ECO Aviation Fuel Services Limited

ANNUAL AUDIT REPORT

For

PERMANENT AVIATION FUEL FACILITY

Environmental Permit
EP-262/2007/B

Date of Audit :		27 February to 19 March 2021
Prepared By :	Michael Chung, Technical Manager	19 March 2021
Reviewed By :	Sylvia Har, Facility Manager	23 March 2021
Approved By :	Tommy Siu, General Manager	26 March 2021

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Introduction

ECO Aviation Fuel Services Limited (EAFS) is the operator of the Permanent Aviation Fuel Facility (PAFF), which is located on 9.28 ha of land at 9 Lung Hong Street, Tap Shek Kok, Tuen Mun. PAFF consists of a tank farm, a twin berth jetty and associated pipelines for receipt of aviation fuel from ocean tankers to the tank farm, and twin submarine pipelines from the tank farm to the aviation fuel receipt facility at Sha Chau Island.

PAFF is accredited with ISO14001.

The tank farm has eight storage tanks of which six (6) 35,000m^3, one (1) 32,000m^3 and one (1) 22,000m^3 respectively thus providing a total storage capacity of 264,000m^3. The tank farm is provided with bund walls and a contained drainage system.

Other facilities within PAFF include a pump platform, where the pumps, filters and recovery system are located. An administration building houses the control room, security control, backup power generator, firefighting equipment, transformers, switch room and workshop.

Aviation fuel is unloaded at a twin berth jetty located approximately 200 meters offshore where water depth is about 17m. The jetty is constructed on tubular piles and designed for berthing tankers of deadweight tonnage ranging from 10,000 to 80,000.

Aviation fuel is transferred to Hong Kong International Airport (HKIA) by means of twin subsea 500mm diameter pipelines to the Sha Chau island custody transfer facility located at 4.4 kilometers south of PAFF. The transfer pipelines are installed with cathodic protection system and leak detection system.

In summary, PAFF is for storage and delivery of aviation fuel to HKIA.

Purpose and Scope

This Annual Audit reviews the performance of the design arrangements and measures mentioned in Condition 3.5 of the Environmental Permit (EP-262/2007/B).

In this report, there are photos and inspection records made available for review. The photos and inspection records that have been attached are representative of the facilities and associated operation process.

Conclusion

The results of the Year 2020 Annual Audit reveal that the Environmental Permit Condition 3.5 requirements are adhered.

Audit Details

Results are designated as "**C"** for Conformance, "**O"** for Observation and "**NC"** as Non-Conformance.

1 Conditions Set Out in the Environmental Permit

1.1 Containment Systems of Aviation Fuel Storage Tank Farm

1.1.1 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.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that :- 1. 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) have been built. 2. 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 far greater than 150% of the largest aviation fuel storage tank in the bunded compounds. 3. 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. 4. The design meets 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. There had been no change made after the completion of construction since October 2010. Photographs No. 1 & 2 show that all eight tanks are located within bunded compounds.	**C**

1.1.2 The bunds shall be partly sunken below the level of ground outside the bunds.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that :- 1. Drawings PAFF/BA/02/DWG/C/1721-1724 illustrate that the bunds have been designed to be partly sunken below ground level outside the bunds in the EVA. There had been no change made after the completion of construction since October 2010. Photographs No. 3 & 4 show that both bunded areas are lower than the ground level outside the bunds.	**C**

1.1.3 Wave Deflector shall be used at the bunds.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that :- 1. Drawings PAFF/BA/02/DWG/C/1721-1724 illustrate the design and installation of wave deflectors on the bund walls." There had been no change made after the completion of construction since October 2010. Photograph No. 5 shows that wave deflectors are located at top of the bunds.	**C**

