000
CPU-9A	7.000	6.005	0.0	0.000	0.0	0.1	9.9	0.000
CPK1	7.940	7.800	0.0	0.000	0.0	0.1	6.0	0.000
CPD1	7.610	7.462	0.0	0.000	0.0	0.1	3.9	0.000
CPC	6.740	6.561	0.0	0.000	0.0	0.1	15.0	0.000
CPD	6.610	6.406	0.0	0.000	0.0	0.1	12.1	0.000
CPK	6.740	6.445	0.0	0.000	0.0	0.1	8.8	0.000
CPL	6.660	6.464	0.0	0.000	0.0	0.1	16.3	0.000
N1-1	6.960	4.211	0.0	0.000	0.0	0.9	21.6	0.000
N1-1a	7.390	4.209	0.0	0.000	0.0	1.1	16.8	0.000
N1-1b	7.250	4.301	0.0	0.000	0.0	0.8	0.0	0.000
N1-2	7.940	4.089	0.0	0.000	0.0	1.6	9.6	0.000
N1-2a	7.790	3.901	0.0	0.000	0.0	1.6	17.4	0.000
N1-3	7.370	3.803	0.0	0.000	0.0	1.0	24.1	0.000
N1-3a	6.970	3.740	0.0	0.000	0.0	1.1	27.1	0.000
N1-4	6.630	3.720	0.0	0.000	0.0	1.6	0.0	0.000
N1-4a	5.610	3.686	0.0	0.000	0.0	2.0	0.0	0.000
N1-5	5.880	3.539	0.0	0.000	0.0	3.8	0.0	0.000
CP-U-3	5.800	5.150	0.0	0.000	0.0	0.2	26.1	0.000
M1	8.100	5.046	0.0	0.000	0.0	0.4	16.2	0.000
M2	7.900	4.850	0.0	0.000	0.0	0.5	16.2	0.000
M3	7.700	4.778	0.0	0.000	0.0	0.8	53.5	0.000
CP-U-8	6.080	4.971	0.0	0.000	0.0	0.2	8.4	0.000
M3-1	6.000	4.861	0.0	0.000	0.0	0.4	22.8	0.000
M4	7.450	4.676	0.0	0.000	0.0	0.9	15.0	0.000
M5	7.150	4.573	0.0	0.000	0.0	0.9	34.9	0.000
M6	7.200	4.486	0.0	0.000	0.0	1.4	26.5	0.000
M7	7.450	4.367	0.0	0.000	0.0	1.5	23.5	0.000
M8	7.550	4.289	0.0	0.000	0.0	1.7	37.3	0.000
M9	7.450	4.187	0.0	0.000	0.0	1.7	21.7	0.000
CP20A	8.190	7.969	0.0	0.000	0.0	0.1	2.3	0.000
CP20	7.340	5.168	0.0	0.000	0.0	0.1	2.3	0.000
CP15B	6.900	6.691	0.0	0.000	0.0	0.1	4.9	0.000
CP19A	8.190	7.976	0.0	0.000	0.0	0.1	3.9	0.000
CP19B	7.140	7.015	0.0	0.000	0.0	0.2	1.4	0.000
CP19	7.320	5.483	0.0	0.000	0.0	0.1	3.9	0.000
CP15A	6.720	6.500	0.0	0.000	0.0	0.1	2.3	0.000
CP15	6.480	5.420	0.0	0.000	0.0	0.1	7.2	0.000
CP14	6.500	4.869	0.0	0.000	0.0	0.1	6.4	0.000
M10	7.080	4.085	0.0	0.000	0.0	1.7	18.7	0.000
M11	7.350	3.981	0.0	0.000	0.0	1.8	36.1	0.000
M12	7.500	4.915	0.0	0.000	0.0	0.4	0.0	0.000
M12-1	7.800	5.242	0.0	0.000	0.0	0.3	26.5	0.000
M8-1	7.500	4.599	0.0	0.000	0.0	1.0	16.2	0.000
CP12A	6.800	6.576	0.0	0.000	0.0	0.1	1.4	0.000

Node Reference	Ground Level (m AD)	Max Level (m AD)	Flood Volume (m3)	Flood Depth (m)	Flood Area (m2)	Max Stored (m3)	Inflow (m3)	Vol Balance (m3)
CP12B	6.730	6.524	0.0	0.000	0.0	0.1	5.1	0.000
CP12	6.650	5.448	0.0	0.000	0.0	0.1	6.4	0.000
CP17	5.400	5.367	0.0	0.000	0.0	0.4	21.9	0.000
CP17A	8.030	5.315	0.0	0.000	0.0	0.4	6.4	0.000
CP17-1A	8.030	7.526	0.0	0.000	0.0	0.1	2.3	0.000
CP17-2A	8.030	7.536	0.0	0.000	0.0	0.1	4.7	0.000
SM1	6.450	3.996	0.0	0.000	0.0	0.6	0.0	0.000
M13	6.490	3.887	0.0	0.000	0.0	2.0	7.2	0.000
CP13A	5.750	5.403	0.0	0.000	0.0	0.2	37.3	0.000
CP13B	5.750	5.499	0.0	0.000	0.0	0.1	13.8	0.000
CP13C	5.750	5.574	0.0	0.000	0.0	0.1	15.8	0.000
CPU-1-1	5.750	5.532	0.0	0.000	0.0	0.1	4.7	0.000
CPU-1-2	5.970	5.760	0.0	0.000	0.0	0.1	6.4	0.000
CP-U-1A	8.000	6.814	0.0	0.000	0.0	0.1	3.7	0.000
CPU1AA	8.100	7.880	0.0	0.000	0.0	0.1	3.5	0.000
CPU1AB	7.200	7.424	0.2	0.224	1.0	0.2	1.0	0.000
CP-U-1B	7.340	5.204	0.0	0.000	0.0	0.1	5.1	0.000
CP-U-1B2	7.940	7.730	0.0	0.000	0.0	0.1	4.5	0.000
CPU-1C	7.550	7.680	0.1	0.130	1.0	0.1	2.7	0.000
CPU2A	5.980	5.770	0.0	0.000	0.0	0.1	4.7	0.000
CPU2B	5.760	5.394	0.0	0.000	0.0	0.1	5.1	0.000
CPU3A	5.750	5.431	0.0	0.000	0.0	0.1	13.6	0.000
CPU3B	6.100	5.914	0.0	0.000	0.0	0.1	12.3	0.000

CPU8B	6.690	6.387	0.0	0.000	0.0	0.1	8.4	0.000
L1	7.750	4.731	0.0	0.000	0.0	0.3	22.9	0.000
L2	7.950	4.647	0.0	0.000	0.0	0.5	16.8	0.000
L3	8.200	4.416	0.0	0.000	0.0	0.5	15.0	0.000
CP-U-2	5.670	4.611	0.0	0.000	0.0	0.1	10.9	0.000
L4	8.100	4.134	0.0	0.000	0.0	0.5	21.1	0.000
L5	7.900	4.048	0.0	0.000	0.0	0.6	50.6	0.000
L6	7.850	3.918	0.0	0.000	0.0	0.7	15.1	0.000
L7	7.880	3.883	0.0	0.000	0.0	0.8	0.0	0.000
L8	6.400	3.870	0.0	0.000	0.0	0.9	0.0	0.000
CP-U-1	5.800	3.878	0.0	0.000	0.0	0.2	11.1	0.000
L9	7.200	3.842	0.0	0.000	0.0	1.1	0.0	0.000
CP22	7.300	4.074	0.0	0.000	0.0	0.1	4.5	0.000
CP22B	7.300	6.184	0.0	0.000	0.0	0.1	1.2	0.000
CP22A	7.300	5.940	0.0	0.000	0.0	0.1	1.2	0.000
CP22C	7.300	6.187	0.0	0.000	0.0	0.1	2.3	0.000
CP23	7.300	4.158	0.0	0.000	0.0	0.1	2.7	0.000
CP23A	7.300	6.135	0.0	0.000	0.0	0.1	1.4	0.000
CP23B	7.300	6.134	0.0	0.000	0.0	0.1	1.4	0.000
CP13	5.600	4.099	0.0	0.000	0.0	0.2	43.3	0.000
BU1	5.900	4.199	0.0	0.000	0.0	0.1	13.8	0.000
L10	5.810	3.730	0.0	0.000	0.0	1.5	0.0	0.000
L11	5.820	3.821	0.0	0.000	0.0	1.2	37.3	0.000
L10-1	5.640	4.056	0.0	0.000	0.0	1.4	60.2	0.001
BU3	6.050	4.308	0.0	0.000	0.0	0.3	29.4	0.000
L10-2	5.900	4.143	0.0	0.000	0.0	1.0	15.0	0.000
BU2	5.900	4.273	0.0	0.000	0.0	0.1	19.9	0.000
CP10-3	5.100	4.211	0.0	0.000	0.0	0.2	16.2	0.000
CP5	5.000	5.630	862.6	0.630	4041.8	863.8	1216.7	-5.774
MF1	7.320	4.987	0.0	0.000	0.0	72.2	0.0	0.000

Node Reference	Ground Level (m AD)	Max Level (m AD)	Flood Volume (m3)	Flood Depth (m)	Flood Area (m2)	Max Stored (m3)	Inflow (m3)	Vol Balance (m3)
UC-A-1	6.220	6.064	0.0	0.000	0.0	0.1	26.1	0.000
UC-A-2	6.900	6.696	0.0	0.000	0.0	0.1	12.3	0.000
CP-A-1	5.600	5.238	0.0	0.000	0.0	0.1	51.1	0.000
CP-A-2	6.100	5.656	0.0	0.000	0.0	0.1	24.0	0.000
CP21-1	6.810	6.669	0.0	0.000	0.0	0.1	3.5	0.000
CP21-1A	7.870	7.722	0.0	0.000	0.0	0.1	3.5	0.000
CP21-2	7.940	7.812	0.0	0.000	0.0	0.1	8.8	0.000
CP21	6.810	5.206	0.0	0.000	0.0	0.1	11.3	0.000
CP17-1	6.000	5.795	0.0	0.000	0.0	0.1	7.2	0.000
CP17-2	6.900	6.704	0.0	0.000	0.0	0.1	14.8	0.000
CP14-1	7.000	6.205	0.0	0.000	0.0	0.1	2.7	0.000
CP14-2	7.000	6.844	0.0	0.000	0.0	0.1	3.7	0.000
CP14-3	6.500	6.353	0.0	0.000	0.0	0.1	2.7	0.000
CP9	3.900	4.985	45.5	1.085	100.0	45.7	6.0	-0.033
CP11	4.100	4.985	217.7	0.885	710.6	218.2	54.2	-0.391
CP10-1	4.000	4.985	25.4	0.985	68.2	25.6	4.2	-0.029
CP10	4.100	4.985	41.3	0.885	127.8	41.8	9.6	-0.063
CP10-2	4.000	4.985	35.5	0.985	97.3	35.7	6.0	-0.043
G1	7.550	4.985	0.0	0.000	0.0	1.5	0.0	0.000
G2	7.470	5.547	0.0	0.000	0.0	0.0	1.8	0.000
CP10-4	5.400	4.959	0.0	0.000	0.0	0.2	18.7	0.000
CP10-4a	5.700	5.311	0.0	0.000	0.0	0.1	11.1	0.000
L10-1a	5.650	3.891	0.0	0.000	0.0	0.9	10.2	0.000
M14	7.950	5.359	0.0	0.000	0.0	0.2	5.4	0.000
M15	7.850	5.289	0.0	0.000	0.0	0.4	17.4	0.000
M16	7.750	5.252	0.0	0.000	0.0	0.4	10.8	0.000
M17	7.800	5.157	0.0	0.000	0.0	0.5	19.9	0.000
M18	7.900	5.082	0.0	0.000	0.0	0.6	24.7	0.000
M19	7.750	5.054	0.0	0.000	0.0	0.6	11.4	0.000
M20	7.850	4.970	0.0	0.000	0.0	0.7	38.5	0.000
M21	7.750	4.840	0.0	0.000	0.0	0.7	24.7	0.000
M22	7.750	4.771	0.0	0.000	0.0	0.8	35.5	0.000
M23	7.850	4.689	0.0	0.000	0.0	0.9	30.1	0.000
M14-1	7.750	5.604	0.0	0.000	0.0	0.1	11.4	0.000
SM2	7.700	4.471	0.0	0.000	0.0	0.6	0.0	0.000
CP208	5.000	6.130	953.1	1.130	2032.6	953.9	1216.1	-1.369
MF2	7.320	5.915	0.0	0.000	0.0	97.8	0.0	0.000

A %% indicates water lost from the system.

********** Link data **********

Link Reference	D/S Node	Pipe Len (m)	Pipe Hgt (mm)	Sed Dpth (mm)	P.Full Flow (m3/s)	Upstream Invert Level (m AD)	Upstream Max Depth (m)	Upstream Max Flow (m3/s)	Upstream Max Vel (m/s)	Upstream Total Flow (m3)	Downstream Invert Level (m AD)	Downstream Max Depth (m)	Downstream Max Flow (m3/s)	Downstream Max Vel (m/s)	Downstream Total Flow (m3)
CPK.1	CP-U-9	52	300	48	0.190	6.350	0.095	0.010	0.828	8.8	5.190	0.161	0.010	0.314	8.8
CPD.1	CP-U-9	70	300	48	0.157	6.300	0.106	0.013	0.890	12.1	5.240	0.111	0.013	0.979	12.1
CPK1.1	CPU-9A	95	225	48	0.076	7.710	0.090	0.007	0.761	6.0	5.920	0.085	0.006	0.916	6.0
CPD1.1	CPU-9A	58	225	48	0.088	7.380	0.082	0.004	0.635	3.9	5.920	0.085	0.004	0.581	3.9
CPC.1	CP-U-4	70	300	48	0.113	6.440	0.121	0.016	0.838	15.0	5.890	0.119	0.016	0.829	15.0
CPL.1	CP-U-4	90	300	48	0.091	6.330	0.134	0.017	0.760	16.3	5.870	0.130	0.017	0.773	16.3
CPC1.1	CPU-4A	66	225	48	0.085	7.380	0.082	0.004	0.628	3.9	5.820	0.082	0.004	0.624	3.9
CPL1.1	CPU-4A	68	225	48	0.076	7.470	0.086	0.005	0.670	4.7	6.200	0.086	0.005	0.665	4.7
E1.1	E2	6	300	48	0.089	4.140	0.150	0.026	0.993	25.0	4.080	0.183	0.026	0.834	25.0
E2.1	E3	5	300	48	0.127	4.080	0.182	0.032	1.042	31.0	3.980	0.268	0.032	0.584	31.0
E3.1	N1-1	19	300	48	0.079	3.980	0.267	0.037	0.701	37.0	3.830	0.382	0.037	0.559	36.8x
N1-1.1	N1-1a	12	900	144	1.169	3.824	0.387	0.060	0.403	58.2	3.761	0.448	0.057	0.244	58.2
N1-1a.1	N1-2	21	1050	165	1.589	3.732	0.477	0.494	1.674	524.9	3.642	0.477	0.492	1.669	525.0
N1-2.1	N1-2a	42	1050	165	1.562	3.593	0.496	0.535	1.699	571.0	3.419	0.495	0.531	1.690	571.1
N1-2a.1	N1-3	26	1050	165	1.723	3.399	0.502	0.547	1.700	588.5	3.268	0.535	0.546	1.531	588.5
N1-3.1	N1-3a	28	1050	165	1.548	3.239	0.564	0.575	1.486	621.8	3.125	0.615	0.575	1.309	621.7
N1-3a.1	N1-4	10	1050	165	2.118	3.115	0.623	0.596	1.332	648.7	3.039	0.681	0.597	1.177	648.7
N1-4.1	N1-4a	45	1500	235	3.889	3.005	0.715	0.669	1.022	725.9	2.827	0.859	0.667	0.768	725.5
N1-4a.1	N1-5	45	1500	235	4.071	2.826	0.853	1.850	2.151	3278.5	2.631	0.908	1.846	1.961	3278.2
N1-5.1	OUT	14	1500	235	21.909	1.901	1.628	1.846	1.119	3278.2x	0.155	3.346	1.846	1.082	3278.2x
CP-U-3.1	M1	11	300	36	0.099	4.960	0.183	0.055	1.362	52.0	4.840	0.207	0.055	1.166	52.1
M1.1	M2	35	375	60	0.122	4.810	0.231	0.072	1.208	68.3	4.610	0.240	0.071	1.131	68.3
M2.1	M3	28	450	72	0.177	4.580	0.269	0.089	1.083	84.6	4.450	0.328	0.087	0.810	84.7
M3.1	M4	28	600	94	0.316	4.420	0.356	0.186	1.268	178.0	4.330	0.346	0.182	1.313	178.0
CP-U-8.1	M3-1	18	300	72	0.063	4.820	0.151	0.018	0.816	16.9	4.700	0.161	0.018	0.715	16.9
M3-1.1	M3	31	600	94	0.471	4.670	0.191	0.043	0.910	39.7	4.450	0.328	0.041	0.318	39.8
M4.1	M5	34	600	94	0.317	4.300	0.375	0.198	1.265	193.1	4.190	0.383	0.195	1.214	193.2
M5.1	M6	25	600	94	0.315	4.160	0.407	0.229	1.325	228.1	4.080	0.406	0.229	1.312	228.2
M6.1	M7	33	600	94	0.322	4.050	0.428	0.253	1.371	254.7	3.940	0.428	0.252	1.351	254.8
M7.1	M8	43	750	118	0.506	3.910	0.455	0.275	1.178	278.2	3.800	0.489	0.271	1.040	277.0
M8.1	M9	25	750	118	0.567	3.770	0.505	0.414	1.527	1076.4	3.690	0.498	0.412	1.545	1074.2
M9.1	M10	41	900	144	0.754	3.660	0.527	0.432	1.351	1095.5	3.570	0.515	0.428	1.376	1092.0
M10.1	M11	35	900	144	0.769	3.540	0.540	0.474	1.429	1140.1	3.460	0.521	0.471	1.497	1137.2
M12.1	M11	21	300	47	0.176	4.800	0.115	0.029	1.631	26.5	4.000	0.115	0.029	1.634	26.5
M12-1.1	M12	19	225	36	0.050	5.100	0.141	0.029	1.331	26.5	4.830	0.141	0.029	1.322	26.5
CP17.1	CP17A	3	300	60	0.153	5.000	0.323	0.046	1.794	44.0x	4.900	0.417	0.046	2.135	44.0x
CP17-1A.1	CP17A	40	225	48	0.090	7.450	0.076	0.002	0.431	2.3	6.400	0.076	0.002	0.431	2.3
CP17-2A.1	CP17A	60	225	48	0.073	7.450	0.086	0.005	0.647	4.7	6.400	0.086	0.005	0.642	4.7
CP17A.1	M23	3	225	48	0.077	4.880	0.168	0.059	2.318	57.4	4.760	0.168	0.060	2.318	57.3
M8-2.1	N1-1b	6	675	108	0.535	3.830	0.499	0.422	1.711	445.6	3.800	0.501	0.421	1.698	445.6
CP12.1	E1	12	300	48	0.282	5.360	0.088	0.013	1.329	13.0	4.170	0.120	0.013	0.932	13.0
CP12B.1	CP12	89	300	48	0.097	6.430	0.094	0.006	0.477	5.1	5.910	0.093	0.005	0.468	5.2
CP12A.1	CP12	40	300	48	0.104	6.500	0.076	0.002	0.228	1.4	6.230	0.076	0.002	0.225	1.4
CP19A.1	CP19	65	300	48	0.154	7.890	0.086	0.004	0.459	3.9	6.940	0.086	0.004	0.453	3.9
CP19B.1	CP19	4	300	48	-0.191	6.840	0.175	0.002	0.045	1.4	6.930	0.089	0.002	0.156	1.4
CP19.1	N1-3	11	300	48	0.338	5.400	0.083	0.010	1.164	9.2	3.840	0.083	0.010	1.164	9.2
CP20A.1	CP20	32	300	48	0.213	7.890	0.079	0.003	0.336	2.3	7.000	0.079	0.003	0.331	2.3
CP20.1	N1-1b	4	300	48	0.373	5.090	0.078	0.005	0.687	4.5	4.400	0.078	0.005	0.686	4.5
N1-1b.1	N1-1a	8	675	108	0.501	3.795	0.477	0.425	1.824	450.1	3.760	0.468	0.424	1.865	449.9
CP15B.1	CP15	58	300	48	0.108	6.600	0.091	0.005	0.500	4.9	6.180	0.091	0.005	0.490	4.9
CP15A.1	CP15	35	300	48	0.105	6.420	0.080	0.002	0.313	2.3	6.180	0.080	0.002	0.311	2.3
CP15.1	CP14	4	300	48	0.077	5.300	0.120	0.015	0.812	14.4	5.270	0.120	0.015	0.811	14.4
CP14.1	M10	4	300	48	0.362	4.770	0.099	0.032	2.464	29.8	4.120	0.099	0.032	2.464	29.8

Link Reference	D/S Node	Pipe Len (m)	Pipe Hgt (mm)	Sed Dpth (mm)	P.Full Flow (m3/s)	Upstream Invert Level (m AD)	Upstream Max Depth (m)	Upstream Max Flow (m3/s)	Upstream Max Vel (m/s)	Upstream Total Flow (m3)	Downstream Invert Level (m AD)	Downstream Max Depth (m)	Downstream Max Flow (m3/s)	Downstream Max Vel (m/s)	Downstream Total Flow (m3)
SM1.1	M13	4	300	48	0.109	3.360	0.610	0.108	1.631	764.8x	3.300	0.607	0.108	1.631	764.7x
MF1.1	SM1					3.400	1.587	0.108		765.0	3.400	0.596	0.108		765.0
CP5.1	MF1	11	300	48	0.066	3.780	1.506	0.220	3.198	1113.8+	3.730	1.277	0.220	3.677	1113.1+
CP208.1	MF2	5	300	48	0.044	4.240	1.753	0.205	3.050	813.0+	4.230	1.698	0.205	3.357	812.7+
MF2.1	SM2					3.850	2.065	0.108		763.7	3.850	0.621	0.108		763.7
SM2.1	M8	10	300	48	0.075	3.850	0.594	0.108	1.632	763.3+	3.780	0.512	0.108	1.786	762.7+
CP13B.1	CP13A	30	375	60	0.172	5.370	0.129	0.015	0.670	13.8	5.200	0.203	0.015	0.308	13.9
CP13C.1	CP13	17	375	60	0.278	5.450	0.124	0.017	0.860	15.8	5.200	0.123	0.017	0.855	15.8
CP13A.1	CP13	48	375	60	0.172	5.200	0.203	0.055	1.108	51.2	4.930	0.201	0.054	1.100	51.2
CPU-1-2.1	CP-U-1	70	300	48	0.099	5.662	0.098	0.007	0.535	6.4	5.240	0.098	0.007	0.528	6.4
CPU-1-1.1	CP-U-1	45	300	48	0.095	5.440	0.092	0.005	0.451	4.7	5.190	0.091	0.005	0.453	4.7
CPU1AA.1	CP-U-1A	8	225	48	0.088	7.800	0.080	0.004	0.591	3.5	7.600	0.080	0.004	0.588	3.5
CPU1AB.1	CP-U-1A	24	225	48	0.057	7.350	0.074	0.001	0.221	1.0	7.100	0.074	0.001	0.218	1.0
CP-U-1A.1	CP-U-1B	5	225	48	0.029	6.700	0.114	0.009	0.658	8.2	6.670	0.113	0.009	0.662	8.2
CPU-1C.1	CP-U-1B	52	225	48	0.069	7.600	0.080	0.003	0.448	2.7	6.800	0.080	0.003	0.447	2.7
CP-U-1B2.1	CP-U-1B	51	225	48	0.057	7.640	0.090	0.005	0.574	4.5	7.100	0.090	0.005	0.569	4.5
CP-U-1B.1	L8	17	225	48	0.100	5.100	0.104	0.022	1.921	20.5	3.950	0.104	0.022	1.923	20.6
CPU2A.1	CP-U-2	50	300	48	0.137	5.680	0.090	0.005	0.491	4.7	5.100	0.090	0.005	0.489	4.7
CPU2B.1	CP-U-2	29	300	48	0.094	5.300	0.094	0.006	0.472	5.1	5.140	0.094	0.006	0.480	5.2

CPU3A.1	CP-U-3	72	300	48	0.079	5.300	0.131	0.015	0.652	13.6	5.020	0.130	0.015	0.766	13.6
CPU3B.1	CP-U-3	71	300	48	0.113	5.800	0.113	0.013	0.779	12.3	5.240	0.113	0.013	0.769	12.4
CPU8B.1	CP-U-8	45	300	48	0.161	6.290	0.097	0.009	0.745	8.4	5.570	0.097	0.009	0.741	8.4
L1.1	L2	26	300	48	0.076	4.580	0.151	0.025	0.917	22.9	4.390	0.257	0.024	0.504	22.9
L2.1	L3	27	300	48	0.073	4.360	0.249	0.070	1.267	66.9	4.180	0.238	0.069	1.348	66.9
L3.1	L4	26	375	60	0.167	4.150	0.246	0.107	1.642	102.7	3.870	0.264	0.107	1.490	102.8
L4.1	L5	25	600	96	0.368	3.840	0.294	0.130	1.193	123.8	3.730	0.318	0.128	1.040	123.9
L5.1	L6	44	750	120	0.542	3.700	0.348	0.182	1.173	174.5	3.570	0.348	0.175	1.217	174.6
L6.1	L7	21	750	120	0.533	3.540	0.378	0.191	1.140	189.6	3.480	0.403	0.187	1.102	189.7
L7.1	L8	21	750	120	0.576	3.450	0.432	0.186	0.938	189.7	3.380	0.490	0.183	0.716	189.7
L8.1	L9	44	750	120	0.521	3.350	0.516	0.223	0.832	232.4	3.230	0.613	0.221	0.650	231.5
L9.1	L11	28	900	141	0.809	3.220	0.616	0.353	0.903	370.3	3.150	0.672	0.349	0.783	369.5
L10.1	N1-4a	11	1200	192	2.738	2.900	0.812	1.190	1.705	2553.1	2.830	0.858	1.189	1.590	2553.0
L10-2.1	L10-1	47	450	71	0.198	3.500	0.609	0.084	0.830	81.0x	3.230	0.829	0.083	0.546	80.9x
BU3.1	L10-1	3	150	24	0.044	4.020	0.246	0.032	2.636	29.4x	3.730	0.353	0.032	2.474	29.4x
CP10-3.1	L10-2	11	300	48	0.185	4.000	0.203	0.048	1.908	46.1	3.530	0.617	0.048	0.724	46.1x
BU2.1	L10-2	10	225	36	0.093	4.170	0.103	0.021	1.704	19.9	3.680	0.466	0.021	1.391	19.9x
L11.1	L10	16	1050	168	1.709	3.130	0.669	1.014	2.062	2372.8	3.050	0.682	1.015	2.014	2372.4
CP-U-2.1	L3	10	300	48	0.160	4.500	0.111	0.023	1.374	20.8	4.180	0.237	0.022	0.448	20.8
BU1.1	CP13	11	225	36	0.050	4.090	0.109	0.016	1.038	13.8	3.930	0.170	0.015	0.556	13.8
CP-U-1.1	L8	5	300	36	0.153	3.700	0.177	0.023	1.050	22.2	3.570	0.300	0.022	0.884	22.2
CP13.1	L9	14	450	71	0.552	3.900	0.199	0.133	2.605	124.1	3.280	0.568	0.132	0.884	124.1x
CP23A.1	CP23	25	225	36	0.060	6.070	0.065	0.002	0.287	1.4	5.820	0.065	0.002	0.286	1.4
CP23B.1	CP23	12	225	36	0.067	6.070	0.064	0.002	0.297	1.4	5.920	0.064	0.002	0.297	1.4
CP23.1	CP22	5	225	36	0.056	4.080	0.078	0.006	0.730	5.6	3.990	0.084	0.006	0.633	5.6
CP22B.1	CP22A	24	225	36	0.058	6.120	0.064	0.001	0.255	1.2	5.890	0.064	0.001	0.254	1.2
CP22A.1	CP22	25	225	36	0.062	5.870	0.070	0.003	0.412	2.5	5.600	0.070	0.003	0.408	2.5
CP22C.1	CP22	8	225	36	0.073	6.120	0.067	0.002	0.415	2.3	6.000	0.067	0.002	0.415	2.3
CP22.1	L9	6	300	36	0.155	3.980	0.094	0.016	1.125	14.8	3.820	0.094	0.016	1.126	14.8
UC-A-1.1	CP-A-1	95	300	48	0.118	5.919	0.145	0.029	1.073	26.1	5.100	0.144	0.028	1.056	26.2
CP-A-1.1	N1-4	20	375	59	0.464	5.091	0.147	0.084	2.869	77.2	3.456	0.265	0.083	1.971	77.2
UC-A-2.1	CP-A-2	65	300	48	0.151	6.588	0.108	0.014	0.878	12.3	5.680	0.108	0.014	0.872	12.3
CP-A-2.1	N1-2	8	225	36	0.136	5.550	0.106	0.041	2.855	36.4	4.709	0.106	0.041	2.852	36.4
CP10-4a.1	CP10-4	55	300	48	0.108	5.200	0.111	0.012	0.730	11.1	4.800	0.159	0.012	0.403	11.1

Link Reference	D/S Node	Pipe Len (m)	Pipe Hgt (mm)	Sed Dpth (mm)	P.Full Flow (m3/s)	< Upstream Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3) >	< Downstream Invert Level (m AD)	Max Depth (m)	Max Flow (m3/s)	Max Vel (m/s)	Total Flow (m3) >
CP10-4.1	CP10-3	55	300	48	0.108	4.800	0.159	0.032	1.051	29.8	4.400	0.157	0.031	1.041	29.9
L10-1.1	L10-1a	9	450	71	0.246	3.200	0.746	0.178	1.175	170.5x	3.120	0.783	0.178	1.172	170.5x
L10-1a.1	L10	5	450	71	0.234	3.090	0.678	0.188	1.250	180.7x	3.050	0.694	0.188	1.249	180.7x
G2.1	MF1	12	300	16	0.475	5.500	0.047	0.002	0.361	1.8	3.400	1.587	0.002	-0.022	1.3x
CP11.1	CP10	5	300	32	0.107	3.660	1.325	-0.036	0.623	-163.5x	3.610	1.375	-0.036	0.548	-163.9x
CP10.1	G1	6	300	32	0.097	3.600	1.385	-0.066	-0.896	-306.1x	3.550	1.435	-0.066	-0.891	-306.5x
G1.1	MF1	13	300	48	0.087	3.500	1.485	-0.066	-0.929	-307.9x	3.400	1.585	-0.066	-0.918	-308.8x
CP10-1.1	CP10	30	200	48	0.052	3.800	1.185	-0.007	0.159	-21.3x	3.610	1.375	-0.024	-0.304	-31.9x
CP9.1	CP10	5	250	48	0.060	3.630	1.355	-0.026	-0.250	-76.3x	3.610	1.375	-0.028	-0.291	-78.1x
CP10-2.1	CP9	20	200	48	0.060	3.800	1.185	-0.008	0.216	-29.6x	3.630	1.355	-0.015	-0.243	-36.6x
CP14-3.1	CP14-1	12	225	48	0.055	6.270	0.083	0.003	0.428	2.7	6.150	0.083	0.003	0.422	2.7
CP14-1.1	CP14	65	225	36	0.057	6.120	0.085	0.006	0.616	5.4	5.530	0.084	0.006	0.607	5.4
CP14-2.1	CP14	62	225	36	0.067	6.770	0.074	0.004	0.550	3.7	5.980	0.074	0.004	0.544	3.7
M11.1	M13	26	900	144	0.835	3.430	0.544	0.528	1.586	1199.3	3.360	0.527	0.524	1.676	1197.2
M13.1	L11	35	1050	168	1.414	3.270	0.613	0.637	1.498	1968.7	3.150	0.671	0.640	1.335	1966.0
CP17-1.1	CP17	40	300	48	0.156	5.700	0.095	0.008	0.673	7.2	5.100	0.267	0.010	0.543	7.2
CP17-2.1	CP17	52	300	48	0.217	6.600	0.104	0.017	1.165	14.8	5.100	0.267	0.016	0.936	14.8
CP21-1.1	CP21	31	225	48	0.059	6.570	0.099	0.008	0.718	7.0	6.220	0.098	0.007	0.712	7.0
CP21-1A.1	CP21-1	60	225	48	0.074	7.640	0.082	0.004	0.558	3.5	6.570	0.099	0.004	0.365	3.5
CP21-2.1	CP21	150	225	48	0.067	7.710	0.102	0.010	0.866	8.8	5.510	0.101	0.009	0.852	8.9
CP21.1	L2	3	300	48	0.231	5.100	0.106	0.028	1.864	27.2	4.900	0.106	0.028	1.864	27.2
M14-1.1	M14	40	300	48	0.073	5.490	0.114	0.012	0.723	11.4	5.220	0.139	0.012	0.497	11.4
M14.1	M15	11	300	94	0.085	5.200	0.159	0.018	0.950	16.8	5.020	0.269	0.018	0.377	16.8
CP-U-9.1	M15	28	450	71	0.178	5.150	0.201	0.046	0.892	41.9	5.020	0.269	0.045	0.545	41.9
CPU-9A.1	M15	7	300	48	0.185	5.900	0.105	0.021	1.451	19.7	5.600	0.105	0.021	1.452	19.7
M15.1	M16	12	600	94	0.322	5.010	0.279	0.104	1.034	95.9	4.970	0.282	0.103	1.005	95.9
M16.1	M17	35	600	94	0.312	4.960	0.292	0.114	1.054	106.8	4.850	0.307	0.111	0.965	106.9
M17.1	M18	39	600	94	0.322	4.840	0.317	0.132	1.092	126.7	4.710	0.372	0.128	0.841	126.8
M18.1	M19	23	600	94	0.329	4.700	0.379	0.151	1.001	151.5	4.620	0.434	0.151	0.790	151.6
M19.1	M20	34	600	94	0.317	4.610	0.442	0.241	1.283	242.7	4.500	0.471	0.240	1.145	242.8
M20.1	M21	32	600	94	0.311	4.490	0.458	0.277	1.384	281.3	4.390	0.452	0.275	1.383	281.4
M21.1	M22	27	675	94	0.450	4.380	0.455	0.298	1.341	306.1	4.290	0.481	0.296	1.218	306.1
M22.1	M23	34	675	94	0.443	4.280	0.489	0.330	1.351	341.7	4.170	0.519	0.327	1.241	341.7
M23.1	M8-1	26	675	94	0.530	4.160	0.524	0.412	1.545	429.2	4.040	0.559	0.410	1.430	429.2
M8-1.1	M8-2	37	675	94	0.313	4.040	0.553	0.425	1.499	445.5	3.980	0.456	0.423	1.861	445.6
CP-U-4.1	M19	32	375	48	0.241	5.800	0.163	0.066	1.734	62.4	5.150	0.163	0.066	1.733	62.4
CPU-4A.1	M19	5	300	48	0.179	5.400	0.103	0.019	1.335	17.3	5.200	0.103	0.019	1.336	17.3

+ after total flow indicates a pipe/channel surcharged by flow and depth at that end.
x after total flow indicates a pipe/channel surcharged by depth only at that end.

NOTE :

(i) maximum elevations, depths, volumes, velocities and discharges are selected from the values at each time increment and will be in general more extreme than the maximum values in the hydrograph files.
(ii) maximum elevations, velocities and discharges are not necessarily calculated at the same time.
(iii) max. velocity is not calculated for a pipe if either the water level does not exceed 5% of the pipe depth or the discharge is less than 0.001 m3/s.

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Table 1 EP Condition 3.5 (c) - Summary of the document

	Content	Remarks
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 c)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; section 3 clause 3.2.10, section 6, clause 6.7.2.1 and 6.7.2.2, section 10 clause 10.5.1 , section 11, clause 11.4.1 and 11.4.6, section 13, clause 13.5.1 and 13.5.2 and section 16 clause 16.2.8
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and Franchisee Requirements Clause 1.05 item (b) and (c)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1. 10, section 5, section 7, section 17 and section 19
5	Contract drawings	**a) Impermeable Lining Leakage Detection System** - PAFF/BA/02/DWG/C/1705 Revision 3 Tank Farm Fuel Tank Foundations - Sections and Details of Ring Beam (sheet 1 of 2)
		b) Emergency Shut Down System and High High Level Switch - PAFF/LC/02/DWG/E/0715 Revision 2 ESD Button Location and ESD Button/HHLS Schematic - PAFF/LC/02/DWG/M/0203 Revision 9 Receipt P & ID - PAFF/LC/02/DWG/M/0204 Revision 7 Product Storage P & ID (No. 1 of 3) - PAFF/LC/02/DWG/M/0205 Revision 4 Product Storage P & ID (No. 2 of 3) - PAFF/LC/02/DWG/M/0206 Revision 5 Product Storage P & ID (No. 3 of 3) - PAFF/LC/02/DWG/M/0202 Revision 7 Jetty P & ID' - PAFF/LC/02/DWG/M/0207 Revision 16 Transfer Pump P & ID - PAFF/LC/02/DWG/M/0209 Revision 5 Sha Chau Jetty Modification P & ID - PAFF/LC/02/DWG/M/0213 Revision 6 Oil / Water Separator Drainage Tank Farm Utility Flow Diagram
6	Photographs	Photographs of the completed works.
7	Technical information	- ESD Breakglass - Instrumentation for Tank Gauging, Level Switches, Temperature Elements and Ultrasonic Flow Transmitters - Flowmeters, Pressure Transmitters, Pressure Switch, Temperature Transmitter - SCADA Screen Shot of ESD System
8	Justification	• The high and high-high levels alarms will be set on each storage tank. The high level alarm will be set by means of the level gauge of each tank and will trigger an alarm on the SCADA system for operations alert. The high-high level alarm has been designed to mitigate the reliance on one single system. A stand-alone device, a vibrating fork level limit switch, will be installed for detecting the high-high level and which will trigger an ESD for the closure of all inlet valves of the tank and the stoppage of all pumps immediately together with the sounding of an audible alarm siren to alert operating personnel through an independent routing system. Thus the tank overfilling monitoring systems has been properly designed at a high integrity level.

	Content	Remarks
		• Drawings PAFF/LC/01/DWG/M/0202-3 & 0207 show the installation of pipeline leakage detection system in the subsea pipelines using COWI Stat Leak System. The testing is by closing the sections of pipelines and by detecting any pressure drop within a specified period inside the pipelines. A pressure drop not due to thermal effect may indicate a possible leak in the pipeline. It will generate an alarm and activate the opening of the motor-operated valves to de-pressurize relevant pipeline section first and re-closing of them to isolate the problem section pending for immediate investigation. If leakage is confirmed, urgent repair will be arranged.
		• Drawing PAFF/BA/02/DWG/C/1705 shows the installation of an 80mm dia. leak detection pipe, in accordance with API 650, underneath the sump of each storage tank. The head of the pipe, which is perforated, is designed to situate above the containment membrane of the tank base and the pipe descending to the end outside the tank ring base. Thus the pipe will collect and drain out fuel, if any, to a designated containment well at the tank side. In this way, any leakage from the bottom of the storage tank can be detected. Also, the bunded areas are laid with impervious membrane to contain any spillage of fuel.
		• Drawing PAFF/LC/02/DWG/E/0715 show the installation of manual-operated emergency shut down (ESD) buttons at strategic points in the tank farm for emergency use. As soon as ESD is activated, all valves and delivery pumps will automatically shut down to isolate the fuel lines and stop the flow of fuel.
		• Drawings PAFF/LC/01/DWG/M/0202 - 0207 & 0209 show the installation of ESD system which will be triggered automatically in case of actuation of fire alarm system, overfilling monitoring system of aviation fuel storage tanks and leakage detection system of sub-sea pipelines.
9	Further Assessment Findings	Findings of further assessment by ET indicated that the design specifications meet the requirements of EP and EIA Report.

香港機場管理局 AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet

EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (c)
Date of Report:	1 December 2009
Date prepared by ET:	1 December 2009
Date received by IEC:	1 December 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (c)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(c) Overfilling Monitoring Systems and Leakage Detection Systems
Tank overfilling monitoring systems, pipeline and impermeable lining leakage detection systems and emergency shutdown (ESD) systems shall be properly designed and constructed for the Project. All ESD systems shall be equipped with manual initiating devices. The ESD systems shall also be initiated automatically in case of actuation of fire alarm system, overfilling monitoring system of aviation fuel storage tanks and leakage detection system of sub-sea pipelines.

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: [signature] Date: 1 December 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

PP Dr Guiyi Li, Independent Environmental Checker: [signature] Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 **499** 章**)**
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. <u>Submissions or Measures during the Construction of Certain Parts of the Project</u>

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements:-

c) <u>Overfilling Monitoring Systems and Leakage Detection Systems</u>

Tank overfilling monitoring systems, pipeline and impermeable lining leakage detection systems and emergency shutdown (ESD) systems shall be properly designed and constructed for the Project. All ESD systems shall be equipped with manual initiating devices. The ESD systems shall also be initiated automatically in case of actuation of fire alarm system, overfilling monitoring system of aviation fuel storage tanks and leakage detection system of sub-sea pipelines.

Environmental Impact Assessment Report Requirement

3 DESCRIPTION OF PROJECT AND ASSUMPTIONS

3.2.10 The tank farm would be provided with bundwalls and contained drainage. There are 2 main bunds (designed to contain any spills from the tank or tank piping), each containing 6 tanks in future but 4 tanks initially. The height of the bundwalls has also been increased from previous April 2002 EIA in order to improve the retention of any fuel spillage from the tanks within the PAFF boundary. The initial bund containment with 4 tanks in each bund would amount to at least 180% of the volume of the largest tank (well exceeding the required 110%) and ultimately (2040) this would be at least 150% of the volume of the largest tank with 6 tanks in each bund. Each tank is also separated by intermediate bund walls to hold minor spills. There are also 2 emergency shutdown valves on the pipeline inlet to the tank farm from jetty and another 2 on the pipeline outlet of the tank farm to the Airport. These valves are operated via motorized electric actuators. The tank bunds and the pump platform are contained areas and drain to the interceptor via bund drain valves. Other leakage prevention devices include fuel tank high-high level alarm and leak detection system for the pipeline. The storm water drain will also have a remotely operated block valve to contain any oil spill on site.

6 WATER QUALITY ASSESSMENT

6.7 Mitigation Measures

6.7.2 Operational Phase

6.7.2.1 The single most important mitigation measure in the operational phase is the placement of a rock armour protective layer positioned to cover the pipeline but not protrude above the sea bed. This will prevent possible mechanical damage, for example from trailing anchors or trawling nets. To provide additional security it is recommended that the pipeline shall be fitted with a leak detection system. The system shall be monitored on a 24 hour basis by the control centre at the Tuen Mun Area 38 site. In the unlikely event of any failure this warning system should trigger the emergency shutdown.

6.7.2.2 Other mitigation measures recommended for the operational phase include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- all tanks shall be bunded to a capacity of at least 150% of the largest individual tank in each compound at the ultimate phase of 2040. For the initial development phase, as only 4 tanks will be present in each bund, a containment capacity of about 175% will be achieved. Tank pits shall be protected by an impermeable bed (e.g. geotextile sheeting) to prevent seepage of aviation fuel to ground.

A leak detection system shall be installed beneath the containment membrane;

10 HAZARD TO LIFE ASSESSMENT

10.1.5 PAFF Safety Systems

10.1.5.1 The Emergency Shutdown (ESD) control philosophy at the facility provides for the shutdown of the following:

- receipt of fuel from the jetty;
- tank farm facility; and
- delivery lines.

10.1.5.2 There are two ESD valves on the inlet to the tank farm (from the jetty) and two on the outlet of the tank farm (to the AFRF at Sha Chau). These valves are operated via motorized electric actuators during normal operation and will be closed by pneumatic power during an interruption to the facility's main power.

10.1.5.3 Each of the above systems has different means of initiating the system. Manual push-buttons provide the primary mode of initiation. However, other initiating devices such as the actuation of the fire alarm system, fuel tank high-high level and a sudden drop in pressure in the delivery pipelines can also activate the ESD system. A leak detection system is provided for the delivery pipeline.

11 FUEL SPILL RISK ASSESSMENT

11.4 Mitigation Measures

11.4.1 The mitigation measures identified here are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B. All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure and resultant leaks and spills to the lowest practicable level. Tanks in the tank farms will be constructed in a bunded area surrounding the tanks which will have an ultimate (2040) collection capacity of at least 150% of the volume of the largest tank in the bund to contain any fuel spills. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages. Protection against leaks from the bottom of the tanks is achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. In respect of the pipeline, besides protection of the pipeline being covered with a protective rock armour layer, integrated methods of control will also be built into the design of the pipeline. A leak detection system will be installed to provide early detection of any leak and at the first sign of a pressure drop, would instigate an automatic shut-off system. Contingency plan procedures will require investigation and immediate action to stem the release, as described below.

11.4.6 On the prevention side, the sub sea pipelines will be protected by impressed current cathodic protection system and monitoring by a leak detection system to prevent and manage the risk of fuel leakage. Routine inspections will be undertaken on a regularly basis (such as daily, weekly, monthly or quarterly basis) to ensure the proper functioning of the whole facility.

13. LAND CONTAMINATION

13.1 Mitigation Measures

13.5.1 The implementation of appropriate mitigation for the oil storage facilities and pipework is required to ensure that risk of ground contamination as a result of oil spills or leaks is kept to a practical minimum. Such measures should include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- bunding of all fuel storage areas;
- adherence to relevant design standards for storage tanks, pipework, containment and drainage;
- regular plant inspections and maintenance;
- impermeable lining of tank pits;
- leak detection systems;
- controlled surface drainage and the provision of emergency shut off valves;

13.5.2 Key mitigation recommendations for the bunded containment have been identified in Section 6.7. The most important features are that all tanks shall be bunded to an ultimate capacity of at least 150% of the largest individual tank in each compound. Following completion of the first phase of works, the bund capacity will be as high as 180% of the largest individual tank in each compound; an only 4 tanks will be present within each bund. Tank pits shall be protected by an impermeable bed (e.g. geotextile sheeting, bitumen lining) to prevent seepage of oil to ground and a leak detection system shall be installed beneath the containment membrane. A concept design for a tank incorporating these features is provided in Figure 13.1.

16. SUMMARY OF ENVIRONMENTAL OUTCOMES

Design

16.2.8 All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure, and the resultant leaks/spills, to the lowest practicable extent. Fuel storage tanks will be constructed in a bunded area which will have collection capacity greater than the maximum content of the largest tank, to contain any fuel leaks or spills. There shall be no direct outlet from the bund to ensure retention of any spilled material. A collection sump shall be included in the base. Protection against leaks or spills from the bottom of the tanks will be achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. A spill detection system will be fitted underneath this membrane to provide additional security.

Removal of accumulated rainwater shall be activated manually and discharged to storm drain via an oil / water separator. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

(i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting

(ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings

(iii) Sampling and product recovery system

(iv) Manifolding to tank farm and existing aviation fuel system simultaneously

(v) Fire protection system

(vi) Power supply and independent standby power generator or second supply

(vii) Buildings including offices, canteen, control room, workshop, stores

(viii) Emergency response facilities

(ix) Storage tanks for fuel, water, chemicals and wastes

(x) Utility and other systems including back-up systems

(xi) Cathodic protection

(xii) Lightning protection

(xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities

(xiv) Electronic tank servo gauges

(xv) Hard standing, roads and parking

(xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services;

(c) Under seabed twin piggable fuel pipelines from jetty to tank farm and from tank farm to the **Existing Aviation Fuel System** including cathodic protection, leak detection system and pig traps at the tank farm;

EPC – Franchisee's Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(b) Tank farm including fuel tanks and ancillary pipework, foundations, earthworks, containment bunds, paving, drainage, fencing, mechanical and electrical services; and associated fire protection;

(c) Under seabed twin piggable fuel pipelines from jetty to tank farm and from tank farm to the **Existing Aviation Fuel System** with connection to the existing submarine pipeline including cathodic protection, leak detection system and pig traps at the tank farm;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19

Cathodic Protection British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed. Also, in the detail design additional standards may be referenced for specific items.

5. Storage Tank (including BUND Wall and Foundation)

5.1 GENERAL

The main storage tanks will be circular and made of steel plate with diameters of 6 x 43.5m, 1 x 41.5m, 1 x 35m and a height of 24.7 metres and nominal capacities of 35,000, 32,000, 22,000 cubic metres respectively. The tanks will be founded on a reinforced concrete ring beam. The eight storage tanks will be contained within two reinforced concrete bund walls (4 nos. of fuel tank for each bund wall) with a membrane lining to contain any leakage. All bund walls will include a wave wall to assist in containing Jet A1 within the bunded area.

Tank gauging will be of the radar type. High high level switches (HHLS) will be fork type.

5.2 CODES AND TECHNICAL STANDARDS

The following design standards will be used for the design of structures as applicable:

(a) API 650 Vertical Storage Tanks
(b) BS EN 12285 Horizontal Storage Tanks
(c) British Standard for Concrete Structures
(d) Code of Practice for Oil Storage Installations 1992 – Building Authority Hong Kong
(e) IP Code of Practice Part 15

5.3 SPECIFIC CRITERIA

5.3.4 Bund Walls

1. The bund walls shall be of reinforced concrete.

2. The capacities of the bunded areas will be 57,691 cubic metres for phase 1a & 2 tank farms and a minimum of 50,695 cubic metres for phase 1b & 2 tank farm, which are not less than 38,500 cubic metres (110% of a 35,000 cubic metres tank) for both areas.

3. The construction of the bund walls joints will provide a continuous barrier to any spill within the bunded area.

4. The bund walls shall be designed to retain the bunded area when full of water or the impact load of an instantaneous release from a simple storage tank which ever is greater.

5. A means of access in and out of the bunded area will be provided adjacent to the stairs fitted to the main storage tanks and as directed by the FSD.

6. The bund wall alignment will allow 25% of the circumstance of each tank to be with in 15 metres of the EVA.

5.3.5 Containment Inside Bunded Areas

1. The floor of the bunded area shall be lined with a seam welded high density polythelyne (HDPE) membrane of not less than 1mm think and covered with a 200 mm thick layer of compacted road base.

2. The HDPE membrane shall be sealed to the concrete foundations, and intermediate bunds to provide a continuous barrier across the bunded area floor.

3. The HDPE membrane shall be laid under the main storage tanks to form a central sump. A tell tail pipe will run from within the central sump through the tank foundation to provide a visual indication of product leaks in the floor plates of the tanks.

4. The bunded area will have a series of open drains leading to a single outlet point. The outlet point will have a manually operated valve (normally closed) leading to an oil interceptor.

5. The bund area will be partitioned by intermediate containment bunds of up to 500m high subject to ground contours around each tank.

5.3.6 Secondary Containment

The security walls adjacent to the bund wall facing public areas will in addition be constructed of reinforced concrete to contain potential overtopping of the bund wall. Gates in the security walls are to be solid and sealed up to the first hinge on the gate.

7. SUBSEA PIPELINES

7.1 GENERAL

7.3 SPECIFIC CRITERIA

7.3.3 Leak detection

The existing COWI leak detection system operating at the existing AFSC is to be upgraded to include the subsea pipelines of the PAFF (refer Design Package PAFF/XX/04/DSG/E/1702).

17. INSTRUMENTATION

17.1 GENERAL

The instrumentation covers all instruments shown on the P& ID s and includes the tank gauging, valve position switches, flow metres, temperature probes pressure gauges, leak detection.

Generally all instruments will feed back to the SCADA. Each instrument will be reviewed individually to consider local indication.

17.2 CODES AND TECHNICAL STANDARDS

The Code of Practice for the Electricity (Wiring) Regulations by EMSD of Hong Kong

IEE	Wiring Regulations
ATEX 95	Electrical Apparatus for Potentially Explosive Atmospheres
BS 5308	Instrumentation Cables
IP Code of Practice	Part 15

17.3 SPECIFIC CRITERIA

The instrumentation will provide the operators with an accurate status of the process equipment at both the jetty and the tank farm.

17.3.1 Instrumentation Philosophy

(1) While the Supervisory, Control and Data Acquisition System (SCADA) for the new facility will be an integrated system, the components and equipment ports used shall be standard and readily available – i.e. not specially made solely for use at the Facility.

17.3.2 General

(1) The final instrumentation required for the operation of the facility shall be indicated on the P & IDs after detail design and engineering has been completed. It shall be sufficient to operate the facility safely and efficiently with present day technology.

(2) As a minimum it shall include instrumentation for:

(a) Tanks
(b) Filters
(c) Pumps
(d) Motorised valves
(e) Selected manual valves (if applicable)
(f) Receipt and Transfer Lines
(g) Fire Fighting Systems
(h) ESD
(i) Switchboard

(3) Functions shall include, among others, product level and alarm conditions, pressure indication, pressure alarm conditions, filter differential pressure and alarm condition, flow indication, flow alarm conditions, valve position status, discharge arm over-reach, jetty foam monitor position and temperature indication.

(4) The instrumentation in the control room shall be able to display the breaker status.

17.3.3 Tanks

(1) Instrumentation shall include:

(a) Level indication with readout in the control room, the level gauge is to be a radar type gauge.

(b) Level gauges shall have facility to read high and low levels.

(c) Independent High/High level alarm with audible and visual alarm in the control room and ESD.

(2) In addition to the above, a mechanical method of level indication shall be provided for the bulk storage tanks. This may comprise a cable attached to the floating section, leading to the outside and fitted with an external weight secured in a guide or by a tie cable on the outside of the tank shell. An adjacent a scale would show fuel capacity at various weight heights.

(3) Provision shall be made for instrumentation of a second motorised inlet valve on each tank.

(4) Provision/Capacity shall also be made for repeat instrumentation on a further four tanks, construction of which shall be done in future.

17.3.4 Filters

(1) Instrumentation shall include but not be limited to:

(a) High differential pressure alarm, audible and visual alarm in the control room.
(b) Local differential pressure indication.

17.3.5 Pumps

(1) A pressure transmitter shall be fitted on the suction piping manifold of the Main Delivery Pumps.

(2) Each main delivery pump shall have an individual pressure transmitter on the discharge side.

(3) All displays shall be in the control room.

(4) Pressure gauges shall be located adjacent to each pressure transmitter.

(5) Each main delivery pump shall have a flow meter for pump sequencing and control.

17.3.6 Inlet Lines from Jetty

(1) Before entry to the bund area and downstream of the ESD valves, the following instrumentation shall be installed:

(a) Flow transmitter with readout in the control room. The transmitter shall have a low flow alarm function with audible and visual alarm in the control room. A means of automatically recording flowrate data shall also be provided.

(b) Pressure transmitter with readout in the control room. This shall have a low pressure alarm function with audible and visual in the control room. A means of automatically recording pressure data shall also be provided.

(c) Temperature transmitter with readout in the control room. A means of automatically recording temperature data shall also be provided.

(d) For the discharge arms, over-reach alarm function, and over-reach unchecked function, with audible and visual in the control room.

(e) For motorised valves, position indicators.

(f) For manual flushing valves, (jetty piping and return to inlet line) position indicator (where applicable).

17.3.7 Delivery Lines

(1) Delivery Line instrumentation shall include:

(a) Pressure, flow and temperature transmitters shall be installed upstream of the ESD valves. Read out shall be in the control room. Pressure transmitters shall have an alarm function for low pressure, with audible and visual in the control room. A means of automatically recording flowrate, pressure and temperature data shall also be provided.

(b) For motorised valves, position indicator.

(c) For manual valves, position indicators.

17.3.8 Leak Detection System

(1) Additional instrumentation shall be installed for the Leak Detection System and shall be coordinated with COWI Consulting Engineers.

(2) The Facility will be designed to allow for the AFSC closing valves without consultation. Waterhammer is the likely impact, base on the analysis of the existing lines this not expected to cause damage. This will be checked in the detail design.

(3) It is envisaged that the procedure for determining system tightness may involve closure of isolating valves at Sha Chau. In this case, valve actuation would be initiated by the AFSC following consultation and coordination with the control centre. AFSC valve condition is not the responsibility of this document.

(4) The Sha Chau valve position status shall be communicated from the AFSC SCADA system to that at the Facility. The valve position of the valves under pressure at the Facility will be relayed to the AFSC.

17.3.9 Fire Fighting Systems

(1) Instrumentation shall be provided for the Fire Fighting Systems to ensure correct automatic operation of pumps, valves and other equipment which is part of the fire control system, both within the Facility and for the Jetty.

(2) The Jetty instrumentation shall include CCTV cameras that can monitor the foam monitor operation. Guidance of the foam monitors shall be from the Control Room.

(3) The instrumentation details shall be included in the Fire Fighting design.

17.3.10 Switchboard

Instrumentation is included in the switchboard design to include the position of the main breakers.

17.4 MATERIALS

Typical Instrument Characteristics

	Range	**Accuracy**
Tank Gauging System		± 1mm
Level Switches (displacement type)	± 50mm adjustment	
Temperature Transmitters	0 to 100	± 1%
Insertion Turbine Flow Meters (under factory conditions)	TBD	± 0.5% of range
Ultrasonic Flow Meters (under factory conditions)	TBD	± 0.75% of range
Pressure Gauges (4” + 6”)	TBD	± 1% of range

TBD – To be defined for each location

17.5 DESIGN AND ANALYSIS METHODS

The design will be presented in two design packages

PAFF/TR/01/DSG/E/1701 - Instrumentation
PAFF/XX/04/DSG/E/1702 - Leak Detection

17.6 INPUT DATA AND MAIN INTERFACES

1. SCADA system
2. Security system

3. Process Design
4. Authority's Design Requirements
5. Franchise Design Proposals

19. COMMUNICATIONS SYSTEMS

19.1 GENERAL

The communications systems include the SCADA system, the telephone communication and the data link from the Facility to the Existing Eastern Tank Farm.

19.2 CODES AND TECHNICAL STANDARDS

The Code of Practice for the Electricity (Wiring) Regulations by EMSD of Hong Kong

IEE	Wiring Regulations
IP Code of Practice	15

19.3 SPECIFIC CRITERIA

Compatible with the existing fuel facility SCADA.

Control Systems

19.3.1 Control Philosophy

(1) Functionality shall cover all required operations, including, but not limited to:-

- (a) Fuel receipt into the Tank Farm.
- (b) Fuel transfer from the Tank Farm to the Airport.
- (c) Tank to Tank transfer.
- (d) Re-circulation and Flushing.
- (e) Back loading of off-specification product.
- (f) Emergency shut down (ESD).

(2) As well as reducing the inputs required by personnel, the control system shall be designed to prevent the risk of certain quality assurance procedures being circumvented. However, it shall be possible to override the system and operate it manually. Management information shall be available for printing out as necessary and as a daily summary.

(3) All alarms, valve status and equipment status will be captured, displayed and historized on the SCADA system.

19.3.2 Main Storage Tanks

(1) The Tank inlet valve will only open for filling if the tank outlet valve is closed. The level in the tank should be between high and low level. (initial filling and recommissioning will be by manual override)

(2) If the High level warning is reached, an alarm will be signalled.

(3) If the High High level is reached during tank filling, independent alarms and control loop signals both the tank inlet valve and the ESD valve at the jetty to close.

The High High level alarm shall be set sufficiently above the high level alarm to allow the operator to take appropriate action.

(4) A tank must settle for at least 2 hours after receipt. Therefore, after receipt, the inlet valve is closed and the outlet valve cannot be opened until the 2 hour period has elapsed. Manual override shall be provided to bypass the 2 hour timer for emergency purposes and/or maintenance operations.

(5) Selection of tank for delivery of product to the airport will be done manually from the control room.

(6) Tank status and content will be displayed on the VDU in the control room, product level in the tank in mm and the corresponding quantity of product in that tank in m^3.