1.1.4 Fire-retardant joints shall be used at the bunds.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that :- 1. Drawings PAFF/BA/02/DWG/C/1722-1724 illustrate the design and installation of special fire-retardant joints at the bunds. The components consist of Flexcell Compressible Filler and Nelson Fire Stop Product ES1399 Joint Sealant (capable of 4 hours of fire resistance). All visible parts of the joints are covered by stainless steel plates on the inside. There had been no change made after the completion of construction since October 2010. For phase 1a bund, the external steel plates are fixed in. For phase 1b bund, the steel plates are embedded in the concrete and span across the construction joint. Photographs No. 6 & 7 show that visible parts of the joints are covered by stainless steel plates on the inside at phase 1a.	**C**

1.1.5 Intermediate bund walls shall be designed and constructed within the bunded compounds for each aviation fuel storage tank.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that :- 1. Drawings PAFF/BA/02/DWG/C/1452 & PAFF/LC/02/DWG/C/0551 illustrate the construction of internal bund (intermediate bund) walls within the bunded compounds for each aviation fuel storage tank meeting the I.P. Code Part 19 "Fire Precautions at Petroleum Refineries and Bulk Storage Installations" item 3.4.2.5.4. There had been no change made after the completion of construction since October 2010. Photographs No. 8 & 9 show that intermediate bund walls are in place.	**C**

1.1.6 Two impervious security walls shall be designed and constructed outside the bunded compounds.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that :- 1. Drawings PAFF/BA/02/DWG/C/1721-1724 illustrate 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. There had been no change made after the completion of construction since October 2010. Photographs No. 10 & 11 show that two impervious security walls outside the bunded compounds are complete in place.	**C**

1.1.7 A landscaped berm of at least 1.5m high shall be designed and constructed outside the bunded compounds.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that :- 1. Drawing PAFF/BA/02/DWG/C/1481 illustrates a landscaped berm of at least 1.5m high outside the outer security wall." There had been no change made after the completion of construction since October 2010. Photographs No. 12 & 13 show that a landscaped berm of at least 1.5m high outside the outer security wall is in place and properly maintained.	**C**

1.1.8 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.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawing PAFF/BA/02/DWG/C/1727 illustrates 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." There had been no change made after the completion of construction since October 2010. Photographs No. 14 & 15 show that the gates at security walls are in place.	**C**

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

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawings PAFF/BA/02/DWG/C/1726, 1728, and 1730 illustrate that all the bund and security walls are constructed by reinforced concrete to provide sufficient structural strength to withstand any liquid surge load in case of any accident." There had been no change made after the completion of construction since October 2010. Photographs No. 16 & 17 show that all the bund and security walls are in place.	**C**

1.2 **Drainage Isolation and Lining System for Aviation Fuel Storage Tank Farm**

1.2.1 Drainage system shall be properly designed and constructed for the aviation fuel storage tank farm to collect aviation fuel in case of spillage.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. The drainage layout plans in Drawings PAFF/BA/02/DWG/C/1452 & PAFF/LC/02/DWG/C/0551 illustrate the construction of the drainage systems with appropriate falls and gradients to collect aviation fuel in case of spillage. 2. The design meets the Hong Kong "Code of Practice for Oil Storage Installation" item 6.2.1. There had been no change made after the completion of construction since October 2010. Photographs No. 18 & 19 show that the impervious lining is in good condition and the drainage falls towards interceptor for collection.	**C**

1.2.2 Valves and oil interceptors shall be properly designed and constructed at the drainage system to prevent any oily discharge to the sea.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. The drainage layout plans in Drawings PAFF/BA/02/DWG/C/1452 & PAFF/LC/02/DWG/C/0551 illustrate the installation of oil interceptors and valves before the drainage outlets of bunded areas. The oil interceptors are designed to intercept and contain spillage while the valves are normally kept in close position as further precaution. They will be opened to release storm water inside the bunded areas as necessary. 2. The design meets the Hong Kong "Code of Practice for Oil Storage Installation" item 7.1. There had been no change made after the completion of construction since October 2010. Photographs No. 20 & 21 show that the valves at the oil interceptors and are kept in normal-close position.	**C**

1.2.3 Impermeable lining shall be installed underneath all aviation fuel storage tanks to prevent seepage of aviation fuel to ground.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawing PAFF/BA/02/DWG/C/1705 illustrates the installation of impermeable lining 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 meets the I.P. Code Part 19 "Fire Precautions at Petroleum Refineries and Bulk Storage Installations" item 3.4.2.5.2. " There had been no change made after the completion of construction since October 2010. Photographs No. 22 & 23 show construction record of the impermeable lining at various locations.	**C**

1.3 **Overfilling Monitoring System and Leakage Detection System**

1.3.1 Tank overfilling monitoring systems shall be properly designed and constructed for the Project.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Tank overfilling monitoring system is in place for each tank. 2. Alarms are set by means of the level gauge of each tank and will trigger an alarm by the SCADA system for operator alert. 3. Additional alarms were designed to supplement the 1st level protection system and independent level switches are installed for the high-high levels and would trigger Emergency Shutdown for the specific tank inlet valve immediately together with an audible alarm for the control room operator. According to appendix 2, PAFF has strict control to monitor and protect storage tanks from overfilling. The normal-fill-level and high level alarms have been set by means of the level gauge of each tank and would trigger alarm for operator alert. The high-high level alarm is set by electronic level gauge of each tank and would trigger an Emergency Shutdown of the tank inlet valves. A critical high alarm is installed to supplement the 1st level protection system of which an independent level switch is installed for detecting the critical high level and would trigger an Emergency Shutdown of the tank inlet valves. PAFF performs regular inspection on the functionality of the level alarms with traceable records. Photographs No. 24, 25 & 26 show that the high level alarm setting in the SCADA system, the regular testing on the high-high level alarm and test record.	**C**

1.3.2 Pipeline leakage detection system shall be properly designed and constructed for the Project.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawings PAFF/LC/01/DWG/M/0202-3 & 0207 illustrate the installation of pipeline leakage detection system in the subsea pipelines using COWI Stat Leak System software. The test is carried by closing inlet/outlet section of specific pipelines and measure pressure drop within a specified time period within the pipeline. A pressure drop not due to thermal effect may indicate a possible leak in the pipeline and will generate an alarm for immediate investigation. The Leak Detection System and associated instrumentation were installed and the software had been updated by the vendor after the completion of construction in October 2010. Photograph No. 27 shows the Leak Detection System is installed on the computer.	**C**

1.3.3 Impermeable lining leakage detection system shall be properly designed and constructed for the Project.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawing PAFF/BA/02/DWG/C/1705 illustrates the installation of 80mm diameter leak detection pipe in accordance with API 650 underneath the sump of each storage tank. 2. The head of the pipe is perforated and designed to situate above the containment membrane of the tank base with the pipe descending to the end outside the tank ring base, ensuring the pipe will collect and drain out fuel, if any, to a designated containment well at the tank side. Therefore, any leakage from the bottom of the storage tank would be detected and the bunded areas are laid with impervious membrane to contain fuel spillage. 3. The construction of this design has been implemented for all tanks. There had been no change made after the completion of construction since October 2010. Photographs No. 28 & 29 show the tell-tale pipe installed and the as-built fuel collection chamber.	**C**

1.3.4 Emergency shutdown (ESD) systems shall be properly designed and constructed for the Project. All ESD systems shall be equipped with manual initiating devices.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawings PAFF/KG/02/DWG/E/7437 & LC/03/DWG/M/0251 show the installation of manual-operated emergency shutdown (ESD) buttons at the strategic points in the tank farm and on the jetty for emergency use. 2. As soon as ESD is activated, all valves and delivery pumps will shut down automatically to isolate the fuel lines and stop fuel flow. The installation of ESD is in place. There had been no change made after the completion of construction since October 2010. Regular inspection is performed on the ESD functionality with records kept in the maintenance system. Photographs No. 30 & 31 show the ESD system and the regular testing.	**C**