(7) Tank valve status and elapsed settling time will be displayed on the VDU.

19.3.3 Product Recovery Tank

(1) High level alarm – action is to close the inlet valve and activate an alarm in the control room except that closed circuit lines from filter air eliminators and all thermal pressure relief lines will not be shut off.

(2) High High level alarm, action is to close the inlet valve and activate a second alarm in the control room.

(3) Low level alarm – action is to close the outlet valve and shut down the product recovery transfer pump.

19.3.4 Drain Down Tank

(1) Automatic Level Monitoring will be the same as for the main tanks.

(2) High level alarm – action is to close the inlet valve and activate an alarm in the control room except that closed circuit lines from filter air eliminators and all thermal pressure relief lines must not be shut off.

(3) High High level alarm, action is to close the inlet valve and activate a second alarm in the control room.

(4) Low level alarm – action is to close the outlet valve and shut down the product recovery transfer pump.

19.3.5 Pumps

(1) For product transfer from the tank farm, pumps cannot start unless at least one tank outlet valve and all other relevant valves, including the outlet ESD valve, are open. Pumps cannot start if the inlet and outlet valves of any tank(s) are simultaneously open. Pumps cannot start if a tank outlet valve is open and a Low or Low Low warning exists for that tank.

(2) Pumps cannot be started without a signal from the AFSC requesting product. Pumps will be started by the control room operator. Pumps will normally be stopped by the control room operator or when a low level signal is received from tank supplying the pump.

(3) Each pump's operating status, delivery pressure and delivery flow rate are monitored and displayed on the VDU.

(4) Each pump's running hours are recorded.

(5) When the recirculation pumps are used for flushing the jetty lines, a tank inlet valve, and tank outlet valve cannot be closed if a pump is running. The ESD system stops the pump(s) before closing the valves. It is also not possible to start a pump if the valves described are closed. This is to prevent inadvertent over-pressurisation of the receiving system.

(6) On the rare occurrence when the recirculation pumps are used for back loading, the system shall be manually overridden.

19.3.6 Jetty Equipment

(1) Status of over-reach of discharge arms are monitored and displayed

(2) Automatic closure of discharge arm local isolating valves

(3) Recovery Header level

(4) Recovery Pump status

19.3.7 Valve Control - General

(1) Enables motor operated isolating valves to be remotely opened / closed.

(2) Status of motor operated isolating valves is monitored and displayed.

(3) Status of selected manually operated isolating valves is monitored and displayed. (where applicable)

(4) When product is being transferred from the Tank Farm to the airport, it will not be possible to open the back loading isolating valve in the branch at pump outlet.

(5) When back loading product, it is not possible to open a tank inlet valve, or the isolating valve in the direct transfer line upstream of the pump.

19.3.8 System Leak Detection

The leak detection system is to be an extension of the existing AFSC system.

(1) Weekly routine to run program - a pressure test of each section of the sub-sea lines.

(2) Monitoring of pressure (and temperature) will be possible with signals transmitted to the AFSC.

(3) Opening/closing of relevant valves on the system, and pressurising the system with a pressurising jockey pump.

(4) Output of results and warning as necessary.

(5) Display of isolating valve status at Sha Chau.

(6) NOTE:- The COWI leak detection system currently installed at the AFSC will be upgraded as part of the Works to include the subsea lines all signals necessary for the monitoring of the leak detection system will be transmitted to the AFSC.

19.3.9 Displays - VDU

(1) VDU displays of system schematics showing status (typically by colour) of:

(a) pumps running/shut down

(b) motorised valves open/closed

(c) manual valve locations on the system and valve status where valve position indication is fitted

(d) Sha Chau isolation valve status

(e) flow rate, pressure and temperature for receipt and delivery

(f) storage tank level and status

(g) ESD status

(h) discharge arm over-reach

(i) discharge arm over-reach unchecked

(j) power meter and main circuit breaker on supply switchboard

(k) Filter water separators differential pressure

All VDU display units are to be powered by UPS.

19.3.10 Reports

(1) Hard copy print out in real time of:

(a) any event outside set limits (e.g. tank High alarm)
(b) any routine event (e.g. pump starts, valve closes)
(c) daily/hourly total volume and flowrate for receipt and delivery
(d) pressure and temperature for receipt and delivery
(e) leak detection report as applicable
(f) ESD report
(g) Over-reach
(h) hours run for each pump

19.3.11 Routine Operator Inputs

(1) Pump Control
(2) Manually nominating tanks for filling and delivery
(3) Key reset after emergency shut down
(4) Operate valves
(5) Operate ESD isolating valves
(6) Drain Down Tank emptying
(7) Product Recovery Tank emptying
(8) Set and initiate back loading sequence
(9) Set and initiate direct transfer sequence
(10) Operate Jetty foam monitors and CCTV system
(11) Revert to full manual operation if necessary

Emergency Shutdown System (ESD)

19.3.12 ESD System Objectives

(1) The ESD System shall be designed and engineered to be a failsafe, hardwired and separate unit within the SDADA system which unit within the SCADA system which will provide receipt and delivery emergency shutdown to ensure:

(a) Safety to personnel.

(b) Prevent damage to the facility.

(c) Protect the environment.

(d) Prevent damage to third party equipment.

(e) Maintain control of a potential emergency, or emergency condition.

(f) Limit and contain emergency situations.

Specific ESD Philosophy

19.3.13 General

(1) The shutdown philosophy is considered in three (3) separate sections:

(a) Receipt of fuel from the jetty.

(b) Within the Tank Farm facility.
(c) Delivery of Product to the Airport.

(2) A cause and effect chart shall be developed as part of the detailed engineering.

(3) The shutdown philosophy shall be a part of the HAZOP which shall be part of the detailed engineering.

(4) Manually operated ESD buttons are considered to be separate from normal equipment controls – e.g. manual pump start or local valve actuation buttons. Manual ESD buttons must be at least 15m away from the area of potential hazard and easily accessible. In general the buttons shall be placed in close vicinity to fire hydrant cabinets.

(5) Initiation of an ESD must not interrupt or depend on interrupting the main electricity supply.

19.3.14 Receipt of Fuel from the Jetty

As minimum the following shall instigate an emergency shutdown to close valves on the receiving lines from the Jetty to the Tank Farm, designated as “emergency shutdown valves”:

(1) Actuation of a fire alarm

(2) Manual operation of the appropriate ESD buttons in the Jetty.

(3) High high level alarm on the main storage tanks.

(4) Initiation of ESD of the receipt line shall not shutdown the Tank Farm delivery facilities.

19.3.15 Within The Tank Farm Facility

Emergency Shut Down (ESD)

(1) Tripping an ESD button within the Tank Farm causes pumps to stop (if running), closely followed by closure of the main outlet or inlet ESD valves, as appropriate.

(2) Pumps cannot be restarted and valves cannot re-open until the lock out system is reset in control room.

(3) Status of ESD valves is monitored and displayed.

(4) The zone in which an ESD is manually or automatically actuated is displayed.

(5) As a minimum the following shall instigate an emergency shutdown of the facility and close those valves designated as “emergency shutdown valves”:

(a) Manual operation of the appropriate ESD buttons.

(b) Actuation of a fire alarm.

(6) This will shut down the entire Tank Farm, including the receipt and delivery system.

19.3.16 Delivery of Product to the Airport

(1) The Delivery Lines extend from the pump outlet to the Tie-ins for the sub sea lines. There are also connections for back loading off specification product and for flushing the receiving lines.

(2) Pressure transmitters shall be installed on all delivery lines.

(3) In the event of sudden pressure drop an ESD will automatically occur, the pumps shall stop, and the designated shutdown valves downstream of the filters will close. Valves should not reach the fully closed position while the pumps are still running.

(4) Manual operation of appropriate ESD buttons will also stop the pumps and close the designated shut down valves.

(5) Neither of these events will interrupt product receipt.

(6) Activation of an ESD from the AFSC will close the ESD valves on the delivery lines.

19.3.17 ESD Valves

(1) All valves designated as ESD shall have fail safe operation.

(2) Where ESD valves are normally operated under electrical power they shall have a secondary means of operation for fail-safe mode.

19.3.18 Drainage ESD Valves

The main drainage outlet through the seawall will be fitted with a separate ESD valve to prevent product flow into the sea in the event of a catastrophic failure. This ESD system shall be activated from the control room only.

19.3.19 Quick Release System for Vessel Berthing

A quick release system is adopted for vessel berthing at the Jetty. It consists of quick release hooks at berthing and mooring dolphins, which are controlled by remote release console located at Control Room inside Operations Building. The console will provide the status indication and release operation for the hooks. In case there is a fire on the vessel or jetty, the hooks will be activated to provide “quick release” to the vessel away from the jetty.

All loading arms will be disconnected prior to hook release, unless there is an extreme emergency.

19.4 MATERIALS

19.4.1 SCADA General

All instruments, valves and equipment will be connected to a central Supervisory Control and Data Acquisition System (SCADA). The SCADA will be computer based and will allow operation of the facility from the control room. A back up monitor will be provided in the case of failure of the primary system.

The SCADA system includes two portions, the first portion is located at the PAFF and the second portion is located in the existing EAFSS control room. Information will be transmitted to and from the existing EAFSS via a leased data cable, this connection will provide the operator at the EAFSS with the ability to activate the emergency shutdown valves and so stop the pumps at the new facility.

The SCADA system will allow the operator in the control room to monitor all major equipment and to activate valves and pumps. Generally it is not proposed to have pumps start automatically, as there are only a limited number of pumps these will be activated from the control room by the operator.

Under diesel generator backup power, it shall be possible to operate the facility manually, both for receipt and transfer of fuel by using minimum one pump.

19.4.2 Main Control Centre

The system at the PAFF will consist of two Operator Workstation (OWS) in the control room and two servers located in the control room. The OWS will connect to the server via a standard Fast Ethernet connection and provide the operator interface to the plant process for control and monitoring purpose. The server will communicate with the field I/O hardware via the industrial standard network to the

- i) Field Instruments
- ii) Tank Gauging System
- iii) Leak Detection System
- iv) Cathodic Protection System
- v) ESD System
- vi) FS System
- vii) Remote server located at EAFSS control room via telephone leased line

The I/O in PAFF will be distributed inside two control panels.

- i) I/O panel located in the electrical room
- ii) Remote I/O located in tank farm pillar box (as required)
- iii) IP66 stainless steel 314 panel located outside at the jetty

19.4.3 Connection to Existing System

The system in EAFSS will consist of one OWS and one server located inside the AFSC control room. The OWS connect to the server via the standard fast Ethernet connection and provide the operator interface to the plant process for control and monitoring purpose. The server will communicate with the existing Tank Farm OWS for gathering of necessary data, and it also connects to the remote server via leased data line for data exchange. The data line will have a capacity of 9.6 Kbps and will have in built line redundancy for greater availability.

In order to integrate the new system into the existing Tank Farm, modification works of the existing UCOS System will be undertaken in the following areas: -

i) OWS workstation logic located in AFSC control room
ii) FCU Logic for Jetty FCU
iii) I/O for valves status for this contract located Sha Chau Jetty

Two (2) additional communication ports shall be provided should data acquisition be required by others.

19.4.4 Backup

The data held on the control system will be backed up by tape drives, the frequency of the backups will be determined by the operator.

19.4.5 Security

Access to the SCADA servers will be restricted by password.

19.4.6 Telephone Services

(1) External communication will consist of:

(a) 3 direct lines (1 fax)
(b) 4 lines to internal exchange
(c) 2 dedicated secure data lines for SCADA with alternative routes to the AFSC.
(d) 1 broadband internet connection

(2) Communication to Sha Chau will be by the existing AFSC microwave link.

19.4.7 Radio Communication

Radio communication will be available to operational and security staff. The design of the radio communication should be suitable for use in tank farm and jetties.

19.4.8 Direct Links

Direct links to the Fire Service Control Centre and the Towngas control centers will be provided.

19.5 DESIGN AND ANALYSIS METHODS

19.5.1 Design Packages

The detail design will be completed in the following design packages

SCADA	-	PAFF/XX/01/DSG/E/1901
Telephone System	-	PAFF/CS/01/DSG/E/1902

19.6 INPUT DATA AND MAIN INTERFACES

19.6.1 Authority's Design Requirements (refer to Appendices)

19.6.2 Franchisee's Design Proposals (refer to Appendices)

Contract Drawings

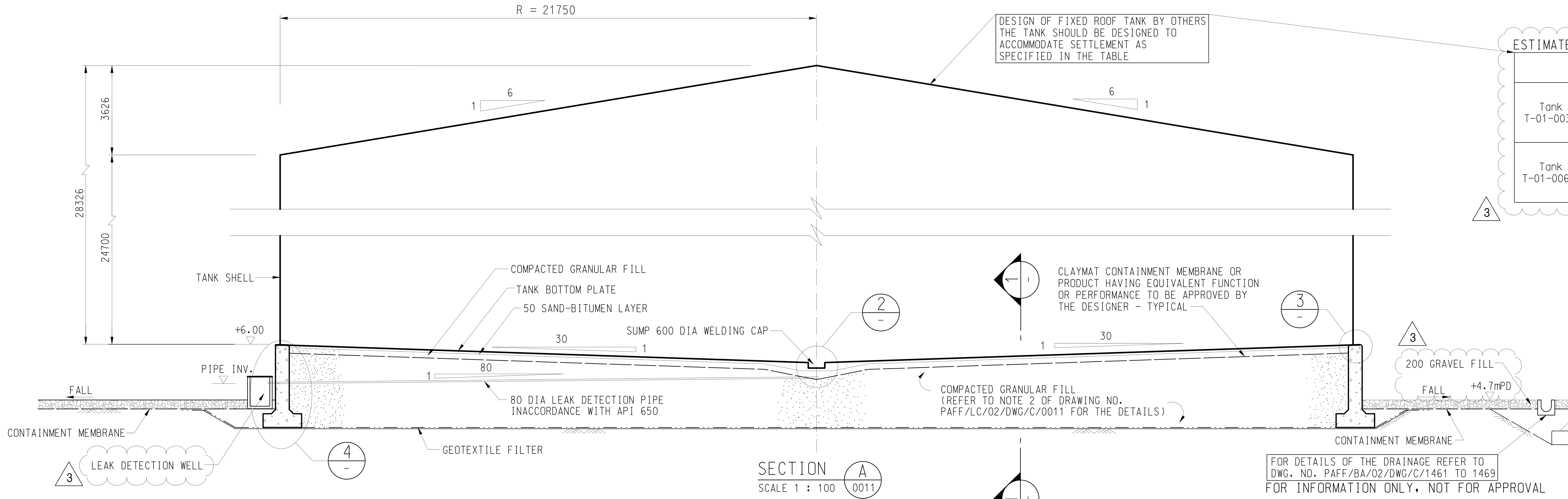
Impermeable Lining Leakage Detection System

- **PAFF/BA/02/DWG/C/1705 Revision 3 Tank Farm Fuel Tank Foundations – Sections and Details of Ring Beam (sheet 1 of 2)**

Emergency Shut Down System and High High Level Switch

- **PAFF/LC/02/DWG/E/0715 Revision 2 ESD Button Location and ESD Button/HHLS Schematic**
- **PAFF/LC/02/DWG/M/0203 Revision 9 Receipt P & ID**
- **PAFF/LC/02/DWG/M/0204 Revision 7 Product Storage P & ID (No. 1 of 3)**
- **PAFF/LC/02/DWG/M/0205 Revision 4 Product Storage P & ID (No. 2 of 3)**
- **PAFF/LC/02/DWG/M/0206 Revision 5 Product Storage P & ID (No. 3 of 3)**
- **PAFF/LC/02/DWG/M/0202 Revision 7 Jetty P & ID**
- **PAFF/LC/02/DWG/M/0207 Revision 16 Transfer Pump P & ID**
- **PAFF/LC/02/DWG/M/0209 Revision 5 Sha Chau Jetty Modification P & ID**
- **PAFF/LC/02/DWG/M/0213 Revision 6 Oil / Water Separator Drainage Tank Farm Utility Flow Diagram**

BD REF. NO. 3/0001/02

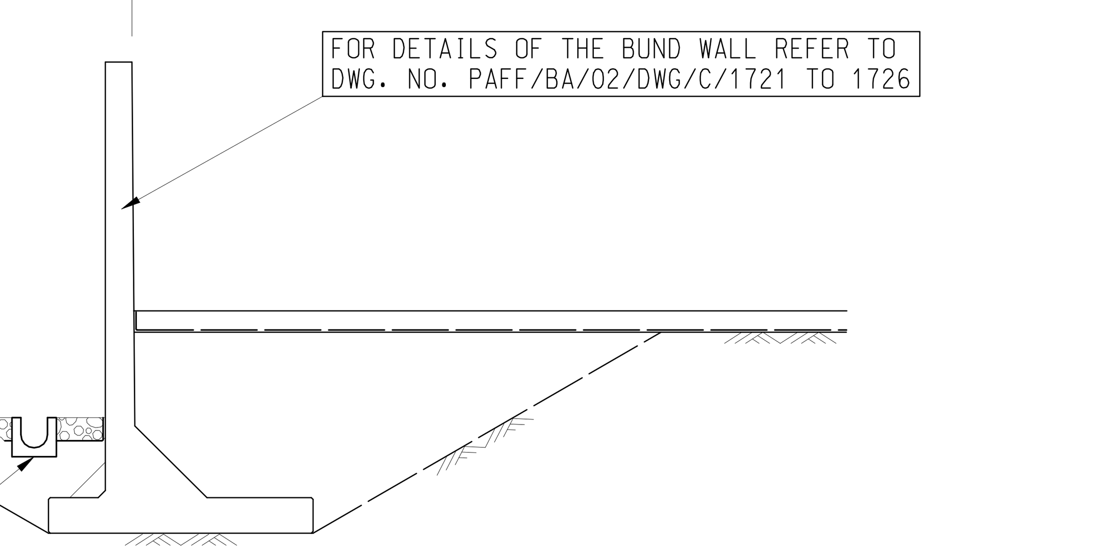


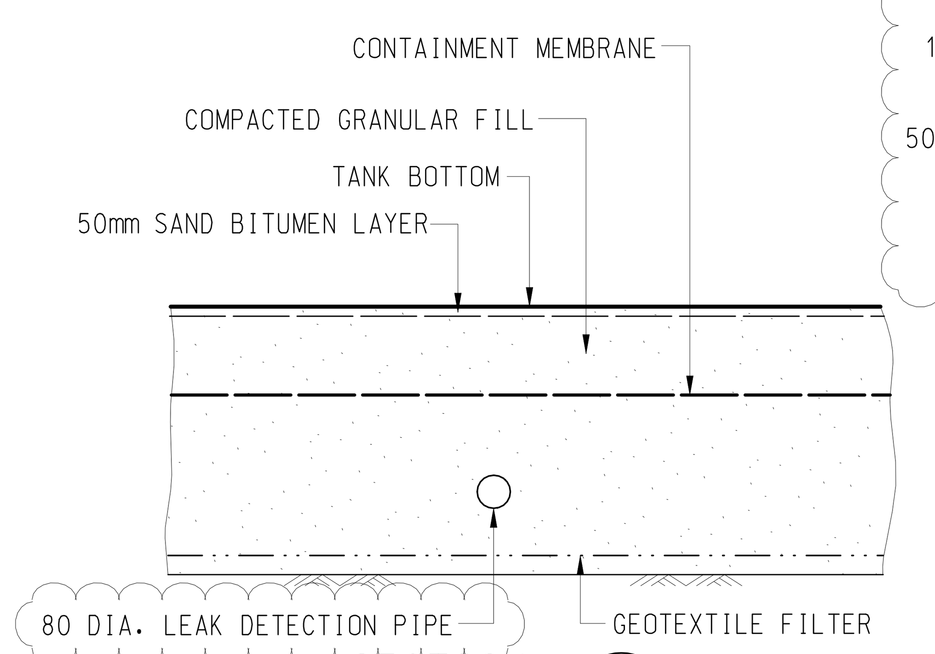
SECTION A
SCALE 1 : 100 (0011)

FOR INFORMATION ONLY, NOT FOR APPROVAL

ESTIMATED / ACTUAL TILTING OF TANKS

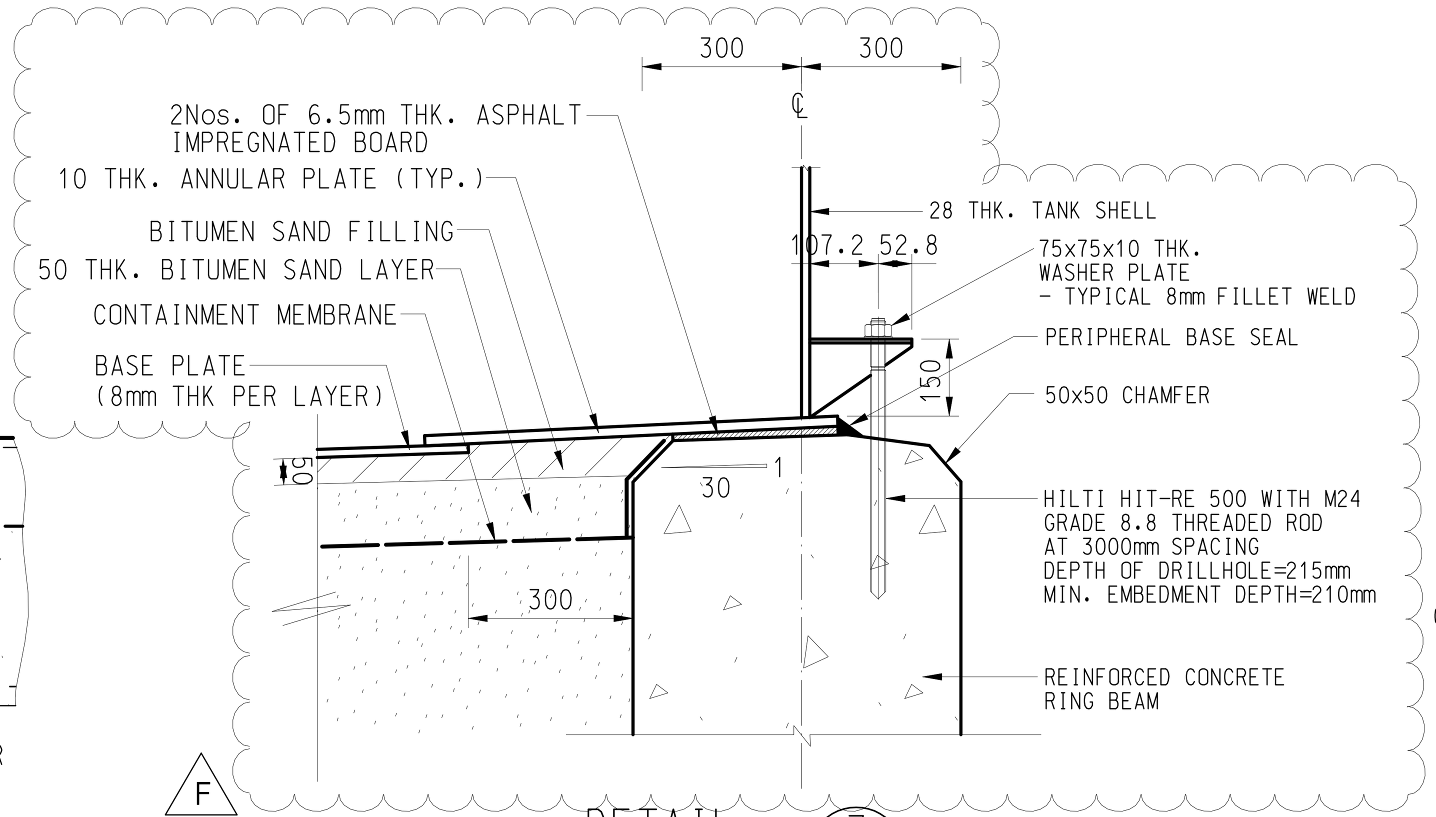
	Max. Tilt of Tank	Max. Settlement Around Periphery
Tank T-01-003	Estimated on Completion of Water Test	
	1 in 2708	1 in 3275
	Estimated At the End of 50yrs Design Life	
	1 in 1211	1 in 763
Tank T-01-006	Actual on Completion of Water Test	
	1 in 320	1 in 285
	Estimated at the End of 50 yrs Design Life	
	1 in 292	1 in 276



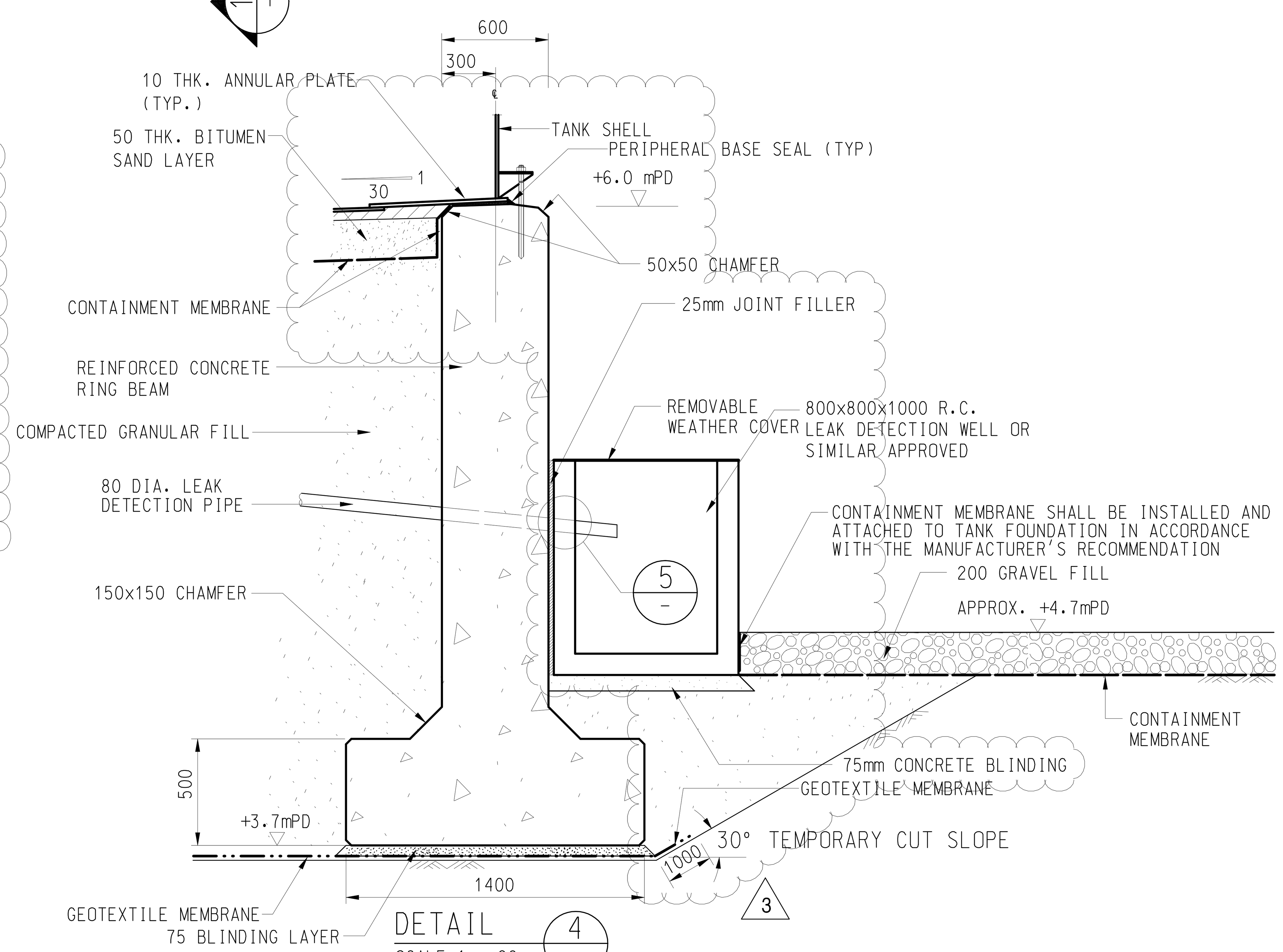


SECTION 1
N.T.S.

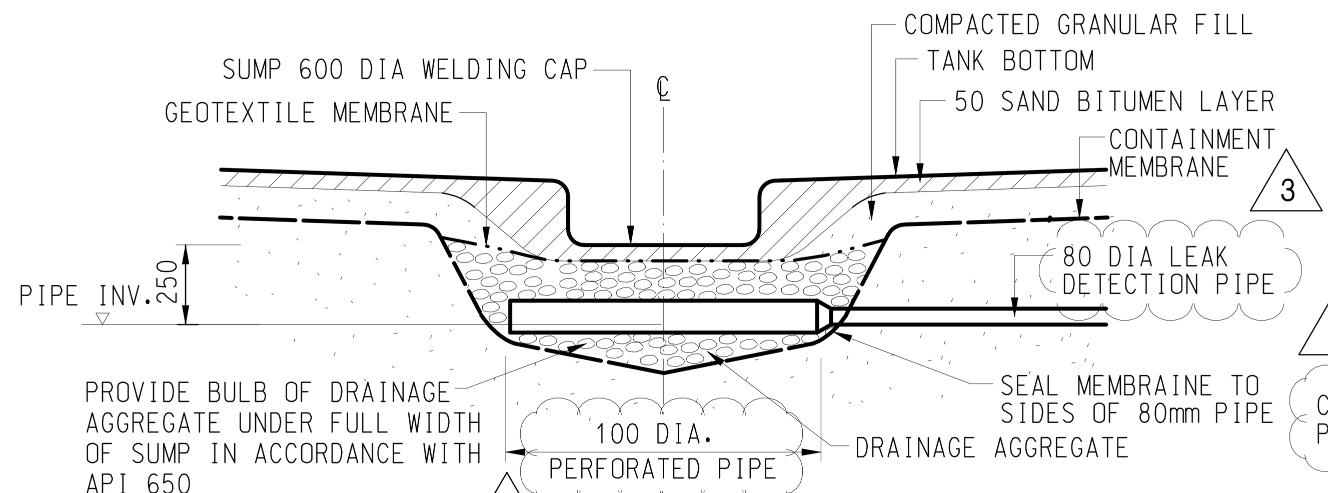
FOR INFORMATION ONLY, NOT FOR APPROVAL



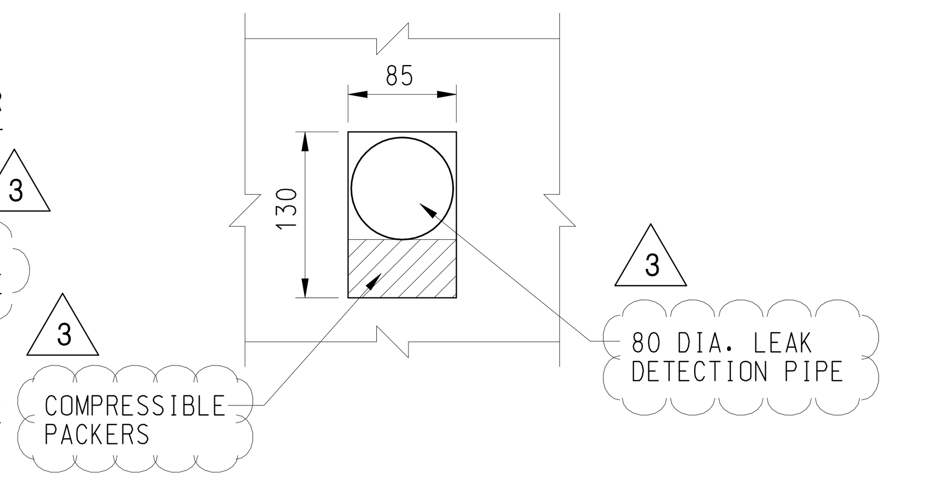
DETAIL 3
SCALE 1 : 10



DETAIL 4
SCALE 1 : 20



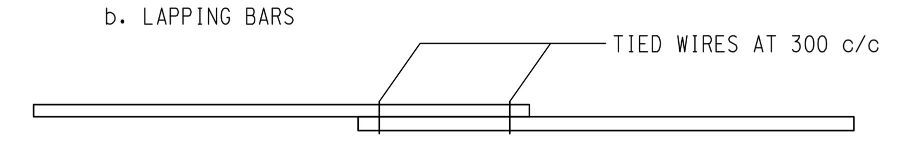
DETAIL 2
N.T.S.



DETAIL 5
SCALE 1 : 5

NOTES :

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NO. PAFF/BA/02/DEG/C/1711.
2. ALL STRUCTURAL CONCRETE SHALL BE A DESIGN MIX OF A GRADE IN ACCORDANCE WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS. DETAILS OF THE DESIGN MIXES TO BE USED ARE GIVEN IN THE PARTICULAR SPECIFICATION.
3. ALL STRUCTURAL CONCRETE SHALL HAVE 40mm COVER.
4. UNLESS OTHERWISE NOTED ALL REINFORCEMENT FOR STRUCTURAL CONCRETE SHALL BE HOT ROLLED HIGH TENSILE STEEL DEFORMED BARS DENOTED BY 'T' WITH MINIMUM YIELD STRENGTH OF NOT LESS THAN 460 N/mm^2.
5. RADII AND BENDS IN REINFORCEMENT TO BE IN ACCORDANCE WITH THE HONG KONG BUILDING (CONSTRUCTION) REGULATIONS AND TO BS 8666.
6. WELDING OF REINFORCEMENT IS NOT PERMITTED WITHOUT PRIOR APPROVAL OF THE DESIGNER.
7. WHERE CONCRETE IS TO BE PLACED, ALL SURFACES SHALL BE CLEANED AND ALL STANDING WATER SHALL BE REMOVED IMMEDIATELY BEFORE THE PLACING OF CONCRETE.
8. NO HOLES IN REINFORCED CONCRETE ARE TO BE FORMED OR CUT WITHOUT THE DESIGNER'S PRIOR AGREEMENT.
9. THE POSITIONS AND DETAILS OF ALL CONSTRUCTION JOINTS ARE TO BE AGREED WITH THE DESIGNER BEFORE WORK COMMENCES.
10. UNLESS OTHERWISE STATED ALL LAP LENGTHS AND ANCHORAGE VALUES OF REINFORCEMENT SHALL BE IN ACCORDANCE WITH TABLE 3.27 OF BS8110: PART 1 : 1985.
11. ALL LAPS TO BE STAGGERED LAPS.
12. UNLESS NOTED OTHERWISE ON THE DRAWINGS. ALL NEW CONCRETE WORKS FOR STRUCTURE SHALL BE GRADE 40D/20 DESIGNED MIX AND SHALL HAVE A CHARACTERISTIC STRENGTH OF 40 N/mm^2 AT 28-DAY. FOR DETAILS REFER TO PARTICULAR SPECIFICATION.
13. FOR CONCRETE FINISH REFER TO GENERAL SPECIFICATION FOR CIVIL ENGINEERING WORKS (1992 EDITION).
14. BARS TIED WITH WIRE :
    a. WIRE SHOULD BE PROVIDED AT THE CROSSING OF ALL BARS AND
    b. LAPPING BARS



15. THE GEOTEXTILES SHOULD BE IN ACCORDANCE WITH WORKS BUREAU TECHNICAL CIRCULAR NO. 10/2001 ON GRANULAR AND GEOTEXTILE FILTERS. THE SIZING OF THE GEOTEXTILE WEAVING MUST ALSO BE COMPATIBLE WITH THE FILL MATERIAL.
16. FOR NOTES ON COMPACTION FILL REFER TO DRAWING NO. PAFF/LC/02/DWG/C/0011.
17. NOT USED
18. THE RING BEAM SHALL BE FOUNDED ON MATERIAL WITH AN ALLOWABLE BEARING CAPACITY OF 250kPa.
19. FOR DETAILS OF REINFORCEMENT REFER TO DRAWING NO. PAFF/BA/02/DWG/C/1711.
20. ALL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH PARTICULAR SPECIFICATION. GENERAL SPECIFICATION AND OTHER CONTRACT DOCUMENTS.
21. THE TANKS SHALL BE LEVELED IF FOUND NECESSARY BY THE SUPPLIER USING SHIMS.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	JAN 2006	FOR CONSTRUCTION	
1	FEB 2006	TOP OF RING BEAM REVISED	
2	JAN 2007	DRAWING UPDATE AS HIGHLIGHTED	
3	JUL 2009	FOR CONSTRUCTION - LEAK DETECTION WELL ADDED, ESTIMATED/ACTUAL TILTING REVISED	

Scale		Date
AS SHOWN (A1)		JAN 2006
Designed: BW	Drawn: SKL	Checked: AS
Design Team Leader: AS		Date: JAN 2006
Approved: LHS		Date: JAN 2006

ECO

Contractor
LEIGHTON 禮頓
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Permanent Aviation Fuel Facility

Title TANK FARM
FUEL TANK FOUNDATIONS - SECTIONS AND DETAILS OF RING BEAM (SHEET 1 OF 2)

Project | Originator | Location | Category | Discipline | Number | Revision
Drawing No. PAFF/BA/02/DWG/C/1705 3

DATE : 8/10/2009
TIME : 1:50:28 PM
PLOT DRV: $PLTDRVL$

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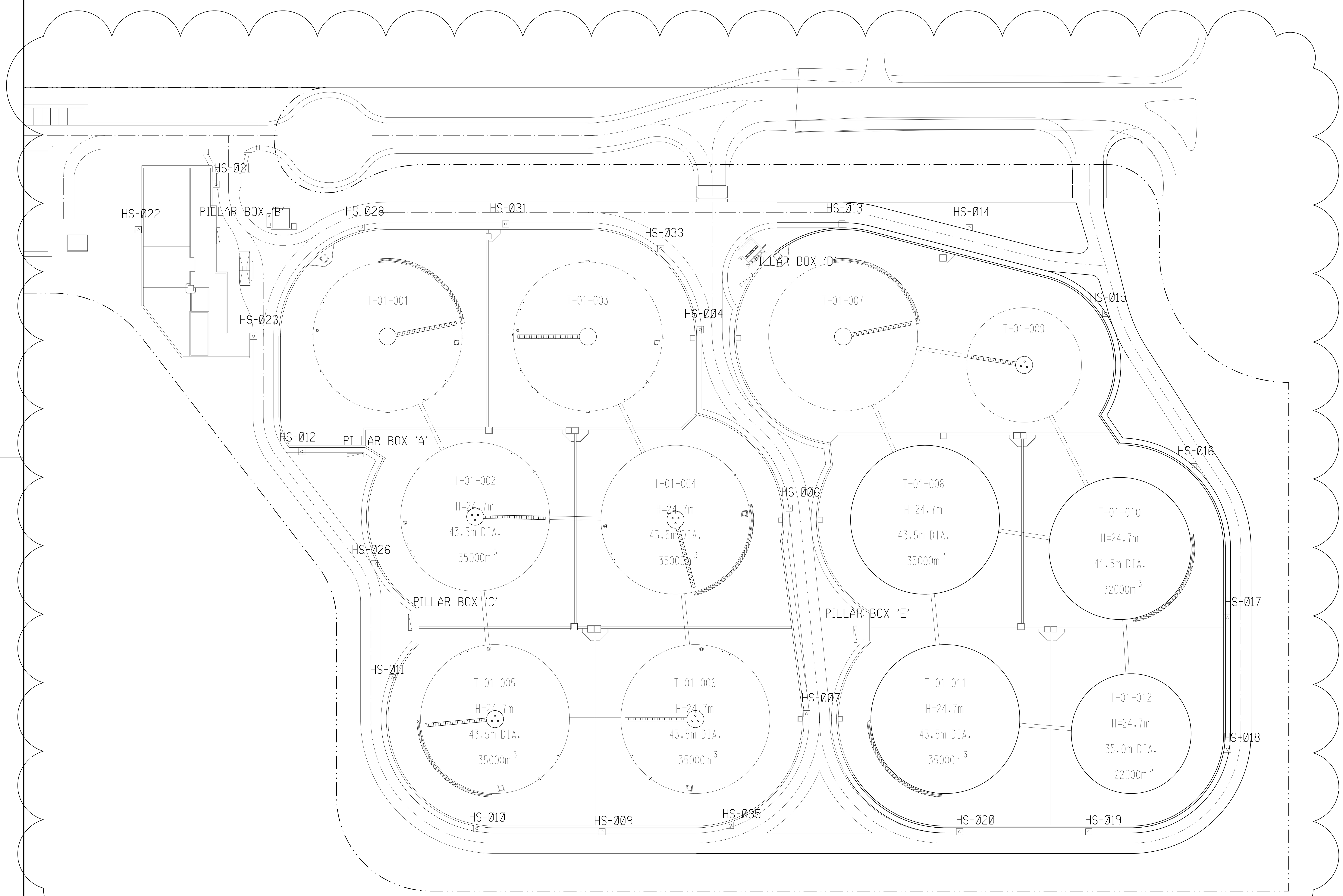
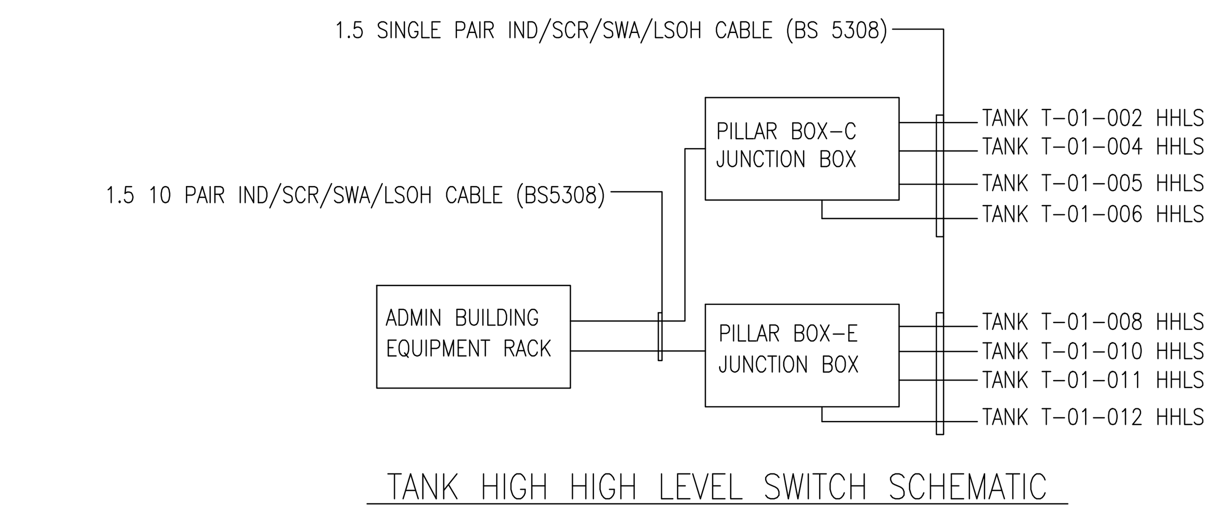
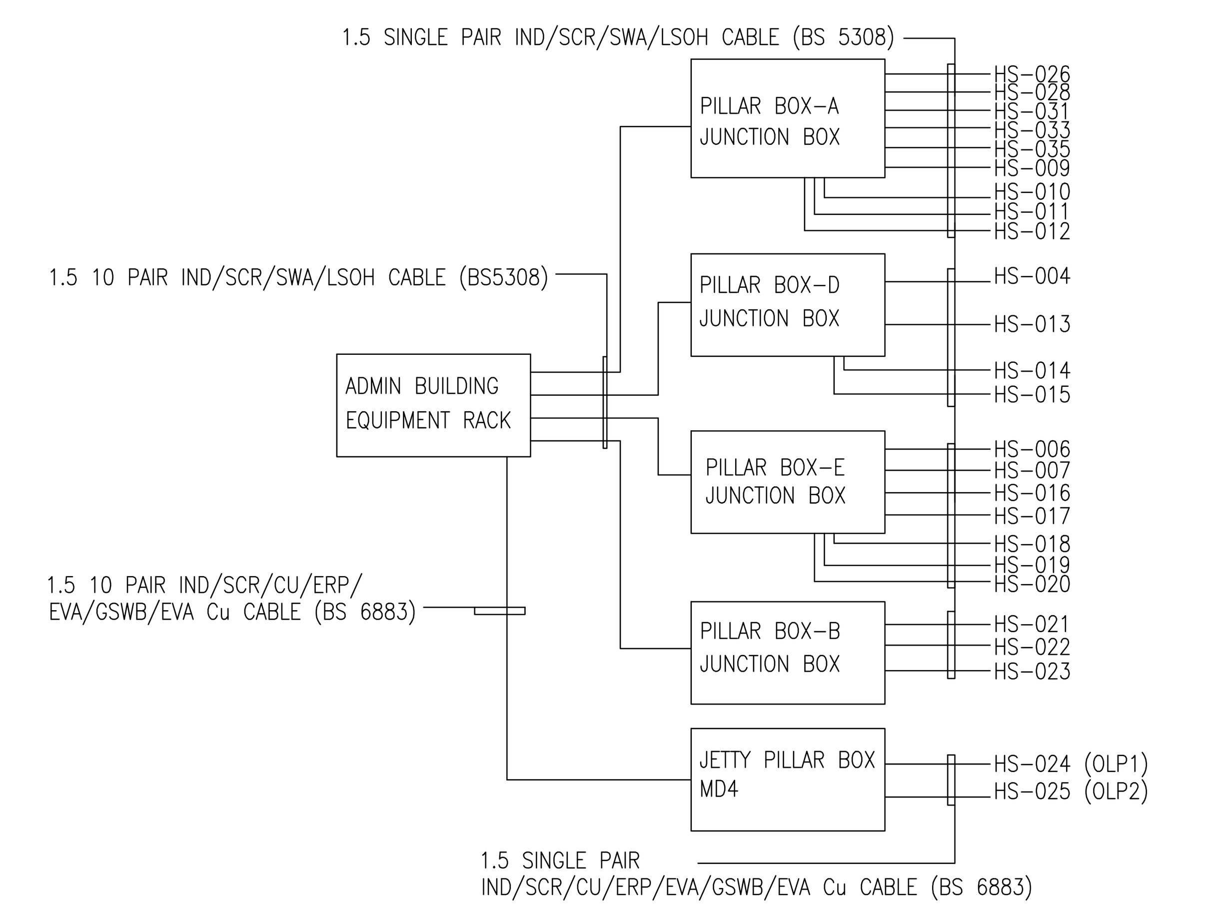


NOTE: 1. ESD SHUTDOWNS MOUNTED IN CLOSE PROXIMITY TO F.S. CABINETS.
PLATE SHALL BE MOUNTED ON PROPRIETARY SUITABLE STAND (PLINTH BY CONTRACTOR)
HOLES DRILLED PRIOR TO PAINTING
FRONT SIDE OF SIGN COATED WITH CLEAR LACQUER FOLLOWING SILK SCREENING
REVERSE SIDE OF SIGN PAINTED YELLOW
LETTER SIZING - 36mm
BACKGROUND COLOUR YELLOW
HATCHING AND LETTERING BLACK
PLATE MANUFACTURED FROM 5mm ALUMINIUM
FIXING BOLTS M6 GALVANISED ROOFING BOLTS
2. EMERGENCY SHUT DOWN (HS) SHALL BE TYPE KAK-WCP3A IP67 BREAK GLASS UNIT (YELLOW IN COLOUR).



TANK HIGH HIGH LEVEL SWITCH SCHEMATIC



ESD PUSH BUTTONS SCHEMATIC

NOTE: 1. EXACT LOCATION OF JETTY H.S. WILL BE DETERMINED LATER.
2. ACTUAL H.S. LOCATION MAY VARY ACCORDING TO SITE CONDITION.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	02.06.09	ISSUE FOR CONSTRUCTION	
1	19.06.09	EMERGENCY SHUT DOWN UPDATED BACKING PLATE (AS PER F.S.D. REQUEST)	
2	21.10.09	ESD LOCATION REVISED	

Scale	Date
N.T.S.	01 NOV 2007

Designed	Drawn	Checked
C.ROBERTS	A.SO	C.ROBERTS

Design Team Leader | Date

Approved	Date
E.ZRAICAT	21 OCT 2009

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Permanent Aviation Fuel Facility

Title
ESD BUTTON
LOCATION AND ESD BUTTON/
HHLS SCHEMATIC

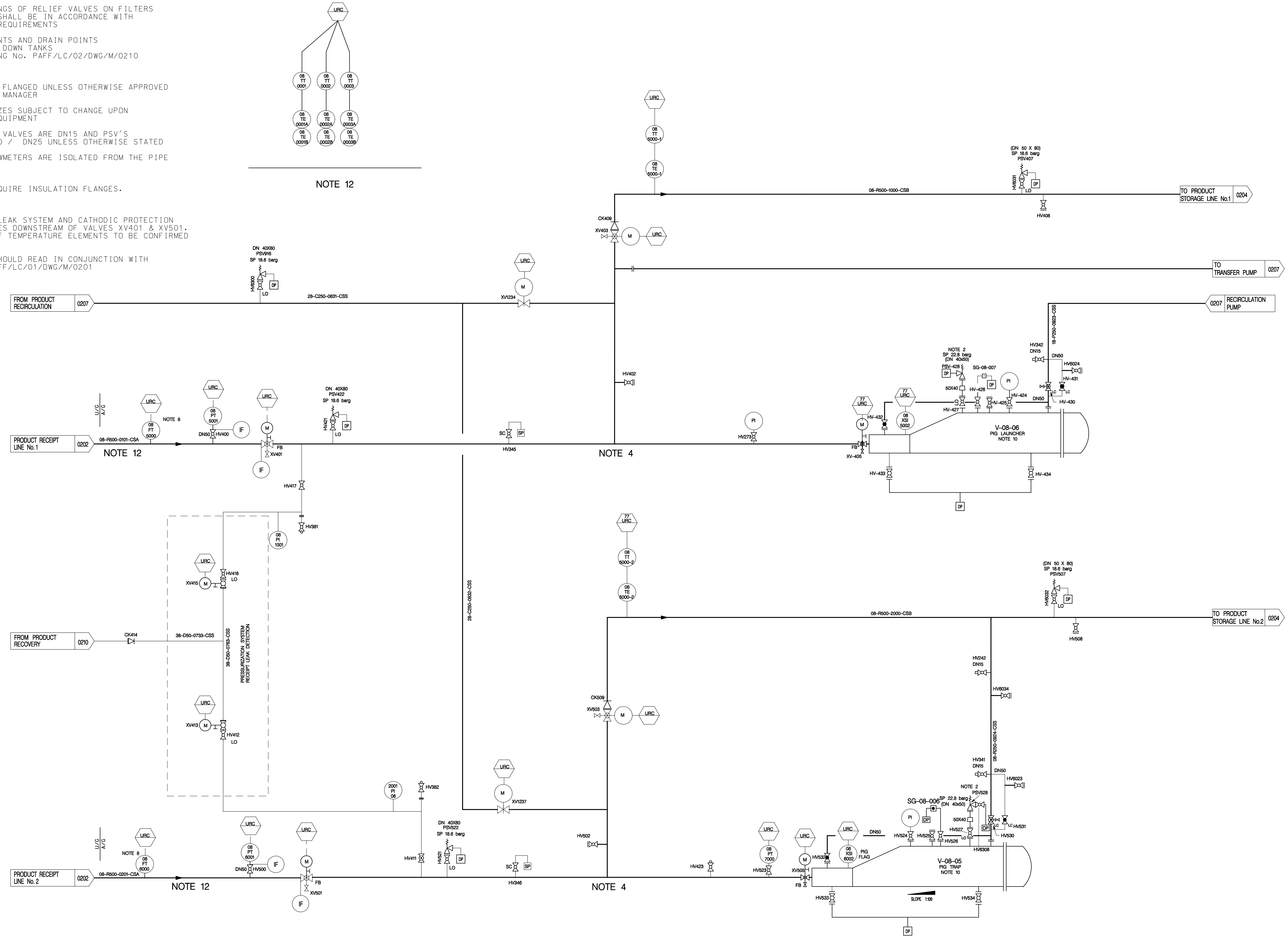
Drawing No. (Project / Originator / Location / Category / Discipline / Number)	Revision
PAFF/LC/02/DWG/E/0715	2

DATE : 18-Nov-09
TIME : 2:45:03 PM

FILENAME : S:\Drawings\DGN\ELEC\LC02DWGE0715_2.dgn

NOTES

1. ALL VALVE TAGS ARE PREFIXED BY SYSTEM NO.08 UNLESS INDICATED OTHERWISE
2. PRESSURE SETTINGS OF RELIEF VALVES ON FILTERS AND PIG TRAPS SHALL BE IN ACCORDANCE WITH SYSTEM DESIGN REQUIREMENTS
3. ALL SAMPLE POINTS AND DRAIN POINTS PIPED TO DRAIN DOWN TANKS REFER TO DRAWING No. PAFF/LC/02/DWG/M/0210
4. BARRED TEE
5. ALL VALVES ARE FLANGED UNLESS OTHERWISE APPROVED BY THE PROJECT MANAGER
6. DRAIN VALVE SIZES SUBJECT TO CHANGE UPON SELECTION OF EQUIPMENT
7. ALL INSTRUMENT VALVES ARE DN15 AND PSV'S INLET/OUT. DN20 / DN25 UNLESS OTHERWISE STATED
8. ULTRASONIC FLOWMETERS ARE ISOLATED FROM THE PIPE
9. N/A
10. PSV OUTLETS REQUIRE INSULATION FLANGES.
11. N/A
12. THE COWI STAT LEAK SYSTEM AND CATHODIC PROTECTION ON THE PIPELINES DOWNSTREAM OF VALVES XV401 & XV501. INVERT LEVEL OF TEMPERATURE ELEMENTS TO BE CONFIRMED BY COWI.
13. THIS DRAWING SHOULD READ IN CONJUNCTION WITH DRAWING No. PAFF/LC/01/DWG/M/0201



AS-BUILT

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	19.09.07	ISSUED FOR CONSTRUCTION	
1	20.11.07	PIG TRAP TAG No. REVISED	
2	03.03.08	PIG TRAP TAG No. REVISED & OPTION 1A INCORPORATED	
3	23.07.08	VENT VALVE ADDED	
4	10.12.08	PSV SIZE AMENDED AND VALVE TAG No. REVISED	
5	10.02.09	CHANGE IN TEMPERATURE ELEMENT DETAIL & VALVES ADDED	
6	15.04.09	DN15 VENT VALVE ADDED	
7	06.07.09	VALVE TAG NOS. REVISED	
8	21.09.09	TAG NOS. REVISED	
9	23.10.09	AS-BUILT	

Scale	N.T.S.
Date	19 SEP 2007
Designed	SK.TSANG
Drawn	A.SO
Checked	SK.TSANG
Design Team Leader	
Approved	E. ZRAICAT
Date	21 SEP 2009

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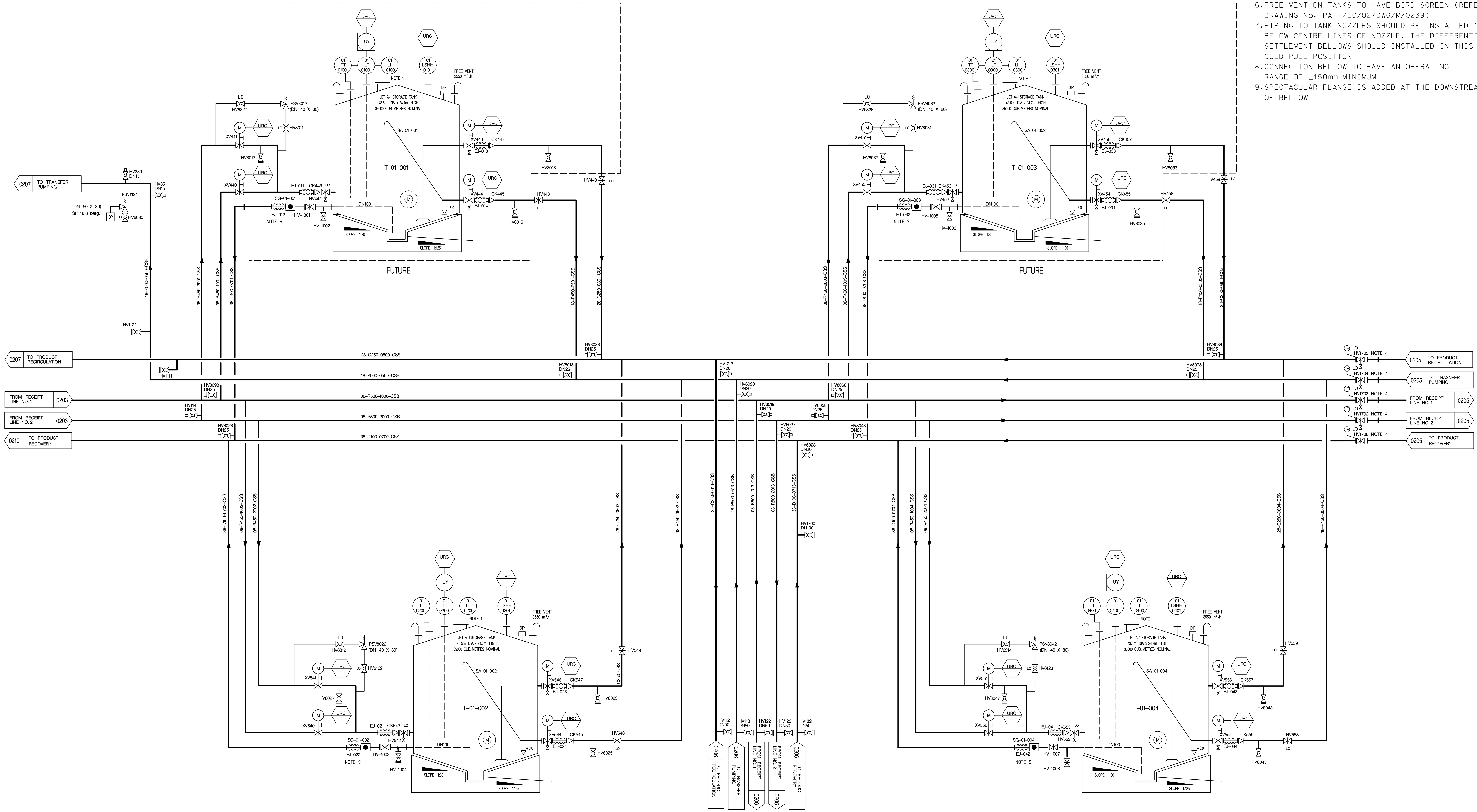
Permanent Aviation Fuel Facility

Title
RECEIPT P&ID

Drawing No. PAFF/LC/02/DWG/M/0203 — Revision 9

DATE : 29-Oct-09
TIME : 11:12:11 AM

FILENAME : S:\Drawings\DGN\P&ID\LC02DWGM0203_9.dgn



NOTES:

1. LEVEL INDICATOR MOUNTED AT LOW LEVEL
2. ALL VALVE TAGS ARE PREFIXED BY SYSTEM No.01 UNLESS INDICATED OTHERWISE
3. FOR SAMPLE SYSTEM REFER TO PID No. PAFF/LC/02/DWG/M/0212
4. BLIND FLANGE SHALL BE PROVIDED FOR OPERATION OF PHASE 1a AND THEN REPLACED WITH RING FLANGE SPACER FOR OPERATION OF PHASE 1b.
5. ALL VALVES AREA FLANGED UNLESS OTHERWISE APPROVED BY THE PROJECT MANAGER
6. FREE VENT ON TANKS TO HAVE BIRD SCREEN (REFER TO DRAWING No. PAFF/LC/02/DWG/M/0239)
7. PIPING TO TANK NOZZLES SHOULD BE INSTALLED 150mm BELOW CENTRE LINES OF NOZZLE. THE DIFFERENTIAL SETTLEMENT BELLOWS SHOULD INSTALLED IN THIS COLD PULL POSITION
8. CONNECTION BELLOW TO HAVE AN OPERATING RANGE OF ±150mm MINIMUM
9. SPECTACULAR FLANGE IS ADDED AT THE DOWNSTREAM OF BELLOW