1.3.5 The ESD system shall 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.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawings PAFF/LC/01/DWG/M/0202 – 0203 & 0207 illustrate 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. The installations are in place. There had been no change made after the completion of construction since October 2010. PAFF performs regular inspection on the functionality of the ESD interface with records kept. Photographs No. 32, 33, 34 & 35 show the regular testing on the ESD interface and testing record.	**C**

1.4 **Installations at the Jetty**

1.4.1 The jetty shall be installed with defensive fenders.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. On top of the standard fender system engineered to suit the full range of vessel sizes and types expected to use the berth, drawings PAFF/MA/03/DWG/C/2807-2808 illustrate the installation of defensive fenders on the shore side of the jetty and end protection units to protect against possible collision from small craft straying into the area. 2. The defensive fenders are in place. There had been no change made after the completion of construction since October 2010. Photographs No. 36, 37 & 38 show that the fender system is installed both at sea side and shore side of the jetty.	**C**

1.4.2 The jetty shall be installed with coupling points with slop collection utilities connecting to oil interceptors.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawing PAFF/LC/03/DWG/M/0251 illustrates the provision of oil interceptors and bunded areas to contain any dripping from the coupling equipment after disconnection from the ships and the minor spill will go into the slop collection utilities connecting to the oil interceptors. There had been no change made after the completion of construction since October 2010. Photographs No. 39 shows that the slop collection utilities are installed to recover excess aviation fuel during coupling and de-coupling.	**C**

1.5 Sub-sea Pipelines Protective Measures

1.5.1 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 the Environmental Permit No. EP-262/2007/B. 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.

Observation	Result
It was confirmed in the Design Audit Report dated October 2010 that : 1. Drawing PAFF/LC/04/DWG/C/0408 illustrates the sub-sea pipelines in accordance with the arrangement as shown in Figure 5 of the Environmental Permit EP-262/2007/B. 2. 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 protective armour rock layer of at least 1.2m thick. 3. The protective armour rock layer does not protrude above the seabed. 4. The installation is in good order. There had been no change made after the completion of construction since October 2010. According to the latest hydrographic survey result in February 2021(attached in Appendix 4) and there is no evidence of damage to the rock-fill protection layer over the subsea pipelines.	**C**

Appendices

Appendix 1 – The Auditor – Mr. Michael, M.K. Chung

Mr. Chung is the Technical Manager of EAFS responsible for project engineering and maintenance matters of the Permanent Aviation Fuel Facility.

Mr. Chung holds a Bachelor Degree in Mechanical Engineering and a Master Degree in Business Administration.

Mr. Chung participated in the PAFF design 2002 with in-depth involvement in the construction, testing and commissioning. He had solid experience in plant construction, maintenance and operation with EAFS' parent organization, the Hong Kong and China Gas Company Limited since 1995.

Appendix 2 – Level Alarms Settings for Each Storage Tank

Tank Operating and Overfill Alarm Setting

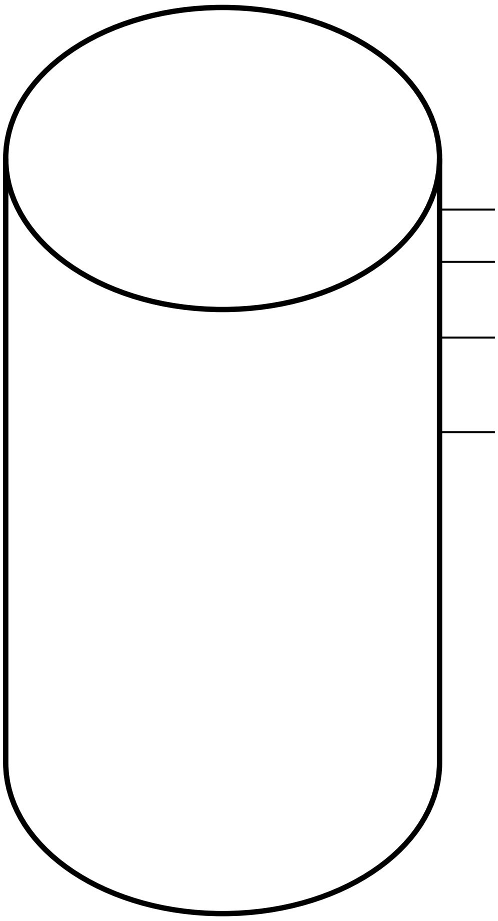
As per American Petroleum Institute guideline "API 2530-2012"