AS-BUILT

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
0	18.09.07	ISSUED FOR CONSTRUCTION					
1	22.07.08	UPDATED TO 8 TANKS					
2	19.11.08	PVS SIZE AMENDED AND VALVE TAG No. REVISED					
3	11.12.08	VALVE TAG No. REVISED					
4	10.02.09	VENT VALVE ADDED					
5	02.07.09	PIPE SPACER ADDED					
6	21.09.09	BALL VALVE HV-351 & INSULATING GASKETS ADDED					
7	27.10.09	AS-BUILT					

Scale: N.T.S.		Date: 18 SEP 2007
Designed: SK.TSANG	Drawn: A.SO	Checked: SK.TSANG
Design Team Leader		Date
Approved: E. ZRAICAT		Date: 21 SEP 2009

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Permanent Aviation Fuel Facility

Title
PRODUCT STORAGE P&ID
(NO. 1 OF 3)

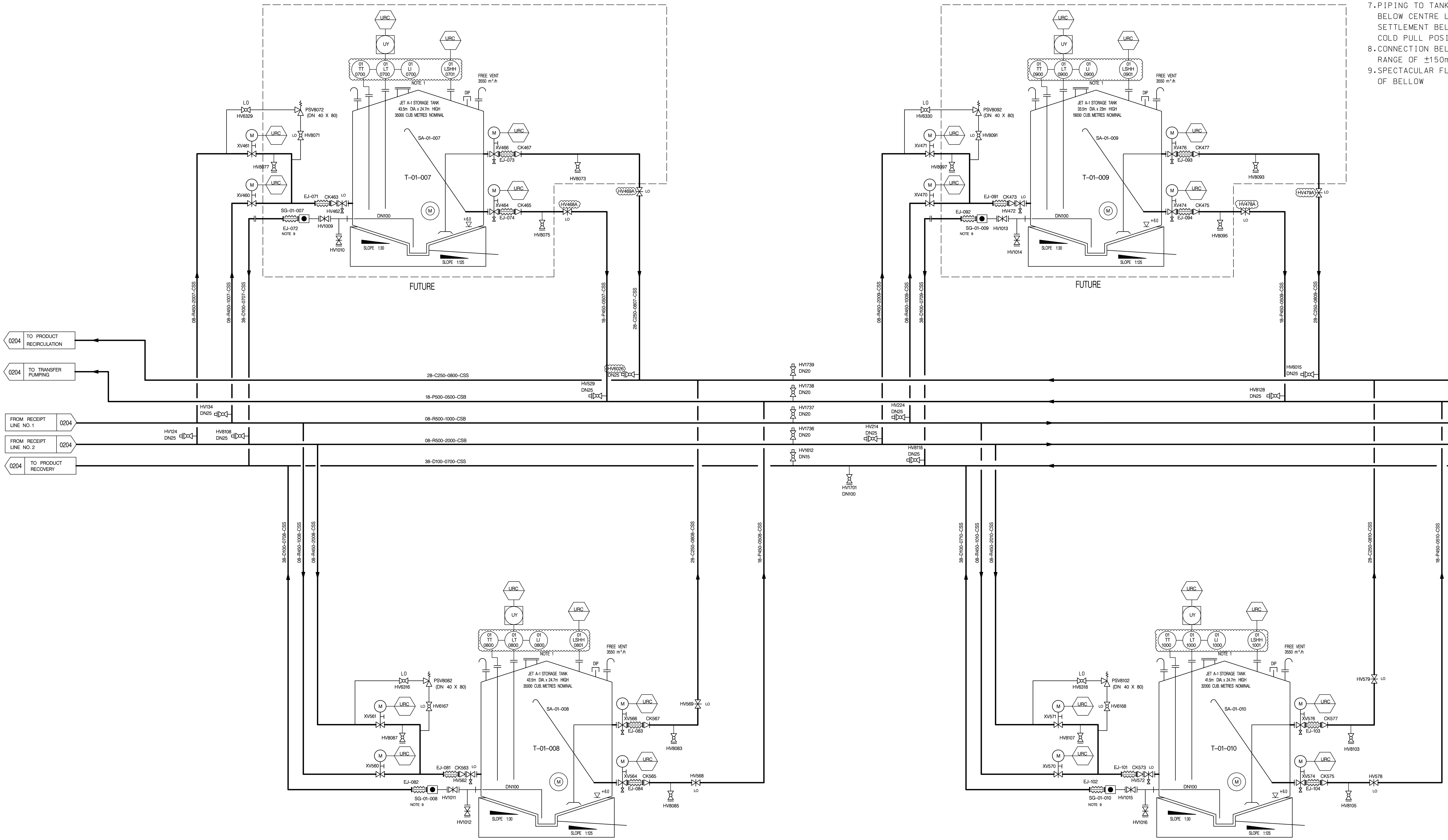
	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/LC/02/DWG/M/0204	7

DATE : 27/10/2009
TIME : 14:32:26

FILENAME : S:\Drawings\DGN\P&ID\LC02DWGM0204_7.dgn

NOTES:

1. LEVEL INDICATOR MOUNTED AT LOW LEVEL
2. ALL VALVE TAGS ARE PREFIXED BY SYSTEM No.01 UNLESS INDICATED OTHERWISE
3. FOR SAMPLE SYSTEM REFER TO PID No. PAFF/LC/02/DWG/M/0212
4. N/A
5. ALL VALVES AREA FLANGED UNLESS OTHERWISE APPROVED BY THE PROJECT MANAGER
6. FREE VENT ON TANKS TO HAVE BIRD SCREEN (REFER TO DRAWING No. PAFF/LC/02/DWG/M/0239)
7. PIPING TO TANK NOZZLES SHOULD BE INSTALLED 150mm BELOW CENTRE LINES OF NOZZLE. THE DIFFERENTIAL SETTLEMENT BELLOWS SHOULD INSTALLED IN THIS COLD PULL POSITION
8. CONNECTION BELLOW TO HAVE AN OPERATING RANGE OF ±150mm MINIMUM
9. SPECTACULAR FLANGE IS ADDED AT THE DOWNSTREAM OF BELLOW



Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	18.09.07	ISSUED FOR CONSTRUCTION	
1	21.07.08	UPDATED TO 8 TANKS	
2	19.11.08	PSV SIZE AMENDED AND VALVE TAG No. REVISED	
3	11.12.08	VALVE TAG No. REVISED	
4	21.09.09	TAG NOS. REVISED	

Scale		Date
N.T.S.		18 SEP 2007
Designed	Drawn	Checked
SK.TSANG	A.SO	SK.TSANG
Design Team Leader		Date
Approved		Date
E. ZRAICAT		21 SEP 2009

ECO

Contractor

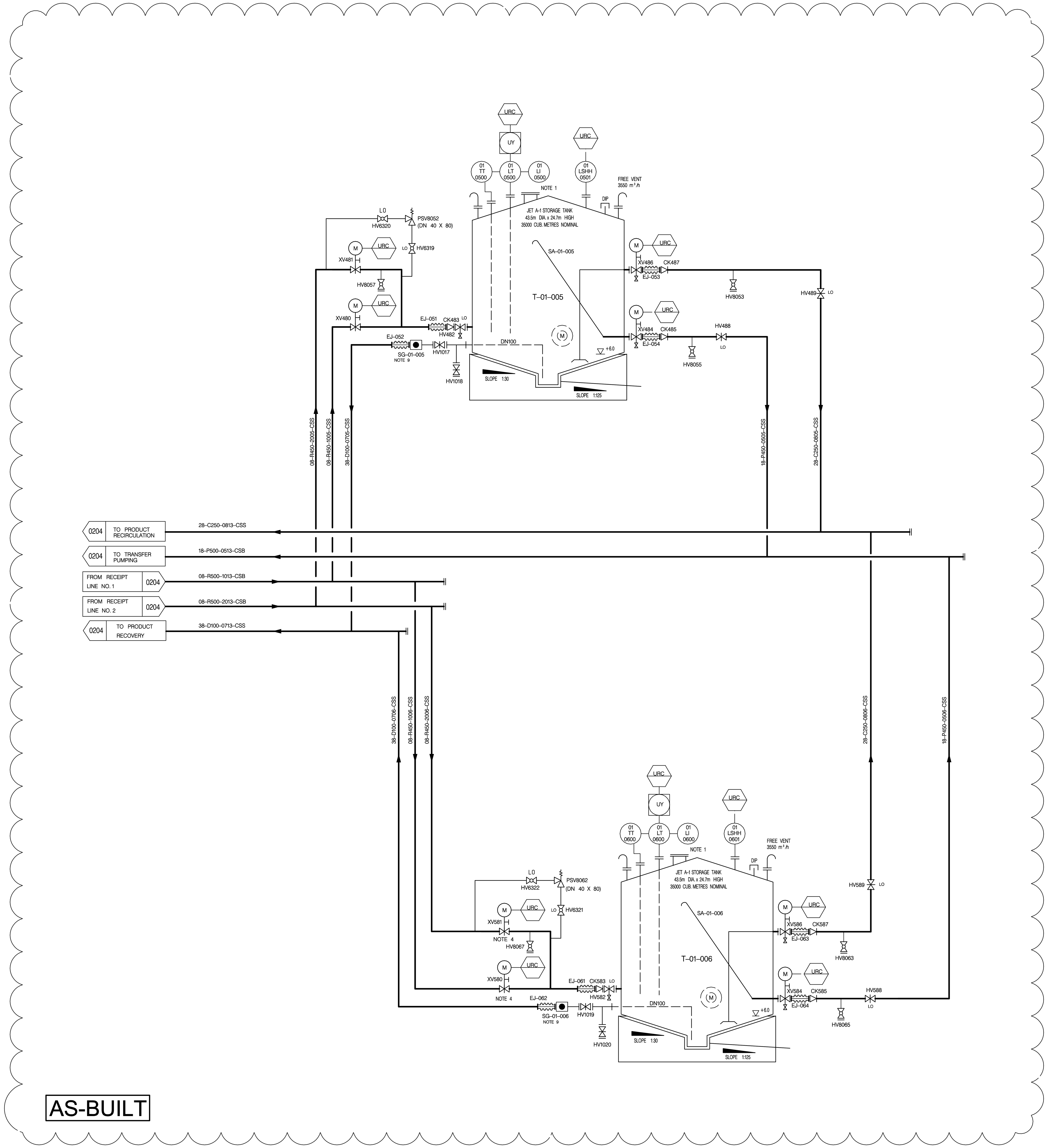
LEIGHTON CONTRACTORS (ASIA) LIMITED

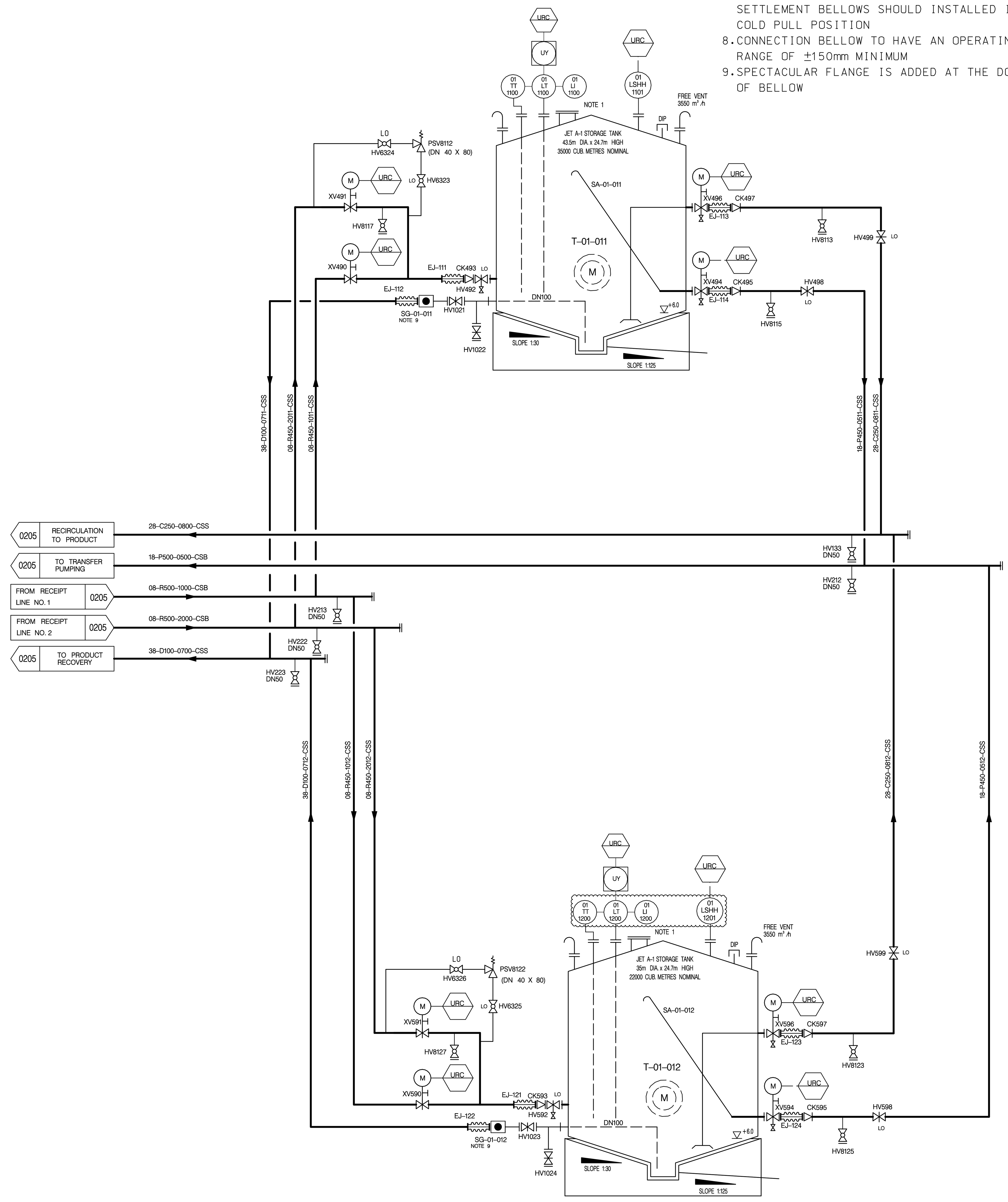
Permanent Aviation Fuel Facility

Title

PRODUCT STORAGE P&ID (NO. 2 OF 3)

	Project	Originator	Location	Category	Discipline	Number	Revision
Drawing No.	PAFF	LC	02	DWG	M	0205	4





NOTES:

1. LEVEL INDICATOR MOUNTED AT LOW LEVEL
2. ALL VALVE TAGS ARE PREFIXED BY SYSTEM No.01 UNLESS INDICATED OTHERWISE
3. FOR SAMPLE SYSTEM REFER TO PID No. PAFF/LC/02/DWG/M/0212
4. N/A
5. ALL VALVES AREA FLANGED UNLESS OTHERWISE APPROVED BY THE PROJECT MANAGER
6. FREE VENT ON TANKS TO HAVE BIRD SCREEN (REFER TO DRAWING No. PAFF/LC/02/DWG/M/0239)
7. PIPING TO TANK NOZZLES SHOULD BE INSTALLED 150mm BELOW CENTRE LINES OF NOZZLE. THE DIFFERENTIAL SETTLEMENT BELLOWS SHOULD INSTALLED IN THIS COLD PULL POSITION
8. CONNECTION BELLOW TO HAVE AN OPERATING RANGE OF ±150mm MINIMUM
9. SPECTACULAR FLANGE IS ADDED AT THE DOWNSTREAM OF BELLOW

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
0	18.09.07	ISSUED FOR CONSTRUCTION					
1	22.07.08	UPDATED OT 8 TANKS					
2	19.11.08	PVS SIZE AMENDED AND VALVE TAG No. REVISED					
3	11.12.08	VALVE TAG No. REVISED					
4	21.09.09	TAG NOS. REVISED					
5	27.10.09	AS-BUILT RECORD OF PHASE 1a					

Scale		Date
N.T.S.		18 SEP 2007
Designed	Drawn	Checked
SK.TSANG	A.SO	SK.TSANG
Design Team Leader		Date
Approved		Date
E. ZRAICAT		21 SEP 2009

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Permanent Aviation Fuel Facility

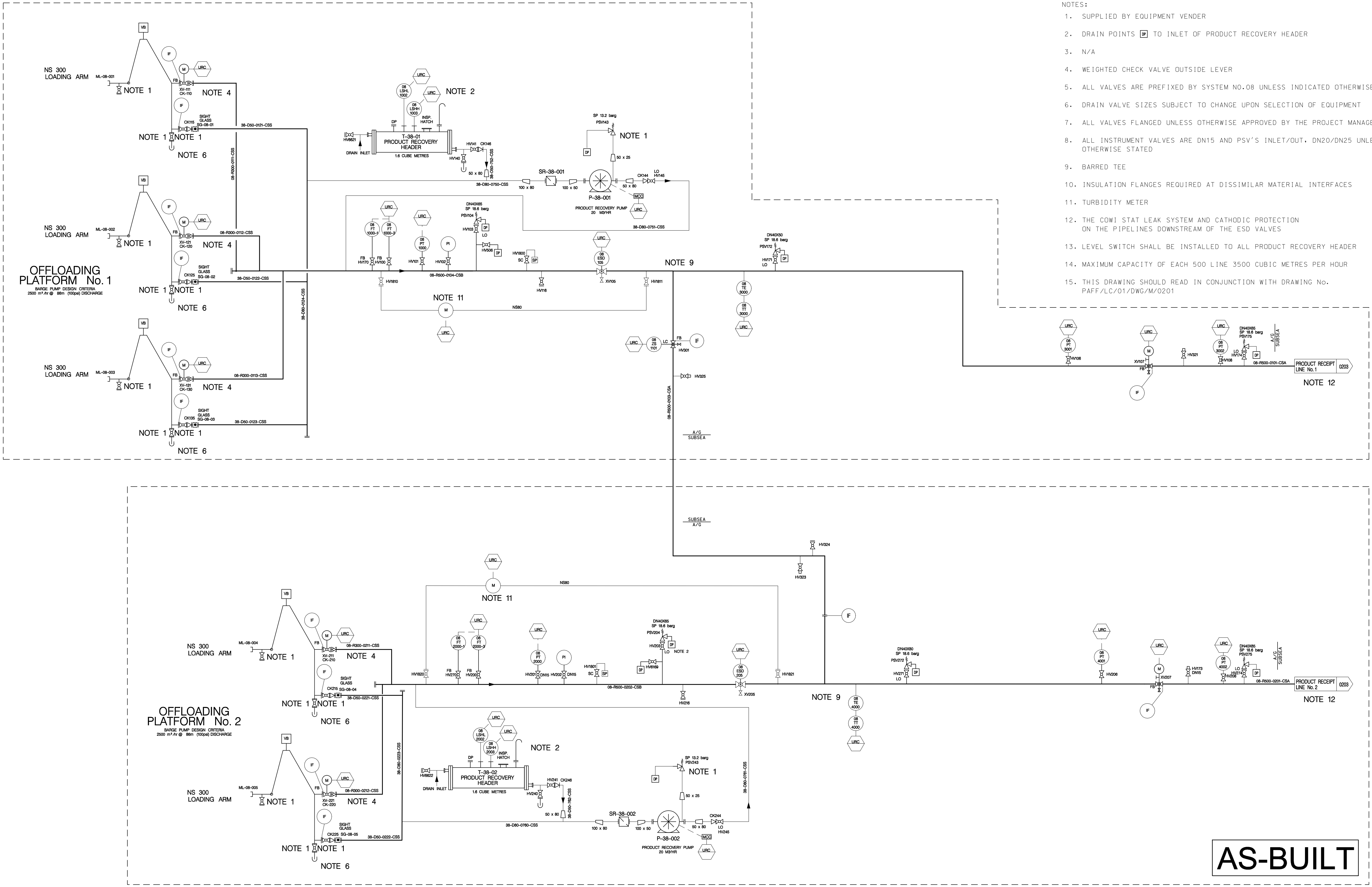
Title

PRODUCT STORAGE P&ID
(No. 3 OF 3)

Drawing No. PAFF/LC/02/DWG/M/0206 Revision 5

DATE : 27/10/2009
TIME : 14:41:29

FILENAME : S:\Drawings\DGN\P&ID\LC02DWGM0206_5.dgn



NOTES:

1. SUPPLIED BY EQUIPMENT VENDER
2. DRAIN POINTS DP TO INLET OF PRODUCT RECOVERY HEADER
3. N/A
4. WEIGHTED CHECK VALVE OUTSIDE LEVER
5. ALL VALVES ARE PREFIXED BY SYSTEM NO.08 UNLESS INDICATED OTHERWISE
6. DRAIN VALVE SIZES SUBJECT TO CHANGE UPON SELECTION OF EQUIPMENT
7. ALL VALVES FLANGED UNLESS OTHERWISE APPROVED BY THE PROJECT MANAGER
8. ALL INSTRUMENT VALVES ARE DN15 AND PSV'S INLET/OUT, DN20/DN25 UNLESS OTHERWISE STATED
9. BARRED TEE
10. INSULATION FLANGES REQUIRED AT DISSIMILAR MATERIAL INTERFACES
11. TURBIDITY METER
12. THE COWI STAT LEAK SYSTEM AND CATHODIC PROTECTION ON THE PIPELINES DOWNSTREAM OF THE ESD VALVES
13. LEVEL SWITCH SHALL BE INSTALLED TO ALL PRODUCT RECOVERY HEADER
14. MAXIMUM CAPACITY OF EACH 500 LINE 3500 CUBIC METRES PER HOUR
15. THIS DRAWING SHOULD READ IN CONJUNCTION WITH DRAWING No. PAFF/LC/01/DWG/M/0201

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
0	18.09.07	ISSUED FOR CONSTRUCTION					
1	11.06.08	MINOR AMENDMENT					
2	23.07.08	GENERAL REVISION					
3	10.12.08	PSV SIZE AMENDED AND VALVE TAG No. REVISED					
4	30.06.09	PSLL DELETED					
5	04.09.09	TURBIDITY METER ADDED & VALVE HV322 DELETED					
6	21.09.09	TAG Nos. REVISED & 50X25 REDUCER ADDED					
7	19.10.09	AS-BUILT					

Scale	Date
N.T.S.	18 SEP 2007

Designed	Drawn	Checked
S.K.TSANG	A.SO	S.K.TSANG

Design Team Leader — Date

Approved: E. ZRAICAT — Date: 04 SEP 2009

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Permanent Aviation Fuel Facility

Title
JETTY P&ID

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/LC/03/DWG/M/0202	7

DATE : 29-Oct-09
TIME : 11:11:58 AM

FILENAME : S:\Drawings\DGN\P&ID\LC03DWGM0202_7.dgn

NOTES:

1. ON POWER FAILURE UPS EMERGENCY SHUTDOWN VALVE.
2. ALL VALVE TAGS ARE PREFIXED BY SYSTEM No.18 UNLESS OTHERWISE INDICATED.
3. SET PRESSURES OF RELEIF VALVES ON FILTERS SHALL BE IN ACCORDANCE WITH SYSTEM DESIGN REQUIREMENTS
4. ALL DRAIN POINTS PIPED TO DP DRAIN DOWN TANKS.SAMPLES TAKEN LOCALLY REFER TO DRAWING No.PAFF/LC/02/DWG/M/0211
5. LONG TERM POST SETTLEMENT CRITERIA: A MINIMUM STATIC HEAD OF 1.4m BETWEEN TANK OUTLET NOZZLE AND PUMP SUCTION NOZZLE IS EQUIRED TO ENSURE PUMP DESIGN CHARACTERISTICS ARE MET.
6. ALL VALVES ARE FLANGED UNLESS OTHERWISE APPROVED BY THE PROJECT MANAGER
7. ALL INSTRUMENT VALVES ARE DN15 AND PSV'S INLET/OUT. HOLD UNLESS OTHERWISE STATED
8. SUPPLIED BY EQUIPMENT VENDOR.
9. ALL ACCESSORY PIPING AND VALVES FROM TOP AND BOTTOM OF FWS TO BE SUPPLIED BY VENDOR. PIPING MATERIAL STAINLESS STEEL.
10. PSV OUTLETS REQUIRE INSULATION FLANGES.
11. 5-VALVES MANIFOLDS ARE SUPPLIED FOR THESE DIFFERENTIAL PRESSURE INSTRUMENTS
12. REFER TO PAFF/LC/02/DWG/M/0210 AND 0215 FOR SAMPLING AND DRAIN DETAILS
13. THE COWI STAT LEAK SYSTEM AND CATHODIC PROTECTION ON THE PIPELINES DOWNSTREAM OF THE ESD VALVE.
14. ULTRASONIC FLOWMETERS ARE ISOLATED FROM THE PIPE.
15. THIS DARWING SHOULD READ IN CONJUNCTION WITH DRAWING No. PAFF/LC/01/DWG/M/0201
16. INSERTION LENGTH SHOULD BE 300mm MEASURE FROM TOP OF THE FLANGE TO TOP OF PIPE

LEGEND:

MAIN PIPELINE INSULATING JOINT

AS-BUILT

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	05.10.07	ISSUED FOR CONSTRUCTION	
1	08.11.07	PSV No. 908, 910 & 912 ON HOLD	
2	12.12.07	REVISED AS CLOUDED	
3	27.03.08	PUMP DETAIL UPDATED & OPTION 1A INCORPORATED	
4	05.06.08	TEMPERATURE ELEMENT ADDED	
5	22.07.08	GENERAL REVISION	
6	18.11.08	PSV SIZE AMENDED AND INSTRUMENTATION TAG No. REVISED	
7	28.11.08	MIJ (MAIN PIPELINE INSULATING JOINT) ADDED & VALVE TAG No. REVISED	
8	11.12.08	VALVE TAG No. REVISED	
9	09.02.09	TEMPERATURE TRANSMITTERS ADDED, DENSITY TRANSMITERS DELETED & VALVES ADDED	
10	23.03.09	VALVE (XV-1632) REVISED	
11	31.03.09	ANTI STATIC INJECTION SYSTEM ADDED	
12	15.04.09	250mm BELLOW FOR PUMP & DN15 VENT VALVE ADDED AND ANTI STATIC INJECTION SYSTEM NOT TO BE INSTALLED AT THIS STAGE	
13	23.04.09	VALVES ADDED & BELLOW RELOCATED	
14	06.07.09	DRAINAGE VALVE ADDED & VALVE TAG NOS. REVISED	
15	21.09.09	VALVE HV-344 ADDED & TAG NOS. REVISED	
16	23.10.09	AS-BUILT	

Scale	N.T.S.
Date	05 OCT 2007
Designed	SK.TSANG
Drawn	A.SO
Checked	SK.TSANG
Design Team Leader	
Date	
Approved	E. ZRAICAT
Date	21 SEP 2009

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Permanent Aviation Fuel Facility

Title
TRANSFER PUMP P&ID

Drawing No. PAFF/LC/02/DWG/M/0207 (Project | Originator | Location | Category | Discipline | Number)
Revision 16

DATE : 23/10/2009
TIME : 14:22:56

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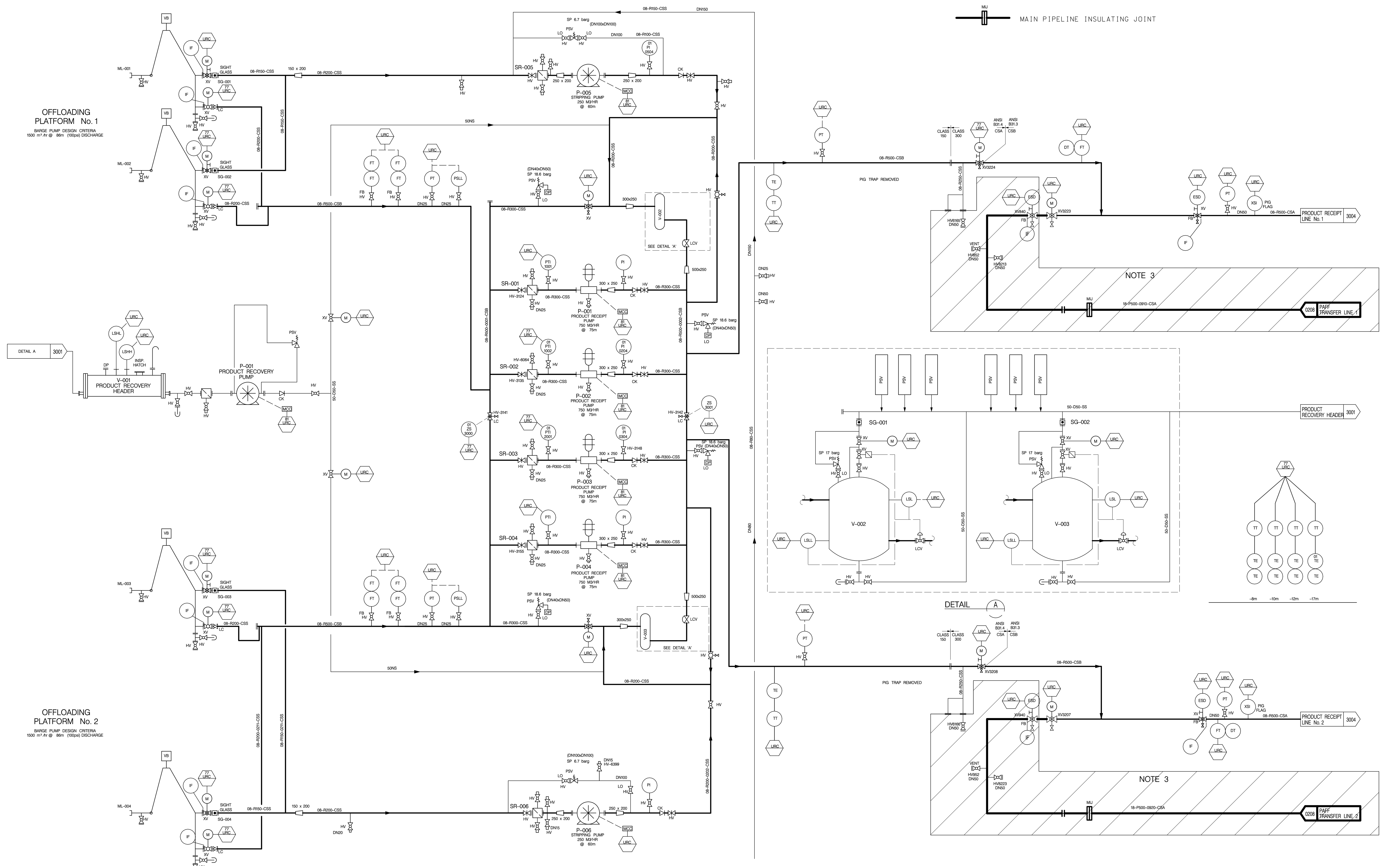

LEGEND:

NEW INSTALLATION

MAIN PIPELINE INSULATING JOINT

NOTES:

1. ALL VALVES FLANGED UNLESS OTHERWISE APPROVED BY THE PROJECT MANAGER.
2. N/A.
3. THE COWI STAT LEAK SYSTEM AND CATHODIC PROTECTION ON THE PIPELINES UPSTREAM OF THE ESD VALVE.

AS-BUILT

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	18.09.07	ISSUED FOR CONSTRUCTION	
1	11.06.08	MODIFICATION CLARIFIED	
2	28.11.08	MIJ (MAIN PIPELINE INSULATING JOINT) ADDED	
3	05.05.09	WELD NECK FLANGES ADDED	
4	19.05.09	NOTE 3 ADDED	
5	29.10.09	AS-BUILT	

Scale	Date
N.T.S.	18 SEP 2007

Designed	Drawn	Checked
SK.TSANG	A.SO	SK.TSANG

Design Team Leader — Date

Approved: E. ZRAICAT — Date: 29 OCT 2009

ECO

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Permanent Aviation Fuel Facility

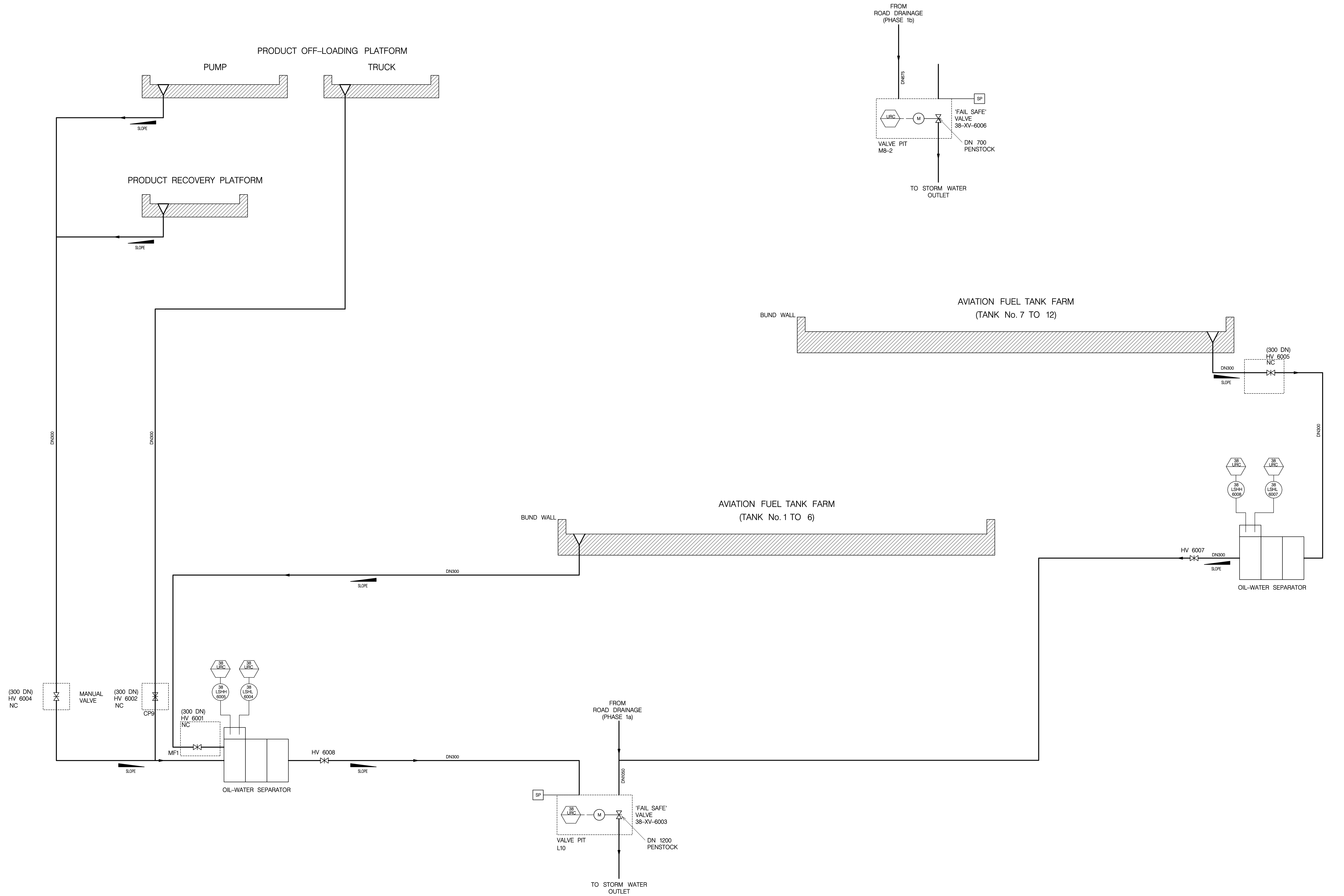
Title: SHA CHAU JETTY
MODIFICATION P&ID

Project | Originator | Location | Category | Discipline | Number | Revision
Drawing No. PAFF/LC/04/DWG/M/0209 — 5

DATE : 31/10/2009
TIME : 8:55:38

FILENAME : S:\Drawings\DGN\P&ID\LC04DWGM0209_5.dgn

NOTES:
1. PLATFORMS ARE IMPERVIOUS
2. REFER TO DRAINAGE LAYOUT
DRAWING No. PAFF/BA/02/DWG/C/1402



AS-BUILT

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
0	18.09.07	ISSUED FOR CONSTRUCTION	
1	23.07.08	UPDATED TO 8 TANKS	
2	12.12.08	DRAINAGE UPDATED TO BD SUBMISSION	
3	03.03.09	VALVE HV6003 IN CP5 CHANGED TO MF1	
4	13.03.09	REVISED AS CLOUDED	
5	21.09.09	TAG NOS. REVISED	
6	28.10.09	AS-BUILT	

Scale	Date	
N.T.S.	18 SEP 2007	
Designed: SK.TSANG	Drawn: A.SO	Checked: SK.TSANG
Design Team Leader		Date
Approved: E. ZRAICAT		Date: 21 SEP 2009

ECO

Contractor
LEIGHTON 禮頓
LEIGHTON CONTRACTORS (ASIA) LIMITED
39th Floor
Sun Hung Kai Centre
30 Harbour Road
Hong Kong SAR
Tel: 2823 1111
Fax: 2529 8784

Permanent Aviation Fuel Facility

Title
OIL-WATER SEPARATOR DRAINAGE
TANKFARM UTILITY FLOW DIAGRAM

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/LC/02/DWG/M/0213	6

DATE : 28/10/2009
TIME : 8:50:41

FILENAME : S:\Drawings\DGN\P&ID\LC02DWGM0213_6.dgn

Photographs

Tank High High Level Alarm

Emergency Shutdown Points

Installation of the leak detection system under the fuel tank

Receipt chamber for leak detection pipe outlet at bottom of fuel tank

Leak detection pipe outlet chamber at base of fuel tank

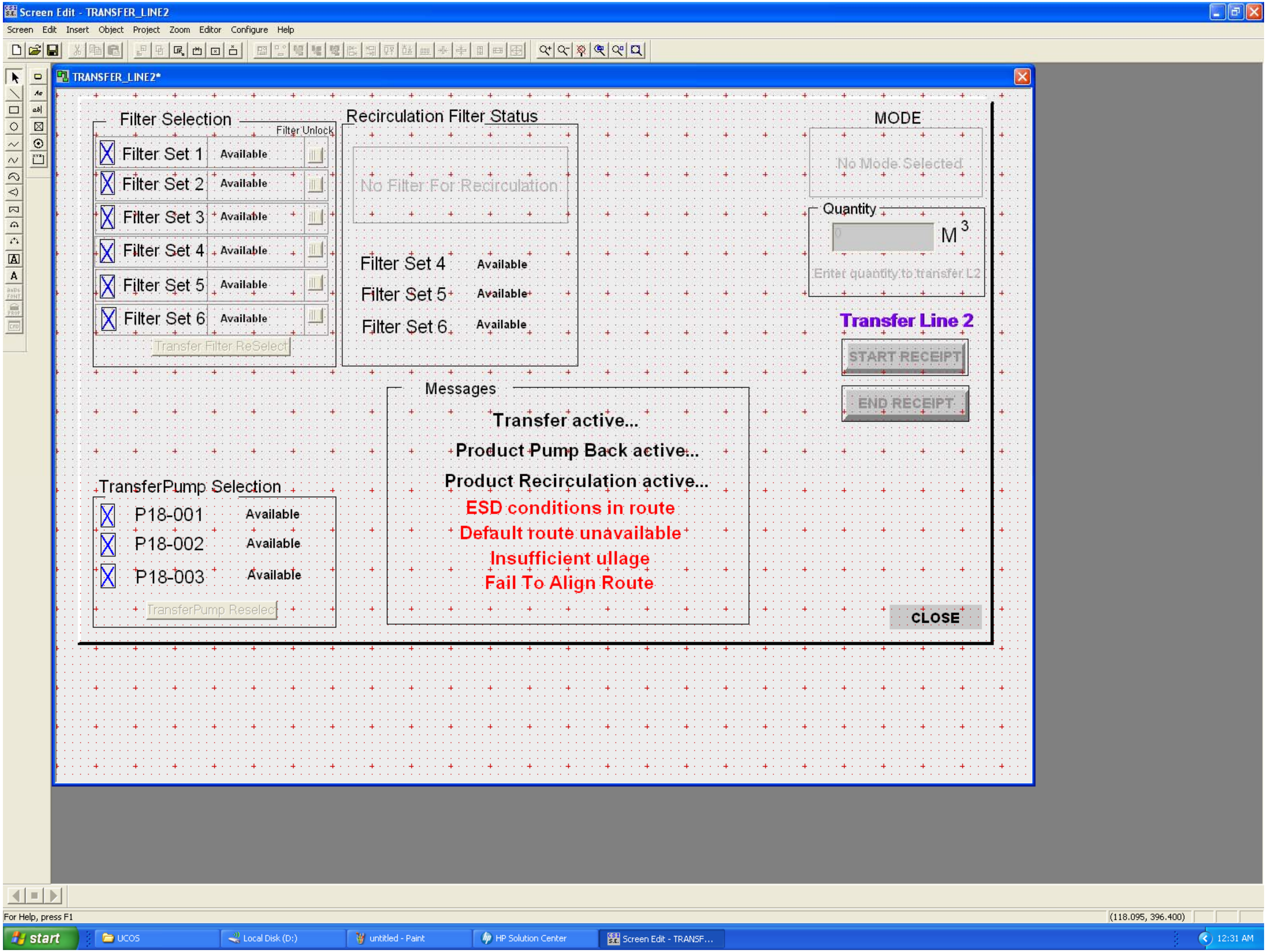
Technical Information for ESD System

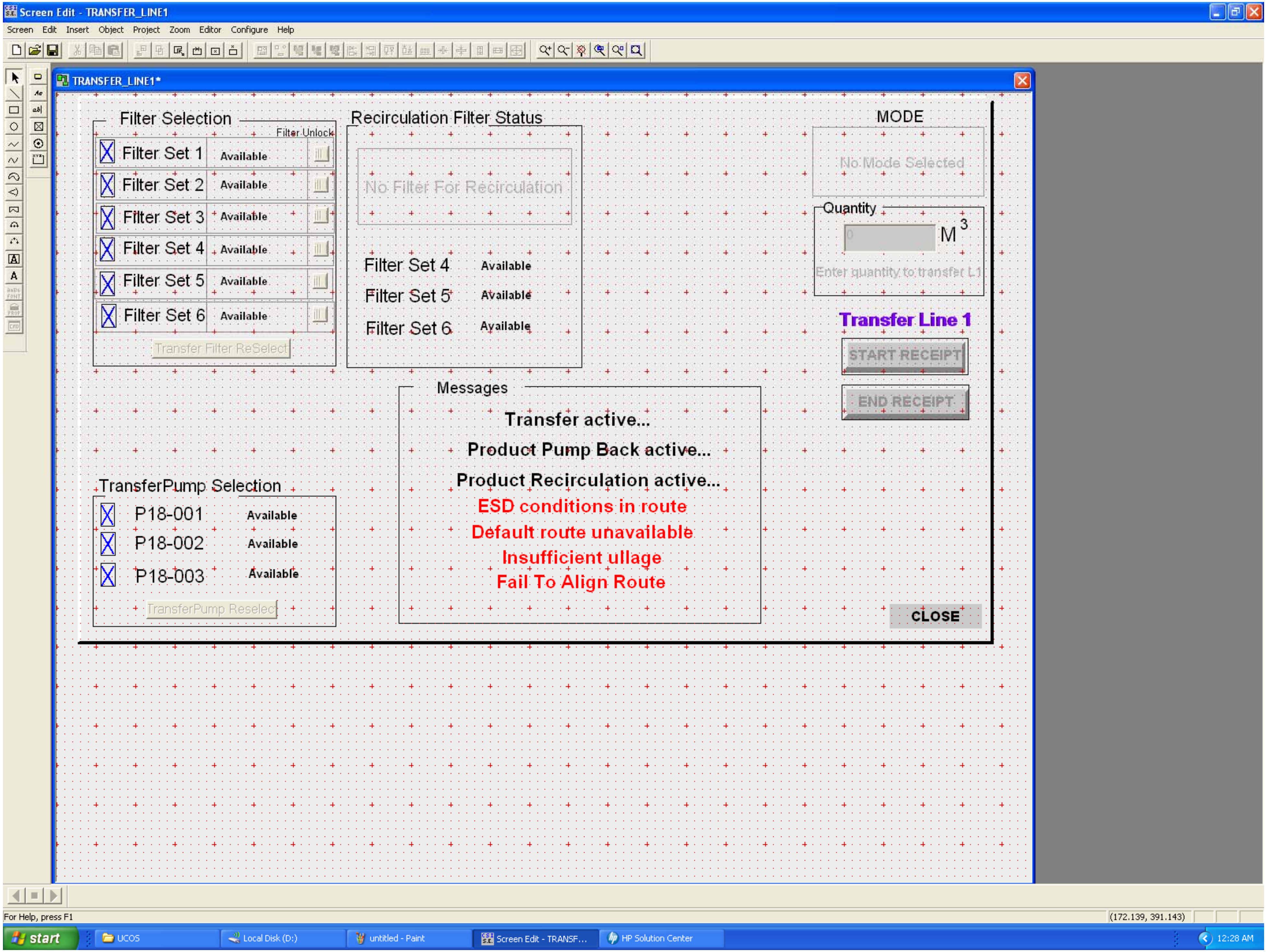
ESD Breakglass

Instrumentation for Tank Gauging, Level Switches, Temperature Elements and Ultrasonic Flow Transmitters

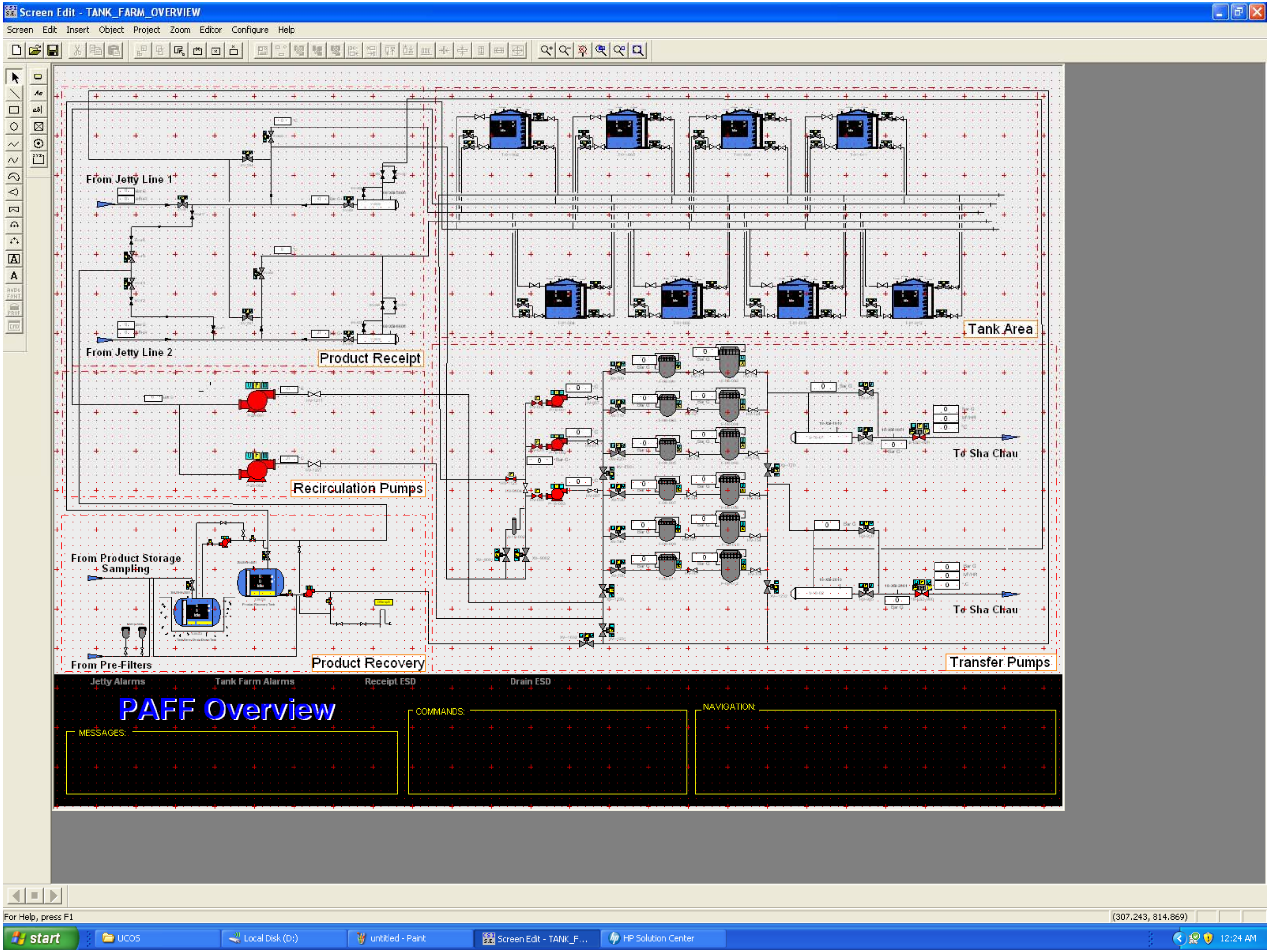
Flowmeters, Pressure Transmitters, Pressure Switch, Temperature Transmitter,

SCADA Screen Shots of ESD System

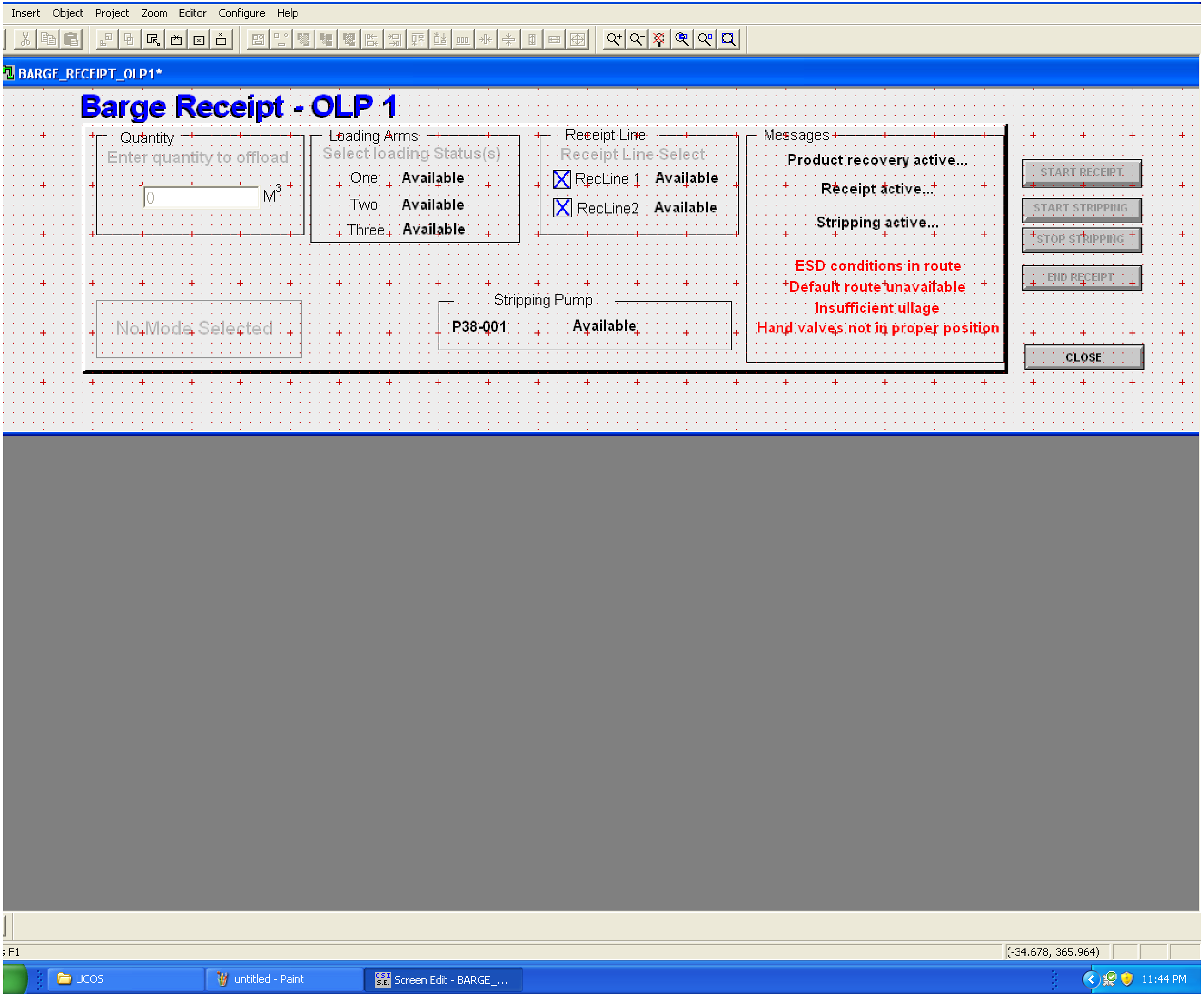

Screen Edit - TRANSFER_LINE2
Screen Edit Insert Object Project Zoom Editor Configure Help
TRANSFER_LINE2*
Filter Selection
Filter Unlock
Filter Set 1 Available
Filter Set 2 Available
Filter Set 3 Available
Filter Set 4 Available
Filter Set 5 Available
Filter Set 6 Available
Transfer Filter ReSelect
Recirculation Filter Status
No Filter For Recirculation
Filter Set 4 Available
Filter Set 5 Available
Filter Set 6 Available
MODE
No Mode Selected
Quantity
M 3
Enter quantity to transfer L2
Transfer Line 2
START RECEIPT
END RECEIPT
Messages
Transfer active...
Product Pump Back active...
Product Recirculation active...
ESD conditions in route
Default route unavailable
Insufficient ullage
Fail To Align Route
TransferPump Selection
P18-001 Available
P18-002 Available
P18-003 Available
TransferPump Reselec
CLOSE
For Help, press F1
(118.095, 396.400)
start
UCOS
Local Disk (D:)
untitled - Paint
HP Solution Center
Screen Edit - TRANSF...
12:31 AM

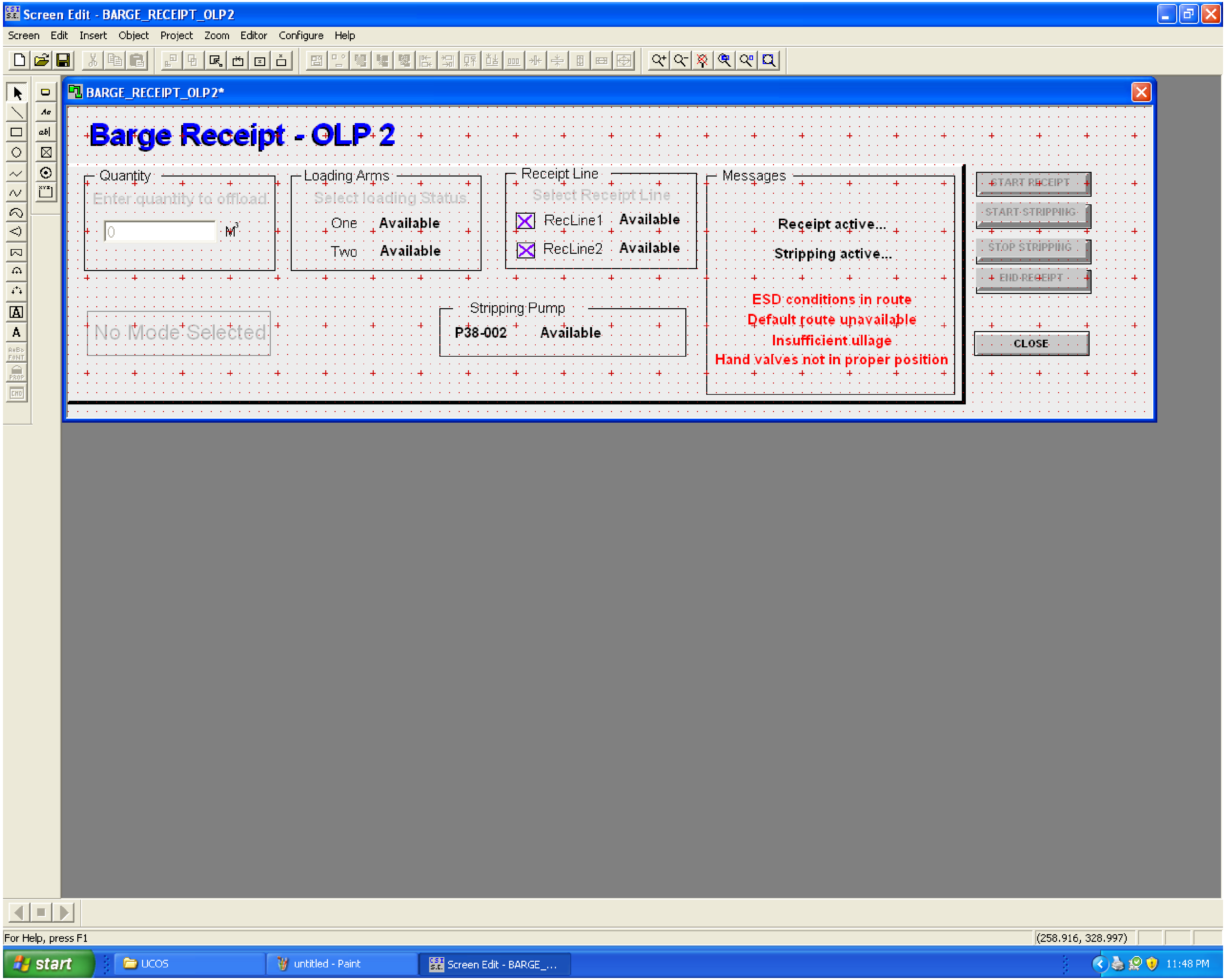


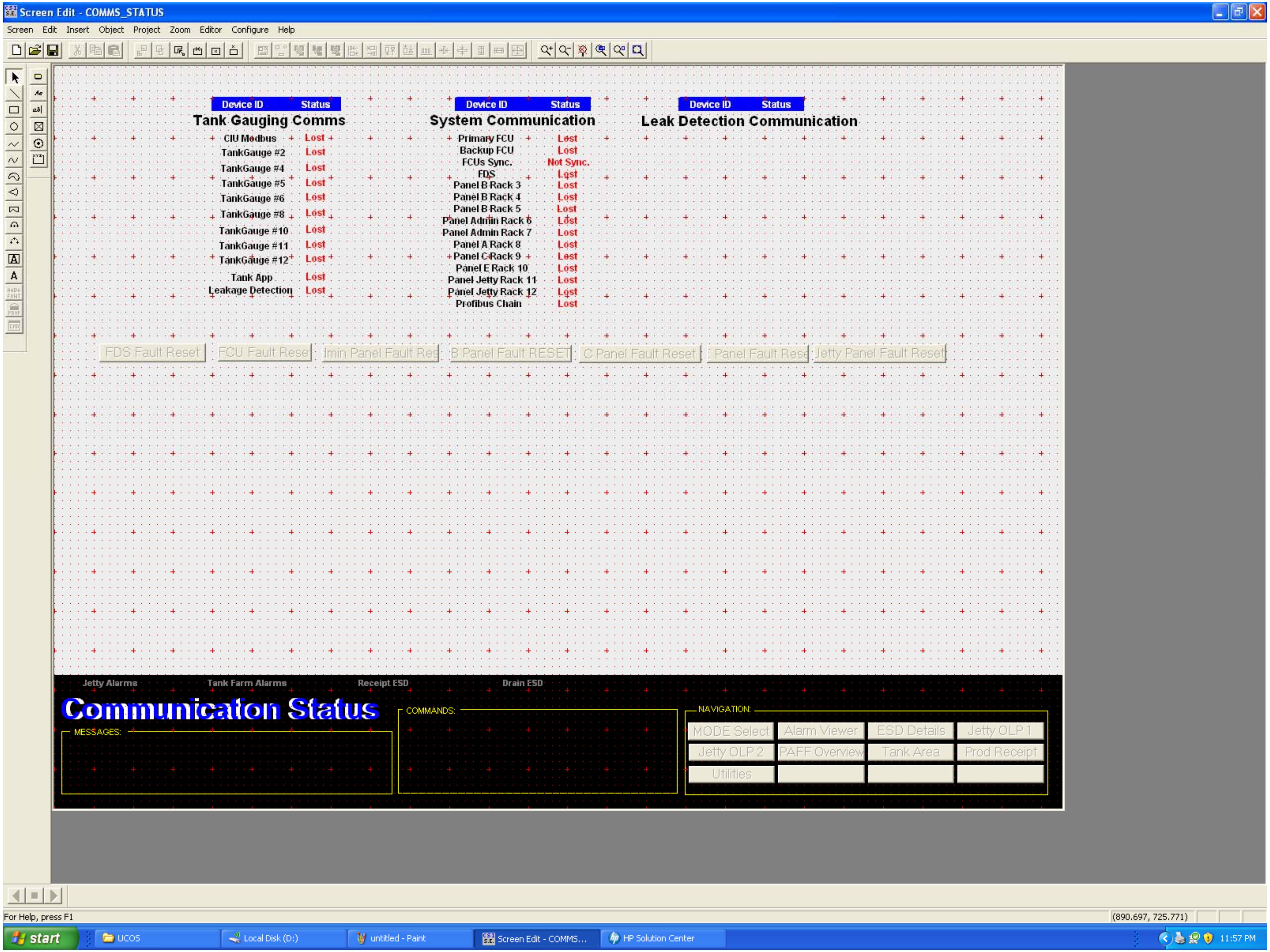
Screen Edit - TRANSFER_LINE1
Screen Edit Insert Object Project Zoom Editor Configure Help
TRANSFER_LINE1*
Filter Selection
Filter Unlock
Filter Set 1 Available
Filter Set 2 Available
Filter Set 3 Available
Filter Set 4 Available
Filter Set 5 Available
Filter Set 6 Available
Transfer Filter ReSelect
Recirculation Filter Status
No Filter For Recirculation
Filter Set 4 Available
Filter Set 5 Available
Filter Set 6 Available
MODE
No Mode Selected
Quantity
M 3
Enter quantity to transfer L1
Transfer Line 1
START RECEIPT
END RECEIPT
Messages
Transfer active...
Product Pump Back active...
Product Recirculation active...
ESD conditions in route
Default route unavailable
Insufficient ullage
Fail To Align Route
TransferPump Selection
P18-001 Available
P18-002 Available
P18-003 Available
TransferPump Reselec
CLOSE
For Help, press F1
(172.139, 391.143)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - TRANSF...
HP Solution Center
12:28 AM

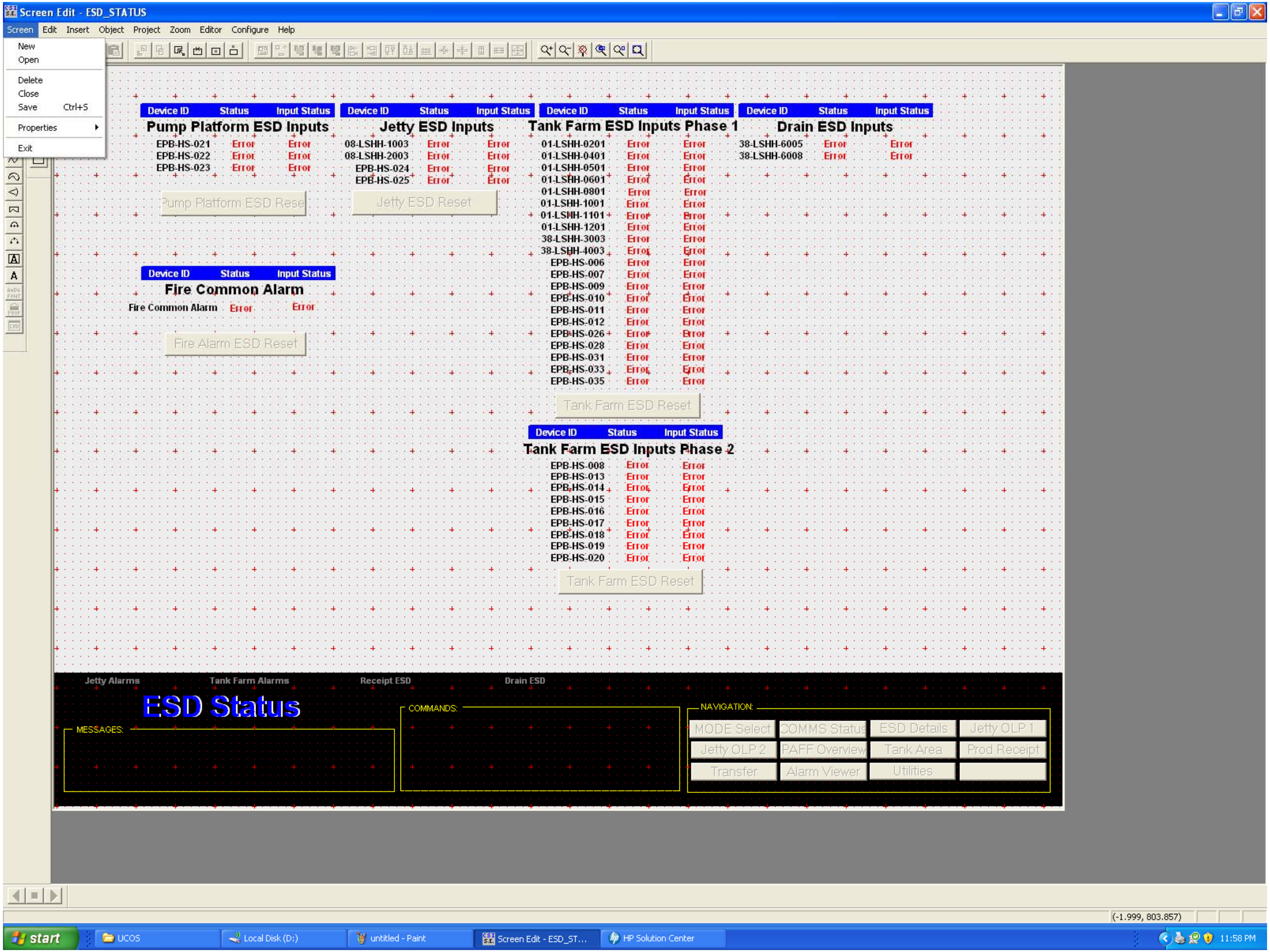


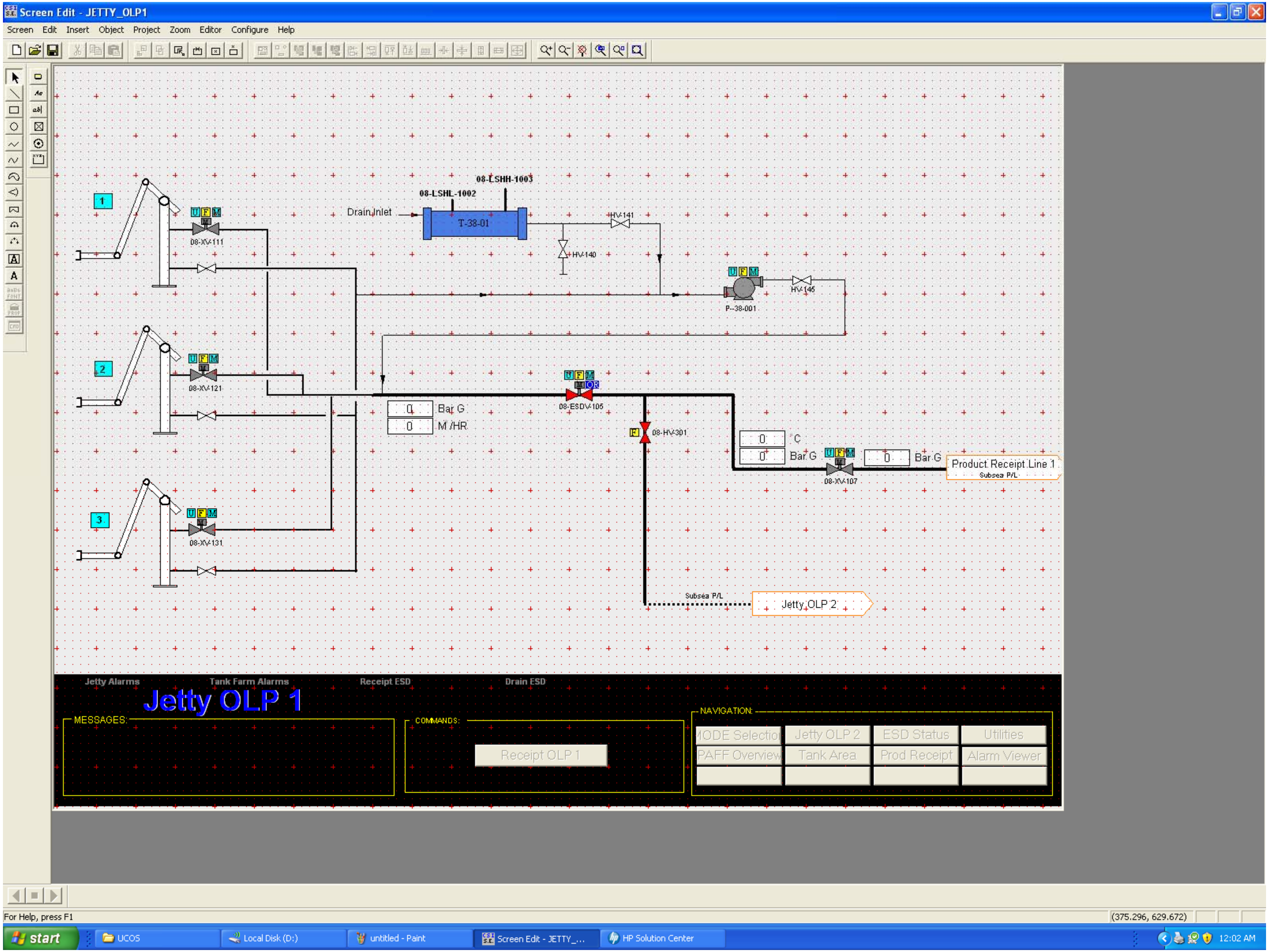
Screen Edit - TANK_FARM_OVERVIEW
Screen Edit Insert Object Project Zoom Editor Configure Help
From Jetty Line 1
From Jetty Line 2
Product Receipt
Tank Area
Recirculation Pumps
To Sha Chau
To Sha Chau
From Product Storage Sampling
From Pre-Filters
Product Recovery
Transfer Pumps
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
PAFF Overview
MESSAGES:
COMMANDS:
NAVIGATION:
For Help, press F1
(307.243, 814.869)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - TANK_F...
HP Solution Center
12:24 AM


Insert Object Project Zoom Editor Configure Help
BARGE_RECEIPT_OLP1*
Barge Receipt - OLP 1
Quantity
Enter quantity to offload
0
M3
Loading Arms
Select loading Status(s)
One Available
Two Available
Three Available
Receipt Line
Receipt Line Select
RecLine 1 Available
RecLine2 Available
Messages
Product recovery active...
Receipt active...
Stripping active...
ESD conditions in route
Default route unavailable
Insufficient ullage
Hand valves not in proper position
START RECEIPT
START STRIPPING
STOP STRIPPING
END RECEIPT
CLOSE
No Mode Selected
Stripping Pump
P38-001
Available
F1
(-34.678, 365.964)
UCOS
untitled - Paint
Screen Edit - BARGE_...
11:44 PM

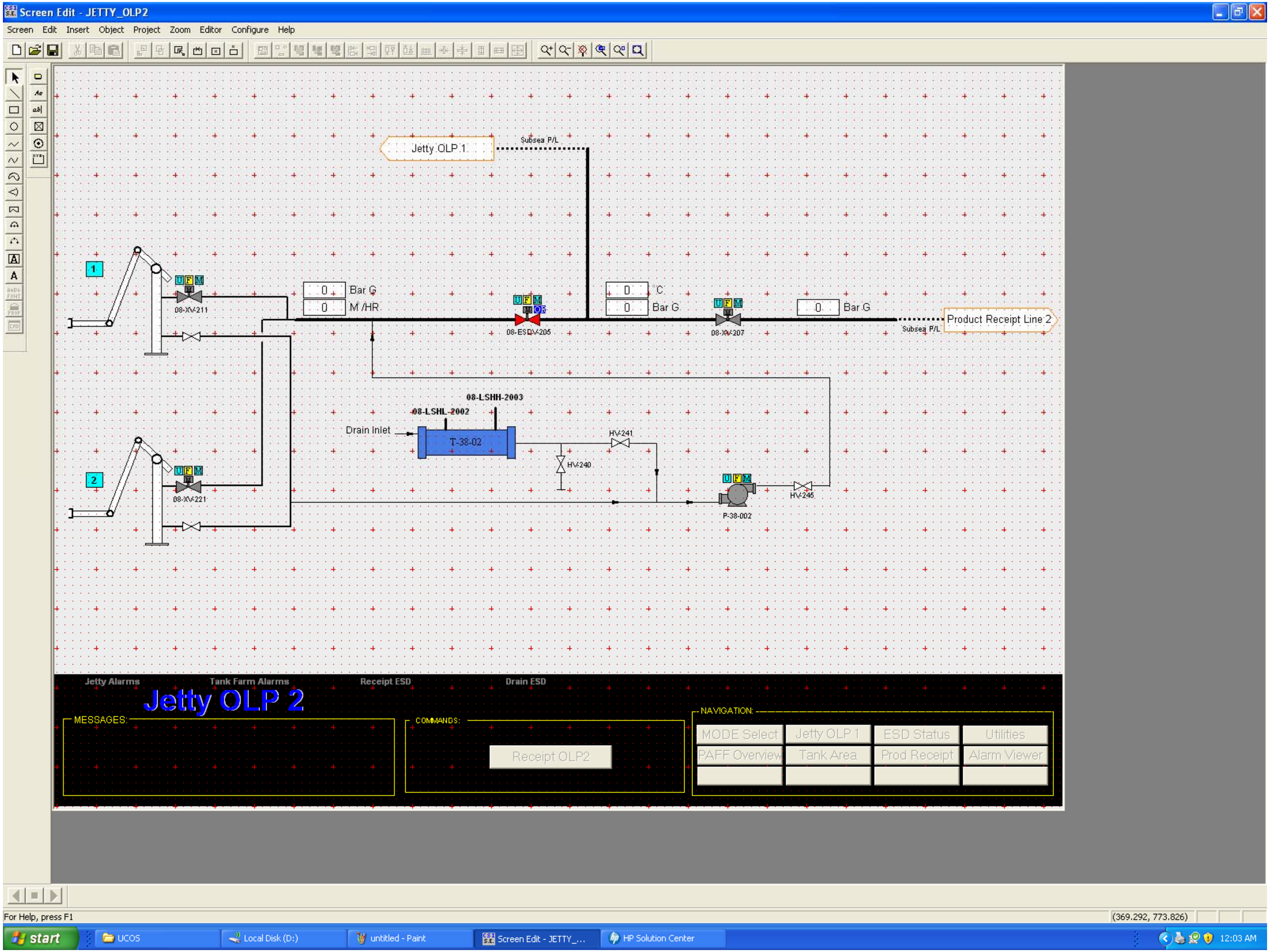

Screen Edit - BARGE_RECEIPT_OLP2
Screen Edit Insert Object Project Zoom Editor Configure Help
BARGE_RECEIPT_OLP2*
Barge Receipt - OLP 2
Quantity
Enter quantity to offload
0
M3
Loading Arms
Select loading Status
One Available
Two Available
Receipt Line
Select Receipt Line
RecLine1 Available
RecLine2 Available
Messages
Receipt active...
Stripping active...
ESD conditions in route
Default route unavailable
Insufficient ullage
Hand valves not in proper position
START RECEIPT
START STRIPPING
STOP STRIPPING
END RECEIPT
CLOSE
No Mode Selected
Stripping Pump
P38-002 Available
For Help, press F1
(258.916, 328.997)
start
UCOS
untitled - Paint
Screen Edit - BARGE_...
11:48 PM


Screen Edit - COMMS_STATUS
Screen Edit Insert Object Project Zoom Editor Configure Help
Device ID Status
Tank Gauging Comms
CIU Modbus Lost
TankGauge #2 Lost
TankGauge #4 Lost
TankGauge #5 Lost
TankGauge #6 Lost
TankGauge #8 Lost
TankGauge #10 Lost
TankGauge #11 Lost
TankGauge #12 Lost
Tank App Lost
Leakage Detection Lost
Device ID Status
System Communication
Primary FCU Lost
Backup FCU Lost
FCUs Sync. Not Sync.
FDS Lost
Panel B Rack 3 Lost
Panel B Rack 4 Lost
Panel B Rack 5 Lost
Panel Admin Rack 6 Lost
Panel Admin Rack 7 Lost
Panel A Rack 8 Lost
Panel C Rack 9 Lost
Panel E Rack 10 Lost
Panel Jetty Rack 11 Lost
Panel Jetty Rack 12 Lost
Profibus Chain Lost
Device ID Status
Leak Detection Communication
FDS Fault Reset
FCU Fault Reset
Admin Panel Fault Res
B Panel Fault RESET
C Panel Fault Reset
Panel Fault Rese
Jetty Panel Fault Reset
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
Communication Status
MESSAGES:
COMMANDS:
NAVIGATION:
MODE Select
Alarm Viewer
ESD Details
Jetty OLP 1
Jetty OLP 2
PAFF Overview
Tank Area
Prod Receipt
Utilities
For Help, press F1
(890.697, 725.771)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - COMMS...
HP Solution Center
11:57 PM

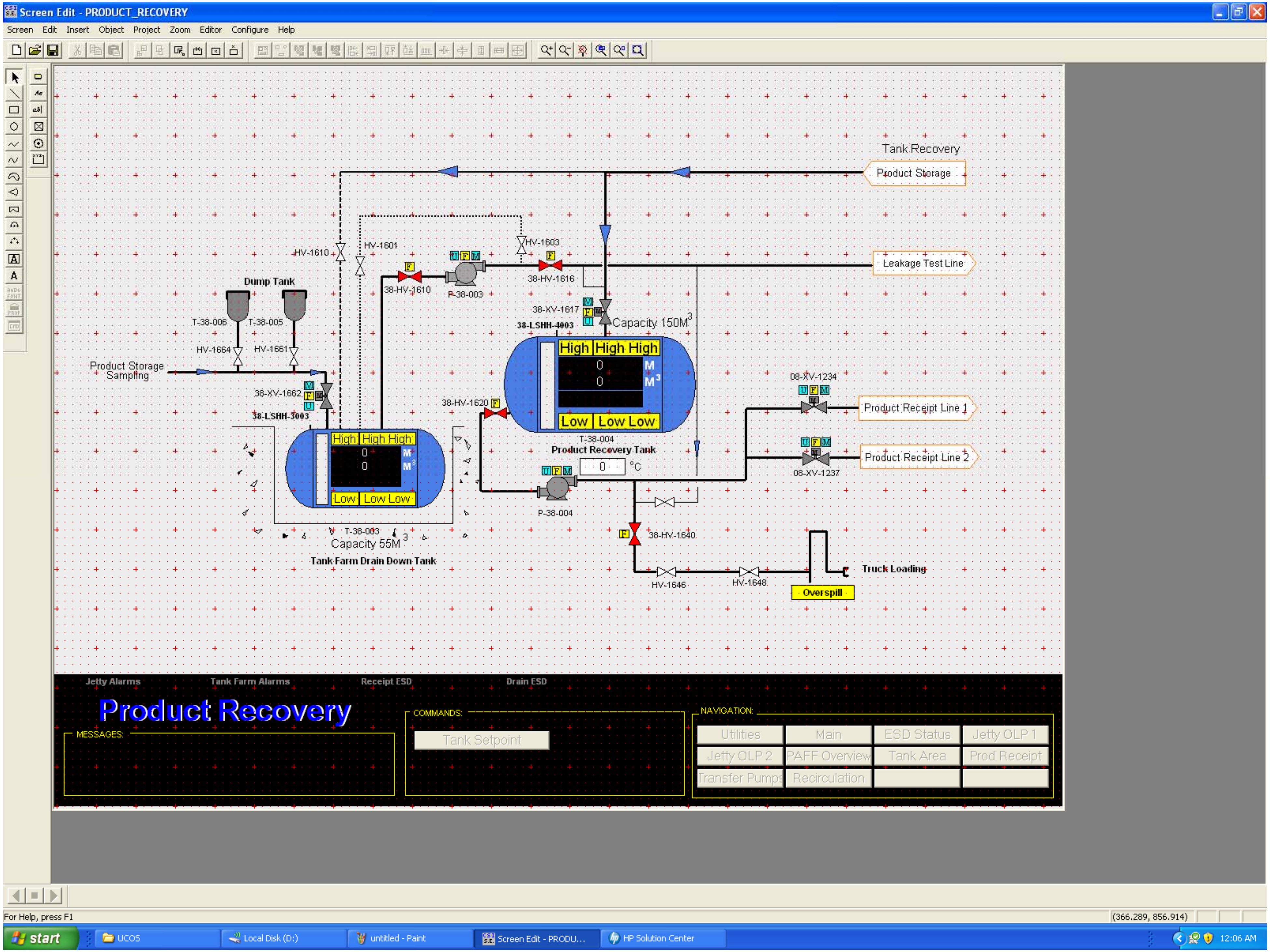

Screen Edit - ESD_STATUS
Screen Edit Insert Object Project Zoom Editor Configure Help
New
Open
Delete
Close
Save Ctrl+S
Properties
Exit
Device ID Status Input Status
Pump Platform ESD Inputs
EPB-HS-021 Error Error
EPB-HS-022 Error Error
EPB-HS-023 Error Error
Pump Platform ESD Rese
Device ID Status Input Status
Jetty ESD Inputs
08-LSHH-1003 Error Error
08-LSHH-2003 Error Error
EPB-HS-024 Error Error
EPB-HS-025 Error Error
Jetty ESD Reset
Device ID Status Input Status
Tank Farm ESD Inputs Phase 1
01-LSHH-0201 Error Error
01-LSHH-0401 Error Error
01-LSHH-0501 Error Error
01-LSHH-0601 Error Error
01-LSHH-0801 Error Error
01-LSHH-1001 Error Error
01-LSHH-1101 Error Error
01-LSHH-1201 Error Error
38-LSHH-3003 Error Error
38-LSHH-4003 Error Error
EPB-HS-006 Error Error
EPB-HS-007 Error Error
EPB-HS-009 Error Error
EPB-HS-010 Error Error
EPB-HS-011 Error Error
EPB-HS-012 Error Error
EPB-HS-026 Error Error
EPB-HS-028 Error Error
EPB-HS-031 Error Error
EPB-HS-033 Error Error
EPB-HS-035 Error Error
Tank Farm ESD Reset
Device ID Status Input Status
Drain ESD Inputs
38-LSHH-6005 Error Error
38-LSHH-6008 Error Error
Device ID Status Input Status
Fire Common Alarm
Fire Common Alarm Error Error
Fire Alarm ESD Reset
Device ID Status Input Status
Tank Farm ESD Inputs Phase 2
EPB-HS-008 Error Error
EPB-HS-013 Error Error
EPB-HS-014 Error Error
EPB-HS-015 Error Error
EPB-HS-016 Error Error
EPB-HS-017 Error Error
EPB-HS-018 Error Error
EPB-HS-019 Error Error
EPB-HS-020 Error Error
Tank Farm ESD Reset
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
ESD Status
MESSAGES:
COMMANDS:
NAVIGATION:
MODE Select
COMMS Status
ESD Details
Jetty OLP 1
Jetty OLP 2
PAFF Overview
Tank Area
Prod Receipt
Transfer
Alarm Viewer
Utilities
(-1.999, 803.857)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - ESD_ST...
HP Solution Center
11:58 PM



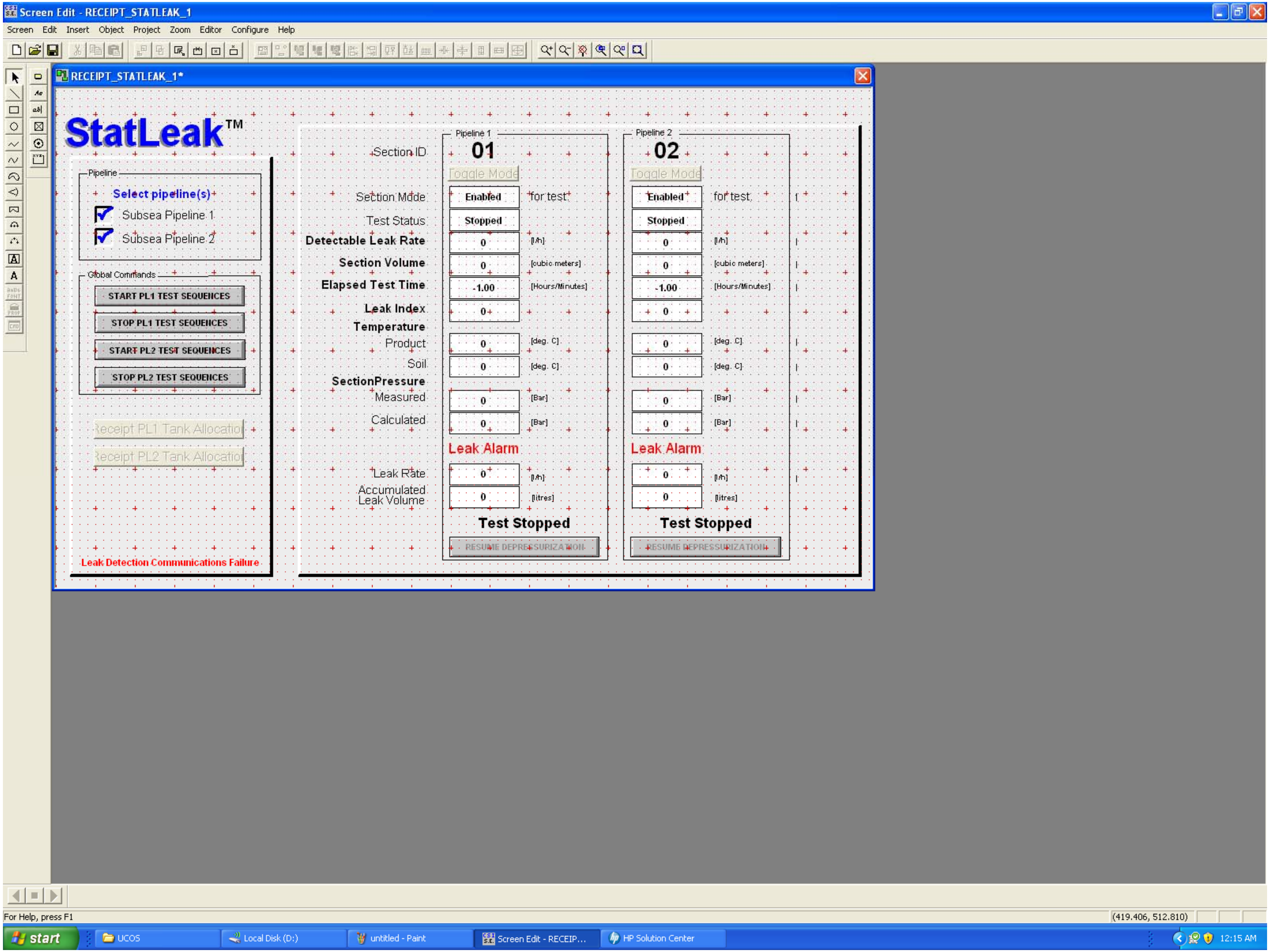
Screen Edit - JETTY_OLP1
Screen Edit Insert Object Project Zoom Editor Configure Help
08-LSHH-1003
08-LSHL-1002
Drain Inlet
T-38-01
HV-141
HV-140
08-XV-111
P-38-001
HV-146
08-XV-121
08-ESDV-105
Bar G
M /HR
08-HV-301
C
Bar G
Bar G
08-XV-107
Product Receipt Line 1
Subsea P/L
08-XV-131
Subsea P/L
Jetty OLP 2
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
Jetty OLP 1
MESSAGES:
COMMANDS:
Receipt OLP 1
NAVIGATION:
MODE Selection
Jetty OLP 2
ESD Status
Utilities
PAFF Overview
Tank Area
Prod Receipt
Alarm Viewer
For Help, press F1
(375.296, 629.672)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - JETTY_...
HP Solution Center
12:02 AM

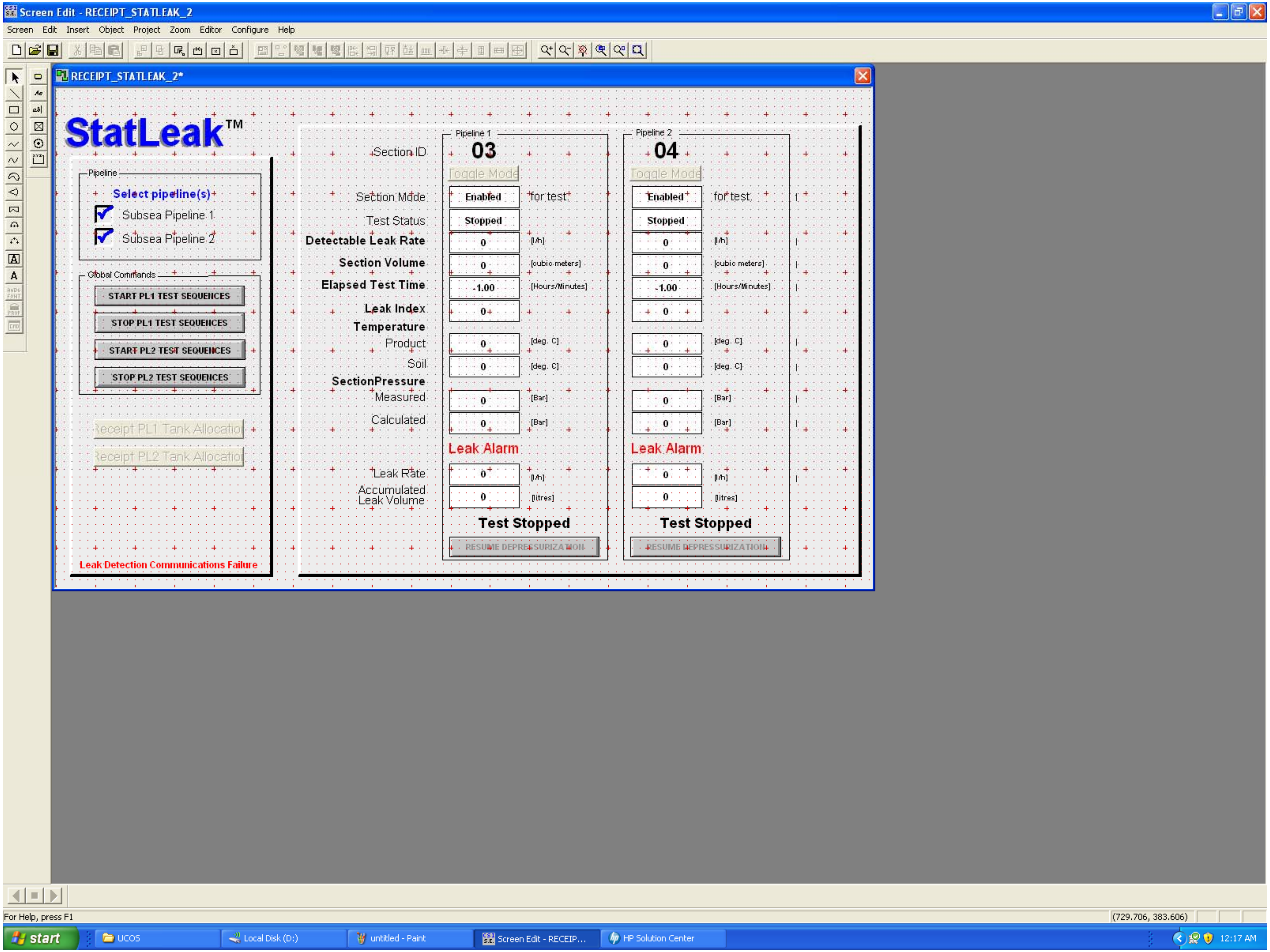


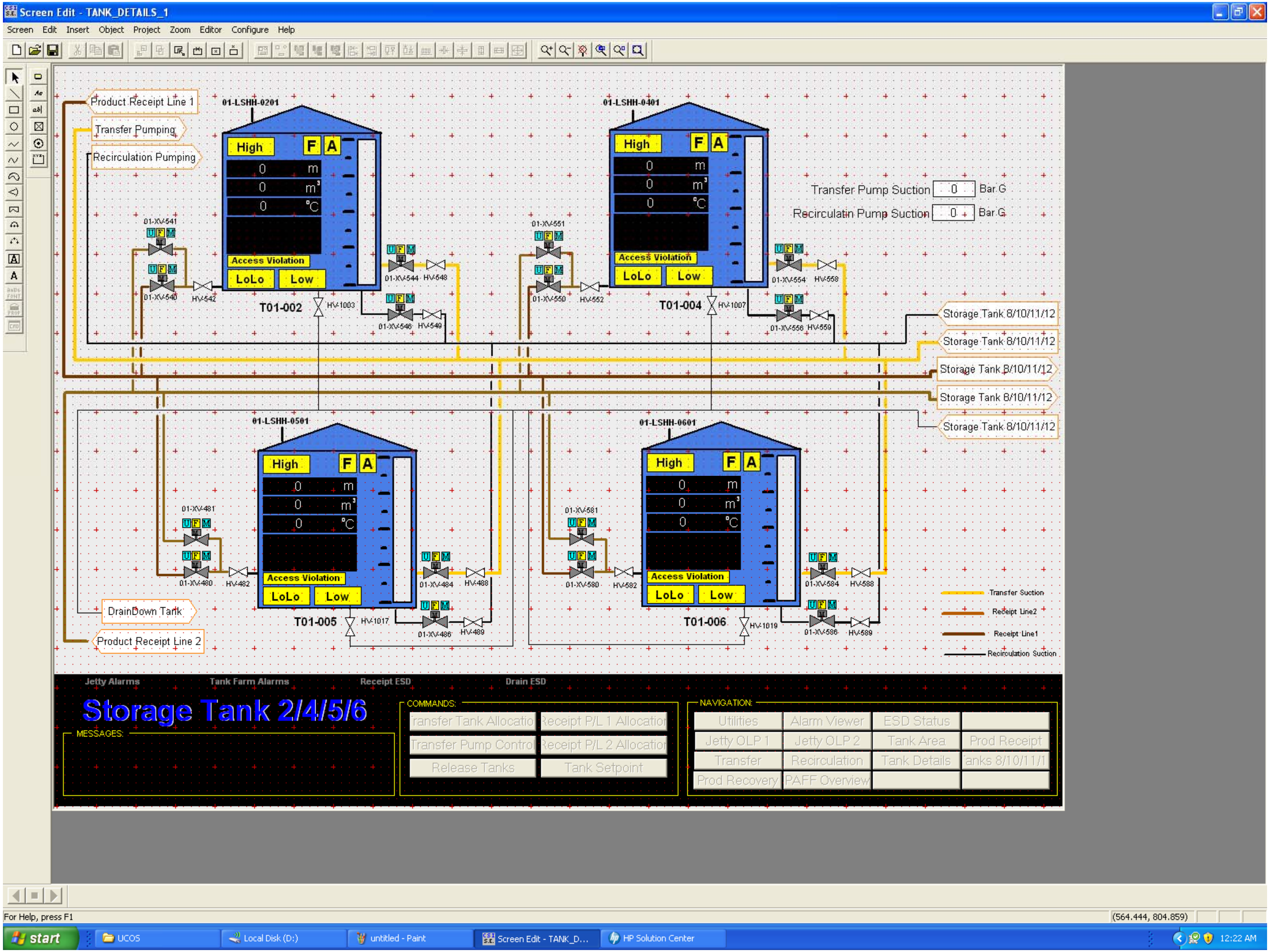
Screen Edit - JETTY_OLP2
Screen Edit Insert Object Project Zoom Editor Configure Help
Jetty OLP 1
Subsea P/L
1
2
08-XV-211
08-XV-221
0 Bar G
0 M /HR
08-ESDV-205
0 C
0 Bar G
08-XV-207
0 Bar G
Product Receipt Line 2
Subsea P/L
08-LSHH-2003
08-LSHL-2002
Drain Inlet
T-38-02
HV-241
HV-240
HV-245
P-38-002
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
Jetty OLP 2
MESSAGES:
COMMANDS:
Receipt OLP2
NAVIGATION:
MODE Select
Jetty OLP 1
ESD Status
Utilities
PAFF Overview
Tank Area
Prod Receipt
Alarm Viewer
For Help, press F1
(369.292, 773.826)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - JETTY_...
HP Solution Center
12:03 AM



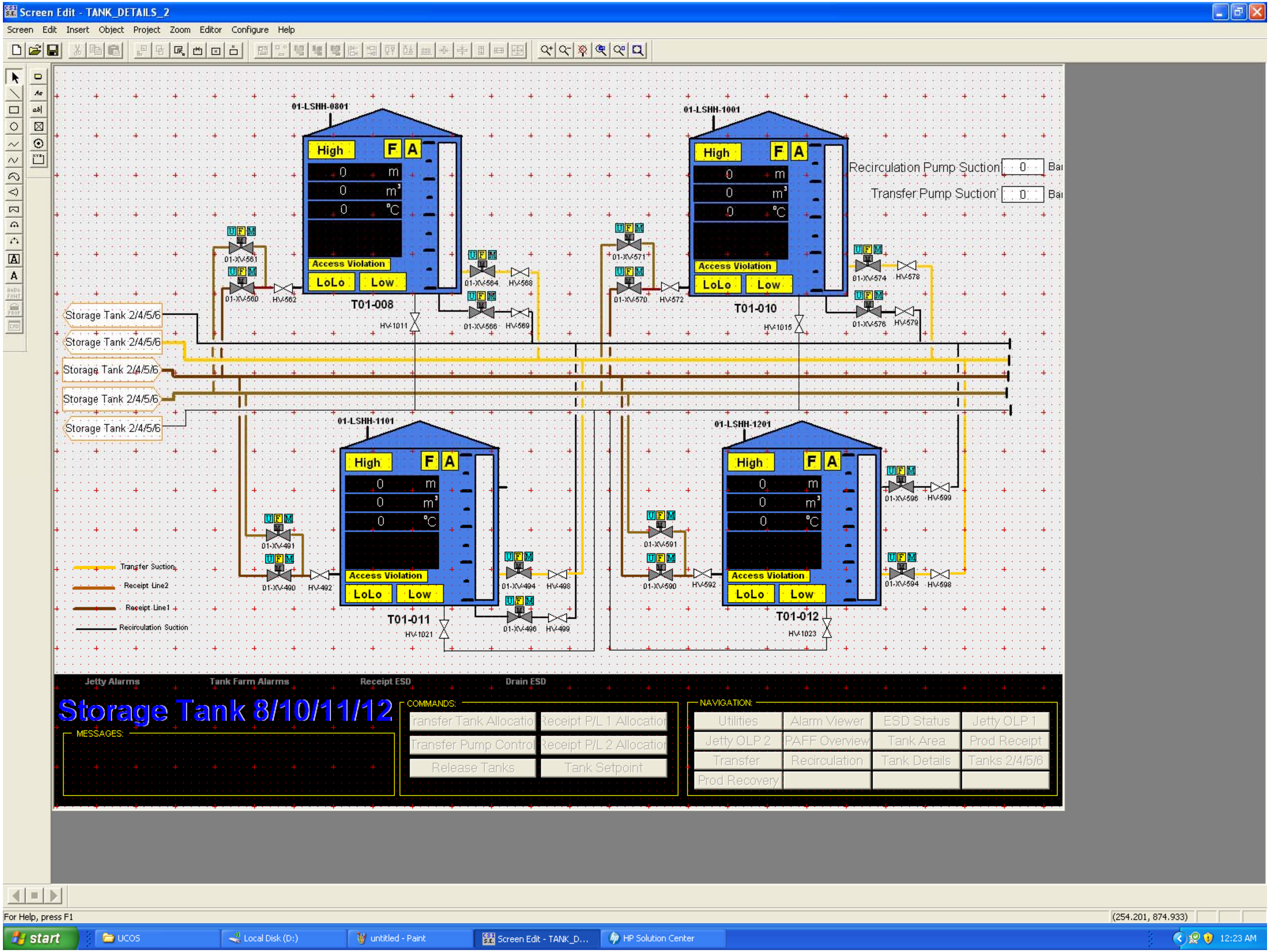
Screen Edit - PRODUCT_RECOVERY
Screen Edit Insert Object Project Zoom Editor Configure Help
Tank Recovery
Product Storage
Leakage Test Line
HV-1610
HV-1601
HV-1603
38-HV-1610
P-38-003
38-HV-1616
38-XV-1617
38-LSHH-4003
Capacity 150M3
Dump Tank
T-38-006
T-38-005
HV-1664
HV-1661
Product Storage Sampling
38-XV-1662
38-LSHH-3003
High High High
Low Low Low
38-HV-1620
T-38-004
Product Recovery Tank
08-XV-1234
Product Receipt Line 1
Product Receipt Line 2
08-XV-1237
P-38-004
T-38-003
Capacity 55M3
Tank Farm Drain Down Tank
38-HV-1640
HV-1646
HV-1648
Truck Loading
Overspill
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
Product Recovery
MESSAGES:
COMMANDS:
Tank Setpoint
NAVIGATION:
Utilities
Main
ESD Status
Jetty OLP 1
Jetty OLP 2
PAFF Overview
Tank Area
Prod Receipt
Transfer Pumps
Recirculation
For Help, press F1
(366.289, 856.914)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - PRODU...
HP Solution Center
12:06 AM


Screen Edit - RECEIPT_STATLEAK_1
Screen Edit Insert Object Project Zoom Editor Configure Help
RECEIPT_STATLEAK_1*
StatLeak™
Pipeline
Select pipeline(s)
Subsea Pipeline 1
Subsea Pipeline 2
Global Commands
START PL1 TEST SEQUENCES
STOP PL1 TEST SEQUENCES
START PL2 TEST SEQUENCES
STOP PL2 TEST SEQUENCES
Receipt PL1 Tank Allocation
Receipt PL2 Tank Allocation
Leak Detection Communications Failure
Pipeline 1
Pipeline 2
Section ID
01
02
Toggle Mode
Section Mode
Enabled
for test
Test Status
Stopped
Detectable Leak Rate
[l/h]
Section Volume
[cubic meters]
Elapsed Test Time
-1.00
[Hours/Minutes]
Leak Index
Temperature
Product
Soil
[deg. C]
SectionPressure
Measured
Calculated
[Bar]
Leak Alarm
Leak Rate
Accumulated Leak Volume
[litres]
Test Stopped
RESUME DEPRESSURIZATION
For Help, press F1
(419.406, 512.810)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - RECEIP...
HP Solution Center
12:15 AM

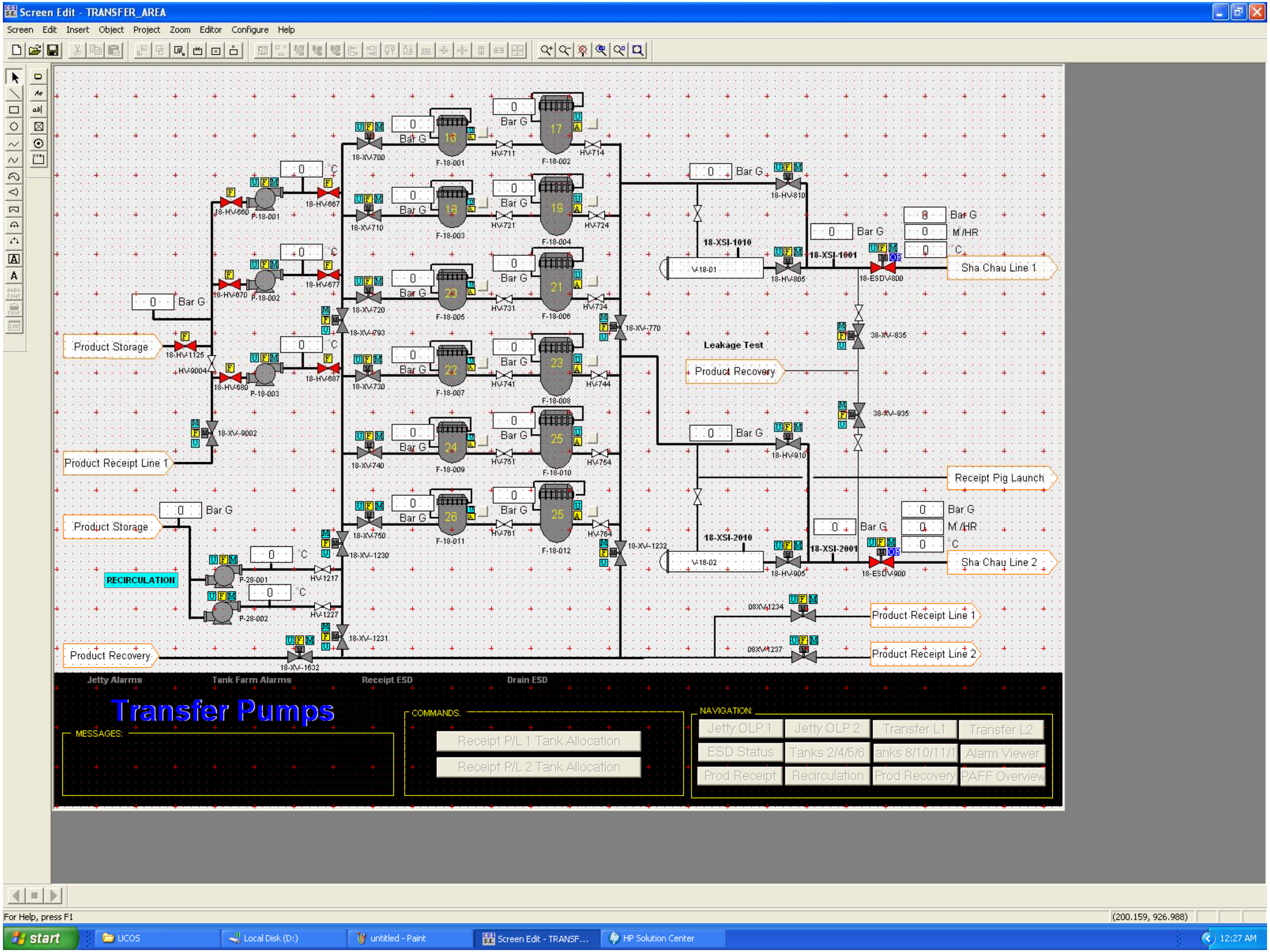

Screen Edit - RECEIPT_STATLEAK_2
Screen Edit Insert Object Project Zoom Editor Configure Help
RECEIPT_STATLEAK_2*
StatLeak™
Pipeline
Select pipeline(s)
Subsea Pipeline 1
Subsea Pipeline 2
Global Commands
START PL1 TEST SEQUENCES
STOP PL1 TEST SEQUENCES
START PL2 TEST SEQUENCES
STOP PL2 TEST SEQUENCES
Receipt PL1 Tank Allocation
Receipt PL2 Tank Allocation
Leak Detection Communications Failure
Pipeline 1
Pipeline 2
Section ID
03
04
Toggle Mode
Section Mode
Enabled
for test
Test Status
Stopped
Detectable Leak Rate
[l/h]
Section Volume
[cubic meters]
Elapsed Test Time
-1.00
[Hours/Minutes]
Leak Index
Temperature
Product
Soil
[deg. C]
SectionPressure
Measured
Calculated
[Bar]
Leak Alarm
Leak Rate
Accumulated Leak Volume
[litres]
Test Stopped
RESUME DEPRESSURIZATION
For Help, press F1
(729.706, 383.606)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - RECEIP...
HP Solution Center
12:17 AM



Screen Edit - TANK_DETAILS_1
Screen Edit Insert Object Project Zoom Editor Configure Help
Product Receipt Line 1
Transfer Pumping
Recirculation Pumping
01-LSHH-0201
01-LSHH-0401
01-LSHH-0501
01-LSHH-0601
High
F
A
Access Violation
LoLo
Low
T01-002
T01-004
T01-005
T01-006
Transfer Pump Suction
Recirculatin Pump Suction
Bar.G
Storage Tank 8/10/11/12
DrainDown Tank
Product Receipt Line 2
Transfer Suction
Receipt Line2
Receipt Line1
Recirculation Suction
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
Storage Tank 2/4/5/6
MESSAGES:
COMMANDS:
Transfer Pump Control
Release Tanks
Tank Setpoint
NAVIGATION:
Utilities
Alarm Viewer
ESD Status
Jetty OLP 1
Jetty OLP 2
Tank Area
Prod Receipt
Transfer
Recirculation
Tank Details
Prod Recovery
PAFF Overview
For Help, press F1
(564.444, 804.859)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - TANK_D...
HP Solution Center
12:22 AM



Screen Edit - TANK_DETAILS_2
Screen Edit Insert Object Project Zoom Editor Configure Help
01-LSHH-0801
01-LSHH-1001
01-LSHH-1101
01-LSHH-1201
High
F
A
Access Violation
LoLo
Low
T01-008
T01-010
T01-011
T01-012
Recirculation Pump Suction
Transfer Pump Suction
Storage Tank 2/4/5/6
Transfer Suction
Receipt Line2
Receipt Line1
Recirculation Suction
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
Storage Tank 8/10/11/12
MESSAGES:
COMMANDS:
Transfer Tank Allocation
Receipt P/L 1 Allocation
Transfer Pump Control
Receipt P/L 2 Allocation
Release Tanks
Tank Setpoint
NAVIGATION:
Utilities
Alarm Viewer
ESD Status
Jetty OLP 1
Jetty OLP 2
PAFF Overview
Tank Area
Prod Receipt
Transfer
Recirculation
Tank Details
Tanks 2/4/5/6
Prod Recovery
For Help, press F1
(254.201, 874.933)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - TANK_D...
HP Solution Center
12:23 AM



Screen Edit - TRANSFER_AREA
Screen Edit Insert Object Project Zoom Editor Configure Help
Product Storage
Product Receipt Line 1
Product Storage
RECIRCULATION
Product Recovery
18-XV-700
18-XV-710
18-XV-720
18-XV-730
18-XV-740
18-XV-750
18-XV-793
18-XV-9002
18-XV-1230
18-XV-1231
18-XV-1632
18-HV-1125
HV-9004
18-HV-660
18-HV-667
18-HV-670
18-HV-677
18-HV-680
18-HV-687
P-18-001
P-18-002
P-18-003
P-28-001
P-28-002
HV-1217
HV-1227
F-18-001
F-18-002
F-18-003
F-18-004
F-18-005
F-18-006
F-18-007
F-18-008
F-18-009
F-18-010
F-18-011
F-18-012
HV-711
HV-714
HV-721
HV-724
HV-731
HV-734
HV-741
HV-744
HV-751
HV-754
HV-761
HV-764
18-XV-770
18-XV-1232
Bar G
M /HR
18-HV-810
18-XSI-1010
18-XSI-1001
V-18-01
18-HV-805
18-ESDV-800
Sha Chau Line 1
38-XV-835
Leakage Test
Product Recovery
38-XV-935
18-HV-910
Receipt Pig Launch
18-XSI-2010
18-XSI-2001
V-18-02
18-HV-905
18-ESDV-900
Sha Chau Line 2
08XV-1234
08XV-1237
Product Receipt Line 1
Product Receipt Line 2
Jetty Alarms
Tank Farm Alarms
Receipt ESD
Drain ESD
Transfer Pumps
MESSAGES:
COMMANDS:
Receipt P/L 1 Tank Allocation
Receipt P/L 2 Tank Allocation
NAVIGATION:
Jetty OLP 1
Jetty OLP 2
Transfer L1
Transfer L2
ESD Status
Tanks 2/4/5/6
anks 8/10/11/1
Alarm Viewer
Prod Receipt
Recirculation
Prod Recovery
PAFF Overview
For Help, press F1
(200.159, 926.988)
start
UCOS
Local Disk (D:)
untitled - Paint
Screen Edit - TRANSF...
HP Solution Center
12:27 AM

Table 1 EP Condition 3.5 (d) - Summary of the document

	Content	Remarks
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 d)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; section 3 clause 3.3, section 6, clause 6.1.1, section 8 clause 8.4.3 and section 16 clause 16.1.3
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items (vii) and (xvii), Schedule F - Appendix 7 item (m), Schedule F - Appendix 7 clause 2.1 and Franchisee Requirements Clause 1.05 item (a)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10, section 3 and section 3.2
5	Contract drawings	**a) For the defensive fenders:** - PAFF/MA/03/DWG/C/2009 Revision 3 General: Typical Sections for Vessels at Berth - PAFF/MA/03/DWG/C/2020 Revision 3 Loading Platforms: General Arrangement - LP1 - PAFF/MA/03/DWG/C/2021 Revision 3 Loading Platforms: General Arrangement - LP2 - PAFF/MA/03/DWG/C/2125 Revision 0 Walkways: General Arrangement - PAFF/MA/03/DWG/C/2070 Revision 7 Berthing Dolphin: General Arrangement and Key Plan
		(b) For the coupling points with slop collection utilities connecting to oil interceptors: - PAFF/LC/03/DWG/C/0258 Revision 2 Jetty Pipe Support - PAFF/MA/03/DWG/C/2022 Revision 1 Loading Platforms: Precast Element Key Plan - LP1 - PAFF/MA/03/DWG/C/2023 Revision 0 Loading Platforms: Precast Element Key Plan - LP2 - PAFF/MA/03/DWG/C/2025 Revision 3 Loading Platforms: Deck Plan - LP1 - PAFF/MA/03/DWG/C/2026 Revision 3 Loading Platforms: Deck Plan - LP2 - PAFF/MA/03/DWG/C/2035 Revision 0 Loading Platforms: Precast Pilecap, Oil Interceptor & Water Supply Dimensions - PAFF/BA/02/DWG/C/1460 Revision 3 Drainage System for Jetty OLP1 and OLP2
6	Design Report	Design requirements for Drainage Design (including drawings) for the oil interceptor
7	Technical information	Technical information from the fender supplier (Trelleborg)
8	Photographs	Photographs of the completed works

香港
機場管理局 | AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (d)
Date of Report:	25 November 2009
Date prepared by ET:	25 November 2009
Date received by IEC:	25 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (d)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(d) Installations at the Jetty

The jetty shall be installed with defensive fenders and coupling points with slop collection utilities connecting to oil interceptors.

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 25 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

pp Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE
A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. Submissions or Measures during the Construction of Certain Parts of the Project

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

d) Installations at the Jetty

The jetty shall be installed with defensive fenders and coupling points with slop collection utilities connecting to oil interceptors.

Environmental Impact Assessment Report Requirement

3 DESCRIPTION OF PROJECT AND ASSUMPTIONS

3.3 Berthing Jetty

3.3.1 The PAFF requires the construction of a twin berth jetty. This will be sited approximately 200m offshore with no direct access to shore. The two end to end berths would run approximately parallel to the quay wall and fuel tanker berthing would be provided on the sea facing side. The main activity at the jetty will be unloading of the tankers to the storage tanks in the tank farm. Two unloading arms on one berth and three unloading arms at the other berth will be provided to unload the fuel at each berth. Fuel lines and services will run to shore through submarine pipes and cabling protected by rock armour not protruding above the existing seabed, so as to provide marine access to other facilities adjoining the tank farm. Details of the jetty are provided in Figure 3.2c.

3.3.4 Two defensive fender piles have already been installed on the on shore side of the jetty to prevent any possible collision from small craft straying into the prohibited area. Coupling points on the ship would be provided with slop trays to catch occasional minor spills of unloaded fuels during coupling and de-coupling and the vessels will deal with the spills.

6. WATER QUALITY ASSESSMENT

6.1.1 Operational Phase

6.1.1.2 Other mitigation measures recommended for the operational phase include the following. These measures are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B:

- ♦ routine losses and spills will also be prevented through design. Coupling points on the jetty will be protected with slop collection utilities;

8. LANDSCAPE AND VISUAL ASSESSMENT

8.4.3 Berthing Jetty

8.4.3.1 The PAFF requires the construction of a twin berth jetty. This will be sited approximately 200m offshore with no direct access to shore. The two end to end berths would run approximately parallel to the quay wall and fuel tanker berthing would be provided on the sea facing side. The main activity at the jetty will be unloading of the tankers to the storage tanks in the tank farm. Two unloading arms on one berth and three unloading arms at the other berth will be provided to unload the fuel at each berth. Fuel lines and services will run to shore through submarine pipes and cabling protected by rock armour not protruding above the existing seabed, so as to provide marine access to other facilities adjoining the tank farm. Details of the jetty are provided in Figure 3.2c.

8.4.3.4 Two defensive fender piles have already been installed on the on shore side of the jetty to prevent any possible collision from small craft straying into the prohibited area. Coupling points on the ship would be provided with slop trays to catch occasional minor spills of unloaded fuels during coupling and de-coupling and the vessels will deal with the spills.

16. SUMMARY OF ENVIRONMENTAL OUTCOMES

Design

16.1.3 The risk of losses and spills from the jetty will be minimised through design to international standards. Vessels coupling points will be protected with slop collection utilities. Auxiliary tanks will be installed at the tank farm for recovered fuel and slops. Oily drainage systems and slop collection systems will connect to an oil/water separator before water is discharged.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.1 Jetty and Berths

The jetty and berths shall include but not be limited to the following items:

(i) Access channel (whether dredged or not)
(ii) Turning circle (whether dredged or not)
(iii) Navigational aids
(iv) A jetty with 2 independent berths which together shall be capable of accommodating 2 vessels simultaneously. One berth shall accommodate vessels of size between 10,000 to 40,000 dwt and the other shall accommodate vessels of size between 10,000 and 80,000 dwt
(v) Pile foundations
(vi) In situ reinforced concrete superstructure for the jetty including the berthing and mooring dolphins
(vii) Marine fixtures and fittings (e.g. bollards, mooring hooks, fenders, boatlandings etc)
(viii) Interconnecting walkways, supports and bearings
(ix) Unloading arms
(x) Fuel receiving pipework to tank farm including fixtures and fittings such as valves, leak detection, corrosion protection
(xi) Fire fighting system, FS inlets for Fireboat and Appliances as agreed with FSD/MD
(xii) Air eliminators, if required
(xiii) Sampling systems
(xiv) Power, lighting and switch gear
(xv) Communication within the Facility and links to the Airport tank farm and elsewhere
(xvi) Systems for waste disposal
(xvii) Spill clean up equipment
(xviii) Utilities and other systems
(xix) Berths, anchorage or moorings and typhoon shelter arrangements for small vessels if necessary

(xx) Small vessel(s) for duties such as transport of personnel, standby, fire fighting, rescue, spill clean up, maintenance and repair of the facilities
(xxi) Emergency access/egress
(xxii) Protection against errant vessels

4. JETTY, PIPELINE AND TANK FARM FACILITIES

4.1 DESIGN OF THE JETTY

The Franchisee shall:

(m) provide suitable protection to the rear and ends of the jetty (in particular to protect vulnerable items such as the fuel pipelines) against impact by errant marine traffic, principally of those approaching or departing from the existing sea wall and Shui Wing Steelworks.