Permanent Aviation Fuel Facility (PAFF)

I. PRIMARY DATA

1. Demonstrated response time to close tank outlet and inlet valves when an alarm is activated = "A" min.
2. Volume transferred into the tank for a period of "A" min. = "B" m^3
3. Volume "B" m^3 with 1.5 factor of safety margin = "C" m^3

II. ALARM AND FILL LEVEL SETTINGS



Level Descriptions	Actions and Alarms
Critical Height (CH) = Independent Level Switch Setting and/or High High Level Alarm	Shutdown Alarm + Close inlet / Outlet Valves
High-High Level Alarm (HHLA) = CH – "C"	Shutdown Alarm + Close Inlet / Outlet Valves
High Level Alarm (HLA) = HHLA – "C"	High Alarm
Normal Fill Level (NFL) = NFL	Annunciation

Appendix 3 – Photos No. 1 to 38

(1) Four tanks are located within bunded compound – Phase 1a

(2) Four tanks are located within bunded compound – Phase 1b

(3) Phase 1a bunded compound is lower than the ground level outside the bunds

(4) Phase 1b bunded compound is lower than the ground level outside the bunds

(5) Wave deflector is located at top of the bund

(6) Visible parts of the joints are covered by stainless steel plates on the inside at phase 1a bund

(7) Maintenance works have been performed on sealant at joints

(8) Intermediate bund walls are provided in place near T-01-004

(9) Intermediate bund walls are provided in place near T-01-002

(10) Two impervious security walls are provided outside the bunded compounds

(11) Two impervious security walls are provided outside the bunded compounds

(12) Landscaped berm is maintained at least 1.5m high

(13) Landscaped berm is maintained at least 1.5m high

(14) Gates at security walls with sealant are maintained in good condition

(15) Gates at security walls with sealant are maintained in good condition

(16) This shows the thickness of the bund wall provided

(17) This shows the thickness of the security wall provided

(18) Impervious lining are maintained in good condition

(19) Tank farm is with appropriate gradient and the drainage falls to interceptor for collection

(20) Outlet valve provided for Phase 1a Interceptor with instruction sign to keep “normally closed”

(21) Outlet valve provided for Phase 1b Interceptor with instruction sign to keep "normally closed"

(22) Record photo shows impervious membrane being installed on top of tank foundation

(23) Record photo shows imperious membrane laid at tank center sump with tell-tale pipe embedded for leak detection