2. Amplifications of the Franchisee's Design for the Facility

Without prejudice and in addition to the requirements described in section 1 above, the Franchisee's design shall comply with the following items:

2.1 Jetty

2.1.1 The aviation fuel system at the Facility jetty shall be protected against errant vessels (using the channel between the jetty and the existing quay wall) by a system designed at least to the following specification: -

An errant 6000 dwt vessel travelling at a velocity, in a direction and causing impact at a position on the vessel to be determined by the Franchisee and reviewed without objection by the Authority's Representative.

1.05 SCOPE OF WORKS

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(a) Marine Receipt Facility jetty and access including foundations/piling, berthing and mooring dolphins, loading platforms, bollards, fenders, loading arms, pipework, and electrical and mechanical services

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(a) Marine Receipt Facility jetty including foundations/piling, berthing and mooring dolphins, loading platforms, bollards, fenders, loading arms, pipework, electrical and mechanical services and associated fire protection;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee's Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed. Also, in the detail design additional standards may be referenced for specific items.

3. MARINE STRUCTURES

3.1 GENERAL

3.1.1 Marine Structures consist of the two receiving jetties, associated berthing and mooring dolphins. The structure is approximately located 200m away from existing seawalls (offshore) and 150m between the protective dolphin structure at the northwest end of the PAFF and the boundary with Shiu Wing Steel measured in a direction normally parallel to the existing sea wall.

The structure shall consist of a reinforcement concrete frame and slab supported by both vertical and raking piles to transfer the vertical and lateral loads to pile founding level. Piles will be driven steel piles with partial concrete infill. The steel pile will be considered as sacrificial above 3 metres below the seabed.

The piles are Circular Hollow Sections (CHS) filled with reinforced concrete down to a minimum of 4m below the seabed or dredged level (whichever is the lowest). The reinforced concrete infill is provided to transfer the load from the structure to the unfilled part of the pile via bonding between the lower part of the reinforced infill and the embedded section of the steel piles. No corrosion protection is provided for the piles.

3.1.2 The northern berth will receive vessels in the range of 10,000 DWT to 50,000 DWT and the southern berth will receive vessels in the range of 10,000 DWT to 80,000 DWT. Each berth will have a central loading platform fitted with loading arms and remotely operated foam monitors on towers. The flow rates in the loading arm shall be limited to 5m/sec for normal operation. Weather protection kiosk will be provided on each berth. Services between the tank farm and jetty will include power, communications, and fire water and foam line.

The loading platforms and mooring dolphins will be connected by structural steel walkways which will also carry power cables, communications cables and fire service pipelines. Fuel lines between berths and between the jetty and tank farm will be subsea.

Sewerage holding tank is designed to collect the sewage waste from the toilet in the kiosk. Specialist contractor with vessel will be employed for the removal of sewage from the holding tank and dispose to an approved disposal site.

Fire services and power will be supplied and controlled from the tank farm.

Landings will be available at the rear of each loading platform for service and fire boats. The maximum size fire boat will be 650DWT and will require a berth of no less than 50 metres.

The outer most mooring dolphins will be protected from an errant 6,000 DWT vessel travelling at a velocity not exceeding 1 m/s by a sacrificial pile structure.

Berthing and Mooring Loads:

(a) Berthing reactions to be calculated in accordance with Clause 4.13 the Hong Kong Port Works Manual. Accident loading (100% berthing energy) to be considered on all berthing dolphins (i.e. The accidental berthing will be considered with a factor of safety of 2.0 on normal berthing).

(b) Berthing velocities shall be in accordance with BS 6349: Pt4 Cl 4.6 and Figure 1 [navigation condition – C up to 10°)] for all vessels.

(c) The design vessel shall be:

(i) tanker berths from 10,000 and up to 80,000 DWT

(ii) fireboat up to 650 DWT with a berthing face of 35 metres, with a minimum berth length of 50 metres. (Confirmed Meeting with FSD 9 June 2003)

(d) Consideration will be given to vessel shape and fender unit spacing in respect to assessment of number of fenders being loaded simultaneously.

(e) Fenders shall be selected to provide a maximum face pressure of 20 tonnes per metre^2 for normal berthing and of 40 tonnes per metre^2 for accidental berthing.

(f) Berthing angle to be assumed at 10° for the tanker berths and 10° for the fire berth.

(g) The mooring system shall be designed in accordance with BS 6349: Pt4 and OCIMF Mooring Guidelines. The average hourly wind speed shall be $15ms^{-1}$

(h) Maximum angle of bollard pull to be 30° above and 20° below the horizontal, acting in an 120° arc from the quay/jetty face. During the detailed design phase a review of these angles will be undertaken.

(i) Mooring loads, including those induced by current and wind forces, to be assumed to act simultaneously to give the most adverse effects.

(j) Quick release hooks will be used on the berths to allow emergency release of vessels.

(k) A doppler radar mooring system is required.

3.2 CODES AND TECHNICAL STANDARDS

The latest amendments of the References listed in Section 1.10 shall be used for the designs with the addition of

- EAU: Recommendations of the Committee for Waterfront Structures, Harbours and Waterways Loadings.

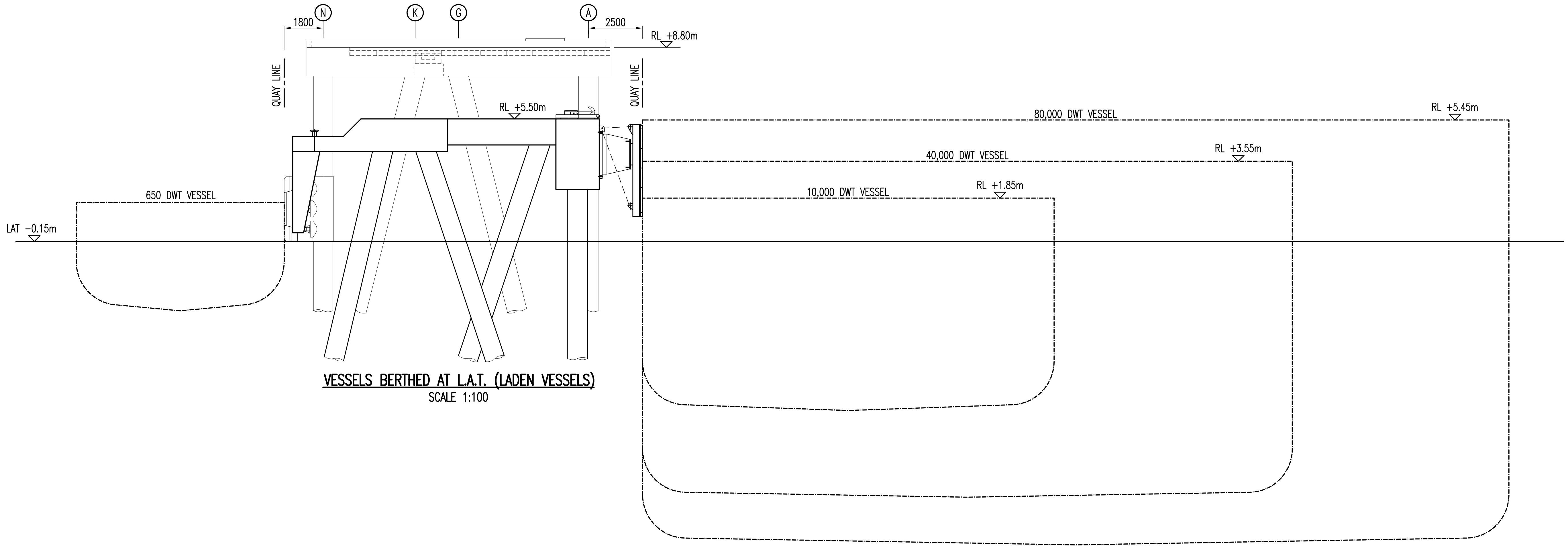
Contract Drawings

For the defensive fenders:

- **PAFF/MA/03/DWG/C/2009 Revision 3 General;: Typical Sections for Vessels at Berth**
- **PAFF/MA/03/DWG/C/2020 Revision 3 Loading Platforms: General Arrangement – LP1**
- **PAFF/MA/03/DWG/C/2021 Revision 3 Loading Platforms: General Arrangement – LP2**
- **PAFF/MA/03/DWG/C/2125 Revision 0 Walkways: General Arrangement**
- **PAFF/MA/03/DWG/C/2070 Revision 7 Berthing Dolphin: General Arrangement and Key Plan**

For the coupling points with slop collection utilities connecting to oil interceptors:

- **PAFF/LC/03/DWG/C/0258 Revision 3 Jetty Pipe Support**
- **PAFF/MA/03/DWG/C/2022 Revision 1 Loading Platforms: Precast Element Key Plan – LP1**
- **PAFF/MA/03/DWG/C/2023 Revision 0 Loading Platforms: Precast Element Key Plan – LP2**
- **PAFF/MA/03/DWG/C/2025 Revision 3 Loading Platforms: Deck Plan – LP1**
- **PAFF/MA/03/DWG/C/2026 Revision 3 Loading Platforms: Deck Plan – LP2**
- **PAFF/MA/03/DWG/C/2035 Revision 0 Loading Platforms: Precast Pilecap, Oil Interceptor & Water Supply Dimensions**
- **PAFF/BA/02/DWG/C/1460 Revision 3 Drainage System for Jetty OLP1 and OLP2**



VESSELS BERTHED AT L.A.T. (LADEN VESSELS)

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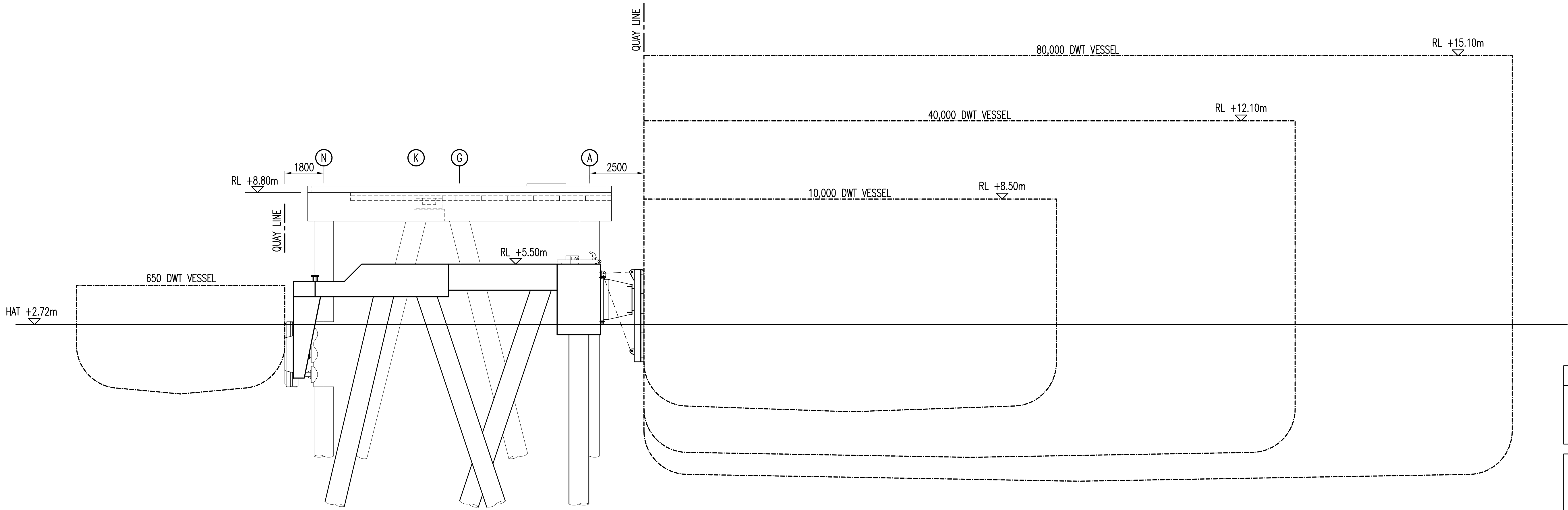

VESSELS BERTHED AT H.A.T. (BALLASTED VESSELS)

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FOR CONSTRUCTION

DOCUMENT CONTROL STATUS

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Notes:
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3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
0	28.02.06	ISSUED FOR CONSTRUCTION	LPM	A	04.08.04	ISSUED FOR APPROVAL	LPM
1	03.03.06	BERTHING DOLPHIN REVISED	LPM				
2	28.04.06	BOLLARDS/HOOKS REVISED	LPM				
3	25.05.06	CAPSTANS REMOVED	LPM				

Scale	Date	
AS SHOWN	20.07.04	
Designed: L.P.M.	Drawn: D.J.G.	Checked: L.M.
Design Team Leader	Date	
Approved	Date	

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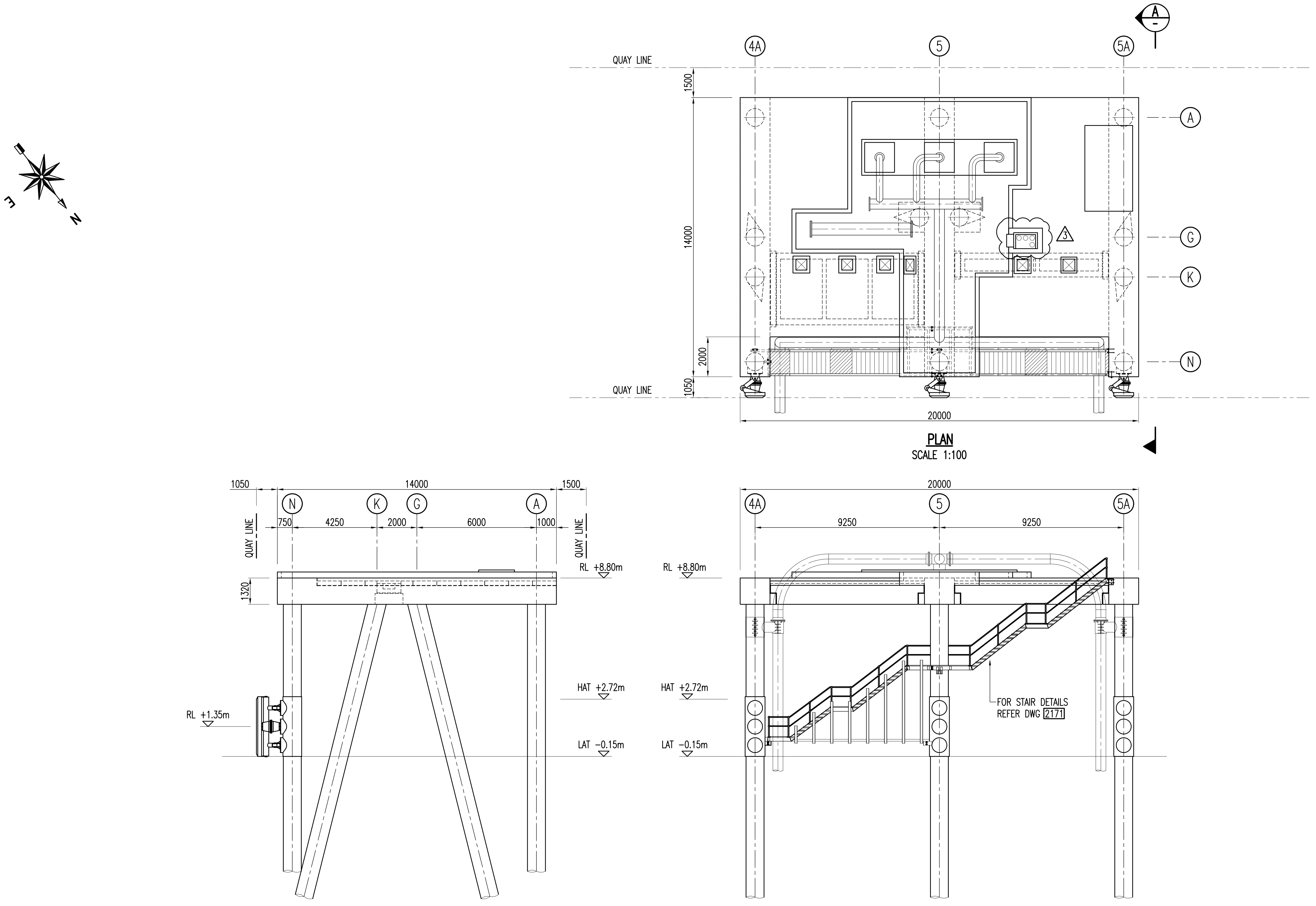
Permanent Aviation Fuel Facility

Title: GENERAL : TYPICAL SECTIONS FOR VESSELS AT BERTH

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/MA/03/DWG/C/2009	3



PLAN
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SECTION A
SCALE: 1:100

ELEVATION
SCALE 1:100

NOTES:

1. FOR PILE PLAN, REFER DWG 2010
2. FOR PRECAST ELEMENT KEY PLAN, REFER DWG 2022
3. FOR PRECAST PILE CAP, OIL INTERCEPTOR & WATER SUPPLY DETAILS, REFER DWG 2035

FOR CONSTRUCTION

DOCUMENT CONTROL STATUS

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0	28.02.06	ISSUED FOR CONSTRUCTION	LPM
1	03.03.06	ISSUED FOR CONSTRUCTION	LPM
2	23.06.06	BOLLARDS REMOVED	LPM
3	05.09.06	ISSUED FOR CONSTRUCTION	LPM

Rev.	Date	Description	Checked
A	10.04.03	PRELIMINARY DESIGN ISSUE	LPM
B	15.06.04	ISSUED FOR APPROVAL	LPM
C	21.06.04	LOADING PLATFORM REVISED	LPM
D	25.06.04	LOADING PLATFORM REVISED	LPM
E	27.10.04	LOADING PLATFORM REVISED	LPM

Scale	Date	
AS SHOWN	10.04.03	
Designed: L.P.M.	Drawn: D.J.G.	Checked: L.M.
Design Team Leader	Date	
Approved	Date	

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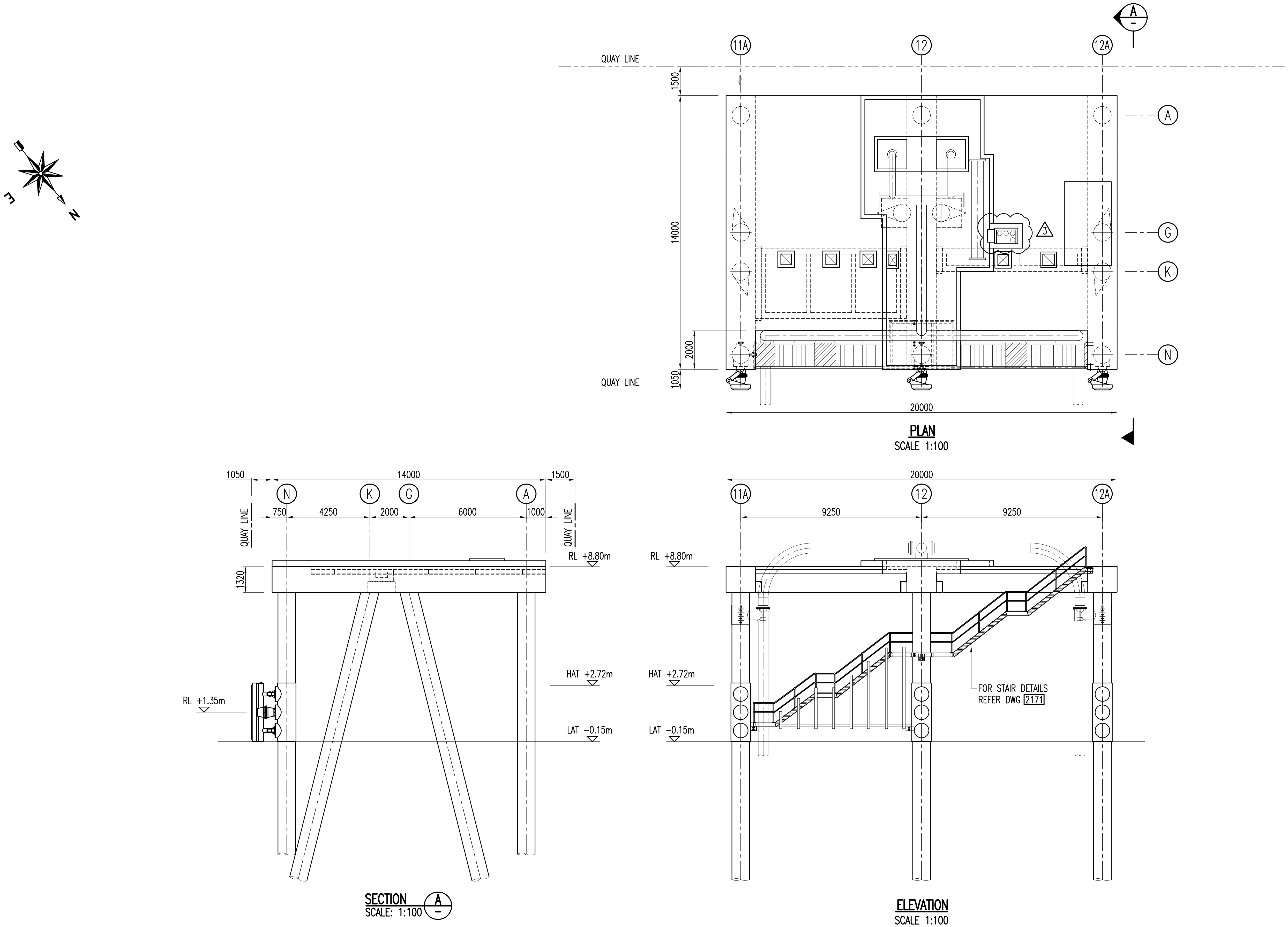
Permanent Aviation Fuel Facility

Title
LOADING PLATFORMS :
GENERAL ARRANGEMENT - LP1

Drawing No. (Project | Originator | Location | Category | Discipline | Number) PAFF/MA/03/DWG/C/2020

Revision 3



NOTES:

1. FOR PILE PLAN, REFER DWG $\boxed{2010}$
2. FOR PRECAST ELEMENT KEY PLAN, REFER DWG $\boxed{2023}$
3. FOR PRECAST PILE CAP, OIL INTERCEPTOR & WATER SUPPLY DETAILS, REFER DWG $\boxed{2035}$

FOR CONSTRUCTION

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1	03.03.06	ISSUED FOR CONSTRUCTION	LPM
2	23.06.06	BOLLARDS REMOVED	LPM
3	05.09.06	ISSUED FOR CONSTRUCTION	LPM

Rev.	Date	Description	Checked
A	10.04.03	PRELIMINARY DESIGN ISSUE	LPM
B	15.06.04	ISSUED FOR APPROVAL	LPM
C	21.06.04	LOADING PLATFORM REVISED	LPM
D	25.06.04	LOADING PLATFORM REVISED	LPM
E	27.10.04	LOADING PLATFORM REVISED	LPM

Scale	Date	
AS SHOWN	10.04.03	
Designed L.P.M.	**Drawn** D.J.G.	**Checked** L.M.
Design Team Leader		**Date**
Approved		**Date**

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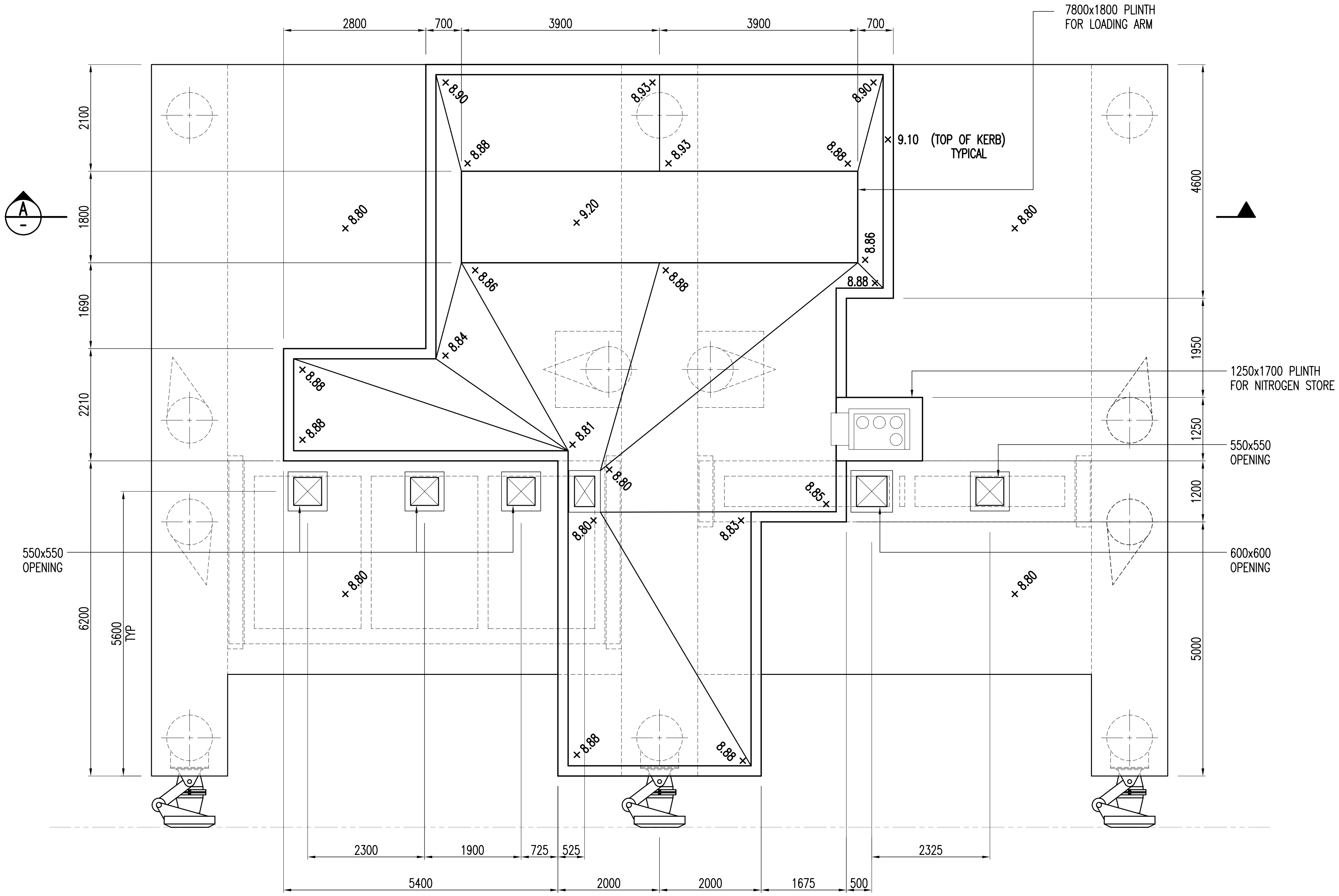
Permanent Aviation Fuel Facility

Title: LOADING PLATFORMS : GENERAL ARRANGEMENT – LP2

Drawing No. (Project / Originator / Location / Category / Discipline / Number)	Revision
PAFF/MA/03/DWG/C/2021	3



DECK PLAN – LP1

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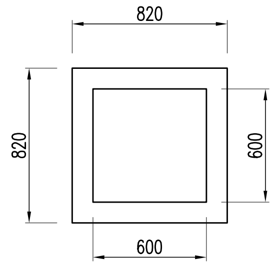

600x600 OPENING

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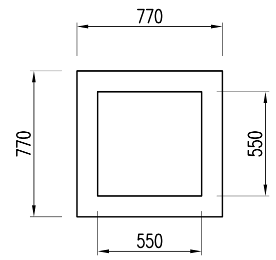

550x550 OPENING

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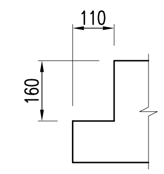

TYPICAL RECESS

SCALE 1:10

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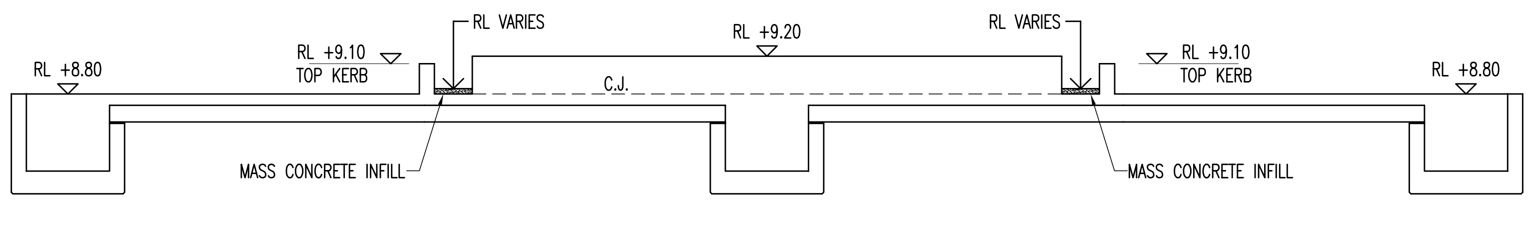

SECTION A –

SCALE: 1:50

FOR CONSTRUCTION

DOCUMENT CONTROL STATUS

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0	01.03.06	ISSUED FOR CONSTRUCTION	LPM
1	09.06.06	OPENINGS REVISED AS REQUESTED	LPM
2	05.09.06	ISSUED FOR CONSTRUCTION	LPM
3	06.09.06	ISSUED FOR CONSTRUCTION	LPM

Rev.	Date	Description	Checked
A	10.06.04	ISSUED FOR APPROVAL	LPM

Scale	Date
AS SHOWN	??.??.02
Designed L.P.M.	Drawn D.J.G. / Checked J.M.
Design Team Leader	Date
Approved	Date

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Permanent Aviation Fuel Facility

Title

LOADING PLATFORMS : DECK PLAN – LP1

	Project	Originator	Location	Category	Discipline	Number	Revision
Drawing No.	PAFF/MA/03/DWG/C/2025						3

NOTES:

1. FOR PILE PLAN, REFER DWG 2010
2. FOR PRECAST ELEMENTS, REFER DWG 2080 , 2081 & 2082
3. FOR LADDER DETAILS, REFER DWG 2100
4. FOR BOLLARD AND QUICK RELEASE HOOK DETAILS, REFER DWG 2165
5. FOR WALKWAY DETAILS, REFER DWG 2132
6. FOR FIRE MONITOR PLATFORM, REFER DWG 2173

FOR CONSTRUCTION

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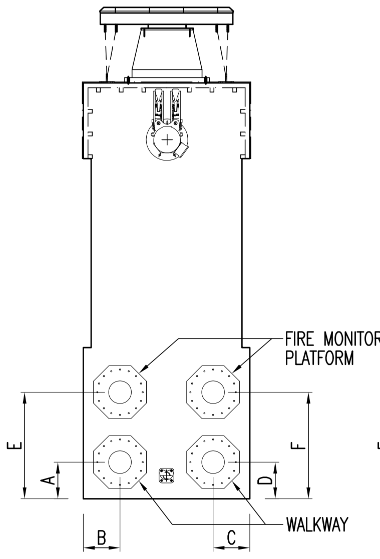
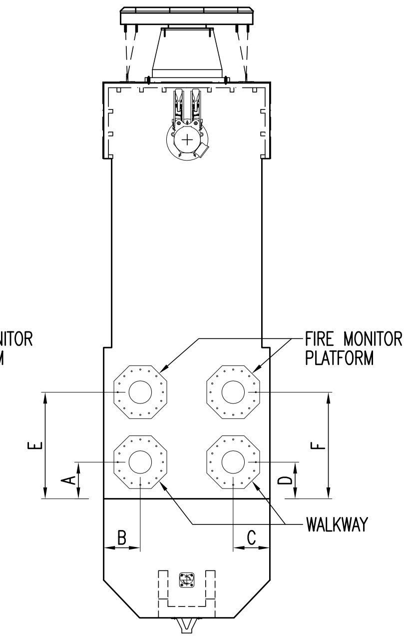
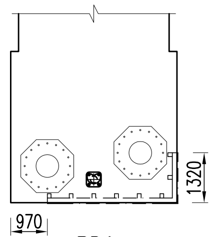
BERTHING DOLPHIN	FENDER TYPE	QUICK RELEASE HOOK TYPE	REAR BOLLARD TYPE	FIRE MONITOR PLATFORM	A	B	C	D	E	F
BD1	SCN1600 E2.2	DOUBLE 30T HOOK	15T KIDNEY HEAD	YES	970	970	970	1320	2820	–
BD2	SCN1400 E2.8	DOUBLE 30T HOOK	15T KIDNEY HEAD	–	1120	970	970	1120	–	–
BD3	SCN1400 E2.8	DOUBLE 30T HOOK	15T KIDNEY HEAD	–	1120	970	970	1120	–	–
BD4	SCN1600 E2.2	DOUBLE 30T HOOK	15T KIDNEY HEAD	YES	1320	970	970	970	–	2820
BD5	SCN1600 E2.4	DOUBLE 30T HOOK	15T KIDNEY HEAD	YES	970	970	970	1320	2820	–
BD6	SCN1600 E2.4	DOUBLE 30T HOOK	15T KIDNEY HEAD	YES	1320	970	970	970	–	2820



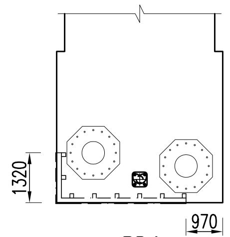
BASE PLATE LAYOUT
SCALE 1:100
(BD1 & BD4)



BASE PLATE LAYOUT
SCALE 1:100
(BD2, BD3, BD5 & BD6)

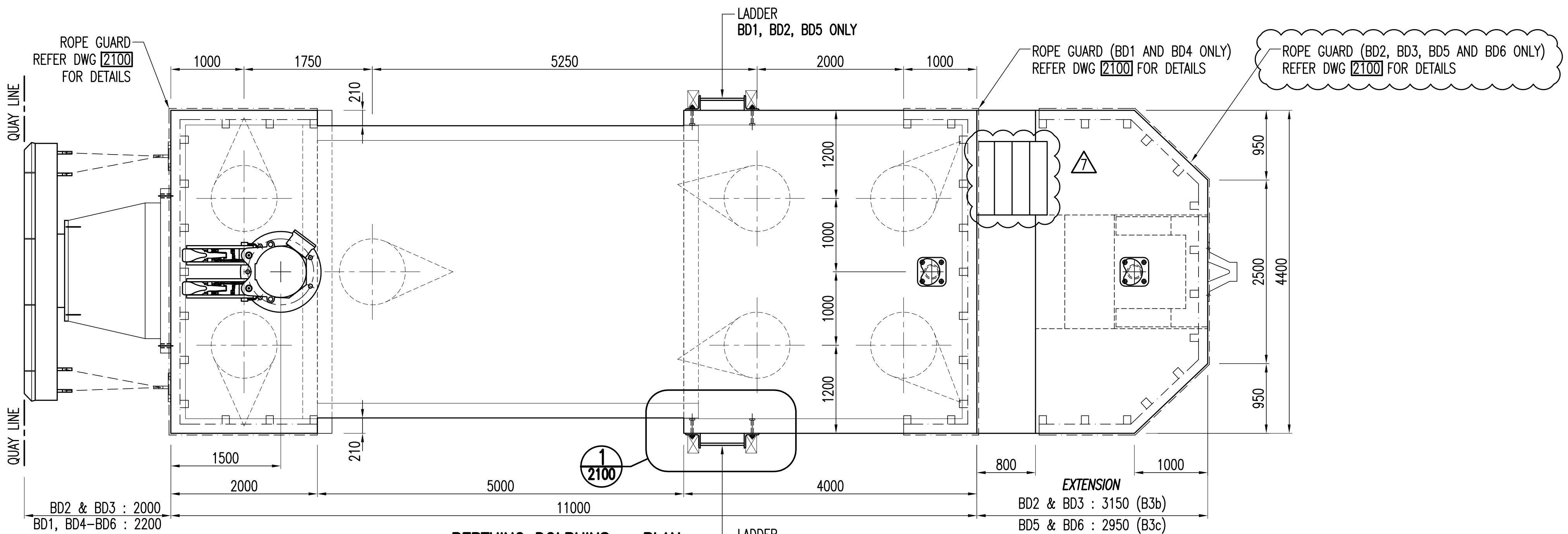


BD1
SCALE 1:100

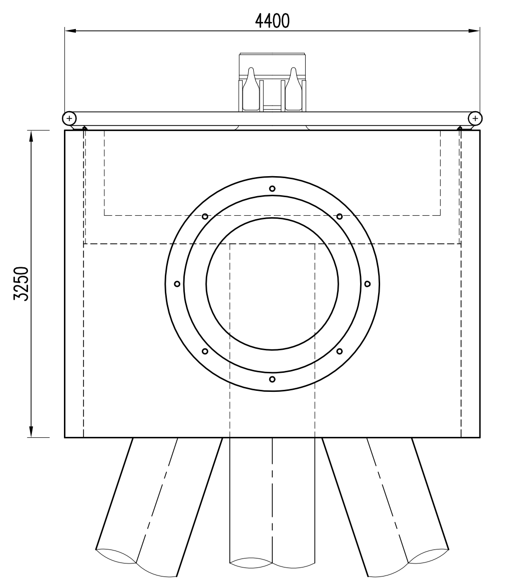


BD4
SCALE 1:100

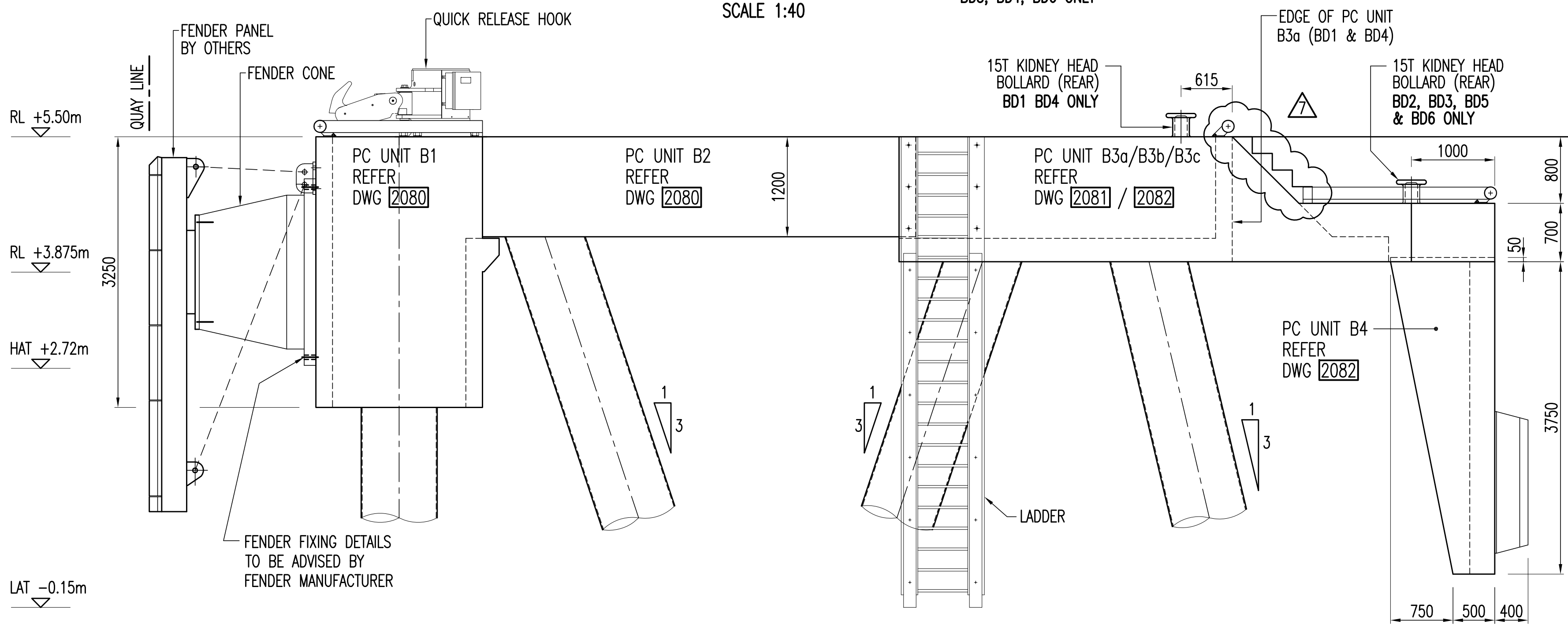
DETAIL 2
SCALE: 1:100



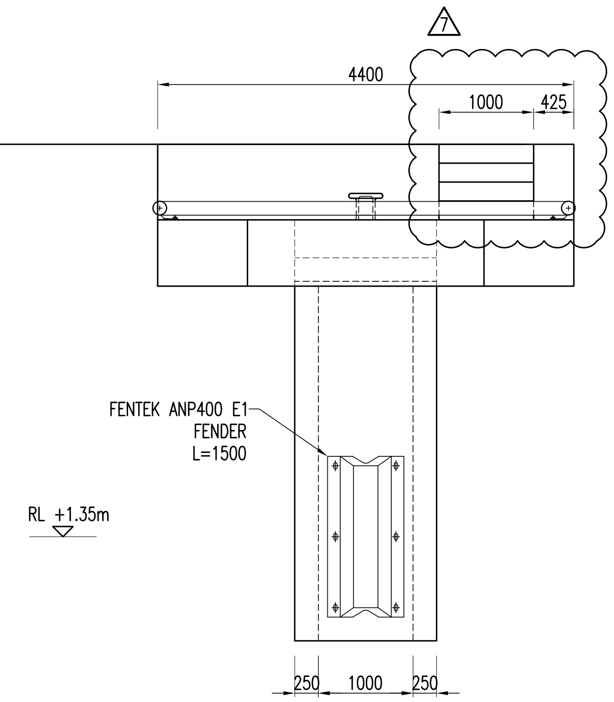
BERTHING DOLPHINS – PLAN
SCALE 1:40



BERTHING DOLPHIN – FRONT ELEVATION
SCALE 1:40
FENDER PANEL NOT SHOWN FOR CLARITY



BERTHING DOLPHIN – ELEVATION
SCALE 1:40



BERTHING DOLPHIN – REAR ELEVATION
SCALE 1:40

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Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
0	01.03.06	ISSUED FOR CONSTRUCTION	LPM	A	10.04.03	PRELIMINARY DESIGN ISSUE	LPM
1	28.04.06	BOLLARDS/HOOKS REVISED	LPM	B	13.02.04	ISSUED FOR APPROVAL	LPM
2	23.05.06	BOLLARDS/HOOKS REVISED	LPM	C	16.04.04	ISSUED FOR APPROVAL	LPM
3	25.05.06	CAPSTANS REMOVED	LPM	D	27.10.04	BERTHING DOLPHIN REVISED	LPM
4	15.06.06	NOTE REVISED	LPM				
5	23.06.06	PC UNIT B1 REVISED	LPM				
6	20.07.06	HOOKS REVISED	LPM				
7	05.12.07	STAIRS ADDED	LPM				

Scale: AS SHOWN | Date: 10.04.03
Designed: S.V. | Drawn: D.J.G. | Checked: L.P.M.
Design Team Leader | Date
Approved | Date

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Title: BERTHING DOLPHIN : GENERAL ARRANGEMENT & KEY PLAN

Drawing No. (Project / Originator / Location / Category / Discipline / Number)	Revision
PAFF/MA/03/DWG/C/2070	7

NOTES:

1. REFER TO DRAWING PAFF/LC/03/DWG/C/0018 FOR DETAILS OF PIPE SUPPORT.

Notes:
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Rev.	Date	Description	Checked
0	05.11.08	FOR CONSTRUCTION	
1	13.01.09	DIMESIONS REVISED	
2	23.01.09	CANTILEVER PIPE SUPPORT TYPE D5 ADDED	
3	10.02.09	PIPE SUPPORT TYPE D5 CHANGED	

Scale	1:75
Date	20 APR 2004
Designed	S.K.TSANG
Drawn	A.SO
Checked	S.K.TSANG
Design Team Leader	
Date	
Approved	B.GILLON
Date	20 APR 2004

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Permanent Aviation Fuel Facility

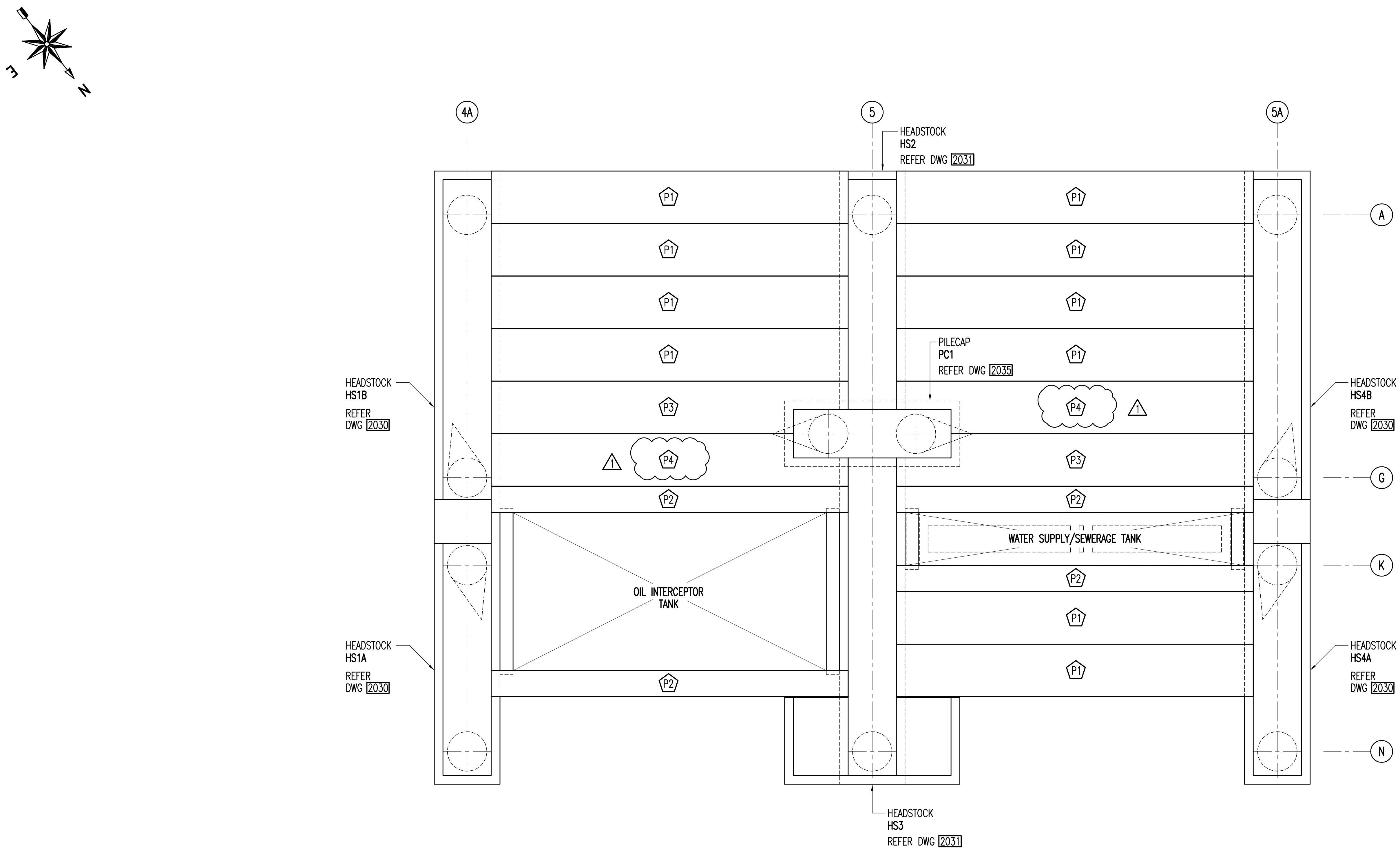
Title

JETTY PIPE SUPPORT

Drawing No. (Project / Originator / Location / Category / Discipline / Number) PAFF/LC/03/DWG/C/0258 — Revision 3

DATE : 2/10/2009
TIME : 2:34:22 PM

FILENAME : S:\Drawings\DGN\lc03dwgc0258_3.dgn



PRECAST ELEMENT KEY PLAN – LP1

SCALE 1:50

P1 – PRECAST PANEL TYPE

FOR CONSTRUCTION

DOCUMENT CONTROL STATUS

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NOTES:

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2. FOR PRECAST PILE CAP, OIL INTERCEPTOR & WATER SUPPLY DETAILS, REFER DWG 2035

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Rev.	Date	Description	Checked
A	10.04.03	PRELIMINARY DESIGN ISSUE	LPM
B	13.02.04	ISSUED FOR APPROVAL	LPM
C	18.03.04	LOADING PLATFORMS REVISED	LPM
D	19.07.04	NOTES REVISED	LPM
E	17.02.06	PLANKS AMENDED	LPM

Scale	Date	
AS SHOWN	10.04.03	
Designed	Drawn	Checked
S.V.	L.C.R.	L.P.M.
Design Team Leader	Date	
Approved	Date	

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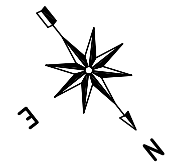
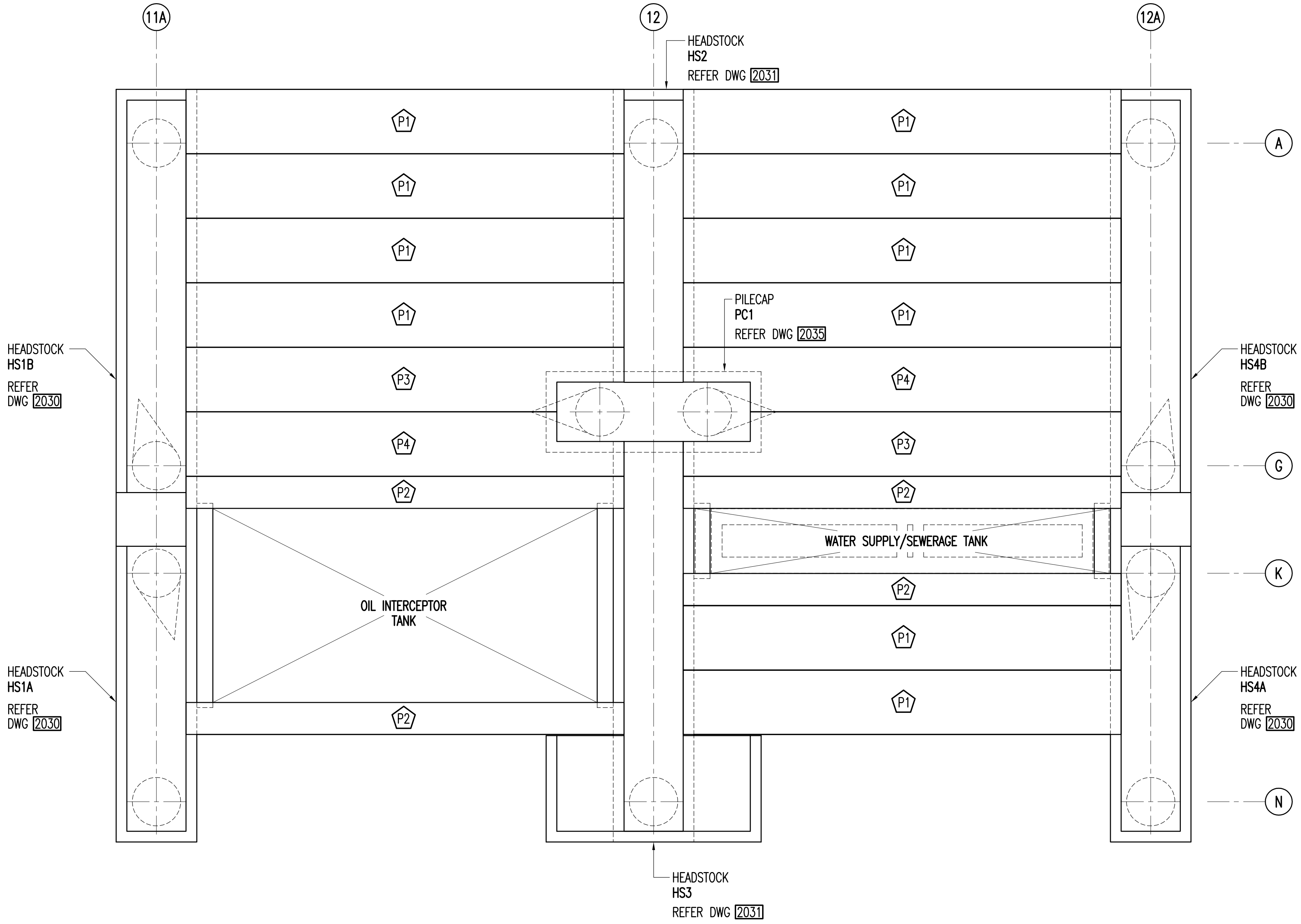
Permanent Aviation Fuel Facility

Title
LOADING PLATFORMS :
PRECAST ELEMENT KEY PLAN – LP1

	Project	Originator	Location	Category	Discipline	Number	Revision
Drawing No.	PAFF	MA	03	DWG	C	2022	1





PRECAST ELEMENT KEY PLAN – LP2

SCALE 1:50

P1 – PRECAST PANEL TYPE

FOR CONSTRUCTION

DOCUMENT CONTROL STATUS

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C	18.03.04	LOADING PLATFORMS REVISED	LPM
D	19.07.04	NOTES REVISED	LPM
E	17.02.06	PLANKS AMENDED	LPM

Scale	Date	
AS SHOWN	10.04.03	
Designed: S.V.	Drawn: L.C.R.	Checked: L.P.M.
Design Team Leader	Date	
Approved	Date	

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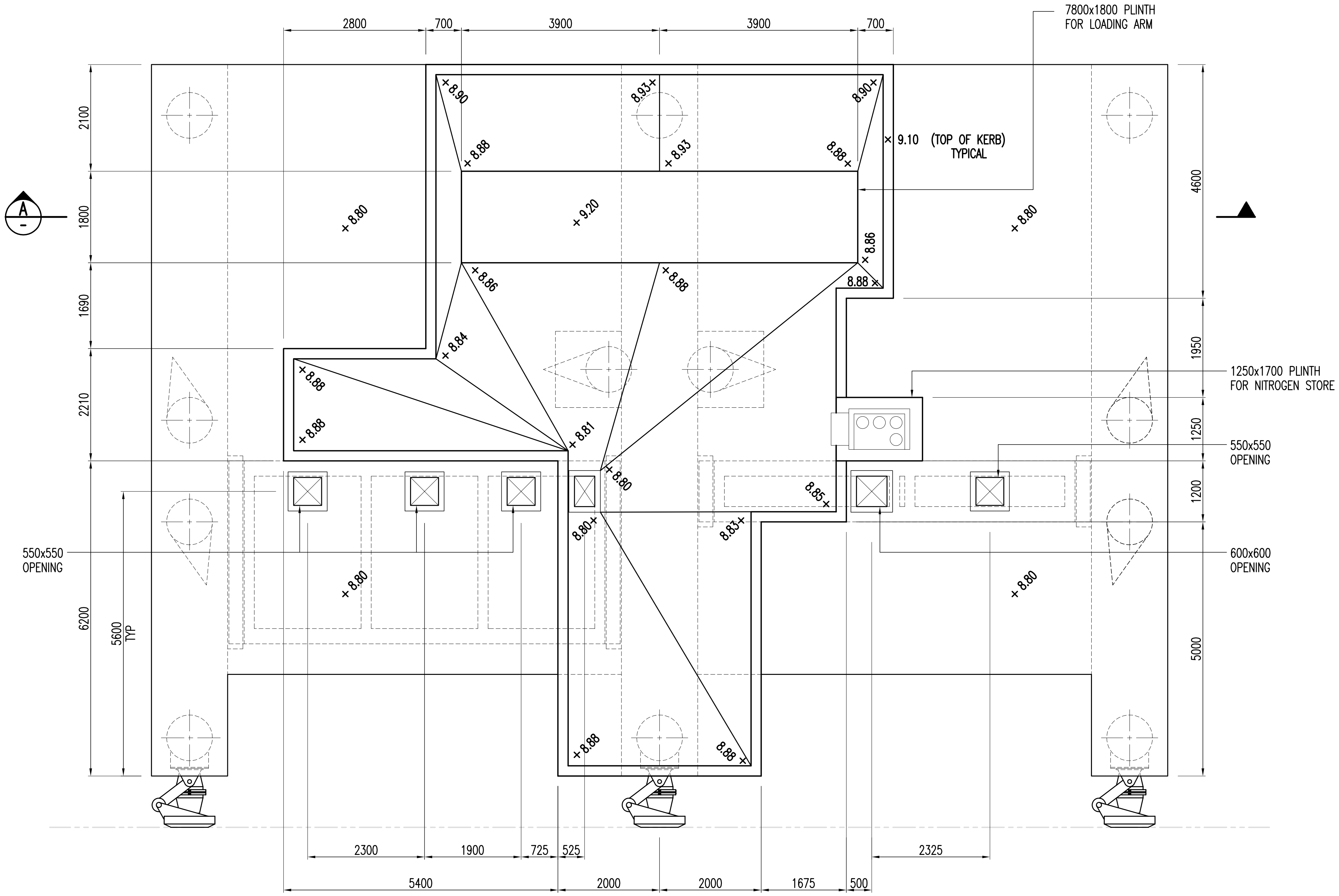
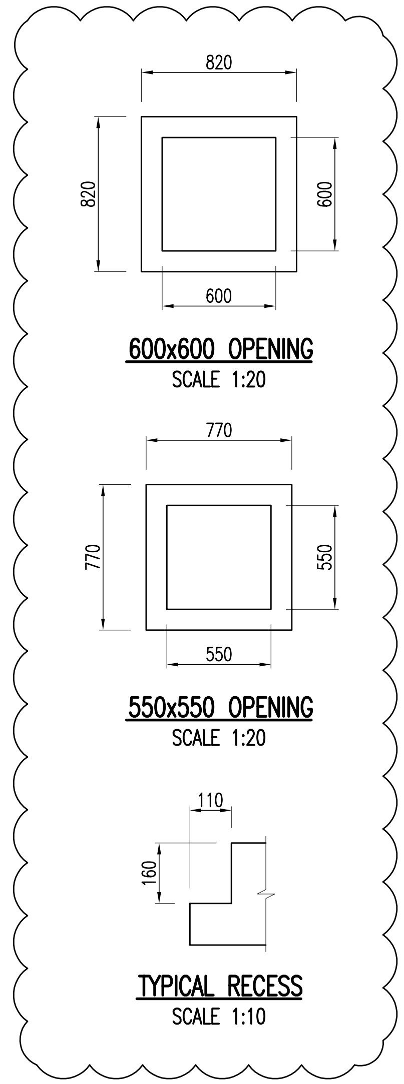
Permanent Aviation Fuel Facility

Title: LOADING PLATFORMS : PRECAST ELEMENT KEY PLAN – LP2

Drawing No. (Project / Originator / Location / Category / Discipline / Number)	Revision
PAFF/MA/03/DWG/C/2023	0



DECK PLAN – LP1
SCALE 1:50



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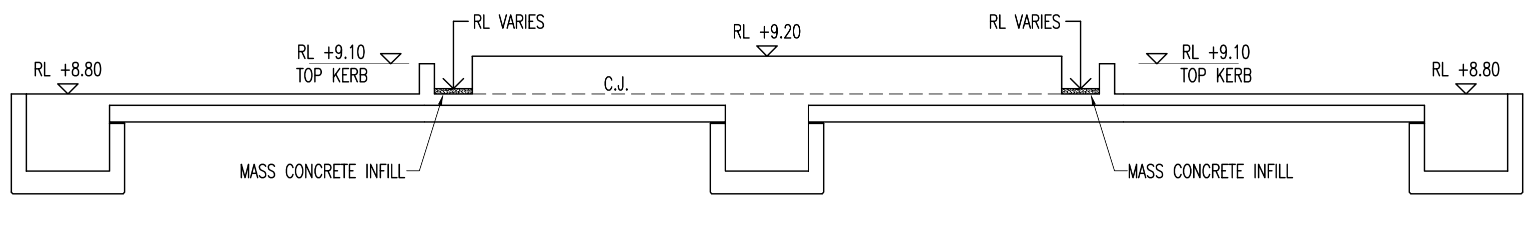

SECTION A
SCALE: 1:50

FOR CONSTRUCTION

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3	06.09.06	ISSUED FOR CONSTRUCTION	LPM

Rev.	Date	Description	Checked
A	10.06.04	ISSUED FOR APPROVAL	LPM

Scale	Date
AS SHOWN	??.??.02

Designed	Drawn	Checked
L.P.M.	D.J.G.	J.M.

Design Team Leader | Date

Approved | Date

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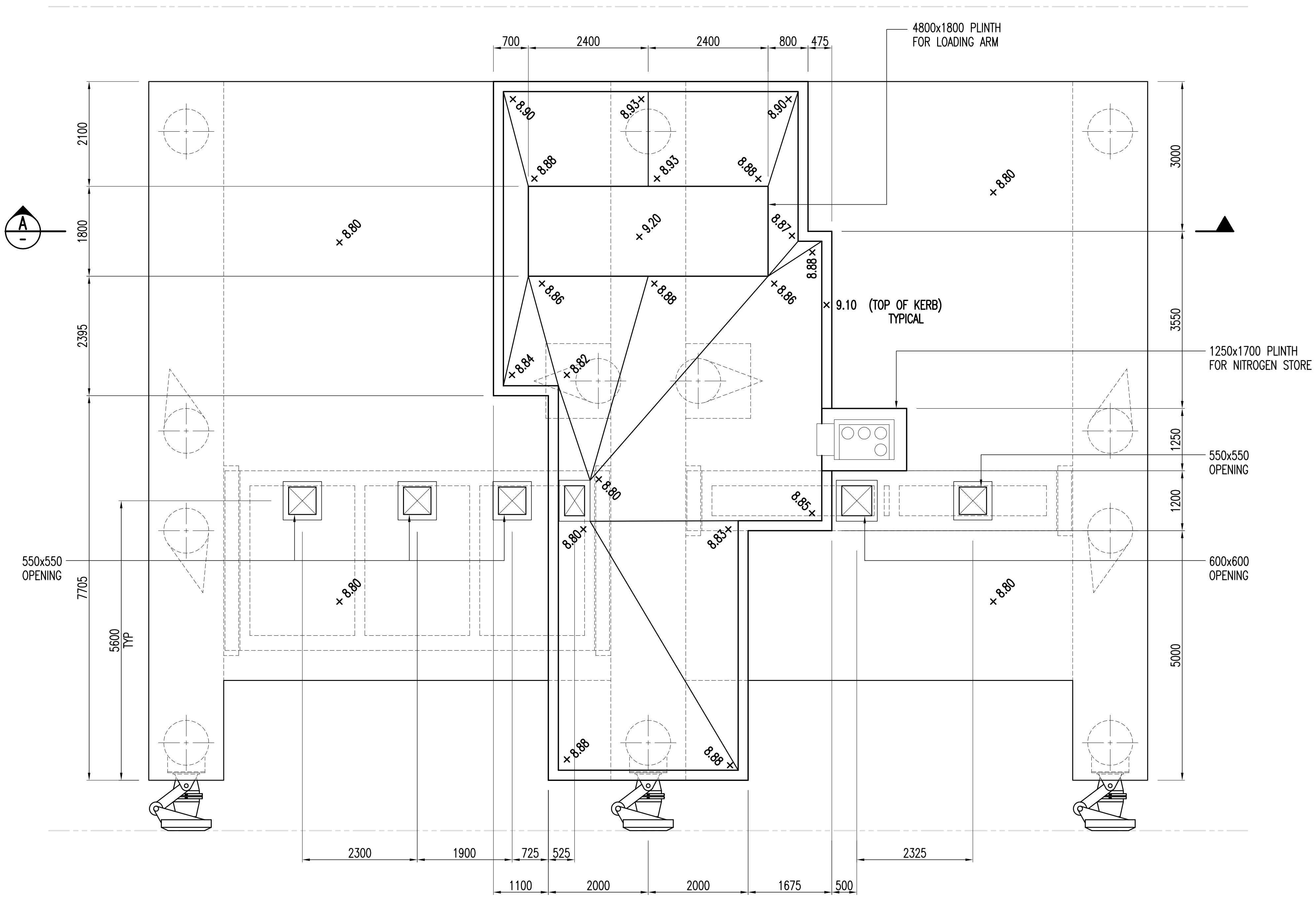
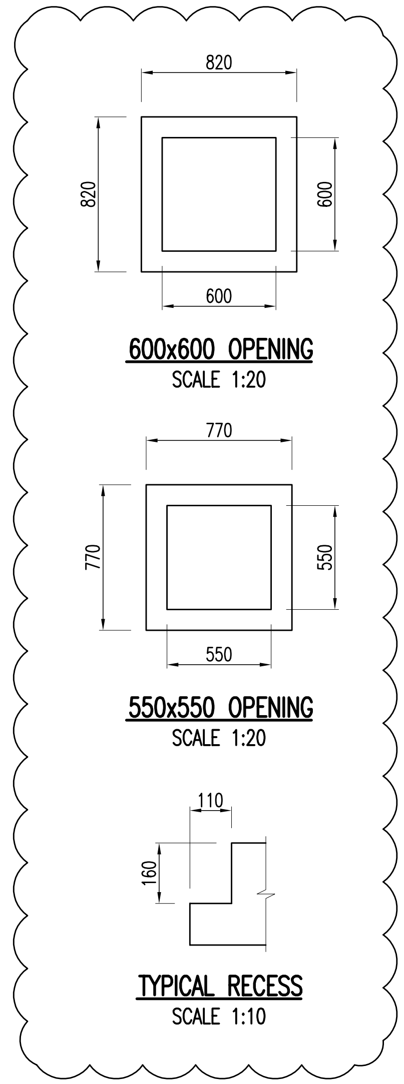
Permanent Aviation Fuel Facility

Title
LOADING PLATFORMS : DECK PLAN – LP1

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/MA/03/DWG/C/2025	3



DECK PLAN – LP2
SCALE 1:50

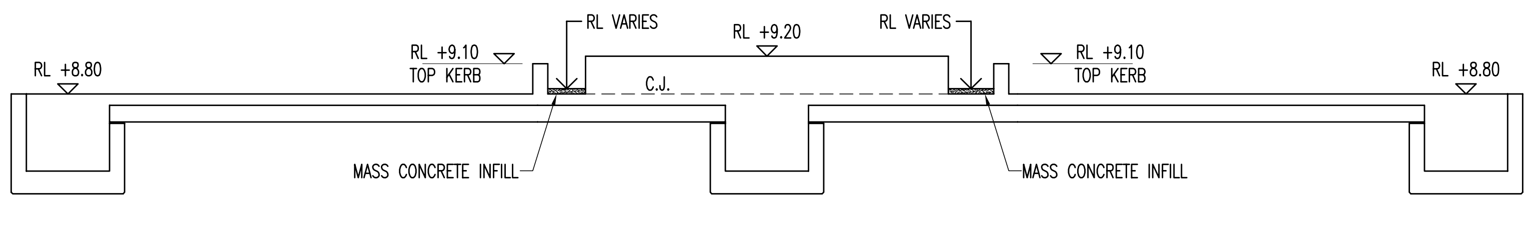


600x600 OPENING
SCALE 1:20

550x550 OPENING
SCALE 1:20

TYPICAL RECESS
SCALE 1:10

3



SECTION A
SCALE: 1:50

FOR CONSTRUCTION

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Rev.	Date	Description	Checked
A	10.06.04	ISSUED FOR APPROVAL	LPM

Scale	Date	
AS SHOWN	??.??.02	
Designed: L.P.M.	Drawn: D.J.G.	Checked: J.M.
Design Team Leader	Date	
Approved	Date	

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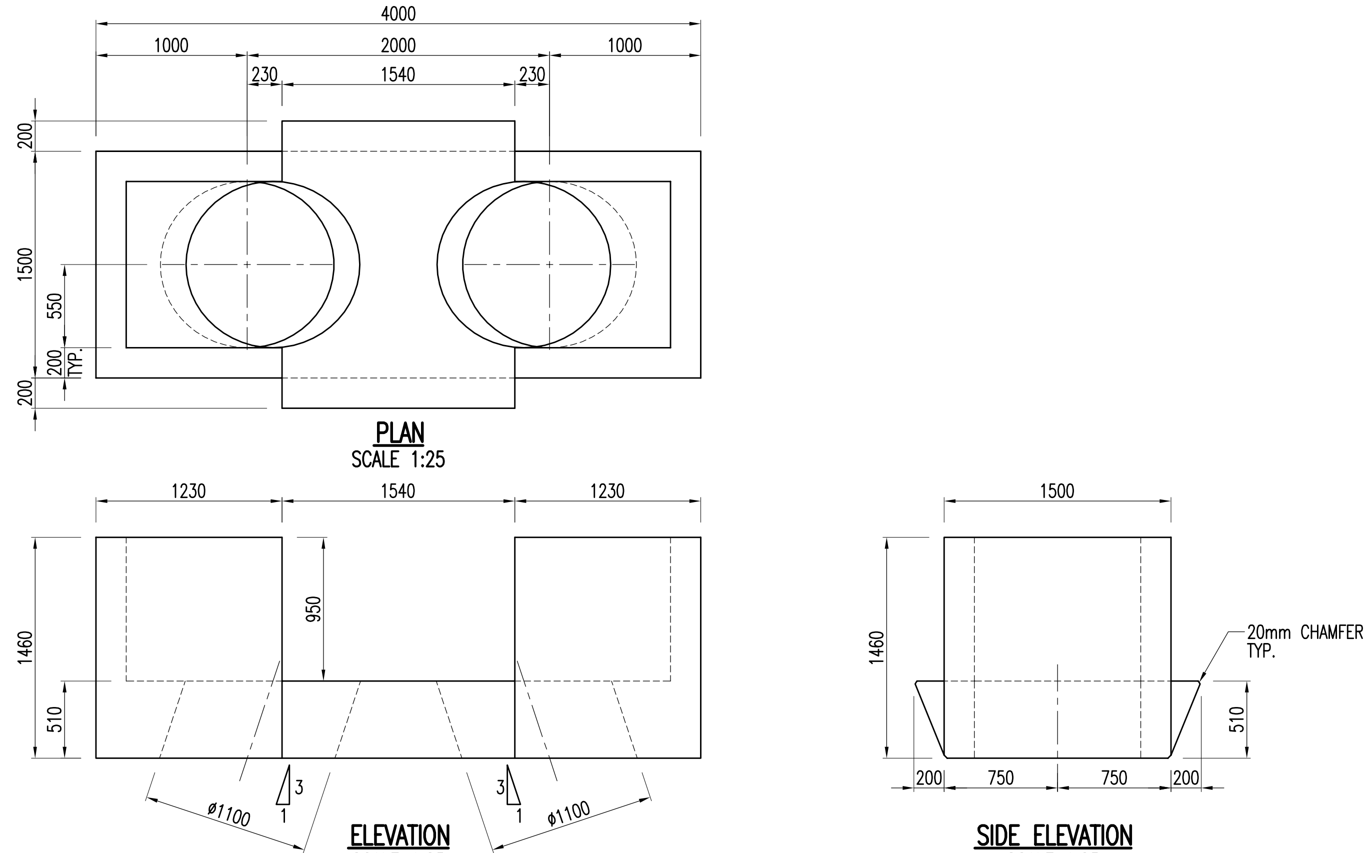
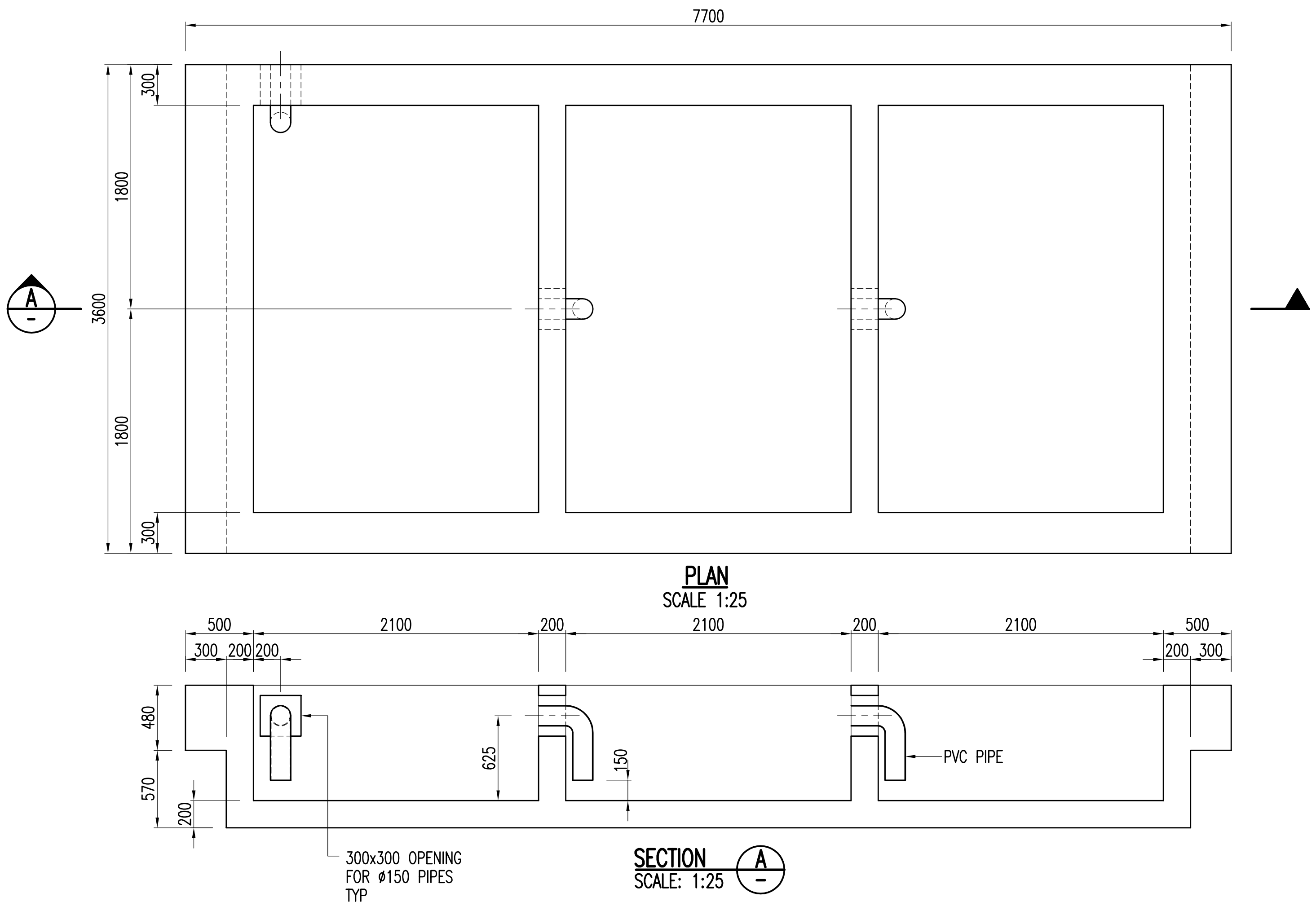
Permanent Aviation Fuel Facility

Title
LOADING PLATFORMS : DECK PLAN – LP2

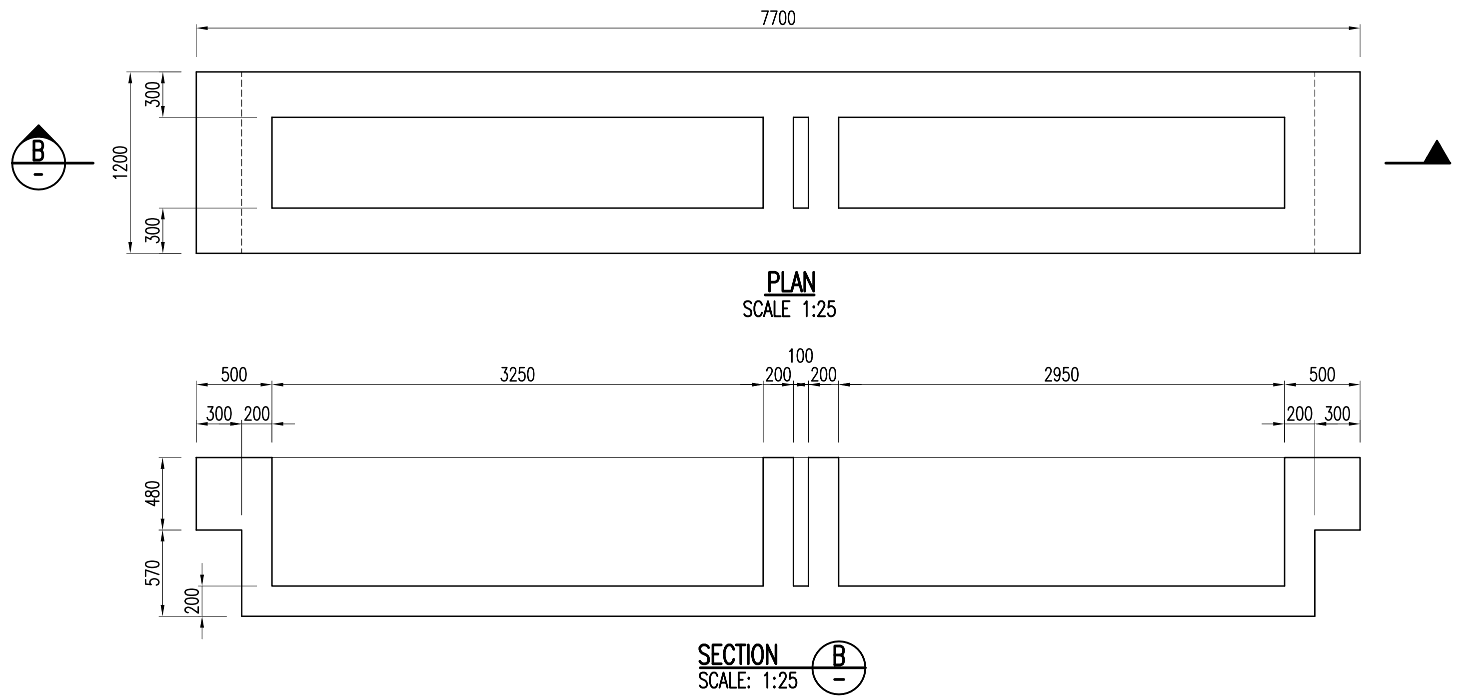
	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/MA/03/DWG/C/2026	3



TYPICAL PILE CAP DIMENSIONS



OIL INTERCEPTOR TANK DIMENSIONS



SEWAGE AND WATER SUPPLY TANK DIMENSIONS

NOTES:

1. FOR PRECAST ELEMENT KEY PLAN, REFER DWG 2022 & 2023
2. FOR REINFORCEMENT, REFER DWG 2050 , 2052 & 2053

FOR CONSTRUCTION

DOCUMENT CONTROL STATUS

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0	28.02.06	ISSUED FOR CONSTRUCTION	LPM

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A	10.04.03	PRELIMINARY DESIGN ISSUE	LPM
B	13.02.04	ISSUED FOR APPROVAL	LPM
C	18.03.04	LOADING PLATFORMS REVISED	LPM
D	17.02.06	DETAILS AMENDED	LPM

Scale	Date		
AS SHOWN	10.04.03		
Designed	Drawn	Checked	
S.V.	L.C.R.	L.P.M.	
Design Team Leader	Date		
Approved	Date		

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Permanent Aviation Fuel Facility

Title: LOADING PLATFORMS : PRECAST PILECAP, OIL INTERCEPTOR & WATER SUPPLY DIMENSIONS

	Project / Originator / Location / Category / Discipline / Number	Revision
Drawing No.	PAFF/MA/03/DWG/C/2035	0

NOTES:

1. THE GENERAL NOTES AND LEGENDS SHALL BE REFERRED TO DRAWING No. PAFF/CSA/01/DWG/B/3801 REV1 APPROVED UNDER BD REF. 4/0001/02 ON 09 SEP 04.
2. ALL DI PIPES AND FITTINGS SHALL COMPLY WITH BS 4772.
3. THE CORRESPONDING BUILDING PLAN WAS APPROVED ON 17 JUN 2004 UNDER BD REF. BD/2/0001/02.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked
1	JUN 2006	CONSTRUCTION DRAWING	
2	NOV 2006	CONSTRUCTION DRAWING	
3	MAY 2008	CONSTRUCTION DRAWING	

Scale	Date	
AS SHOWN	09 JUN 06	
Designed: PC	Drawn: JL	Checked: BW
Design Team Leader: BW	Date: 07 MAR 08	
Approved: LHS	Date: 07 MAR 08	

ECO

Contractor
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Permanent Aviation Fuel Facility

Title
DRAINAGE SYSTEM FOR JETTY OLP 1 AND OLP 2

Drawing No. PAFF/BA/02/DWG/C/1460 Revision 3

J:\DME\2511\BD SUBMISSION\060601_Jetty OLP1 And OLP2\2nd Amendment_0803xx\PAFF_A1.dwg

Design Report – Drainage Design

DESIGN REPORT
Drainage Design

PERMANENT AVIATION FUEL FACILITY

HONG KONG

B	Issued for Information	LM	20.01.06	LPM	20.01.06	LPM	20.01.06
A	Issued to Leighton for approval	LPM	31.10.02	LPM			
REV	DESCRIPTION	PREPARED	DATE	CHECKED	DATE	APPROVED	DATE

MADSEN GIERSING	Project: Permanent Aviation Fuel Facility, Hong Kong		Job No. 889
consulting engineers	Madsen Giersing Document No. PAFF/MA/03/DSG/C/0309	Date 05.09.05	Rev. B

TABLE OF CONTENTS

APPENDICES

A Drawing Nos: PAFF/MA/03/DWG/C/2025A, 2026A, 2035C

1. SCOPE

Part of the deck on the loading platform is bunded with a kerb to catch any accidental spillage of product. The deck inside the bunded area will have a fall towards a sump grate which is an opening to a petrol interceptor positioned under the deck.

2. PETROL INTERCEPTOR

The petrol interceptor is a precast box that is placed on brackets on the headstock beams. The roof of the petrol interceptor will be a cast insitu concrete slab, which is an integral part of the deck.

The precast unit is shown on Sketch No: PAFF/MA/03/DWG/C/2035.

3. DESIGN OF PETROL INTERCEPTOR

The petrol interceptor is designed in accordance with the Highway Department's rules for petrol interceptors for open public transport interchange.

The total catchment area:

OLP 1	90 m^2
OLP 2	67 m^2

The catchment area on each of the loading platforms is less than 1000 m^2.

Comparison with a standard Highways Department petrol interceptor for a catchment area less than 1000 m^2, refer to Drawing H3136, Sheet 3 of 11.

Two numbers of compartments are required:

Volume below pipe: $2 \times 1.35 \times (0.5 + 0.4) \times 2 = 4.86\ m^3$
Volume above pipe: $2 \times 1.35 \times 0.45 \times 2 = 2.43\ m^3$

The volume of the proposed petrol interceptor for each loading platform:

Volume below pipe: $3 \times 2.1 \times (0.15 + 0.4) \times 3 = 10.40\ m^3$
Volume above pipe: $3 \times 2.1 \times 0.3 \times 3 = 5.67\ m^3$

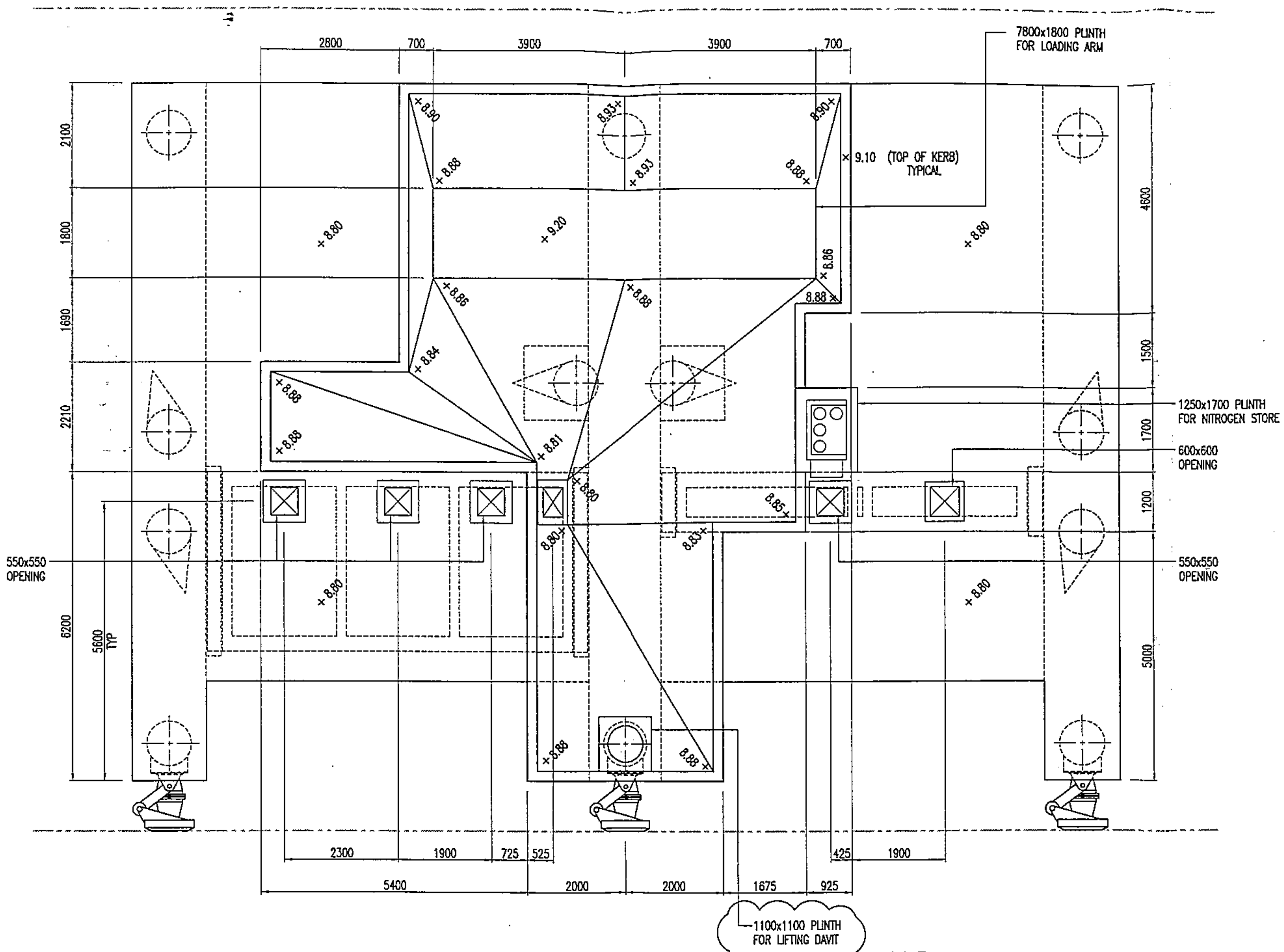
The volume of the interceptor provided is greater than the standard design and will therefore be more than adequate.

Appendix A

Drawing Nos: PAFF/MA/03/DWG/C/2025A, 2026A, 2035C

Appendix A

Drawing Nos: PAFF/MA/03/DWG/C/2025A, 2026A, 2035C



DECK PLAN – LP1
SCALE 1:50

FOR APPROVAL
DOCUMENT CONTROL STATUS

UNLESS STAMPED OTHERWISE IN RED THIS DRAWING IS UNCONTROLLED AND MUST BE VERIFIED AGAINST A CONTROLLED COPY OF THE DRAWING PRIOR TO USE TO ENSURE IT IS THE CURRENT ISSUE.

Rev.	Date	Description	Checked
A	10.06.04	ISSUED FOR APPROVAL	LPM

Scale	AS SHOWN	Date	??.??.02
Designed	L.P.M.	Drawn	D.J.G.
Checked	J.M.		
Design Team Leader		Date	
Approved		Date	

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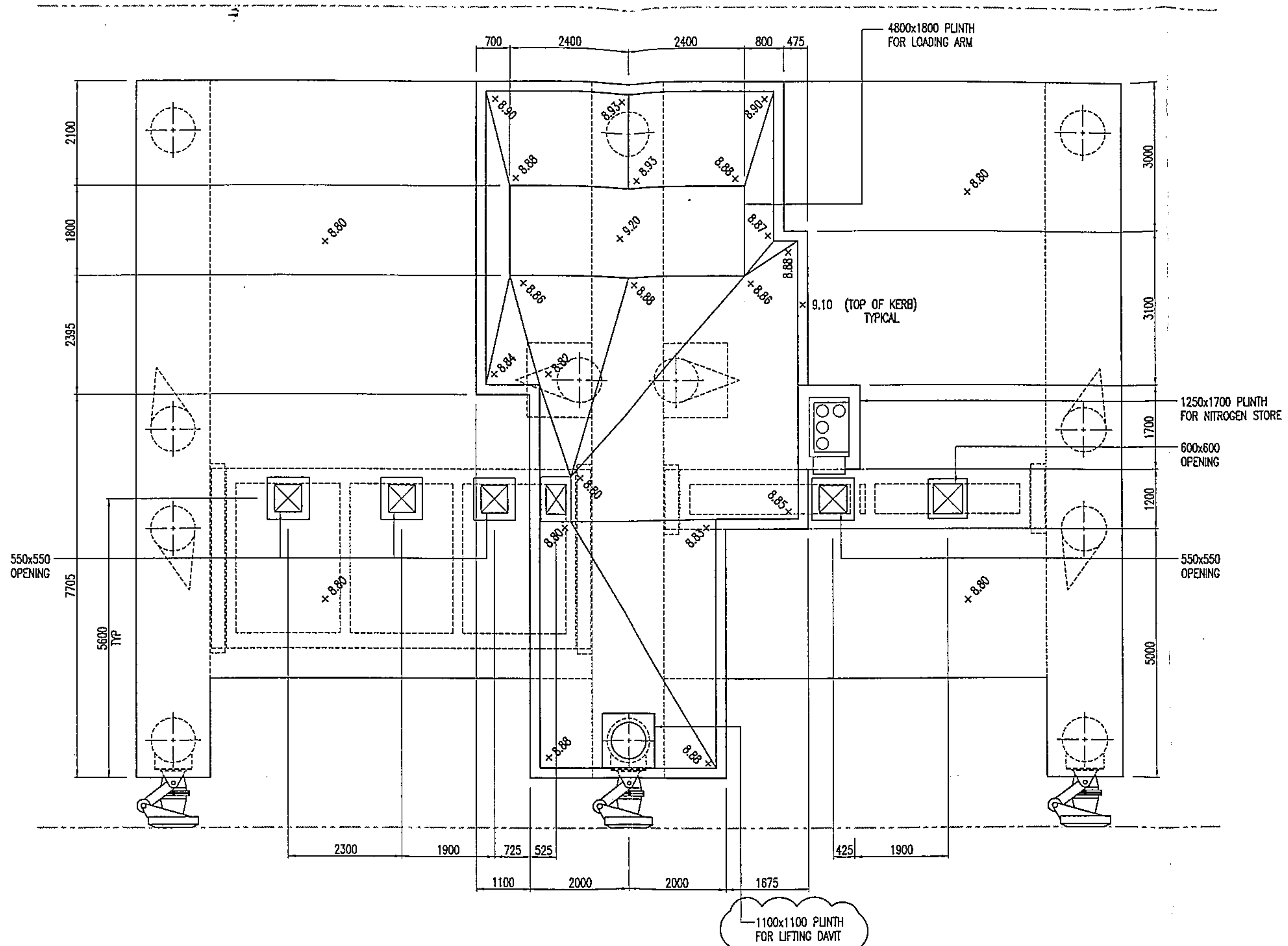
Permanent Aviation Fuel Facility

Title: LOADING PLATFORMS :
DECK PLAN – LP1

Drawing No. PAFF/MA/03/DWG/C/2025 Revision A



DECK PLAN – LP2
SCALE 1:50

FOR APPROVAL

DOCUMENT CONTROL STATUS

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Rev.	Date	Description	Checked
A	10.05.04	ISSUED FOR APPROVAL	LPM

Scale: AS SHOWN | Date: ??.??.02
Designed: L.P.M. | Drawn: D.J.G. | Checked: J.M.
Design Team Leader | Date
Approved | Date

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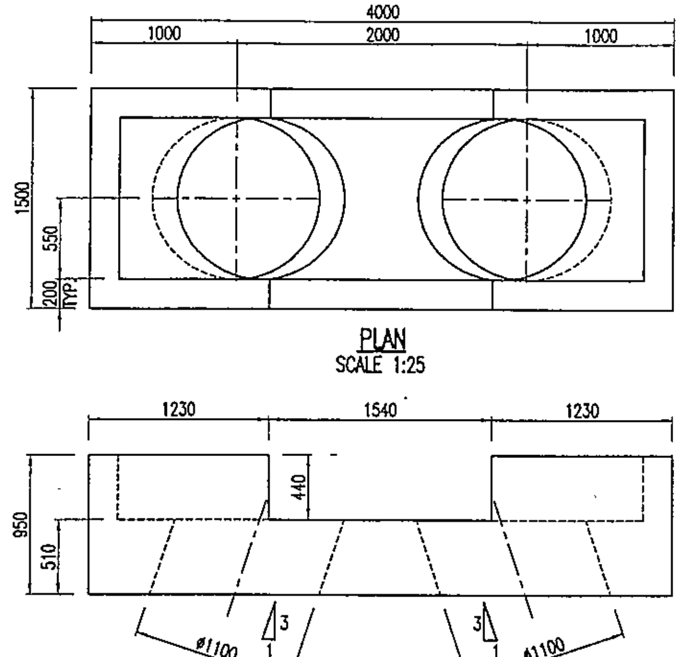
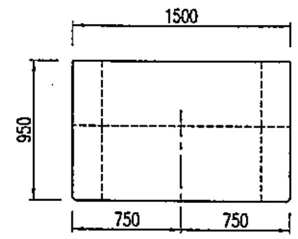
MADSEN GIERSING
consulting engineers

Permanent Aviation Fuel Facility

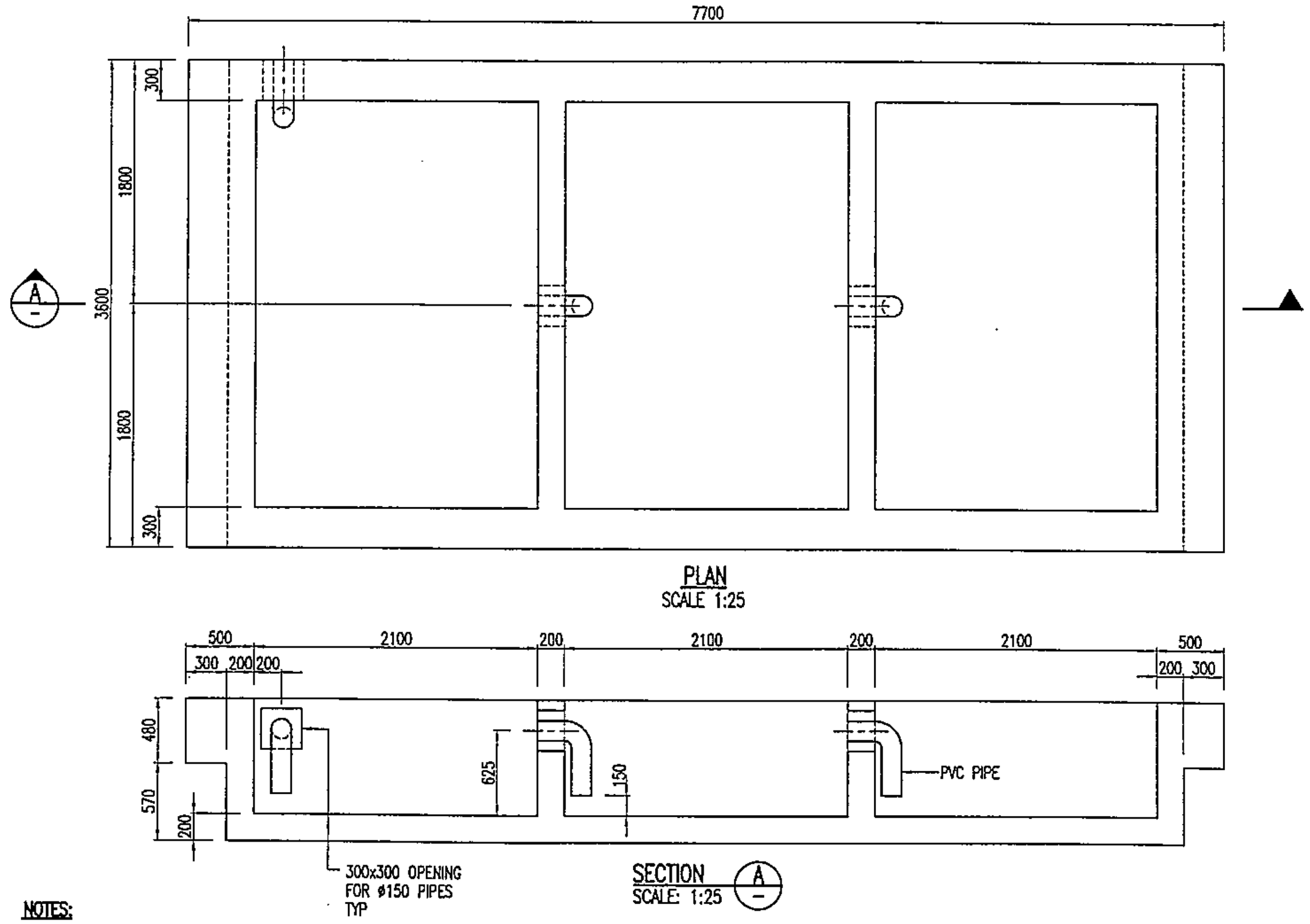
Title: LOADING PLATFORMS : DECK PLAN – LP2

Drawing No. PAFF/MA/03/DWG/C/2026 | Revision A

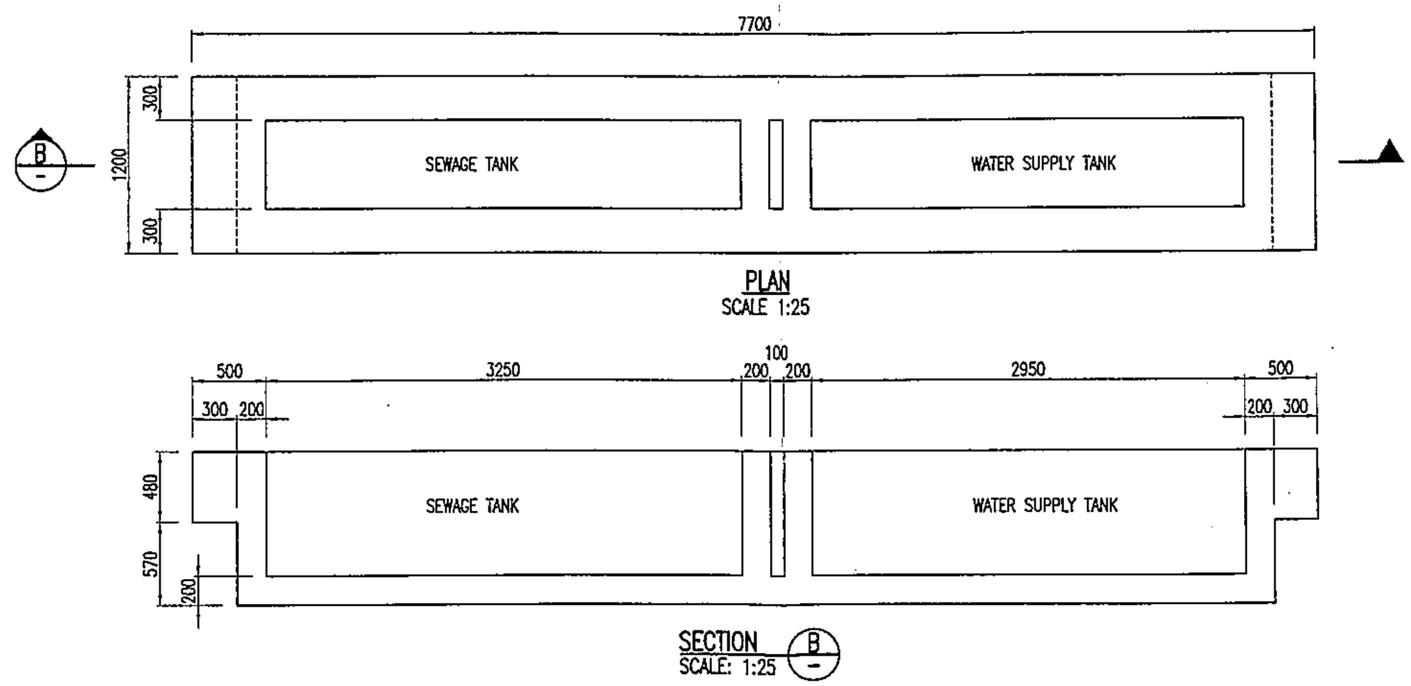




TYPICAL PILE CAP DIMENSIONS



OIL INTERCEPTOR TANK DIMENSIONS



SEWAGE AND WATER SUPPLY TANK DIMENSIONS

NOTES:

1. FOR PRECAST ELEMENT KEY PLAN, REFER DWG 2022 & 2023
2. FOR REINFORCEMENT, REFER DWG 2050 , 2052 & 2053

Rev.	Date	Description	Checked
A	10.04.03	PRELIMINARY DESIGN ISSUE	LPM
B	13.02.04	ISSUED FOR APPROVAL	LPM
C	30.03.04	LOADING PLATFORMS REVISED	LPM

Scale: AS SHOWN
Date: 10.04.03
Designed: S.V.
Drawn: L.C.R.
Checked: L.P.M.
Design Team Leader
Date
Approved
Date

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FOR APPROVAL
DOCUMENT CONTROL STATUS
UNLESS STAMPED OTHERWISE IN RED THIS DRAWING IS UNCONTROLLED AND MUST BE VERIFIED AGAINST A CONTROLLED COPY OF THE DRAWING PRIOR TO USE TO ENSURE IT IS THE CURRENT ISSUE.

Permanent Aviation Fuel Facility

Title: LOADING PLATFORMS : PRECAST PILECAP, OIL INTERCEPTOR & WATER SUPPLY DIMENSIONS

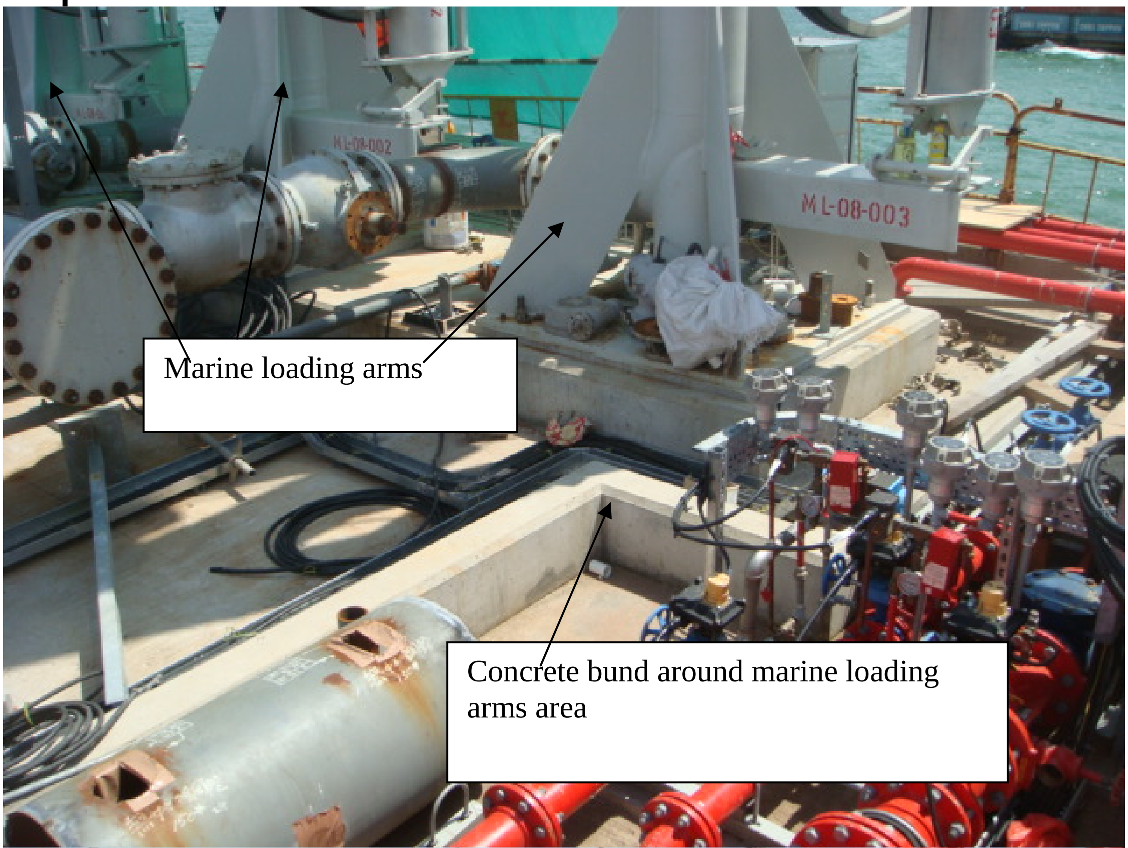
Drawing No. PAFF/MA/03/DWG/C/2035 Revision C

Fender Information

Photographs

Defensive Fenders

Slop Collection




Collection point for oil interceptor

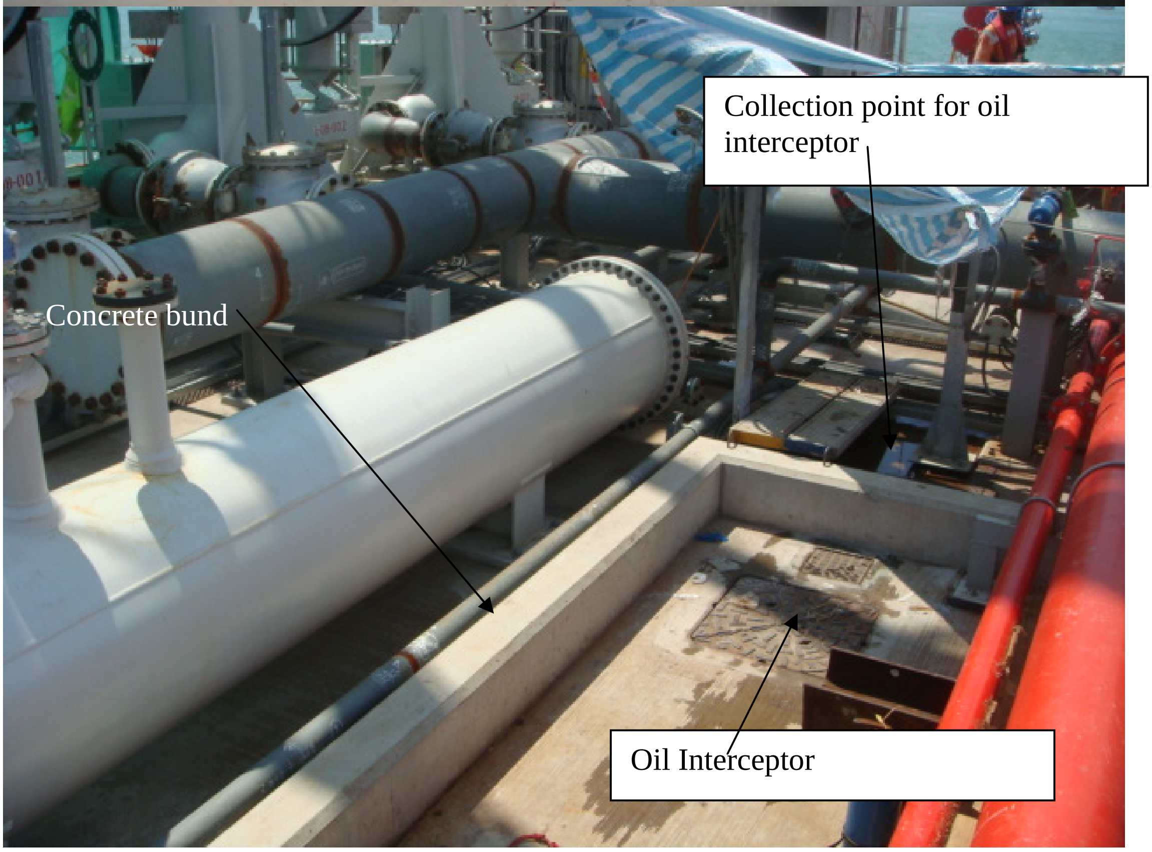

Collection point for oil interceptor
Concrete bund
Oil Interceptor

Table 1 EP Condition 3.5 (e) - Summary of the document

	Content	**Remarks**
1	EP Condition	Extract from the Environmental Permit No. EP-262/2007/B Condition 3.5 e)
2	EIA Requirements	Extract from the Environmental Impact Assessment Report; section 3 clause 3.1 and clause 3.4, section 6, clause 6.7.2.1, section 11 clause 11.3.1 and section 16 clause 16.2.7
3	Design Requirements	Extracts from the contract documents; Franchise Agreement - Schedule C items C1.2 and (i) and Franchisee Requirements Clause 1.05 item (c)
4	Design Requirements	Extracts from the Design Premise including standards and references; Section 1.4, section 1.10 and section 7
5	Contract drawings	**Submarine Pipeline** - PAFF/LC/04/DWG/C/0408 Revision 1 Subsea Pipeline Cross Section and Field Joint Details
6	Photographs	Photographs of the completed works
7	Technical information	Technical information: a) Dragged Anchor and Dropped Objects Protection Report b) Rock Armour and Rock Fill
8	Justification	Drawing PAFF/LC/04/DWG/C/408 shows the sub-sea pipelines in accordance with the arrangement as shown in Figure 5 of the Environmental Permit No. EP-262/2008/B. The sub-sea pipelines have been installed in a dredged trench and have been buried at least 3m below the seabed level and covered with preotective armour rock layer of at least 1.2m thick. The protective armour rock layer is not allowed to protrude above the seabed.

香港機場管理局 AIRPORT AUTHORITY HONG KONG

Permanent Aviation Fuel Facility for Hong Kong International Airport

Environmental Certification Sheet
EP-262/2007/B

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Environmental Design Audit - Compliance Report for EP Clause 3.5 (e)
Date of Report:	25 November 2009
Date prepared by ET:	25 November 2009
Date received by IEC:	25 November 2009

Reference EP Condition

Environmental Permit Condition: Condition No.: 3.5 (e)

Content: Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

(e) Sub-sea Pipelines Protective Measures
The sub-sea aviation fuel transfer pipelines shall be properly designed and constructed to prevent or minimize any damage or leakage risk. The sub-sea pipelines shall be protected in accordance with the arrangement as shown in Figure 5 of this Permit. The sub-sea pipelines shall be buried at least 3m below the seabed level and covered with protective armour rock layer of at least 1.2m thick. No protective armour rock layer shall be protruded above the seabed..

ET Certification

I hereby certify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

Craig A Reid, Environmental Team Leader: Date: 25 November 2009

IEC Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-262/2007/B

pp Dr Guiyi Li, Independent Environmental Checker: Date: 2 Dec 2009

Notes: EP-262/2007/B has replaced the former EP-262/2007/A, EP-262/2007 and EP-139-2002/A for the PAFF project after the resubmission of revised EM&A Manual and revised EIA Report respectively.

Environmental Permit Requirement

ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTIONS 10 AND 13

環境影響評估條例
(第 499 章)
第 **10** 及 **13** 條

ENVIRONMENTAL PERMIT TO CONSTRUCT AND OPERATE
A DESIGNATED PROJECT

建造及營辦指定工程項目的環境許可證

3. Submissions or Measures during the Construction of Certain Parts of the Project

Measures to Prevent Risk to Life, Fuel Spillage, Land Contamination and Water Quality Impact during Operation

3.5 The Permit Holder shall, at least one month before commencement of implementation of the measures to prevent risk to life, fuel spillage, land contamination and water quality impact during operation of the Project, deposit with the Director four hard copies and one electronic copy of the detailed design showing details of the measures to be used in the Project. Before submission to the Director, the detailed design shall be certified by the ET Leader and verified by the IEC as conforming to the information and recommendations contained in the approved EIA Report (Register No. AEIAR-107/2007). The measures shall include, but not be limited to, the following requirements :-

e) Sub-sea Pipelines Protective Measures

The sub-sea aviation fuel transfer pipelines shall be properly designed and constructed to prevent or minimize any damage or leakage risk. The sub-sea pipelines shall be protected in accordance with the arrangement as shown in Figure 5 of this Permit. The sub-sea pipelines shall be buried at least 3m below the seabed level and covered with protective armour rock layer of at least 1.2m thick. No protective armour rock layer shall be protruded above the seabed.

Environmental Impact Assessment Report Requirement

3 DESCRIPTION OF PROJECT AND ASSUMPTIONS

3.1 Background

3.1.1 It is proposed that the PAFF will be located at an undeveloped reclaimed shoreline site at Tuen Mun Area 38. It will consist of the following major elements:

- a jetty with two berths, which together will accommodate a full range of vessels from 10,000 to 80,000 dwt vessels;
- a tank farm with gross aviation fuel tankage capacity of 264,000m^3 on commissioning and an ultimate tankage of about 388,000m^3 as well as pumps and associated facilities;
- on site operational facilities including offices;
- 500mm diameter twin subsea pipelines to transfer the fuel to the aviation fuel system at the airport.

3.4 Pipeline

3.4.1 A short buried submarine twin pipeline will connect the reception jetty to the onshore tank farm, together with the utilities required for the jetty. The fuel from the jetty to the tank farm will be transferred at a rate of 3,500m^3 per hour. It is proposed that the fuel would then be delivered to the airport site by means of further buried twin subsea pipelines which would connect to the existing facility at Sha Chau. The total length of the pipelines would be about 4.8km including a 400m stretch within the Lung Kwu Chau and Sha Chau Marine Park in the approach to the existing AFRF pipeline.

3.4.2 The twin pipelines would each have an outside diameter of 500mm. The pipelines will be operated at a pressure of 30 barg (gauge pressure) and have a pumping rate of 30,000m^3 per day or 1,500m^3 per hour based upon 20 hours per day of pumping. It is assumed that these would be continuously welded, encased in concrete and lowered into a trench of 3m depth to protect against 6 to 22 tonne anchors. Future dredging activities are planned along the pipeline route for a coal berth for CLP in Urmston Road and, therefore, in this section of the alignment, the pipeline depth will be increased to about 6.5m below seabed. In both cases, the trench would then be backfilled with graded stones and rock armour to protect the pipelines. Schematic illustrations of the proposed pipelines and utilities from the jetty to shore and from the tank farm to the connection with the AFRF at Sha Chau are provided in cross sections (A) and (B) respectively in Figure 3.3.

3.4.3 The pipeline from the PAFF to the existing AFRF would be connected by being brought up one of the existing dolphin piles and flanged together with the existing pipeline using a new valve arrangement incorporated in-between.

3.4.4 The trench is assumed to be formed by a combination of trailer suction hopper dredger for the deeper areas in Urmston Road and by grab dredging for the remaining length. Graded rock would be subsequently placed either down pipe directly into the trench or lowered by grab. The proposed outline construction method for the placing of the rock armor is provided below:

- The submarine pipelines are protected from dragging anchors by layers of large crushed rock up to 700mm in size. The crushed rock will be quarry rock without clay or silt contamination minimising any release of additional sediment load to the surrounding waters;
- It is proposed to use a target barge, hopper barges, and derrick lighters for the backfilling work;
- Position of the target barge will be controlled by DGPS (Differential Global Positioning System). The barge will be held in position with 4 mooring lines;
- The first layer of material over the submarine pipelines will be Grade 200mm bedding layer. This layer of rock will be placed by hopper barge in shallow (less than 10 metres) water depth areas. A derrick lighter will be used for placing the protection layer at section where the water depth exceeds 10metres;
- When the target barge is set to correct position, the hopper barge or derrick lighter will be moored to the target barge and backfill of rock will commence;
- The protection berm will be checked by echo sounding to ensure sufficient rock cover is provided before placement of Grade 700mm rock fill layer in a similar manner;
- A derrick lighter will trim the rock to the required profile, to ensure no rock protrudes above the original seabed level;

- Intermediate surveys by echo and chain soundings will be conducted to verify the rock profile; and.
- On completion of rock dumping work, a hydrographic survey will be carried out to verify the profile of the rock armour complies with the design requirements. A copy of final survey will be transmitted to the Marine Department and the Lands Department for their records.

6. WATER QUALITY ASSESSMENT

Mitigation Measures

6.1.1 Operational Phase

6.1.1.1 The single most important mitigation measure in the operational phase is the placement of a rock armour protective layer positioned to cover the pipeline but not protrude above the sea bed. This will prevent possible mechanical damage, for example from trailing anchors or trawling nets. To provide additional security it is recommended that the pipeline shall be fitted with a leak detection system. The system shall be monitored on a 24 hour basis by the control centre at the Tuen Mun Area 38 site. In the unlikely event of any failure this warning system should trigger the emergency shutdown

11 FUEL SPILL RISK ASSESSMENT

11.3 Mitigation Measures

11.3.1 The mitigation measures identified here are also summarised in the Environmental Mitigation Implementation Schedule in Appendix B. All elements of the fuel handling, storage and transportation system will be designed to minimise the risk of failure and resultant leaks and spills to the lowest practicable level. Tanks in the tank farms will be constructed in a bunded area surrounding the tanks which will have an ultimate (2040) collection capacity of at least 150% of the volume of the largest tank in the bund to contain any fuel spills. Emergency shut down valves shall be installed within the wider site storm drainage system to provide for further emergency retention of spillages. Protection against leaks from the bottom of the tanks is achieved by the installation of an impermeable membrane in the tank foundation beneath the tank bottom. In respect of the pipeline, besides protection of the pipeline being covered with a protective rock armour layer, integrated methods of control will also be built into the design of the pipeline. A leak detection system will be installed to provide early detection of any leak and at the first sign of a pressure drop, would instigate an automatic shut-off system. Contingency plan procedures will require investigation and immediate action to stem the release, as described below.

16. SUMMARY OF ENVIRONMENTAL OUTCOMES

Design

16.2.7 One of the most important mitigation measures is the placement of a rock armour protective layer positioned to cover the pipeline but not protrude above the seabed. This will prevent possible mechanical damage, for example from trailing anchors or trawling nets. To provide additional security it is proposed that the pipeline shall be fitted with a leak detection system. This system shall be monitored on a 24-hour basis by the control centre at the Tuen Mun Area 38 site. In the unlikely event of any failure this warning system would trigger emergency shutdown.

Contract Requirements

SCHEDULE C

The Facility

The Facility includes the access channel, navigational aids, turning circle, jetty and berths and associated structures and facilities, office and other buildings, tank farm (Phase 1), piggable receiving pipelines to tie into the existing aviation fuel system and all fuel pipework and associated works.

C1.2 Tank Farm

The Tank Farm shall include all tanks, pipework, pumps, filters, power supply, controls and associated structures, systems, fixtures, fittings, buildings, bunds, roadwork, drainage, fencing and landscaping. The Tank Farm shall be designed to be easily expandable in all aspects to accommodate the construction of further aviation fuel storage tanks. It shall include but not be limited to the following items:

(i) Aviation fuel storage tanks of about 120,000 cu.m. working volume including all necessary buildings, fencing, fire fighting systems, pipework, roads, drainage and lighting
(ii) Pipework, filters, pumps including the transfer (or booster) pumps, controls, protection and associated fixtures fittings and buildings
(iii) Sampling and product recovery system
(iv) Manifolding to tank farm and existing aviation fuel system simultaneously
(v) Fire protection system
(vi) Power supply and independent standby power generator or second supply
(vii) Buildings including offices, canteen, control room, workshop, stores
(viii) Emergency response facilities
(ix) Storage tanks for fuel, water, chemicals and wastes
(x) Utility and other systems including back-up systems
(xi) Cathodic protection
(xii) Lightning protection
(xiii) Equipment, fuel, supplies and spares for maintenance, operation and repair of the facilities
(xiv) Electronic tank servo gauges
(xv) Hard standing, roads and parking
(xvi) Emergency shutdown system

1.05 **SCOPE OF WORKS**

(1) The **Works** to be executed under this **EPC Contract** shall include the design, construction completion, commissioning, and rectification of defects occurring during the maintenance period of the following major items:

(c) Under seabed twin piggable fuel pipelines from jetty to tank farm and from tank farm to the **Existing Aviation Fuel System** including cathodic protection, leak detection system and pig traps at the tank farm;

EPC – Franchisee's Requirements

Design Premise

PROJECT: PERMANENT AVIATION FUEL FACILITY

CLIENT: ECO AVIATION FUEL DEVELOPMENT LIMITED

DESIGN PREMISE

1.4 SCOPE OF WORKS

(1) The **Works** to be executed shall include the design, construction, and commissioning, of the following major items:

(c) Under seabed twin piggable fuel pipelines from jetty to tank farm and from tank farm to the **Existing Aviation Fuel System** with connection to the existing submarine pipeline including cathodic protection, leak detection system and pig traps at the tank farm;

1.10 DESIGN REFERENCES

The basic references for the designs shall be as given in the Franchisee’s Agreement and the EPC Contract.

In order to standardize the application of the standards and codes, the following broad guidelines will be adopted. These broad standards reference the appropriate back up standards for materials and specialist areas.

General	Hong Kong Building Codes of Practice including Fire Service Regulations, Port Works Manual, Oil Storage etc.
Civil and Building Works	Hong Kong Civil Engineering Specification as augmented by the EPC Particular Specification.
Process Works	American Petroleum Institute (API) American Society of Mechanical Engineers (ASME)
Hazardous Areas	Institute of Petroleum Guidelines (IP)
Electrical	British Standards (BS)
Berth Design	Oil Companies International Marine Forum (OCIMF)
Fire Services	National Fire Protection Association (NFPA) augmented with IP 19
Cathodic Protection	British Standards

The latest versions of the standards and regulations shall be used. In the event that there is not an appropriate standard then additional standards will be agreed. Also, in the detail design additional standards may be referenced for specific items.

7. SUBSEA PIPELINES

7.1 GENERAL

Subsea pipelines consists of the twin 500 diameter aviation fuel lines for Tuen Mun Area 38 to the existing facility at Sha Chau and the fuel and services lines that connect the proposed receival facility to Tuen Mun Area 38.

7.1.1 The subsea pipelines shall consist of

Line A – a single 500 DN line between the jetty berths
Line B – a single 500 DN line from each berth to the tank farm
Line C – twin 500 DN lines from the tank farm to Sha Chau
Line D – service lines from the tank farm to jetty

- electric power
- fire water
- foam concentrate
- communications

sizes to be confirmed in the detail design.

7.2 CODES AND TECHNICAL STANDARDS

a.	API 5L	Specification for Line Pipe
b.	ASME B31.4	Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols .Note : NDT (radiography where possible) of welds to be minimum 10% for above ground welds and 100% for buried and subsea
c.	API 1104	Welding / NDT / Fabrication

7.3 SPECIFIC CRITERIA

7.3.1 Anchor Protection, will be confirmed with the Marine Department during detail design, the current proposal is to provide

- 22 tonne anchor protection across Urmston Road to the extent of the likely future channel
- 12 tonne anchor protection in waters shallower than 10 metres
- 6 tonne anchor protection between the jetty and seawall where vessel access is restricted.

7.3.2 Burial Depth across Urmston Road is set at –26.5 m PD, the extent of the length of pipe line to be buried at this depth will be confirmed with the Marine Department

7.3.3 (Not used.)

7.3.4 Leak detection

The existing COWI leak detection system operating at the existing AFSC is to be upgraded to include the subsea pipelines of the PAFF (refer Design Package PAFF/XX/04/DSG/E/1702).

7.3.5 Cathodic Protection

The subsea pipelines will be protected by a cathodic protection system (ref. Design Package PAFF/XX/04/DSG/E/2301).

7.3.6 Sha Chau Tie In

The tie in at Sha Chau shall be programmed to allow one line from Sha Chau to the Airport to be operational at all times. The structural connection details at Sha Chau shall be approved by the Buildings Department.

7.4 MATERIALS

7.4.1 Pipe material shall be API 5L SAW pipe suitable for the operating pressure, the minimum requirements are

Line A and B

- DN 500 API 5Lx42 or Grade B SAW Pipe
- ASME B16.5 Class 150 Flanges
- Test pressure 28.5 bar or 150% of maximum operating pressure
- Lines to be piggable by an intelligent pig
- Pipe bends to be a minimum of 5D radius

Line C

- DN 500 API 5Lx42 or Grade B SAW Pipe
- ASME B16.5 Class 300 Flanges
- Test pressure 62.5 bar
- Line to be piggable by an intelligent pig
- Pipe bends to be a minimum 5D radius

Line D (fire water and foam concentrate line)

- HDPE pipe material in subsea sections
- Ductile iron, black carbon steel and stainless steel 312 in exposed sections.

7.5 DESIGN AND ANALYSIS METHODS

7.5.1 Pipeflow Analysis: Applied Flow Technology Mercury 5.0, Intelligent sizing for incompressible flow piping and ducting.

7.5.2 Surge Analysis: Applied Flow Technology Impulse 2.0 Waterhammer modeling in piping systems.

7.5.3 Armouring protection of the pipe line will be reviewed and the option of carrying out model studies reviewed

7.5.4 Design Reports will consist of

PAFF/LC/04/DSG/C/0701 - Subsea Lines Flow and Surge Analysis

PAFF/LC/04/DSG/C/0702	-	Subsea Line Coating
PAFF/LC/04/DSG/C/0703	-	Subsea Line Protection
PAFF/LC/04/DSG/C/0704	-	Subsea Line Alignment and Depth

7.6 INPUT DATA AND MAIN INTERFACES

7.6.1 The main interface is with the existing structure at Sha Chau and the operating conditions of the existing pipeline, head losses along the existing pipeline and through the existing facility will be confirmed with the current operator.

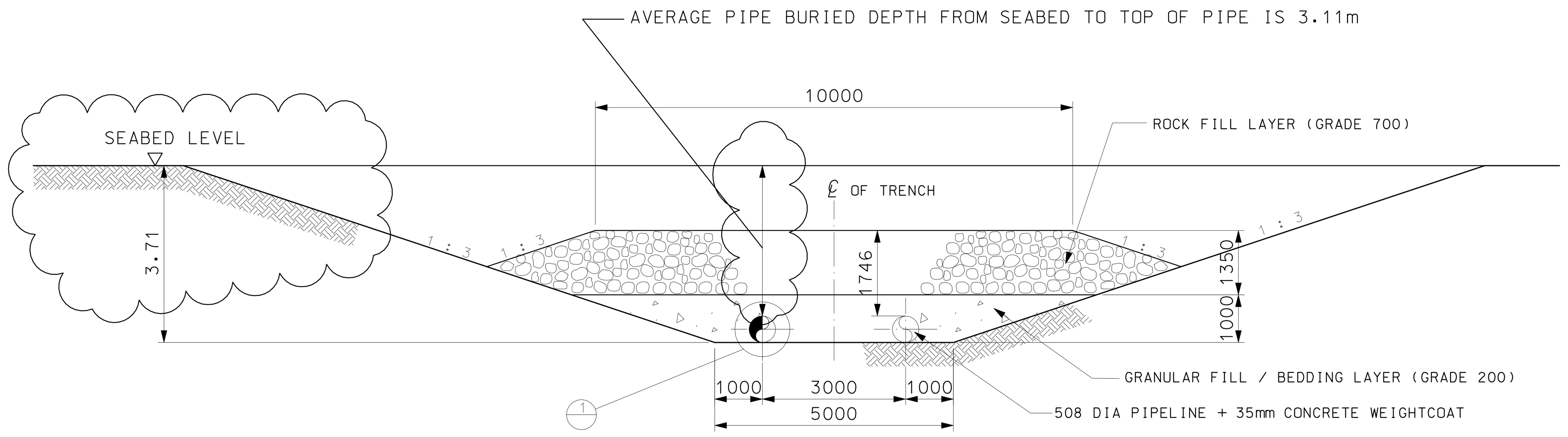
7.6.2 Authority's Design Requirements (refer to Appendices)

7.6.3 Franchisee's Design Proposal

Contract Drawings

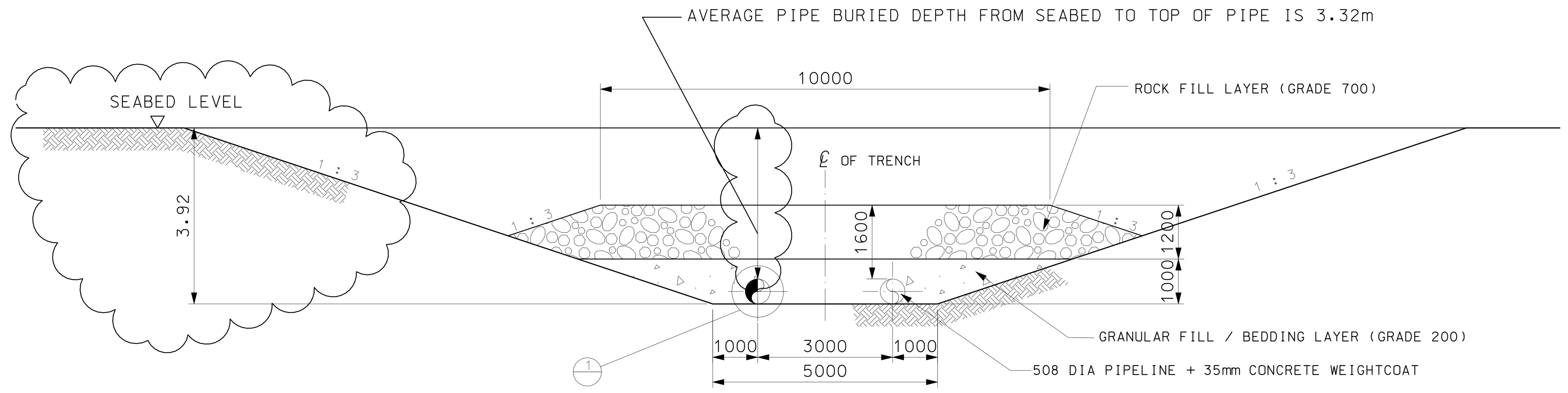
Submarine Pipeline

- **PAFF/LC/02/DWG/C/0408 Revision 1 Subsea Pipeline Cross Section and Field Joint Details**



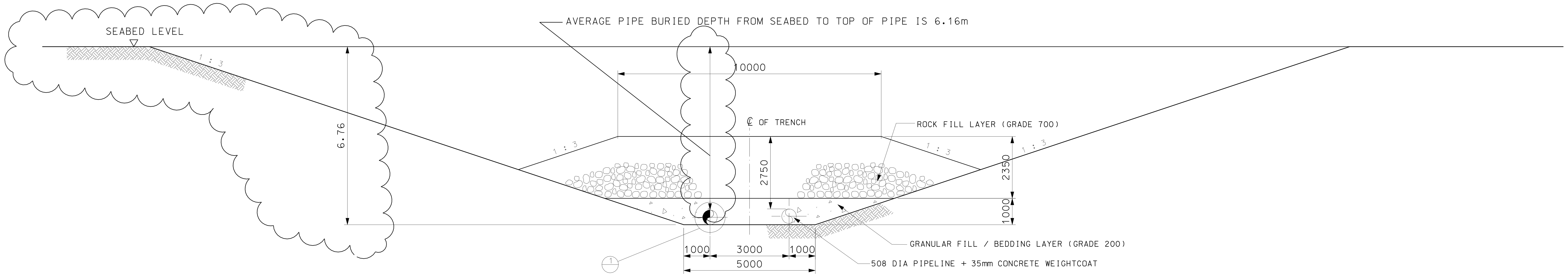
12T ANCHOR PROTECTION TYPE A

NOTES
1. MINIMUM DEPTH OF ROCK COVER FROM TOP OF CONCRETE COATED PIPE IS 1746mm.
2. TO ALLOW FOR NAVIGATION MAINTENANCE DREDGING, TOP OF THE ROCK BERM SHALL NOT PROTRUDE ABOVE THE ORIGINAL SEABED LEVEL.



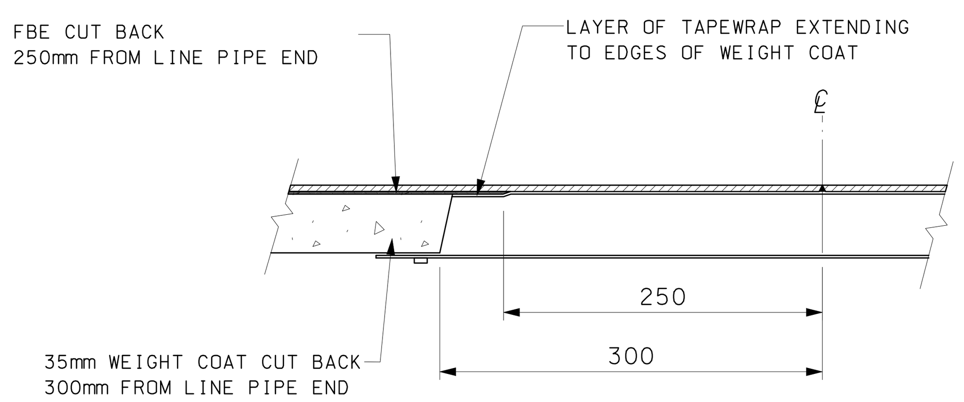
6T ANCHOR PROTECTION TYPE C

NOTES
1. MINIMUM DEPTH OF ROCK COVER FROM TOP OF CONCRETE COATED PIPE IS 1600mm.
2. TO ALLOW FOR NAVIGATION MAINTENANCE DREDGING, TOP OF THE ROCK BERM SHALL NOT PROTRUDE ABOVE THE ORIGINAL SEABED LEVEL.



22T ANCHOR PROTECTION TYPE B

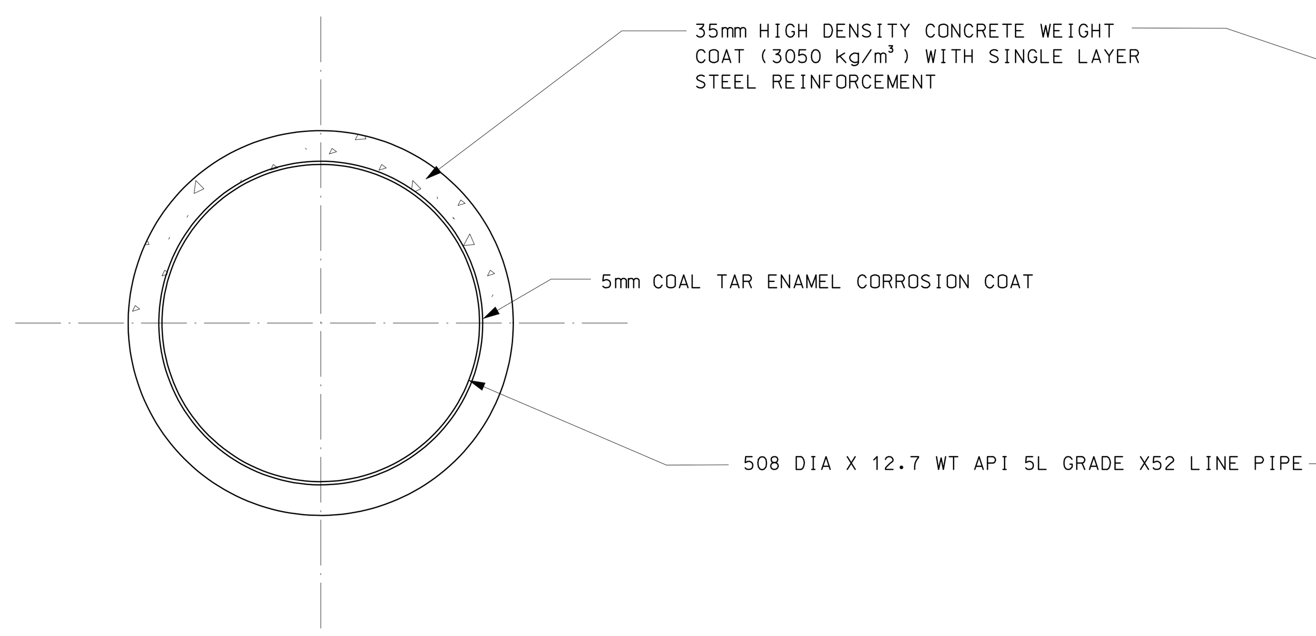
NOTES
1. TOP IS MINIMUM -26.5mPD.
2. MINIMUM DEPTH OF ROCK COVER FROM TOP OF CONCRETE COATED PIPE IS 2750mm.
3. TO ALLOW FOR NAVIGATION MAINTENANCE DREDGING, TOP OF THE ROCK BERM SHALL NOT PROTRUDE ABOVE THE ORIGINAL SEABED LEVEL.



DETAIL 2

FIELD JOINT COATING

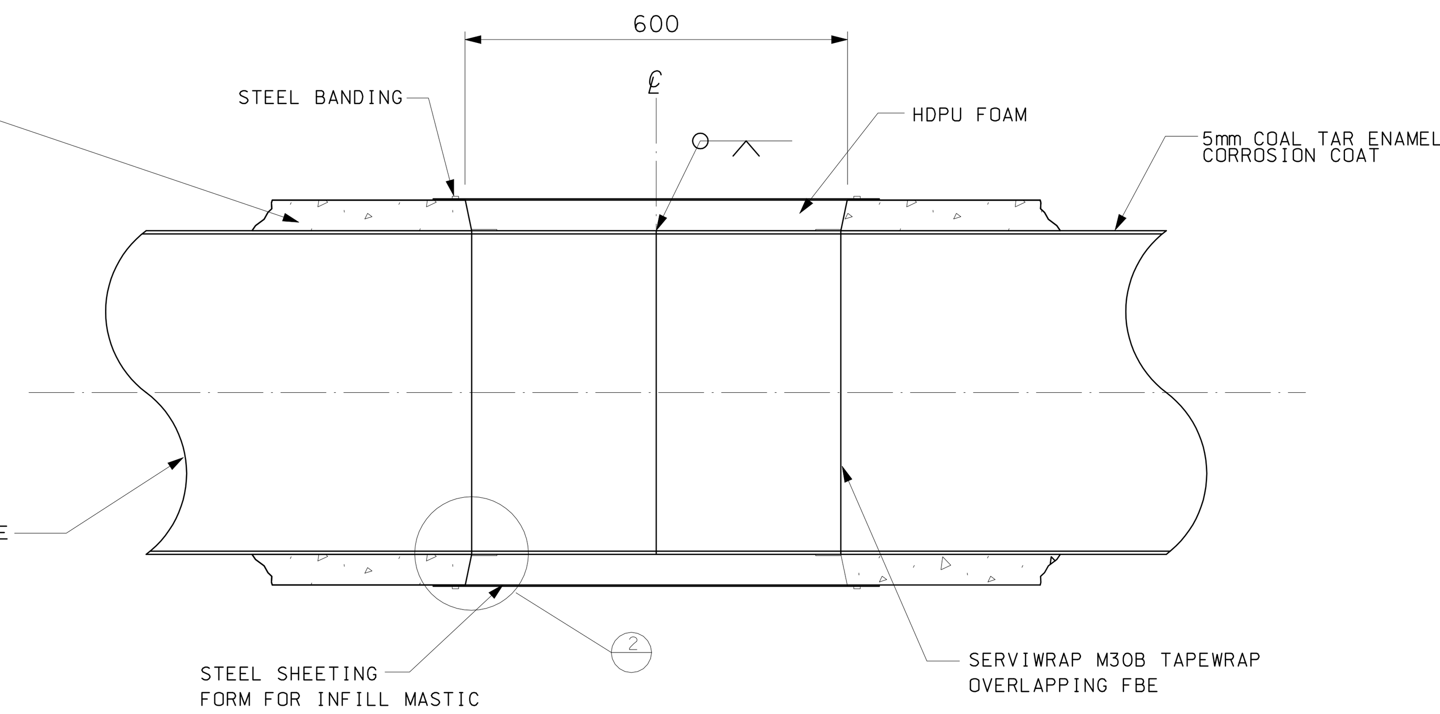
SCALE 1 : 5



DETAIL 1

PIPE CROSS-SECTION

SCALE 1 : 10



TYPICAL LONGITUDINAL SECTION

THROUGH FIELD JOINT

SCALE 1 : 10

NOTES :

BURIAL DEPTHS AND ARMOUR PROTECTION TO BE FINALISED IN DETAILED DESIGN.

Notes:
1. Measurements are based on metric system.
2. All levels are in metres to Principal Datum (mPD) unless noted otherwise.
3. Do not scale drawing.
4. Figure dimensions are to be followed.
5. Do not use for construction unless expressly permitted.
6. The Contractor shall verify all conditions on the Site & notify the Project Manager of any variations from dimensions before construction.

Rev.	Date	Description	Checked	Rev.	Date	Description	Checked
0	21.11.07	FOR CONSTRUCTION					
1	19.11.09	DEPTH OF PIPE BELOW SEABED LEVEL ADDED					
2	24.11.09	SECTIONS REVISED					

Scale		Date
AS SHOWN		02 JUL 2002
Designed	Drawn	Checked
S.K.TSANG	A.SO	S.K.TSANG
Design Team Leader		Date
Approved		Date
B.GILLON		02 JUL 2002

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Permanent Aviation Fuel Facility

Title SUBSEA PIPELINE CROSS SECTION AND FIELD JOINT DETAILS

	Project	Originator	Location	Category	Discipline	Number	Revision
Drawing No.	PAFF	LC	04	DWG	C	0408	2

DATE : 24-Nov-09
TIME : 10:01:11 AM

FILENAME : S:\Drawings\DGN\LC04DWGC0408_2.dgn

Photographs

Technical Data

Dragged Anchor and Dropped Objects Protection Report

PERMANENT AVIATION FUEL FACILITY

DRAGGED ANCHOR AND DROPPED OBJECTS PROTECTION REPORT

LEIGHTON
禮頓

PREPARED FOR

LEIGHTON CONTRACTORS (ASIA) LTD

INTEC PROJECT 22024301

Rev.	Date	Description	By	Chkd	Appd	Client
4	04-Jul-2007	REISSUED FOR USE	IMcP	AM	IMcP	
3	20-Apr-2007	REISSUED FOR USE	IMcP	AWR	IMcP	
2	5-Feb-2007	REISSUED FOR USE	IMcP	AM	IMcP	
1	29-Jan-2007	REISSUED FOR USE	IMcP	AM	IMcP	
0	24-Aug-2006	ISSUED FOR DESIGN	IMcP	AM	IMcP	

INTEC ENGINEERING PTY. LTD.	22024301-201-RPT-006

TABLE OF CONTENTS

HOLDS LIST

Hold	Section/Para	Description

CHANGE LOG

(To be filled in for all revisions after Rev 0)

Rev.	Date	Section/Para	Description
2	5/2/07	2.3	Recommendations reworded.
3	20/4/07	Section 3.2	2nd last paragraph revised to include TOP burial and maintenance dredging requirement.
		Section 5.4	Maintenance dredging requirement added.
		Section 6.0	Table nos. revised.
		Section 6.2	TOP burial depth added for Urmston Road channel.
		Section 6.5	Text revised to include rock grade.
		Tables 7-1, 7-2 & 7-3	Table nos. revised. Type A cover revised to 1746 mm with revised clearances.
		Appendix A	Notes added.
4	4/7/07	2.2	Reworded to include conclusions on maintenance dredging
		5.4	Added criterion for dropped dredge bucket.
		7.1	Added comment on result of dropped dredge bucket.

1. INTRODUCTION

1.1 Project Description

The Airport Authority has awarded a franchise to ECO Aviation Development Limited to build and operate the Permanent Aviation Fuel Facility (PAFF) to provide fuel for the Hong Kong International Airport at Chek Lap Kok.

The PAFF will consist of a Tank Farm, with the facility for expansion at Tuen Mun, a two berth jetty and associated pipelines for receipt of fuel from Tanker vessels, and two submarine pipelines from the tank farm at Tuen Mun to Sha Chau existing jetty.

1.2 Pipeline System Description

The pipeline system includes:

- Two separate 20 inch OD pipelines each 4.3 km long for the conveyance of aviation fuel from the tank farm at Area 38 Tuen Mun to tie into the existing fuel facilities at the jetty on Sha Chau;
- One 20 inch OD submarine pipeline (which is a looped system) for the conveyance of aviation fuel from a proposed fuel facilities jetty offshore at Tuen Mun to the tank farm at Area 38 Tuen Mun.

1.3 Objective

The objective of the pipeline protection study is to verify that the pipeline protection design provides sufficient mechanical protection against dropped objects and dragged anchor events.

1.4 Scope

The scope of the study extends along the pipeline route from Tuen Mun to Sha Chau. A cross-section of the route is shown in Figure 1.4. The protection zones are categorized as follows:

- 12 Te Anchor Protection - Type A
- 22 Te Anchor Protection - Type B
- 6 Te Anchor Protection - Type C

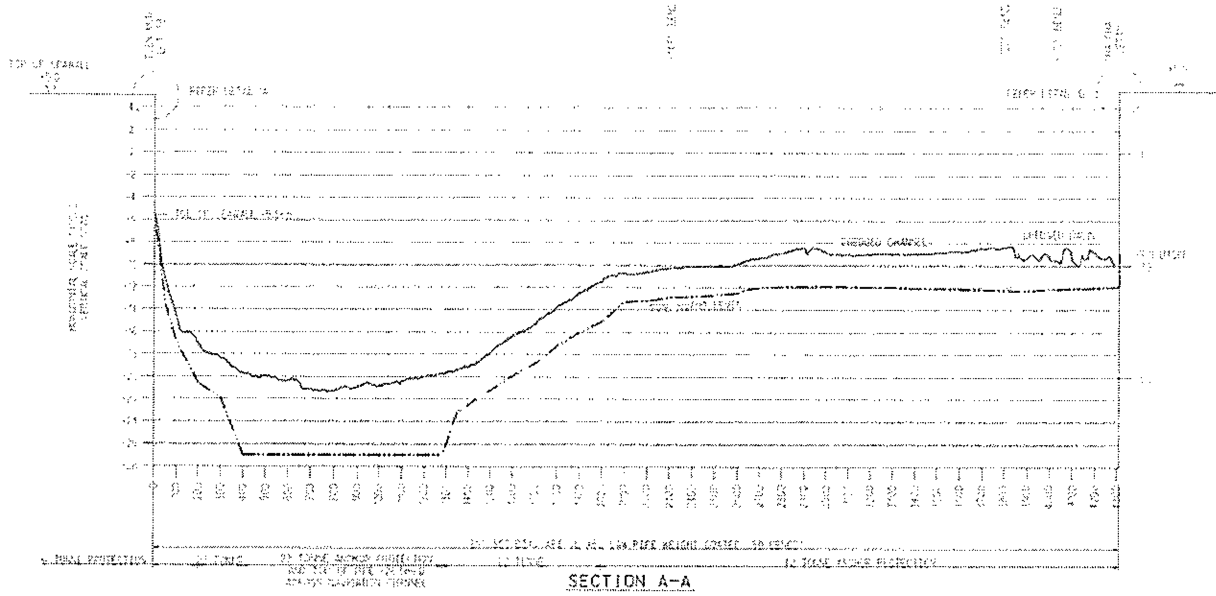

Figure 1.4: Pipeline Cross-Section Tuen Mun to Sha Chau

1.5 Units and Reference Systems

All calculations, drawings and reporting shall be in SI units. In addition, the units noted in Table 1-1 may also be used.

Table 1-1: Supplementary Units of Measurement

Parameter	Symbol
Mass (tonne)	Te
Nominal Pipe Size	inch
Temperature	°C

Preferred units of pressure are MPa. Unless otherwise stated, pressures are gauge.

Standard conditions are defined as 288.71 K and 0.101 MPa.

Water depths, tidal levels and offshore levels will be defined by reference to the Lowest Astronomical Tide (LAT).

1.6 Legislation, Codes and Standards

1.6.1 Principal Design Codes

DNV-RP-F107	"Risk Assessment of Pipeline Protection", Recommended Practice, DNV RP F107, March 2001
DNV-OS-F101	Det Norske Veritas, "Submarine Pipeline Systems", Offshore Standard OS-F101, 2000

1.7 Abbreviations

AC	Admiralty Cast
DNV	Det Norske Veritas
FBE	Fusion Bonded Epoxy
KP	Kilometer Point
KE	Kinetic Energy
LAT	Lowest Astronomical Tide
OD	Outside Diameter
PAFF	Permanent Aviation Fuel Facility
PD	Principal Datum
SI	Systeme International
TOP	Top of Pipe
US	United States

2. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

2.1 General

A dragged anchor and dropped objects protection study has been performed to verify the rockberm design specified in Ref [8] for different pipeline protection zones encountered along the 4.3 km long offshore pipeline route from Tuen Mun to Sha Chau and the pipeline from Tuen Mun Seawall to the proposed Jetty.

For the purpose of this study the following anchor types were considered, which were deemed to be representative of the majority of vessel traffic:

- US Navy Stockless anchors;
- Baldt anchors;
- Admiralty Cast (AC 14) anchors;
- Hall anchors; and
- Spek anchors.

The dimensions and weight of these anchor types that closely match the 6Te, 12Te and 22Te anchor weight class described in the pipeline protection design specified in Ref.[8] have been considered in the study.

The dropped object impact assessment has been performed according to the guidelines specified in DNV-RP-F107 Ref [3]. A verified in-house Mathcad sheet has been used for the dropped object impact assessment analysis.

The criterion for dragged anchor assessment is to avoid the anchor fluke coming into contact with the pipeline. A conservative approach has therefore been adopted, where the whole fluke length of the anchor is assumed to have penetrated the rock fill material and the anchor stock remains horizontal.

2.2 Conclusions

The results indicate that the berm profiles defined by anchor protection Types A, B and C provide adequate dropped and dragged anchor protection for the specific anchor types and sizes within each Type.

Top of pipe burial across Urmston road navigation channel is more than 5m below seabed level. Minimum rock cover for Type B protection is 2.75m, which gives 2.25m clearance for maintenance dredging in the navigation channel. The berm also provides sufficient protection from the largest dropped dredge bucket (25 tonne).

2.3 Recommendations

The study is based on a conservative assumption that the anchor fluke is fully embedded in the pipeline rock fill material. It is recommended that full or scaled model anchor drag tests be conducted to optimize the berm profile.

3. PIPELINE PROTECTION REQUIREMENTS

3.1 Hazard Identification

For the two pipelines described in Section 1.2, the following hazards are identified:

Vessel Traffic

The proposed pipeline crosses a major shipping channel (Urmston Road) between KP0 and KP2.0. Considering the large amount of traffic traversing the shipping channel, there is a risk from dropped or dragged anchors from the vessels.

Dropped Objects from the Jetties

The two pipelines from Area 38 Tuen Mun to Sha Chau are tied into two risers at the Jetty at Sha Chau.

The 20" pipeline (which is a looped system) from Tuen Mun tank farm traverse through the proposed Jetty and then return back to the tank farm.

Dropped objects on the pipelines are possible due to lifting operations at both Jetties. However, both jetties are mainly for jet fuel unloading and therefore heavy lifting operations are not anticipated at the jetties.

Fishing Activities

It is assumed that commercial and recreational fishing activities are not prohibited in this area. However, trawling or other ground penetrating activities due to fishing are not considered.

3.2 Evaluation of Protection Principle

Based on the above hazard identification, the governing hazard is identified as dropped or dragged ship anchors and dropped dredge buckets.

The pipelines described in Section 1.2 are laid into a pre-dredged trench and covered with selected rock backfill material.

The following protection zones and rock berm profiles are identified in Ref.[7] and Ref.[8] and shown in Figure 1.4 and Appendix A respectively.

- 12 Te anchor protection Type A in waters shallower than 10 m;
- 22 Te anchor protection Type B across Urmston Road to the extent of the likely future channel; and
- 6 Te anchor protection Type C between the jetty and seawall where vessel access is restricted.

Top of pipe burial depth across Urmston road navigation channel is set at -26.5m PD Ref [1], which is more than 5m below seabed level. The extent of the length of pipeline to be buried at this depth will be confirmed with the Marine Department. Minimum rock cover for Type B protection is 2.75m, which gives 2.25m clearance for maintenance dredging in the navigation channel. In no case shall the top of the rock berm protrude above the original seabed level. The rock cover shall also be adequate to protect the pipeline from a dropped 25 tonne dredge bucket.

The current study will evaluate the adequacy of the anchor protection zones specified above.

4. DESIGN METHODOLOGY

4.1 Dropped Anchor

4.1.1 Fall Trajectory of a Dropped Anchor

The cause of anchors dropping accidentally is mainly due to failure of the brake system when anchors are made ready for use. The anchor enters the water with a certain initial velocity and falls through the water column prior to impacting the seabed. Kinetic energy is accumulated during the fall trajectory of the dropped anchor. This energy is released at impact with the seabed.

The energy impact capacities of the pipeline and the concrete coating are estimated based on the methodology given in DNV-RP-F107 Ref [3]. Anchor penetration depth into the rock fill cover is estimated based on a methodology given in Ref [6]. Both of these methods are briefly described in following sections.

4.1.2 Energy Absorption Method

A methodology for assessing pipeline damage from dropped anchor impact is outlined in DNV-RP- F107 Ref. [3].

Impact damage is based on an energy balance approach where the available kinetic energy (KE) from an impacting object is compared to the energy required to produce a dent in the steel pipe wall. DNV-RP- F107 assumes a 100% delivery of KE to the pipeline, i.e. a direct hit on TOP without any KE losses. The dent size, expressed as a percentage of the pipeline OD, is an indication as to the likelihood of a leak or rupture. A dent size of 5% of the pipeline OD (Minor damage (D1)) as described in Ref [3] has been used in the calculations.

DNV-RP- F107 also allows for energy absorption by pipeline protective coatings (i.e. concrete weight coating and external anti-corrosion coating) and, in case of a protected/buried pipeline, energy absorption by rock or sand backfill.

Sufficient protection against anchor impact is achieved when the total energy absorption of the steel pipe wall, protective coatings and backfill material combined, i.e. maximum energy absorption capacity, is greater than the anchor impact energy. Alternatively, if the predicted anchor penetration into the pipeline backfill material is less than the backfill cover provided, protection against anchor impact can be considered as satisfactory.

4.1.3 Anchor Penetration Depth

The methodology presented in DNV-RP-F107 Ref [3] for determining the impact resistance of sand backfill is derived from tests that are based on the penetration of drill piping in gravel dumps. As the test results may not strictly apply to an anchor impact, an alternative methodology was used to predict the anchor penetration depth into the rock fill material.

The methodology is outlined in a technical paper published by Duke Energy Corporation, "Qualification of Buried Pipeline for Postulated Surface Impact during Steam Generator Replacement in Nuclear Power Plants" Ref [6].

Firstly, an estimate is made of the impact force at the penetrated surface, based on penetration depth of the anchor into the seabed. The penetration depth is based on the results of an extensive testing program carried out by the Bureau of Yards and Docks, Department of the U.S. Navy Ref. [5].

4.1.4 Impact Velocity

The above methods require as input the velocity of the anchor just prior to impacting the seabed. The terminal velocity of anchors impacting the seabed is calculated by the Mathcad sheet based on the formula (13) given in Ref [3].

4.2 Dragged Anchor

4.2.1 Mitigation Measures

The primary pipeline protection measure against dragged anchors is by providing sufficient rock cover to the pipelines installed in the pre excavated trench. The rock cover to the pipeline must be determined based on the design anchor properties and the material properties of the rock cover.

Based on practical experiments and limited scientific research an anchor penetration depth during dragging can be predicted. This will ensure that an adequate rock cover is present for the pipeline protection.

A rock berm used as an anchor deflection device has to be designed to be able to:

- Deflect the anchor chain to lift anchor out of the seabed; and
- Prevent the anchor from coming into contact with the pipeline.

The design parameters for such a rock berm are:

- Rock berm profile - sufficiently wide rock berm profile will lift the anchor before the pipeline route is reached and should be high enough to lift the anchor above the pipeline; and
- Rock size - instability of the anchor due to uneven loads on anchor flukes will prevent the anchor from dragging through the berm but "walk" over the berm.

4.3 Anchor Types

In order to assess the risk to the pipelines from ship's anchors, it is necessary to examine the design features of different anchor types in use and their size distribution and how this affects penetration into trench backfill material.

The pipeline protection zones and protection types specified in Ref [7 & 8] refer to anchor weights of 6 Te, 12 Te and 22 Te.

Based upon certain characteristics such as fluke area, shank, stabilizers etc it is possible to classify the various anchor types ranging from Class A to Class G.

Class A anchors are deep penetrating anchors designed for high holding power applications, e.g. Vrijhof and Stevpris anchors. Commercial vessels most commonly use stockless anchors in the category Class F and improved stockless anchors (higher holding power) in Class E.

Typical Class E anchors are the Admiralty Cast 14 [AC 14], Stokes, Baldt, Snugstow and Weldhold anchors. Typical Class F anchors are the US Navy Stockless, Byers, Union, Hall and Spec anchors.

For the purpose of this study, US Navy Stockless, Admiralty Cast (AC), Baldt, Hall and Spek anchor type designs have been selected. The dimensions and mass of these anchor types closely match the weight class defined above.

4.4 Anchor Penetration Depth

The most important parameters to anchor users are holding power and the drag distance needed to realize full holding power. Direct measurements of the penetration into the seabed or rock material are therefore not readily available as this is dependent on the drag distance.

In general, ships anchor in good ground with anchor penetration in the region of one fluke length, equivalent to around 2.2m for the largest anchors Ref [9].

Practical trials have demonstrated that maximum holding power is achieved with a fluke angle of 32° in gravel, whereas the optimum for soft mud is 50°. Manufactures often use 40° as a compromise for all types of seabed. A fluke angle of 40° will limit the vertical penetration in good ground where the stock remains horizontal on the surface, to the fluke length times sin 40° Ref [9].

Therefore, for this study, it is conservatively assumed that a dragged anchor may penetrate one fluke length into the rock cover before extricating out of the rock berm. Further, it is assumed that the fluke angle of the anchor types considered in the study is 40°.

5. DESIGN CRITERIA

5.1 General

For a dropped anchor, the pipeline shall have a sufficient burial depth and / or a sufficient concrete weight coating thickness and steel wall thickness to resist an anchor impacting, and causing a dent not exceeding 5% of the pipeline steel OD Ref.[3].

For a dragged anchor the pipeline shall be laid in an excavated trench and the trench backfilled with graded rock to ensure that no anchor pull-over or hooking scenarios are possible. The rock cover depth shall be based on the maximum anchor penetrations possible, considering the trench backfill material.

The pipeline protection requirements against accidental anchor drop and drag are assessed in accordance with DNV-OS-F101 Ref [2] and DNV-RP-F107 Ref [3].

5.2 Dropped Anchor

Design criteria for assessing pipeline damage from dropped anchor impact are outlined in DNV-RP-F107 Ref [3]. The following criteria are adopted for determining the maximum allowable energy absorption by the pipeline.

<u>Buried Pipeline - Pipeline Backfill Material</u>

Maximum energy absorption is defined by the total energy absorption capacity of the material. The total energy absorption capacity of the backfill material may be assumed to be utilised before the protection coating is damaged.

Sufficient protection against anchor impact is achieved when the total energy absorption of the steel pipe wall, protective coatings and backfill material combined, i.e. maximum energy absorption capacity, is greater than the anchor impact energy.

<u>Steel Pipe Wall</u>

The maximum allowable energy absorption of the steel pipe wall is defined by the limiting dent size, i.e. 5% of the pipe steel OD. Dent sizes smaller than 5% of the pipe steel OD, fall under damage classification D1: "Damage neither requiring repair, nor resulting in any release of hydrocarbons".

<u>Protection Coating (Concrete)</u>

The maximum allowable energy absorption is defined by the total energy absorption capacity of the protection coating. The protection coating may be assumed to be completely damaged before the steel pipe wall is damaged.

5.3 Dragged Anchor

Dragging of an anchor across a buried pipeline may result in the following interaction types:

- No interaction, i.e. the anchor is dragged across the pipeline without making physical contact with the pipeline;
- Pull-over interaction, i.e. the tips of the anchor flukes impact the side of the pipeline and the anchor is subsequently pulled over the pipeline; and
- Hooking interaction, i.e. the anchor flukes impact the side of the pipeline and the pipeline is subsequently hooked between the flukes and shank.

The protection mechanism for the pipeline against a drag anchor should avoid a pull-over interaction and / or a hooking interaction.

A safety margin of 200 mm to account for any long term settlement is considered for the rock cover over pipeline against a penetrating anchor for the anchor drag scenario.

5.4 Maintenance Dredging

To permit maintenance dredging, the top of the rock berm shall not protrude above the original seabed level. The berm shall also have sufficient rock cover to protect the pipeline from a dropped 25 tonne dredge bucket.

6. DESIGN DATA

6.1 Mechanical Pipeline Data

Pipeline data applicable to the 20 inch aviation fuel pipelines are given in Tables 6-1. Unless otherwise specified all design data are from Ref [1].

Table 6-1: Pipeline Data

Parameter	Unit	Value
Outside Diameter	mm	508
Wall Thickness	mm	11.9 Ref [11]
Pipe Grade	-	X52
SMYS	MPa	359
Type Corrosion Coating	-	FBE
Corrosion Coating Thickness	mm	0.725
Corrosion Coating Density	kg/m^3	1350
Concrete Coating Thickness	mm	35 Ref [12]
Concrete Coating Density	kg/m^3	3050
Concrete Cube Strength	MPa	40 Ref [13]

For the anchor impact assessment calculations, a minimum concrete coating thickness of 35 mm has been assumed.

6.2 Shipping Channel Crossing Locations

The offshore pipeline crosses a shipping lane (Urmston Road) between KP0 and KP2.0 Ref [7]. TOP is a minimum -26.5m below principle datum in this section.

6.3 Geophysical Data

The geophysical data used for the study is obtained from Ref [4] and presented in Table 6-2.

Table 6-2: Geophysical Data

Parameter	Unit	Value
Seawater Density	kg/m^3	1025
Max water depth shipping channel	m	27.0
Max water depth	m	27.0
Rock backfill – dry bulk density	kg/m^3	1800$^{(1)}$
Soil Classification shipping channel	-	Clayey/ Silty Sand
Soil Classification Pipeline Route	-	Clayey/ Silty Sand
Note: 1.0 Typical value		

6.4 Depth of Penetration Data

The material's coefficient of penetration used in the impact analysis to determine the depth of penetration of the anchor into the rock fill material is assumed based on the values given for other materials in the Bureau of Yards and Docks, Department of the U.S. Navy Ref [5]. These are presented in Table 6-3.

Table 6-3: Seabed Material's Coefficient for Penetration

Parameter	Unit	Value
Sandy Soil	m^3/kg	0.00229
Soft Soil	m^3/kg	0.00457
Stone Masonry	m^3/kg	0.00073
Brick Work	m^3/kg	0.00128
Rockfill$^{(1)}$	m^3/kg	0.00156
Note: 1.0 The coefficient of penetration for rockfill material is an assumed value based on above given values in Ref.[5]		

6.5 Trench Profile

The trench profile, rock berm profile and rock grade specified for the different anchor protection zones are given in Appendix-A.

6.6 Anchor Types and Dimensions

The anchor types and dimensions in Table 6-4 Ref [9 & 10] have been used in the calculations.

Table 6-4: Anchor Types and Dimensions

Parameter	Unit	Anchor Type – AC 14		
Anchor Weight		5.6	13.5	23.0
Anchor Length	m	3.305	4.429	5.290
Anchor Width	m	2.559	3.249	4.096
Anchor Crown Width	m	0.768	1.029	1.229
Anchor Fluke Length	m	1.741	2.333	2.787
Parameter	**Unit**	**Anchor Type – US Navy Stockless**		
Anchor Weight	Te	6.8	13.6	18.1
Anchor Length	m	2.680	3.372	3.708
Anchor Width	m	2.089	2.608	2.872
Anchor Crown Width	m	1.295	1.616	1.778
Anchor Fluke Length	m	1.861	2.394	2.619
Parameter	**Unit**	**Anchor Type – Baldt**		
Anchor Weight	Te	6.06	12.47	-
Anchor Length	m	2.490	3.180	-
Anchor Width	m	1.950	2.700	-
Anchor Crown Width	m	1.020	1.410	-
Anchor Fluke Length	m	1.470	2.030	-
Parameter	**Unit**	**Anchor Type - Hall**		
Anchor Weight	Te	6.0	12.3	23.0
Anchor Length	m	3.270	3.600	4.465
Anchor Width	m	2.033	2.520	3.125
Anchor Crown Width	m	0.829	1.140	1.385
Anchor Fluke Length	m	1.625	1.800	2.230
Parameter	**Unit**	**Anchor Type - Spek**		
Anchor Weight	Te	6.0	12.3	20.0
Anchor Length	m	2.700	3.440	4.070
Anchor Width	m	2.060	2.632	3.018
Anchor Crown Width	m	1.006	1.297	1.493
Anchor Fluke Length	m	1.500	1.910	2190

Note:
1.0 Baldt anchors do not have a matching anchor for the 22 Te weight class.

7. RESULTS

7.1 Anchor Impact Study

Results obtained from the anchor impact study are shown in Table 7-1.

Table 7-1: Anchor Impact Study Results

Parameter	Unit	Anchor Protection Type		
		Type C	**Type A**	**Type B**
Rock Cover (TOP)(1)	mm	1600	1746	2750
Anchor Type	-	US Navy Stockless	AC 14	AC 14
Anchor Weight	T	6.8	13.5	23.0
Anchor Energy at Impact on Rock berm	kJ	171	630	1052
Energy Absorption Potential of Pipe Concrete Coating	kJ	323	256	306
Energy Absorption Potential of Pipe Steel Wall	kJ	6.3	6.3	6.3
Predicted Anchor Penetration into Rock fill	mm	**15**	43	**48**
Rock Cover adequate?	-	**YES**	**YES**	**YES**

Notes:
1. Rock cover from top of concrete coated pipe

The results show that all anchors have minimal penetration as would be expected. By inspection, the penetration of a large 25 tonne dredge bucket will also have minimal penetration into the rock berm.

7.2 Dragged Anchor Study

For the berm dimensions shown in Table 7-2, the results obtained from the dragged anchor protection study are shown in Table 7-3.

Table 7-2: Rock Cover

Parameter	Unit	Rock Berm Data		
Protection Type	-	Type C (6Te)	Type A (12Te)	Type B (22Te)
Minimum Rock Cover Available	m	1.600	1.746	2.750

Table 7-3: Dragged Anchor Protection Study Results

Parameter	Unit	Anchor Type - AC14		
Anchor Fluke Length	m	1.741	2.333	2.787
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	1.119	1.500	1.791
Clearance against Fluke Penetration	m	**0.481**	**0.246**	**0.959**
		Anchor Type – US Navy Stockless		
Anchor Fluke Length	m	1.861	2.394	2.619
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	1.196	1.539	1.683
Clearance against Fluke Penetration	m	**0.404**	**0.207**	**1.067**
		Anchor Type – Baldt		
Anchor Fluke Length	m	1.470	2.030	-
Anchor Fluke Angle	Deg.	40	40	-
Anchor Fluke Penetration Depth	m	0.945	1.305	-
Clearance against Fluke Penetration	m	**0.655**	**0.441**	-
		Anchor Type – Hall		
Anchor Fluke Length	m	1.625	1.800	2.230
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	1.045	1.157	1.433
Clearance against Fluke Penetration	m	**0.555**	**0.589**	**1.354**
		Anchor Type – Spek		
Anchor Fluke Length	m	1.500	1.910	2.190
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	0.964	1.228	1.408
Clearance against Fluke Penetration	m	**0.636**	**0.518**	**1.342**

The results show that all anchors exceed the nominal safety margin clearance of 200 mm.

8. REFERENCES

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4. Babtie Asia Ltd; Final Geotechnical Report for Proposed Fuel Pipeline, Report No. R/2511/006/1 Issue 2, February 2003.

5. Arminikian, Arsham, Design of Protective Structures, Bureau of Yards and Docks, Department of the U.S. Navy, Washington D.C. 1950.

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7. Subsea Pipeline Tuen Mun 38 to Sha Chau Option 1, Drawing. Number PAFF/LC/04/DWG/C/0401, Rev. B, May 2002.

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9. "Threats to Submarine Cables", Seymour Shapiro, James G Murray, Robert F Gleason, Stuart R Barnes, Brian A Eales, P R Woodward, Alcatel Submarine Networks, London, UK.

10. Vrijhof Anchor Manual 2000, Vrijhof Anchors, www.vrijhof.com .

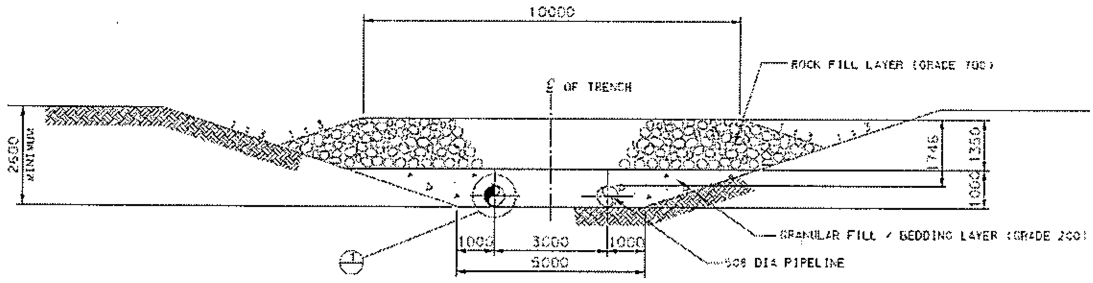
11. "Steel Wall Thickness Report", Permanent Aviation Fuel Facility, Document Number 22024301-201-RPT-001, Rev 0, Aug 2006.

12. "On bottom Stability Report", Permanent Aviation Fuel Facility, Document Number 22024301-201-RPT-002, Rev 0, Aug 2006.

13. "Concrete Weight Coating Specification", Permanent Aviation Fuel Facility, Document Number 22024301-301-SPC-006, Rev 0, Aug 2006.

APPENDIX A

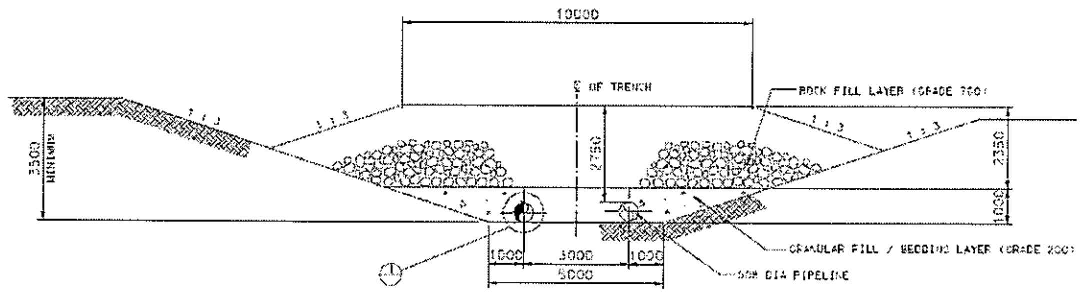
ROCK BERM PROFILES



12T ANCHOR PROTECTION TYPE A

Notes:

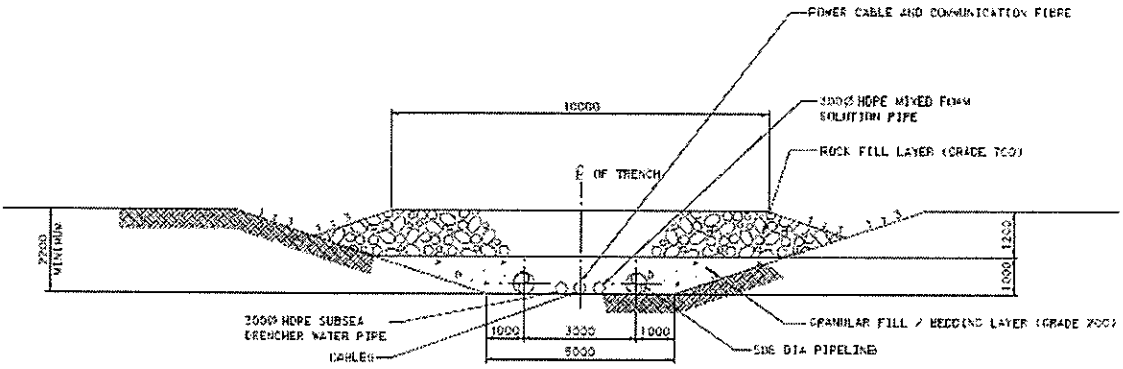
1. Minimum depth of rock cover from top of concrete coated pipe is 1746 mm.
2. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.



22T ANCHOR PROTECTION TYPE B

Notes:

1. TOP is minimum -26.5mPd.
2. Minimum depth of rock cover from top of concrete coated pipe is 2750 mm.
3. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.



6T ANCHOR PROTECTION TYPE C
SECTION A-A

Notes:
1. Minimum depth of rock cover from top of concrete coated pipe is 1600 mm.
2. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.

Rock Armor and Rock Fill

LEIGHTON
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26 March 2009

Ref: H2104/C22/10844/BM/SH/YNW/GC/kk

10844
H2104 File: C22
Action:
Circulation: Y | N
Copies:
Date: 26 MAR 2009
Response To:
Keys: MAT SUP
※ = Without Attachments

Scott Wilson Limited
(Site Office)
Lung Hong Street
Lung Mun Road
Tuen Mun Area 38
Tap Shek Kok
New Territories

Attn: Mr. Michael Kay

(By Hand)

Dear Sir,

PERMANENT AVIATION FUEL FACILITY
SUBSEA PIPELINE – TEST REPORT FOR ROCK FILL MATERIAL

We submit herewith for your approval the report of particle size distribution for the samples of G200 and G700 rock fill material taken from the proposed quarries at Zhong Shan – Sun Lung and Zhuhai – Hengqin.

Yours faithfully

Boyd Merrett
Project Manager

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f: +852 2404 0081

Attached Test Report (A4 x 3 sheets)
cc: ECO – Mr. Tommy Siu (w/encl) (By Hand)
Jacobs – Mr Leslie Swann (w/encl) (By Fax 2565 5561)

10844.doc

FUGRO TECHNICAL SERVICES LIMITED
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E-mail : matlab@fugro.com.hk
Website : www.materialab.com.hk

MateriaLab

Report No. : 090719PJ900536

Report on Particle Size Distribution of Aggregate

Information Supplied by Client

Client	:	UDL Dredging Ltd.
Project	:	Permanent Aviation Fuel Facility at Tuen Mun Area 38
Source	:	新龍 Quarry
Place of sampling	:	新龍 Quarry
Place of testing	:	新龍 Quarry
Sample description	:	Rock Fill Material, Grade 200
Client sample ID	:	2

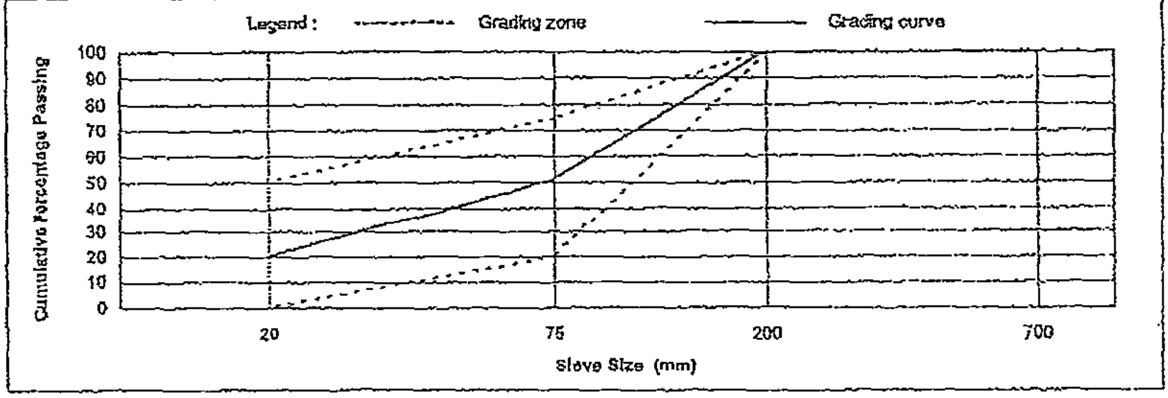
Test Results

Date of sampling	:	12-03-2009
Date of testing	:	12-03-2009
Lab sample ID.	:	PJ90536/1
Sample mass	:	276.4 kg

Tested by : M.T. Chan

Test method : Based on General Specification for Civil Engineering Works : 1992, Section 6, Clause 3.59(3) with Modification (see remark 2)

Sieve size (mm)	Mass retained (kg)	Percentage retained	Cumulative percentage passing	Grading zone (%)
700	0	0	100	100
200	0	0	100	100-100
75	135.4	49.0	51	20-75
20	85.2	30.8	20	0-50
Pan	55.8	20.2	-	-



Remark : 1. The test results complied with the grading zone specified in General Specification for Civil Engineering Works : 1992, Section 21, Clause 21.11.
2. The test portion of fill material passing 75mm was subjected to dry sieving on site.

Checked by : Ya Date : 17/3/09 Certified by : [signature] Francis Chan/Tommy F.K. Chan Date : 17/3/09

GEN01/1205

FUGRO TECHNICAL SERVICES LIMITED
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Website : www.materialab.com.hk

MateriaLab

Report No. : 090719PJ900536(1)

Report on Particle Size Distribution of Aggregate

Information Supplied by Client

Client : UDL Dredging Ltd.
Project : Permanent Aviation Fuel Facility at Tuen Mun Area 38
Source : 横琴
Place of sampling : 横琴
Place of testing : 横琴
Sample description : Rock Fill Material, Grade 700
Client sample ID : 1

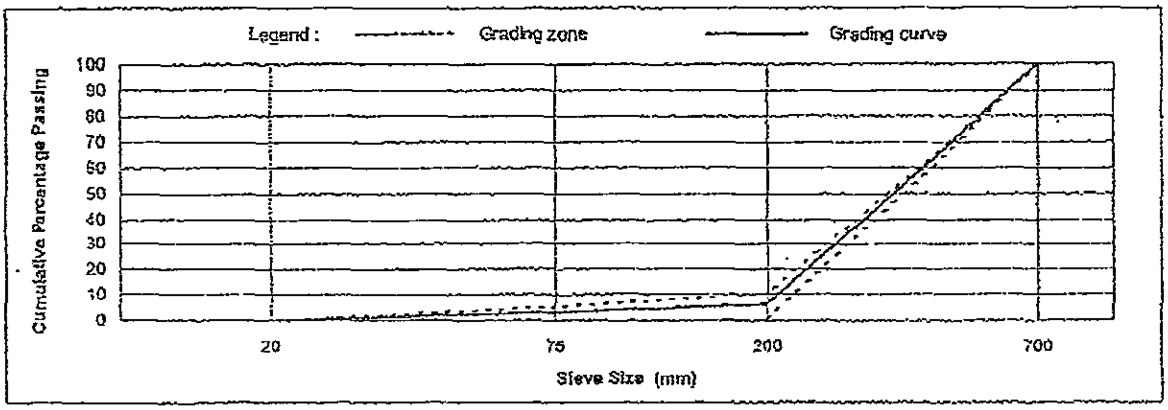
Test Results

Date of sampling : 12-03-2009
Date of testing : 12-03-2009
Lab sample ID. : PJ90536/2
Sample mass : 1101.4 kg

Tested by : M.T. Chan

Test method : Based on General Specification for Civil Engineering Works : 1992, Section 6, Clause 3.59(3) with Modification (see remark 2)

Sieve size (mm)	Mass retained (kg)	Percentage retained	Cumulative percentage passing	Grading zone (%)
700	0	0	100	100
200	1040.6	94.5	6	0-10
75	24.3	2.2	3	0-5
20	36.5	3.3	0	0
Pan	0	0	-	-



Remark :
1. The test results complied with the grading zone specified in General Specification for Civil Engineering Works : 1992, Section 21, Clause 21.11.
2. The test portion of fill material passing 75mm was subjected to dry sieving on site.

Checked by : Y Date : 17/3/09 Certified by : Felix K.W. Chan/Tommy F.K. Chan Date : 17/3/09

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MateriaLab

Report No. : 090718PJ900536(2)

Report on Particle Size Distribution of Aggregate

Information Supplied by Client

Client : UDL Dredging Ltd.
Project : Permanent Aviation Fuel Facility at Tuen Mun Area 38
Source : 新龍 Quarry
Place of sampling : 新龍 Quarry
Place of testing : 新龍 Quarry
Sample description : Rock Fill Material, Grade 700
Client sample ID : 1 & 2

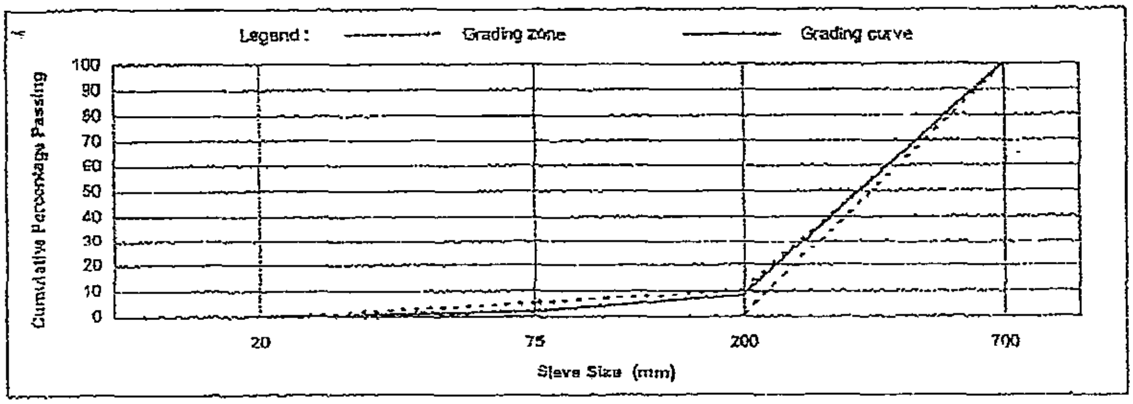
Test Results

Date of sampling : 12-03-2009
Date of testing : 12-03-2009
Lab sample ID. : PJ90536/3
Sample mass : 1201.3 kg

Tested by : M.T. Chan

Test method : Based on General Specification for Civil Engineering Works : 1992, Section 6, Clause 3.59(3) with Modification (see remark 2)

Sieve size (mm)	Mass retained (kg)	Percentage retained	Cumulative percentage passing	Grading zone (%)
700	0	0	100	100
200	1102.8	91.8	8	0-10
75	80.5	6.7	2	0-5
20	18.0	1.5	0	0
Pan	0	0	-	-



Remark :
1. The test results complied with the grading zone specified in General Specification for Civil Engineering Works : 1992, Section 21, Clause 21.11.
2. The test portion of fill material passing 75mm was subjected to dry sieving on site.

Checked by : ______ Date : 17/3/09 Certified by : ______ Date : 17/3/09

Keith K.W. Chan/Tommy P.K. Chan

119871

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偉信 Scott Wilson

Leighton Contractors (Asia) Ltd
Lung Hong Street
Lung Mun Road
Tuen Mun Area 38
Tap Shek Kok
New Territories

Your Reference:

Our Reference: 01368/12/5/S002629

Date: 2 April 2009

Attn.: Mr Boyd Merrett

BY HAND

Dear Sirs

Permanent Aviation Fuel Facility
Subsea Pipeline – Test Report for Rock Fill Material

We refer to your letter dated 26 March 2009 reference H2104/C22/10844/BM/SH/YNW/GC/kk regarding the captioned subject.

You are advised that we have no adverse comment to the submitted test reports for the Grade 200 and Grade 700 rock fill material from the proposed quarries at Zhong Shan (Sun Lung) and Zhuhai (Hengqin) for the constructions of the subsea pipelines.

119871

H2104	File: C23
Action: G Chn	
Circulation: Y	N.
Copies: YNW, DH.	
Date: - 2 APR 2009	
Response To:	
Keys: SUP MAT	
* = Without Attachments	

Yours faithfully
SCOTT WILSON LTD

M G Kay

Michael G KAY
Construction Manager

MGK/BWCY/cmc

cc ECO (Attn: Mr Tommy Siu) – by Fax only (2214 1484)

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24 March 2009

Our Ref: H2104/C22/10826/BM/SH/YNW/kk
Your Ref: 01368/12/3/S002536

10826.

H2104	File: C22
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Circulation: Y	N
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Scott Wilson Limited
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Lung Hong Street
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New Territories

Attn: Mr. Michael Kay

(By Hand)

Dear Sir,

PERMANENT AVIATION FUEL FACILITY
SUBSEA PIPELINES – ROCKFILL MATERIAL FOR PROTECTION OF PIPELINS

With reference to your letter ref. 01368/12/3/S002536 dated 9 March 2009, we submit herewith for your information a copy of the revised "Dragged Anchor and Dropped Objects Protection Report Rev.5" with the design of Grade 200 and Grade 700 rockfill materials for pipelines protection.

In accordance with section 5.1.3 of the "Rock Placement Specification Rev. 3", the Grade 200 and Grade 700 rockfill materials will be tested for grading at a frequency of once every 14 days of material loaded onto the rock dump vessel.

Yours faithfully

S Barrett

Boyd Merrett
Project Manager

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Attache Tranmittal No. H2104-10965 + Dragged Anchor and Dropped Objects Protection Report Rev.5
cc: ECO – Mr. Tommy Siu (w/Tranmittal No. H2104-10958) (By Hand)

10826.doc

TO:
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TUEN MUN,
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Transmittal No : H2104 - 10965

Date : 24/03/09

H2104 PAFF - PERMANENT AVIATION FUEL FACILITY

Transmitted By : HAND

ISSUED FOR INFORMATION

TRANSMITTED HEREWITH ARE THE FOLLOWING: 1 A4 PRINT

ITEM	DOCUMENT NUMBER	REV	STS*	TITLE
1	22024301-201-RPT-006	.	IFC	DRAGGED ANCHOR AND DROPPED OBJECTS PROTECTION REPORT

REFER ANY QUERIES TO : Boyd Merrett

PLEASE ACKNOWLEDGE RECEIPT BY SIGNING, DATING AND RETURNING A COPY OF THIS TRANSMITTAL.

*STS LEGEND: APPCH=Approved Checked Drawings, APPDT=Approved Detailed Design, APPPR=Approved Preliminary Design, APS-A=Approved as Amended, ASB=As-Built, BDRS=BD Re-submission, COM=Issued for Comments, DRAFT=Draft, FIN=Final, FIN_A=Final, IAP=Issued for Approval, IFC=Issued for Construction, IFQ=Issued for Quotation, INF=Issued for Information, ISSCH=Issued Checked Drawings, ISSDT=Issued Detail Design for Approval, ISSPR=Issued Preliminary Design for Approval, ISSRE=Issued for Review, ISSSU=Issued for Submission, REC=Issued for Record, REV-A=Reviewed as indicated, RWC=Reviewed with Comments, TENDR=Tender Drawing

YOURS FAITHFULLY

Mr Boyd Merrett
Leighton Contractors (Asia) Limited

RECEIPT ACKNOWLEDGED

DATE RECEIVED:__/__/__

Mr Michael KAY
Scott Wilson

REMARKS: Please sign and return.

TO:
Mr Tommy K Siu
ECO Aviation Fuel Development Limited
17/F, 363 Java Road, North Point

Hong Kong

S.A.R Hong Kong
PHONE: (852) 2963 1668 **FAX:** (852) 2516 7728

Leighton Contractors (Asia) Limited
Area 38, Lung Hong Street
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TUEN MUN,
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Tel: 2404 8900
Fax: 2404 0081

Transmittal No : H2104 - 10958

Date : 24/03/09

H2104 PAFF - PERMANENT AVIATION FUEL FACILITY

Transmitted By : HAND

ISSUED FOR INFORMATION

TRANSMITTED HEREWITH ARE THE FOLLOWING: 1 A4 PRINTS

ITEM	DOCUMENT NUMBER	REV	STS*	TITLE
1	22024301-201-RPT-006		IFC	DRAGGED ANCHOR AND DROPPED OBJECTS PROTECTION REPORT

REFER ANY QUERIES TO : Boyd Merrett

PLEASE ACKNOWLEDGE RECEIPT BY SIGNING, DATING AND RETURNING A COPY OF THIS TRANSMITTAL.

*STS LEGEND: APPCH=Approved Checked Drawings, APPDT=Approved Detailed Design, APPPR=Approved Preliminary Design, APS-A=Approved as Amended, ASB=As-Built, BDRS=BD Re-submission, COM=Issued for Comments, DRAFT=Draft, FIN=Final, FIN_A=Final, IAP=Issued for Approval, IFC=Issued for Construction, IFQ=Issued for Quotation, INF=Issued for Information, ISSCH=Issued Checked Drawings, ISSDT=Issued Detail Design for Approval, ISSPR=Issued Preliminary Design for Approval, ISSRE=Issued for Review, ISSSU=Issued for Submission, REC=Issued for Record, REV-A=Reviewed as indicated, RWC=Reviewed with Comments, TENDR=Tender Drawing

YOURS FAITHFULLY

Mr Boyd Merrett
Leighton Contractors (Asia) Limited

RECEIPT ACKNOWLEDGED

DATE RECEIVED:___/___/___

Mr Tommy K Siu
ECO Aviation Fuel Development Limited

REMARKS: Please sign and return.

PERMANENT AVIATION FUEL FACILITY

DRAGGED ANCHOR AND DROPPED OBJECTS PROTECTION REPORT

LEIGHTON

PREPARED FOR

LEIGHTON CONTRACTORS (ASIA) LTD

FOR INFORMATION

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INTEC PROJECT 22024301

5	17-Mar-2009	REISSUED FOR USE	LD	JMcP	JmcP	
4	04-Jul-2007	REISSUED FOR USE	ImcP	AM	ImcP	
3	20-Apr-2007	REISSUED FOR USE	ImcP	AWR	ImcP	
2	5-Feb-2007	REISSUED FOR USE	ImcP	AM	ImcP	
1	29-Jan-2007	REISSUED FOR USE	ImcP	AM	ImcP	
0	24-Aug-2006	ISSUED FOR DESIGN	ImcP	AM	ImcP	
Rev.	Date	Description	By	Chkd	Appd	Client

INTEC ENGINEERING PTY. LTD.	22024301-201-RPT-006

TABLE OF CONTENTS

HOLDS LIST

Hold	Section/Para	Description

CHANGE LOG

(To be filled in for all revisions after Rev 0)

Rev.	Date	Section/Para	Description
2	5/2/07	2.3	Recommendations reworded.
3	20/4/07	Section 3.2	2^{nd} last paragraph revised to include TOP burial and maintenance dredging requirement.
		Section 5.4	Maintenance dredging requirement added.
		Section 6.0	Table nos. revised.
		Section 6.2	TOP burial depth added for Urmston Road channel.
		Section 6.5	Text revised to include rock grade.
		Tables 7-1, 7-2 & 7-3	Table nos. revised. Type A cover revised to 1746 mm with revised clearances.
		Appendix A	Notes added.
4	4/7/07	2.2	Reworded to include conclusions on maintenance dredging
		5.4	Added criterion for dropped dredge bucket.
		7.1	Added comment on result of dropped dredge bucket.
5	17/3/09	4.5	Design methodology for rock berm design included.
		5.5	Design criteria for rock berm added.
		6.7	Environmental data used for rock berm design added.
		7.3	Results of rock berm design presented.
		Appendix B	Design calculation included for rock berm

1. INTRODUCTION

1.1 Project Description

The Airport Authority has awarded a franchise to ECO Aviation Development Limited to build and operate the Permanent Aviation Fuel Facility (PAFF) to provide fuel for the Hong Kong International Airport at Chek Lap Kok.

The PAFF will consist of a Tank Farm, with the facility for expansion at Tuen Mun, a two berth jetty and associated pipelines for receipt of fuel from Tanker vessels, and two submarine pipelines from the tank farm at Tuen Mun to Sha Chau existing jetty.

1.2 Pipeline System Description

The pipeline system includes:

- Two separate 20 inch OD pipelines each 4.3 km long for the conveyance of aviation fuel from the tank farm at Area 38 Tuen Mun to tie into the existing fuel facilities at the jetty on Sha Chau;
- One 20 inch OD submarine pipeline (which is a looped system) for the conveyance of aviation fuel from a proposed fuel facilities jetty offshore at Tuen Mun to the tank farm at Area 38 Tuen Mun.

1.3 Objective

The objective of the pipeline protection study is to verify that the pipeline protection design provides sufficient mechanical protection against dropped objects and dragged anchor events.

1.4 Scope

The scope of the study extends along the pipeline route from Tuen Mun to Sha Chau. A cross-section of the route is shown in Figure 1.4. The protection zones are categorized as follows:

- 12 Te Anchor Protection - Type A
- 22 Te Anchor Protection - Type B
- 6 Te Anchor Protection - Type C

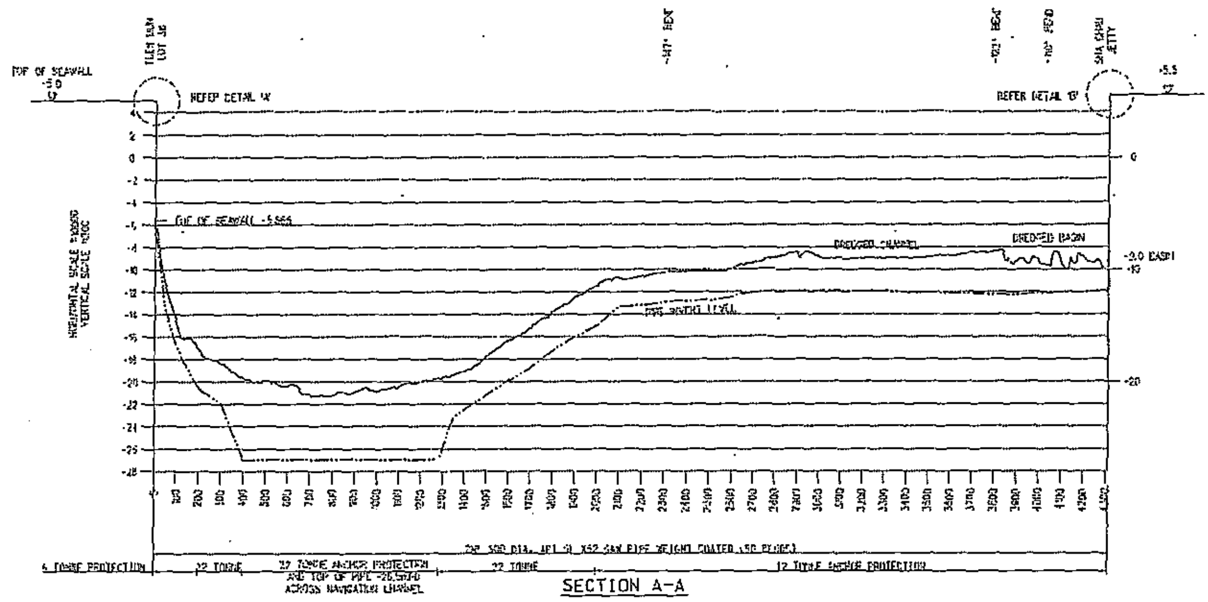

Figure 1.4: Pipeline Cross-Section Tuen Mun to Sha Chau

1.5 Units and Reference Systems

All calculations, drawings and reporting shall be in SI units. In addition, the units noted in Table 1-1 may also be used.

Table 1-1: Supplementary Units of Measurement

Parameter	Symbol
Mass (tonne)	Te
Nominal Pipe Size	inch
Temperature	°C

Preferred units of pressure are MPa. Unless otherwise stated, pressures are gauge.

Standard conditions are defined as 288.71 K and 0.101 MPa.

Water depths, tidal levels and offshore levels will be defined by reference to the Lowest Astronomical Tide (LAT).

1.6 Legislation, Codes and Standards

1.6.1 Principal Design Codes

DNV-RP-F107	"Risk Assessment of Pipeline Protection", Recommended Practice, DNV RP F107, March 2001
DNV-OS-F101	Det Norske Veritas, "Submarine Pipeline Systems", Offshore Standard OS-F101, 2000

1.7 Abbreviations

AC	Admiralty Cast
DNV	Det Norske Veritas
FBE	Fusion Bonded Epoxy
KP	Kilometer Point
KE	Kinetic Energy
LAT	Lowest Astronomical Tide
OD	Outside Diameter
PAFF	Permanent Aviation Fuel Facility
PD	Principal Datum
SI	Systeme International
TOP	Top of Pipe
US	United States

2. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

2.1 General

A dragged anchor and dropped objects protection study has been performed to verify the rockberm design specified in Ref [8] for different pipeline protection zones encountered along the 4.3 km long offshore pipeline route from Tuen Mun to Sha Chau and the pipeline from Tuen Mun Seawall to the proposed Jetty.

For the purpose of this study the following anchor types were considered, which were deemed to be representative of the majority of vessel traffic:

- US Navy Stockless anchors;
- Baldt anchors;
- Admiralty Cast (AC 14) anchors;
- Hall anchors; and
- Spek anchors.

The dimensions and weight of these anchor types that closely match the 6Te, 12Te and 22Te anchor weight class described in the pipeline protection design specified in Ref.[8] have been considered in the study.

The dropped object impact assessment has been performed according to the guidelines specified in DNV-RP-F107 Ref [3]. A verified in-house Mathcad sheet has been used for the dropped object impact assessment analysis.

The criterion for dragged anchor assessment is to avoid the anchor fluke coming into contact with the pipeline. A conservative approach has therefore been adopted, where the whole fluke length of the anchor is assumed to have penetrated the rock fill material and the anchor stock remains horizontal.

The recommended cover and rock size grading are verified for stability against environmental forces.

2.2 Conclusions

The results indicate that the berm profiles defined by anchor protection Types A, B and C provide adequate dropped and dragged anchor protection for the specific anchor types and sizes within each Type. Further, the rock size grading/thickness of armour and bedding layers are considered to be stable.

Top of pipe burial across Urmston road navigation channel is more than 5m below seabed level. Minimum rock cover for Type B protection is 2.75m, which gives 2.25m clearance for maintenance dredging in the navigation channel. The berm also provides sufficient protection from the largest dropped dredge bucket (25 tonne).

2.3 Recommendations

The study is based on a conservative assumption that the anchor fluke is fully embedded in the pipeline rock fill material. It is recommended that full or scaled model anchor drag tests be conducted to optimize the berm profile.

3. PIPELINE PROTECTION REQUIREMENTS

3.1 Hazard Identification

For the two pipelines described in Section 1.2, the following hazards are identified:

Vessel Traffic

The proposed pipeline crosses a major shipping channel (Urmston Road) between KP0 and KP2.0. Considering the large amount of traffic traversing the shipping channel, there is a risk from dropped or dragged anchors from the vessels.

Dropped Objects from the Jetties

The two pipelines from Area 38 Tuen Mun to Sha Chau are tied into two risers at the Jetty at Sha Chau.

The 20" pipeline (which is a looped system) from Tuen Mun tank farm traverse through the proposed Jetty and then return back to the tank farm.

Dropped objects on the pipelines are possible due to lifting operations at both Jetties. However, both jetties are mainly for jet fuel unloading and therefore heavy lifting operations are not anticipated at the jetties.

Fishing Activities

It is assumed that commercial and recreational fishing activities are not prohibited in this area. However, trawling or other ground penetrating activities due to fishing are not considered.

3.2 Evaluation of Protection Principle

Based on the above hazard identification, the governing hazard is identified as dropped or dragged ship anchors and dropped dredge buckets.

The pipelines described in Section 1.2 are laid into a pre-dredged trench and covered with selected rock backfill material.

The following protection zones and rock berm profiles are identified in Ref.[7] and Ref.[8] and shown in Figure 1.4 and Appendix A respectively.

- 12 Te anchor protection Type A in waters shallower than 10 m;
- 22 Te anchor protection Type B across Urmston Road to the extent of the likely future channel; and

- 6 Te anchor protection Type C between the jetty and seawall where vessel access is restricted.

Top of pipe burial depth across Urmston road navigation channel is set at -26.5m PD Ref [1], which is more than 5m below seabed level. The extent of the length of pipeline to be buried at this depth will be confirmed with the Marine Department. Minimum rock cover for Type B protection is 2.75m, which gives 2.25m clearance for maintenance dredging in the navigation channel. In no case shall the top of the rock berm protrude above the original seabed level. The rock cover shall also be adequate to protect the pipeline from a dropped 25 tonne dredge bucket.

The current study will evaluate the adequacy of the anchor protection zones specified above.

4. DESIGN METHODOLOGY

4.1 Dropped Anchor

4.1.1 Fall Trajectory of a Dropped Anchor

The cause of anchors dropping accidentally is mainly due to failure of the brake system when anchors are made ready for use. The anchor enters the water with a certain initial velocity and falls through the water column prior to impacting the seabed. Kinetic energy is accumulated during the fall trajectory of the dropped anchor. This energy is released at impact with the seabed.

The energy impact capacities of the pipeline and the concrete coating are estimated based on the methodology given in DNV-RP-F107 Ref [3]. Anchor penetration depth into the rock fill cover is estimated based on a methodology given in Ref [6]. Both of these methods are briefly described in following sections.

4.1.2 Energy Absorption Method

A methodology for assessing pipeline damage from dropped anchor impact is outlined in DNV-RP- F107 Ref. [3].

Impact damage is based on an energy balance approach where the available kinetic energy (KE) from an impacting object is compared to the energy required to produce a dent in the steel pipe wall. DNV-RP- F107 assumes a 100% delivery of KE to the pipeline, i.e. a direct hit on TOP without any KE losses. The dent size, expressed as a percentage of the pipeline OD, is an indication as to the likelihood of a leak or rupture. A dent size of 5% of the pipeline OD (Minor damage (D1)) as described in Ref [3] has been used in the calculations.

DNV-RP- F107 also allows for energy absorption by pipeline protective coatings (i.e. concrete weight coating and external anti-corrosion coating) and, in case of a protected/buried pipeline, energy absorption by rock or sand backfill.

Sufficient protection against anchor impact is achieved when the total energy absorption of the steel pipe wall, protective coatings and backfill material combined, i.e. maximum energy absorption capacity, is greater than the anchor impact energy. Alternatively, if the predicted anchor penetration into the pipeline backfill material is less than the backfill cover provided, protection against anchor impact can be considered as satisfactory.

4.1.3 Anchor Penetration Depth

The methodology presented in DNV-RP-F107 Ref [3] for determining the impact resistance of sand backfill is derived from tests that are based on the penetration of drill piping in gravel dumps. As the test results may not strictly apply to an anchor impact, an alternative methodology was used to predict the anchor penetration depth into the rock fill material.

The methodology is outlined in a technical paper published by Duke Energy Corporation, "Qualification of Buried Pipeline for Postulated Surface Impact during Steam Generator Replacement in Nuclear Power Plants" Ref [6].

Firstly, an estimate is made of the impact force at the penetrated surface, based on penetration depth of the anchor into the seabed. The penetration depth is based on the results of an extensive testing program carried out by the Bureau of Yards and Docks, Department of the U.S. Navy Ref. [5].

4.1.4 Impact Velocity

The above methods require as input the velocity of the anchor just prior to impacting the seabed. The terminal velocity of anchors impacting the seabed is calculated by the Mathcad sheet based on the formula (13) given in Ref [3].

4.2 Dragged Anchor

4.2.1 Mitigation Measures

The primary pipeline protection measure against dragged anchors is by providing sufficient rock cover to the pipelines installed in the pre excavated trench. The rock cover to the pipeline must be determined based on the design anchor properties and the material properties of the rock cover.

Based on practical experiments and limited scientific research an anchor penetration depth during dragging can be predicted. This will ensure that an adequate rock cover is present for the pipeline protection.

A rock berm used as an anchor deflection device has to be designed to be able to:

- Deflect the anchor chain to lift anchor out of the seabed; and
- Prevent the anchor from coming into contact with the pipeline.

The design parameters for such a rock berm are:

- Rock berm profile - sufficiently wide rock berm profile will lift the anchor before the pipeline route is reached and should be high enough to lift the anchor above the pipeline; and
- Rock size - instability of the anchor due to uneven loads on anchor flukes will prevent the anchor from dragging through the berm but "walk" over the berm.

4.3 Anchor Types

In order to assess the risk to the pipelines from ship's anchors, it is necessary to examine the design features of different anchor types in use and their size distribution and how this affects penetration into trench backfill material.

The pipeline protection zones and protection types specified in Ref [7 & 8] refer to anchor weights of 6 Te, 12 Te and 22 Te.

Based upon certain characteristics such as fluke area, shank, stabilizers etc it is possible to classify the various anchor types ranging from Class A to Class G.

Class A anchors are deep penetrating anchors designed for high holding power applications, e.g. Vrijhof and Stevpris anchors. Commercial vessels most commonly use stockless anchors in the category Class F and improved stockless anchors (higher holding power) in Class E.

Typical Class E anchors are the Admiralty Cast 14 [AC 14], Stokes, Baldt, Snugstow and Weldhold anchors. Typical Class F anchors are the US Navy Stockless, Byers, Union, Hall and Spec anchors.

For the purpose of this study, US Navy Stockless, Admiralty Cast (AC), Baldt, Hall and Spek anchor type designs have been selected. The dimensions and mass of these anchor types closely match the weight class defined above.

4.4 Anchor Penetration Depth

The most important parameters to anchor users are holding power and the drag distance needed to realize full holding power. Direct measurements of the penetration into the seabed or rock material are therefore not readily available as this is dependent on the drag distance.

In general, ships anchor in good ground with anchor penetration in the region of one fluke length, equivalent to around 2.2m for the largest anchors Ref [9].

Practical trials have demonstrated that maximum holding power is achieved with a fluke angle of 32° in gravel, whereas the optimum for soft mud is 50°. Manufactures often use 40° as a compromise for all types of seabed. A fluke angle of 40° will limit the vertical penetration in good ground where the stock remains horizontal on the surface, to the fluke length times sin 40° Ref [9].

Therefore, for this study, it is conservatively assumed that a dragged anchor may penetrate one fluke length into the rock cover before extricating out of the rock berm. Further, it is assumed that the fluke angle of the anchor types considered in the study is 40°.

4.5 Rock Berm Design

The rock berm is designed to withstand the environmental loading. Basically, the rock berm will consist of two layers of engineering backfill. The top layer, the armour rock layer, provides the mechanical protection against the environmental forces. The second layer is the under layer or the bedding layer which is introduced between the trench bed and the armour layer. The purpose of this layer is to prevent any mechanical damage to the pipelines by the larger size rocks of the armour layer during rock dumping as well as to protect base material from being transported away through the armour layer.

The protection design carried out is in accordance with the "Shore Protection Manual" Ref [14].

4.5.1 Armour Layer Design

The top layer engineering backfill, as a minimum, should comprise of well-graded rock with unit weight of approximately 2600 kg/m^3. The required armour rock weight or size, to withstand the environmental forces (largely on-bottom current and wave induced velocity) from sliding or overturning/rolling, is determined considering factors such as the Isbach's constant for embedded stone and slope influence on the flow velocity. The current velocity should be determined at the top of the rock berm. The equations for the required rock weight are presented below.

$$W = \frac{\pi V^6 w_r}{48\gamma^6 g^3}\left[\frac{w_w}{w_r - w_w}\right]^3\left[1-\frac{\sin^2\theta}{\sin^2\phi}\right]^{-\frac{3}{2}}$$

$$D_{50\min} = \left(\frac{6}{\pi}\right)^{\frac{1}{3}} \times \left(\frac{W}{w_r}\right)^{\frac{1}{3}}$$

where:

W	=	weight of individual stones (kg)
V	=	current and wave induced velocities (m/s)
g	=	acceleration due to gravity (m/s^2)
w_w	=	unit weight of water (kg/m^3)
w_r	=	unit weight of rock (kg/m^3)
θ	=	angle of berm slope with horizontal (°)
ϕ	=	angle of repose of the stones (°)
γ	=	Isbach's constant: 0.86 for non-embedded or 1.2 for embedded
D_{50min}	=	Minimum diameter exceeded by coarsest 50% of rock layer (m)

Instability and erosion of backfill will occur if the combined effect of grading and average particle size are insufficient to resist the hydrodynamic forces exerted upon them at the near shore region. Therefore, to ensure minimum erosion of the top layer of engineering backfill during the worst storm conditions, the equivalent stone diameter, D_{50min}, as calculated above, is used to determine the grading distribution curve.

The grading distribution curve for the armour rock layer should satisfy the requirement given below:

$D_{50max} = (1.5)^{1/3}D_{50min}$;

$D_{15min} = (0.31)^{1/3}D_{50min}$; $D_{15mzx} = (0.75)^{1/3}D_{50min}$;

$D_{100min} = (2)^{1/3}D_{50min}$; $D_{100mzx} = (5)^{1/3}D_{50min}$

The thickness of the armour layer, r, is determined by the following equation:

$$r = 3.2 D_{50\,\mathrm{min}} \left(\frac{\pi}{6} \right)^{\frac{1}{3}}$$

4.5.2 Underlayer Design

Under the influence of hydraulic gradient that may exist in the backfill, there is a possibility that the finer (base) material will be transported through the coarser material, causing instability. Thus, an underlayer is introduced below the armour rock layer to minimise occurrence of such an event. The "Shore Protection Manual" recommends the following criteria for the underlayer design.

$$D_{15\,(A)} \leq 5D_{85\,(U)}$$

where: A = Top layer of backfill (armour rock)
U = Under layer of backfill (bedding gravel)

5. DESIGN CRITERIA

5.1 General

For a dropped anchor, the pipeline shall have a sufficient burial depth and / or a sufficient concrete weight coating thickness and steel wall thickness to resist an anchor impacting, and causing a dent not exceeding 5% of the pipeline steel OD Ref.[3].

For a dragged anchor the pipeline shall be laid in an excavated trench and the trench backfilled with graded rock to ensure that no anchor pull-over or hooking scenarios are possible. The rock cover depth shall be based on the maximum anchor penetrations possible, considering the trench backfill material.

The pipeline protection requirements against accidental anchor drop and drag are assessed in accordance with DNV-OS-F101 Ref [2] and DNV-RP-F107 Ref [3].

5.2 Dropped Anchor

Design criteria for assessing pipeline damage from dropped anchor impact are outlined in DNV-RP-F107 Ref [3]. The following criteria are adopted for determining the maximum allowable energy absorption by the pipeline.

Buried Pipeline - Pipeline Backfill Material

Maximum energy absorption is defined by the total energy absorption capacity of the material. The total energy absorption capacity of the backfill material may be assumed to be utilised before the protection coating is damaged.

Sufficient protection against anchor impact is achieved when the total energy absorption of the steel pipe wall, protective coatings and backfill material combined, i.e. maximum energy absorption capacity, is greater than the anchor impact energy.

Steel Pipe Wall

The maximum allowable energy absorption of the steel pipe wall is defined by the limiting dent size, i.e. 5% of the pipe steel OD. Dent sizes smaller than 5% of the pipe steel OD, fall under damage classification D1: "Damage neither requiring repair, nor resulting in any release of hydrocarbons".

Protection Coating (Concrete)

The maximum allowable energy absorption is defined by the total energy absorption capacity of the protection coating. The protection coating may be assumed to be completely damaged before the steel pipe wall is damaged.

5.3 Dragged Anchor

Dragging of an anchor across a buried pipeline may result in the following interaction types:

- No interaction, i.e. the anchor is dragged across the pipeline without making physical contact with the pipeline;
- Pull-over interaction, i.e. the tips of the anchor flukes impact the side of the pipeline and the anchor is subsequently pulled over the pipeline; and
- Hooking interaction, i.e. the anchor flukes impact the side of the pipeline and the pipeline is subsequently hooked between the flukes and shank.

The protection mechanism for the pipeline against a drag anchor should avoid a pull-over interaction and / or a hooking interaction.

A safety margin of 200 mm to account for any long term settlement is considered for the rock cover over pipeline against a penetrating anchor for the anchor drag scenario.

5.4 Maintenance Dredging

To permit maintenance dredging, the top of the rock berm shall not protrude above the original seabed level. The berm shall also have sufficient rock cover to protect the pipeline from a dropped 25 tonne dredge bucket.

5.5 Rock Berm Design

The rock berm shall be designed to withstand the 100 year return period extreme environmental loading with an acceptable total cumulative damage over the design life. The selected nominal rock size D_{50} should exceed the required stone diameter D_{50min} and the thickness of the armour layer should meet the minimum calculated requirement. The nominal rock size in the under/bedding layer should meet the criteria (see 4.5.2) to prevent seabed sediment from the base of the rock berm to be washed away.

6. DESIGN DATA

6.1 Mechanical Pipeline Data

Pipeline data applicable to the 20 inch aviation fuel pipelines are given in Tables 6-1. Unless otherwise specified all design data are from Ref [1].

Table 6-1: Pipeline Data

Parameter	Unit	Value
Outside Diameter	mm	508
Wall Thickness	mm	11.9 Ref [11]
Pipe Grade	-	X52
SMYS	MPa	359
Type Corrosion Coating	-	FBE
Corrosion Coating Thickness	mm	0.725
Corrosion Coating Density	kg/m³	1350
Concrete Coating Thickness	mm	35 Ref [12]
Concrete Coating Density	kg/m³	3050
Concrete Cube Strength	MPa	40 Ref [13]

For the anchor impact assessment calculations, a minimum concrete coating thickness of 35 mm has been assumed.

6.2 Shipping Channel Crossing Locations

The offshore pipeline crosses a shipping lane (Urmston Road) between KP0 and KP2.0 Ref [7]. TOP is a minimum -26.5m below principle datum in this section.

6.3 Geophysical Data

The geophysical data used for the study is obtained from Ref [4] and presented in Table 6-2.

Table 6-2: Geophysical Data

Parameter	Unit	Value
Seawater Density	kg/m^3	1025
Max water depth shipping channel	m	27.0
Max water depth	m	27.0
Rock backfill – dry bulk density	kg/m^3	1800$^{(1)}$
Soil Classification shipping channel	-	Clayey/ Silty Sand
Soil Classification Pipeline Route	-	Clayey/ Silty Sand

Note:
1.0 Typical value

6.4 Depth of Penetration Data

The material's coefficient of penetration used in the impact analysis to determine the depth of penetration of the anchor into the rock fill material is assumed based on the values given for other materials in the Bureau of Yards and Docks, Department of the U.S. Navy Ref [5]. These are presented in Table 6-3.

Table 6-3: Seabed Material's Coefficient for Penetration

Parameter	Unit	Value
Sandy Soil	m^3/kg	0.00229
Soft Soil	m^3/kg	0.00457
Stone Masonry	m^3/kg	0.00073
Brick Work	m^3/kg	0.00128
Rockfill$^{(1)}$	m^3/kg	0.00156

Note:
1.0 The coefficient of penetration for rockfill material is an assumed value based on above given values in Ref.[5]

6.5 Trench Profile

The trench profile, rock berm profile and rock grade specified for the different anchor protection zones are given in Appendix-A.

6.6 Anchor Types and Dimensions

The anchor types and dimensions in Table 6-4 Ref [9 & 10] have been used in the calculations.

Table 6-4: Anchor Types and Dimensions

Parameter	Unit	Anchor Type – AC 14		
Anchor Weight		5.6	13.5	23.0
Anchor Length	m	3.305	4.429	5.290
Anchor Width	m	2.559	3.249	4.096
Anchor Crown Width	m	0.768	1.029	1.229
Anchor Fluke Length	m	1.741	2.333	2.787
Parameter	**Unit**	**Anchor Type – US Navy Stockless**		
Anchor Weight	Te	6.8	13.6	18.1
Anchor Length	m	2.680	3.372	3.708
Anchor Width	m	2.089	2.608	2.872
Anchor Crown Width	m	1.295	1.616	1.778
Anchor Fluke Length	m	1.861	2.394	2.619
Parameter	**Unit**	**Anchor Type – Baldt**		
Anchor Weight	Te	6.06	12.47	-
Anchor Length	m	2.490	3.180	-
Anchor Width	m	1.950	2.700	-
Anchor Crown Width	m	1.020	1.410	-
Anchor Fluke Length	m	1.470	2.030	-
Parameter	**Unit**	**Anchor Type - Hall**		
Anchor Weight	Te	6.0	12.3	23.0
Anchor Length	m	3.270	3.600	4.465
Anchor Width	m	2.033	2.520	3.125
Anchor Crown Width	m	0.829	1.140	1.385
Anchor Fluke Length	m	1.625	1.800	2.230
Parameter	**Unit**	**Anchor Type - Spek**		
Anchor Weight	Te	6.0	12.3	20.0
Anchor Length	m	2.700	3.440	4.070
Anchor Width	m	2.060	2.632	3.018
Anchor Crown Width	m	1.006	1.297	1.493
Anchor Fluke Length	m	1.500	1.910	2190

Note:
1.0 Baldt anchors do not have a matching anchor for the 22 Te weight class.

6.7 Enviromental Data for Rock Berm Design

As a conservative measure, the worst case scenario is assumed where the rock berm is designed for 100-year return period omni-directional maximum wave and current. The environmental data at the seawall location is as shown in Table 6-5.

Table 6-5: Environmental Data

Description	Parameter
Significant Wave Height, Hs	3.87 m $^{(1)}$
Spectral Peak Period, Tp	11 s
Current Velocity @ 4 m above seabed	0.85 m/s $^{(2)}$

Note:
1.0 Maximum wave height 6.97 m is used for rock berm design (estimated to be 1.8Hs).
2.0 Current velocity @ 0.1 m above seabed is determined (through $1/7^{th}$ power law) to be 0.5 m/s and used as the rock berm is embedded.

7. RESULTS

7.1 Anchor Impact Study

Results obtained from the anchor impact study are shown in Table 7-1.

Table 7-1: Anchor Impact Study Results

Parameter	Unit	Anchor Protection Type		
		Type C	Type A	Type B
Rock Cover (TOP)[1]	mm	1600	1746	2750
Anchor Type	-	US Navy Stockless	AC 14	AC 14
Anchor Weight	T	6.8	13.5	23.0
Anchor Energy at Impact on Rock berm	kJ	171	630	1052
Energy Absorption Potential of Pipe Concrete Coating	kJ	323	256	306
Energy Absorption Potential of Pipe Steel Wall	kJ	6.3	6.3	6.3
Predicted Anchor Penetration into Rock fill	mm	15	43	48
Rock Cover adequate?	-	YES	YES	YES

Notes:
1. Rock cover from top of concrete coated pipe

The results show that all anchors have minimal penetration as would be expected. By inspection, the penetration of a large 25 tonne dredge bucket will also have minimal penetration into the rock berm.

7.2 Dragged Anchor Study

For the berm dimensions shown in Table 7-2, the results obtained from the dragged anchor protection study are shown in Table 7-3.

Table 7-2: Rock Cover

Parameter	Unit	Rock Berm Data		
Protection Type	-	Type C (6Te)	Type A (12Te)	Type B (22Te)
Minimum Rock Cover Available	m	1.600	1.746	2.750

Table 7-3: Dragged Anchor Protection Study Results

Parameter	Unit	Anchor Type - AC14		
Anchor Fluke Length	m	1.741	2.333	2.787
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	1.119	1.500	1.791
Clearance against Fluke Penetration	m	**0.481**	**0.246**	**0.959**
		Anchor Type – US Navy Stockless		
Anchor Fluke Length	m	1.861	2.394	2.619
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	1.196	1.539	1.683
Clearance against Fluke Penetration	m	**0.404**	**0.207**	**1.067**
		Anchor Type – Baldt		
Anchor Fluke Length	m	1.470	2.030	-
Anchor Fluke Angle	Deg.	40	40	-
Anchor Fluke Penetration Depth	m	0.945	1.305	-
Clearance against Fluke Penetration	m	**0.655**	**0.441**	-
		Anchor Type – Hall		
Anchor Fluke Length	m	1.625	1.800	2.230
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	1.045	1.157	1.433
Clearance against Fluke Penetration	m	**0.555**	**0.589**	**1.354**
		Anchor Type – Spek		
Anchor Fluke Length	m	1.500	1.910	2.190
Anchor Fluke Angle	Deg.	40	40	40
Anchor Fluke Penetration Depth	m	0.964	1.228	1.408
Clearance against Fluke Penetration	m	**0.636**	**0.518**	**1.342**

The results show that all anchors exceed the nominal safety margin clearance of 200 mm.

APPENDIX B

ROCK BERM DESIGN CALCULATION

Armour Rock Backfill Design (Shore Protection Manual - 1984)

INPUT DATA	Sym	Units	1	2	3
Water Depth	d	m	10	16	22
Wave Period (100-year RP)	T	s	11	11	11
Wave Height (100-year RP) (1)	H	m	6.97	6.97	6.97
Current at 0.1m Above Seabed (100-year RP) (2)	V_c	m/s	0.50	0.50	0.50
Acceleration due to Gravity	g	m/s^2	9.81	9.81	9.81
Seawater Density	ρ_w	kg/m^3	1025	1025	1025
Rock oven-dried Density	ρ_r	kg/m^3	2600	2600	2600
Isbash Coefficient (1.2 for Embeded, 0.86 for Non-embeded)			1.2	1.2	1.2
Berm Slope (1 : X)	X	-	3.0	3.0	3.0
Berm Slope Angle	θ	deg	18.4	18.4	18.4
Angle of Response of Rock	φ	deg	40	40	40
OUTPUT DATA	**Sym**	**Units**	**1**	**2**	**3**
Wave-induced Velocity	V_w	m/s	3.07	2.24	1.75
Total Velocity	V	m/s	3.57	2.74	2.25
Weight of stone	W	kg	52.28	10.69	3.30
Stone Size Diameter	D_{50}	mm	337	199	134
	D_{50min}	mm	337	199	134
	D_{50max}	mm	386	228	154
Selected D_{50min}	D_{50min}	mm	400	400	400
$D_{50max} = (1.5)^{1/3} D_{50min}$	D_{50max}	mm	458	458	458
$D_{15min} = (0.31)^{1/3} D_{50min}$	D_{15min}	mm	271	271	271
$D_{15max} = (0.75)^{1/3} D_{50min}$	D_{15max}	mm	363	363	363
$D_{100min} = (2)^{1/3} D_{50min}$	D_{100min}	mm	504	504	504
$D_{100max} = (5)^{1/3} D_{50min}$	D_{100max}	mm	684	684	684
Thickness of Layer, $r = 3.2 {}^* D_{50min} {}^* (\pi/6)^{1/3}$	r	mm	1032	1032	1032
Recommended D_{50max}	D_{50max}	mm	460	460	460
Selected Thickness	-	mm	1200	1200	1200
Status	-	-	OK	OK	OK

Notes:

1. Maximum wave height used (estimated to be 1.8 Hs).

2. Current velocity at near bottom (0.1m from seabed) is estimated using 1/7th power law based on current velocity 0.85 m/s at 4m above seabed.

7.3 Rock Berm Design

The details of the analysis are provided in Appendix B. The results of calculations carried out for three water depths 10 m, 16 m and 22m are shown in Table 7-3.

Table 7-3: Required Armour Layer Rock Size and Cover

Parameter	Unit	Water Depth		
		10 m	16 m	22 m
Required D_{50min}	mm	337	199	134
Selected D_{50min}	mm	400	400	400
D_{100max} (corresponding to the selected D_{50min})	mm	684	684	684
Minimum armour cover required	m	1.03	1.03	1.03
Minimum armour cover available (1)	m	1.20	1.20	1.20

Note:
1.0 For anchor protection Type-C.

The particle size distributions specified for installation of the rock berm are shown in Table 7-4 and Table 7-5 for armour layer and under layer respectively.

Table 7-4: Armour Layer Particle Size Distribution

Parameter	Unit	By Size Passing		
		700 mm	200 mm	75 mm
Rock fill material, Grade 700	%	100	0 - 10	0 - 5

Table 7-5: Under Layer Particle Size Distribution

Parameter	Unit	By Size Passing		
		200 mm	75 mm	20 mm
Rock fill material, Grade 200	%	100	20 - 75	0 - 50

As the specified D_{100} (700 mm) is larger than D_{100max} (684 mm) and the minimum armour cover available (1.2 m) is greater than the required (1.03 m), the armour layer rock size and thickness are considered acceptable.

The under layer particle size design criteria requires that:

$$D_{15\,(A)} \leq 5D_{85\,(U)}$$

From the calculations, mean $D_{15\,(A)}$ is 317 mm. From Table 7-5 above, it can be seen that $D_{85\,(U)}$ will be larger than 75 mm. Assuming $D_{85\,(U)}$ = 75 mm, $5D_{85\,(U)}$ = 375 mm. The design criteria for under layer particle size is therefore satisfied.

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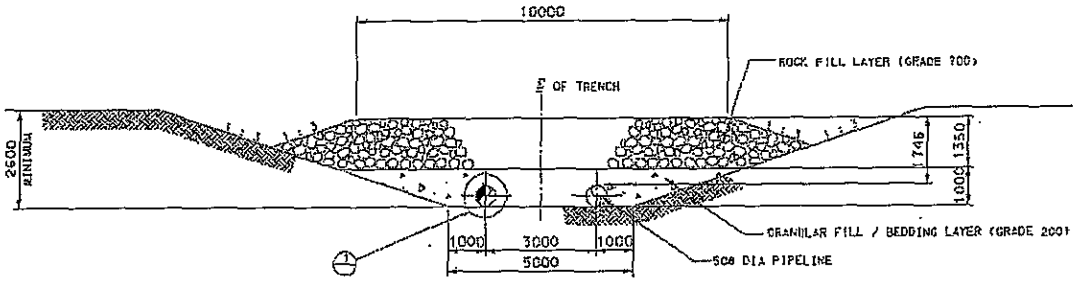
14. "Shore Protection Manual", US Army Corps of Engineers, 1984.

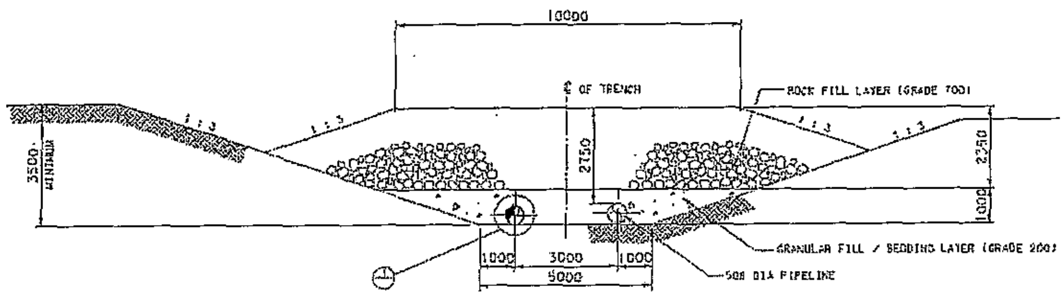
APPENDIX A

ROCK BERM PROFILES



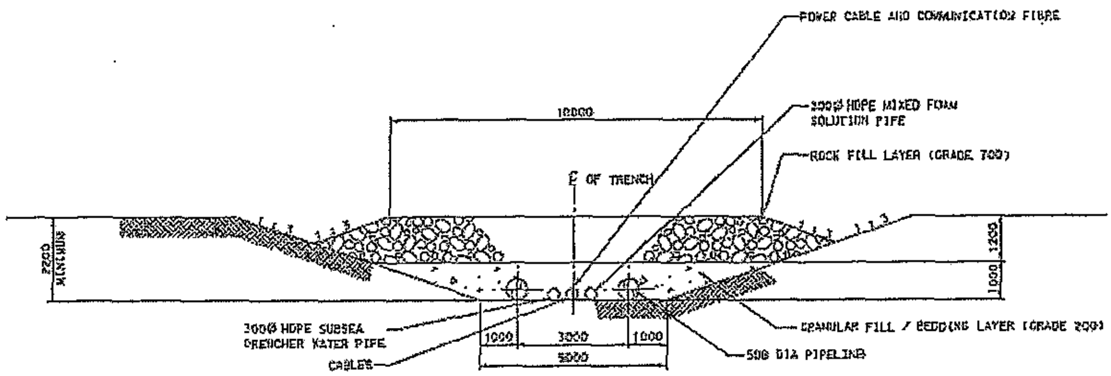
12T ANCHOR PROTECTION TYPE A

Notes:
1. Minimum depth of rock cover from top of concrete coated pipe is 1746 mm.
2. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.



22T ANCHOR PROTECTION TYPE B

Notes:
1. TOP is minimum -26.5mPd.
2. Minimum depth of rock cover from top of concrete coated pipe is 2750 mm.
3. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.



6T ANCHOR PROTECTION TYPE C
SECTION A-A

Notes:

1. Minimum depth of rock cover from top of concrete coated pipe is 1600 mm.
2. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.

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偉信 Scott Wilson

Leighton Contractors (Asia) Ltd
Lung Hong Street
Lung Mun Road
Tuen Mun Area 38
Tap Shek Kok
New Territories

Your Reference:
Our Reference: 01368/12/3/S002536
Date: 9 March 2009

Attn.: Mr Boyd Merrett

BY HAND

Dear Sirs

Permanent Aviation Fuel Facility
Subsea Pipelines – Material Proposal for Rockfill Material

We refer to your letters dated 2 March 2009 and 6 March 2009 reference H2104/C22/10604/BM/SH/YNW/pl and H2104/C22/10650/BM/SH/YNW/kk respectively regarding the captioned subject.

We note that the "Dragged Anchor and Dropped Object Protection Report" provides calculations to verify the thickness of rockfill specified on drawing no. PAFF/LC/04/DWG/C/0408, however the report seems not provide any design for choosing of the Grade 200 and Grade 700 rockfill.

Grade 700 rockfill is specified in Section 21 of GS for marine works while Grade 200 rockfill is specified in Section 6 of GS for general earthworks. You are requested to provide design calculations for choosing of these rockfill materials, their suitability and stabilities (e.g. migration of fine particles in the rockfill) on the seabed.

You are also requested to provide a summary of testing regimes for the Grade 200 rockfill and Grade 700 rockfill respectively.

Yours faithfully
SCOTT WILSON LTD

M G Kay

Michael G KAY
Construction Manager

MGK/BWCY/cmc

cc ECO (Attn: Mr Tommy Siu) – by Fax only (2214 1484)

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2 March 2009

Our Ref: H2104/C22/10604/BM/SH/YNW/kk
Your Ref: 01368/12/3/S002477

10604
H2104 File: C22
Action:
Circulation: Y N
Copies: YNW, SH, AH
Date: - 3 MAR 2009
Response To:
Keys: SUP
※ = Without Attachments

Scott Wilson Limited
(Site Office)
Lung Hong Street
Lung Mun Road
Tuen Mun Area 38
Tap Shek Kok
New Territories

Attn: Mr. Michael Kay

(By Hand)

Dear Sir,

PERMANENT AVIATION FUEL FACILITY
SUBSEA PIPELINES – MATERIAL PROPOSAL FOR ROCKFILL MATERIAL

We refer to your letter ref. 01368/12/3/S002477 dated 23 February 2009 and would like to reply as follows:

1. The design of the rockfill protection to pipeline is provided in the "Dragged Anchor and Dropped Objects Protection Report" submitted under cover of our letter ref. H2104/C22/7602/BG/SH/EC/pl dated 26 February 2008. The report is based on the rockfill sizes as shown on drawing PAFF/LC/04/DWG/C/0408. Please refer to paragraph 3 in Section 3.2 and Section 6.5 of the report. According to Appendix A of the report (copy attached), the rockfill sizes used in the report are Grade 700 and Grade 200 for the upper and lower rockfill layer respectively.

2. Grade 200 rockfill material will comply with GS Table 6.1.

Date of quarry visit will be confirmed later.

Yours faithfully

Boyd Merrett
Project Manager

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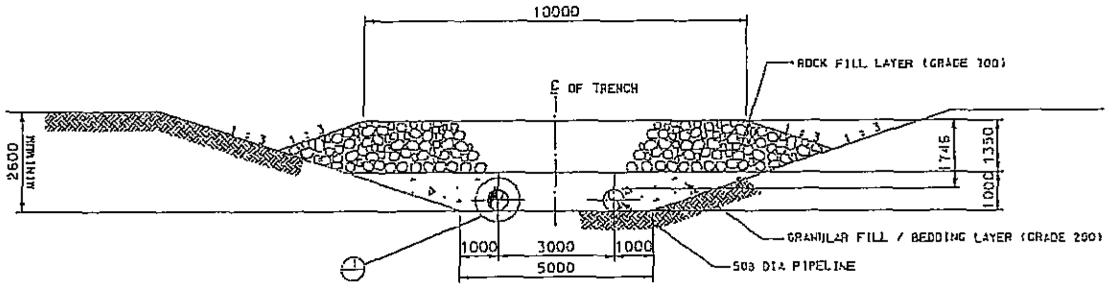
f: +852 2404 0081
10604.doc

LEIGHTON
禮頓

Attached: 1)Dagged Anchor and Dropped Objects Proejction Report (A4 x 3 sheets)
cc: ECO – Mr. Tommy Siu (w/encl) **(By Hand)**

APPENDIX A

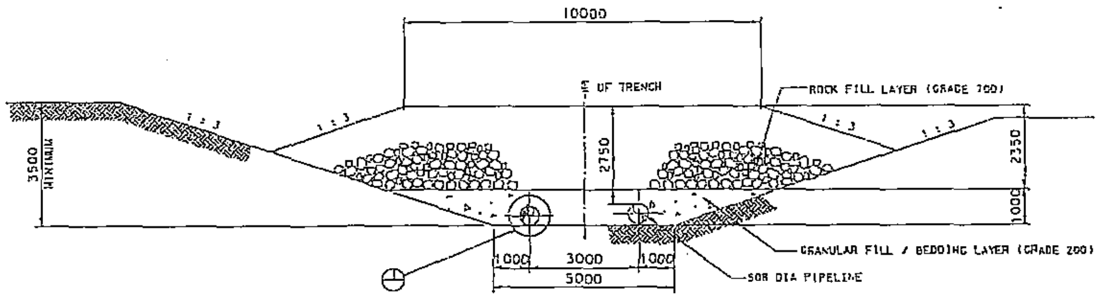
ROCK BERM PROFILES



12T ANCHOR PROTECTION TYPE A

Notes:

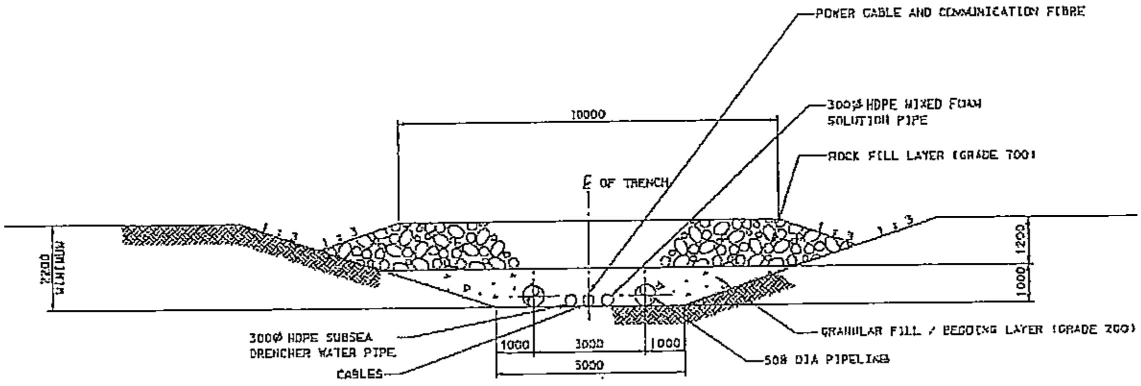
1. Minimum depth of rock cover from top of concrete coated pipe is 1746 mm.
2. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.



22T ANCHOR PROTECTION TYPE B

Notes:

1. TOP is minimum -26.5mPd.
2. Minimum depth of rock cover from top of concrete coated pipe is 2750 mm.
3. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.



6T ANCHOR PROTECTION TYPE C
SECTION A-A

Notes:

1. Minimum depth of rock cover from top of concrete coated pipe is 1600 mm.
2. To allow for navigation maintenance dredging, top of the rock berm shall not protrude above the original seabed level.

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Tap Shek Kok
New Territories

Your Reference:

Our Reference: 01368/12/3/S002477

Date: 23 February 2009

Attn.: Mr Boyd Merrett

BY HAND

Dear Sirs

Permanent Aviation Fuel Facility
Subsea Pipelines – Material Proposal for Rockfill Material

We refer to your letter dated 16 February 2009 reference H2104/C22/10457/BM/SH/YNW/pl regarding the captioned subject.

Please provide the following for our comment:-

1) Design calculations for the rockfill sizes of the subsea pipe trench

2) Specifications of the Grade 200 rockfill

Please advise your proposed date for the quarry visit.

Yours faithfully
SCOTT WILSON LTD

M G Kay

Michael G KAY
Construction Manager

MGK/BWCY/cmc

cc ECO (Attn: Mr Tommy Siu) – by Fax only (2214 1484)

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16 February 2009

Ref: H2104/C22/10457/BM/SH/YNW/pl

10457

H2104	File: C22
Action: YNW	
Circulation: Ⓨ	N
Copies: SH, DH	
Date: 18 FEB 2009	
Response To:	
Keys: SUP	
※ = Without Attachments	

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Attn: Mr. Michael Kay

(By Hand)

Dear Sir,

PERMANENT AVIATION FUEL FACILITY
SUBSEA PIPELINES – MATERIAL PROPOSAL FOR ROCKFILL MATERIAL

With reference to rockfill requirements as shown on drawing PAFF/LC/04/DWG/C/0408, we propose to supply rock materials from the following sources.

1. Type of material: Grade 200 and Grade 700 rockfill
2. Location of source:
   a) Zhon Shan Heng Men – Sun Lung Quarry
   b) Aberdeen – Hong Kong

Site visit to the proposed quarry can be arranged if required.

Yours faithfully

Boyd Merrett
Project Manager

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cc: ECO – Mr. Tommy Siu (By Hand)

10457.doc