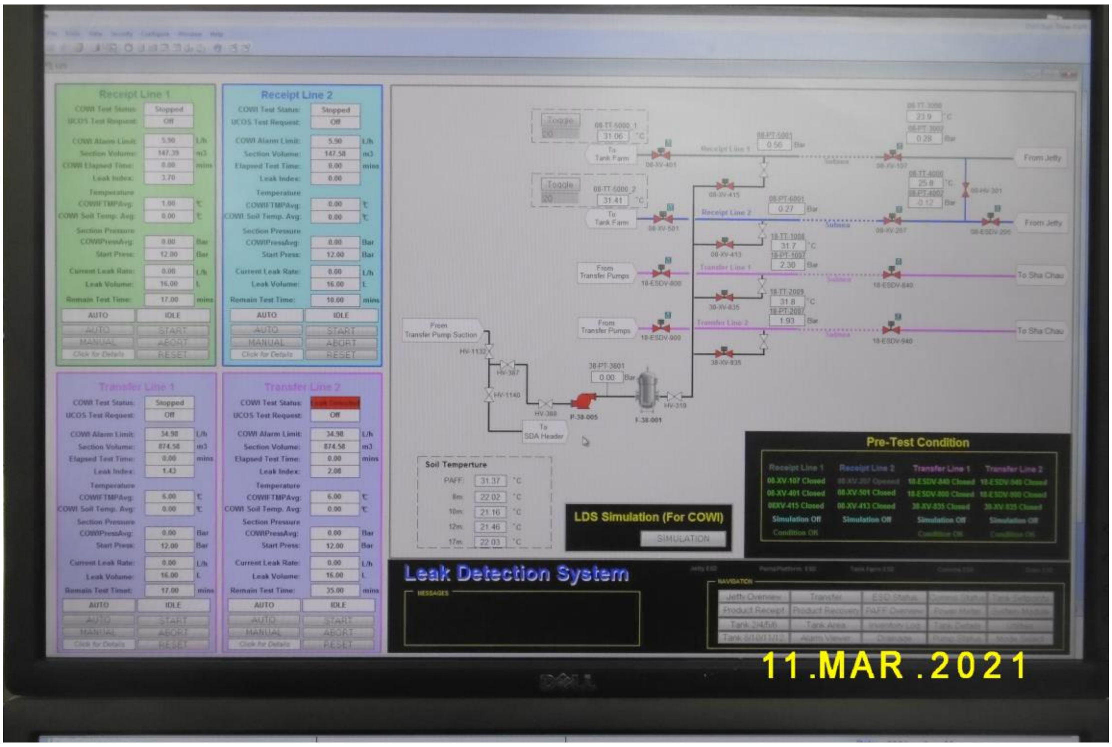
(24) High Level Alarm being set in the SCADA System

(25) Regular inspection performed on overfilling monitoring device (High-High Level Alarm)

Vertical Tank Surveillance

Tank No.		T-01- 002 (Fill in tank no. xxx)	Surveillance Date: 1/1-2021		
Item No.	Item	Acceptance Criteria/Ref. Standard	Compliance ✓ Yes	No	Note Fault & Ratification Completed/Action Required
1.0	**Tank Shell**				
1.1	Tank Shell	Any areas of flaking paint or corrosion. Inspect wind grinder and floor to shell areas.		✓	
1.2	Tank Shell Joints	Any signs of weeping, leaks or wetness from welded or reverted shell joint.		✓	
1.3	Stairs handrails and walkways	Any corrosion or paint flaking on stairways, treads, walks, handrails and underside of stair landings? Any structural damage.		✓	
1.4	Fixed Roof	Any visible damage, excessive corrosion or abnormal penetrations on roof top plates?		✓	
2.0	**Foundation**				
2.1	Foundation shape	Is the original foundation shape retained	✓		
2.2	Foundation	Are there signs of cracks or differential settlement? Dis it allow water to drain away from the tank edge?		✓	
	Foundation water retention	Are there signs that water is retained on shoulder areas?		✓	
3.0	**Valves**				
3.1	Valve operation	Are the valves free to operate and do the spindles have lubrication?	✓		
3.2	Security Valve and openings	Are all the valves not open/in sued locked? Are all spare nozzles, drain points ect. Positively secured by cap plug or blank?	✓		
3.3	Vents	Are vents operating correctly, no blockage by insects or bird nest?	✓		
3.4	Earthing connection and conductors	Is there any fraying or cables or damaged ot corroded conductors, connections or earth's takes?	✓		
3.5	Other tank roof fittings	Are the cable trays all in serviceable condition, free from damage and corrosion?	✓		
4.0	**Fire Protection**				
4.1	Cooling sprays & deflector plates	Any blockage with debris or any visible corrosion?		✓	
4.2	Base foam injection valve	Is the valve opened?	✓		
4.3	Top foam pourer	Are there any signs of corrosion or blockage to the pourer, aerator or supply piping? Are pipe bracket to tank secure?	N/A		
5.0	**Overfill Protection**				
5.1	Independent hi-hi level alarm	Does the alarm operate correctly?	✓		
5.2	Tank high level alarm	Does the alarm operate correctly?	✓		

(26) Record for regular inspection performed on overfilling monitoring device (High-High Level Alarm)

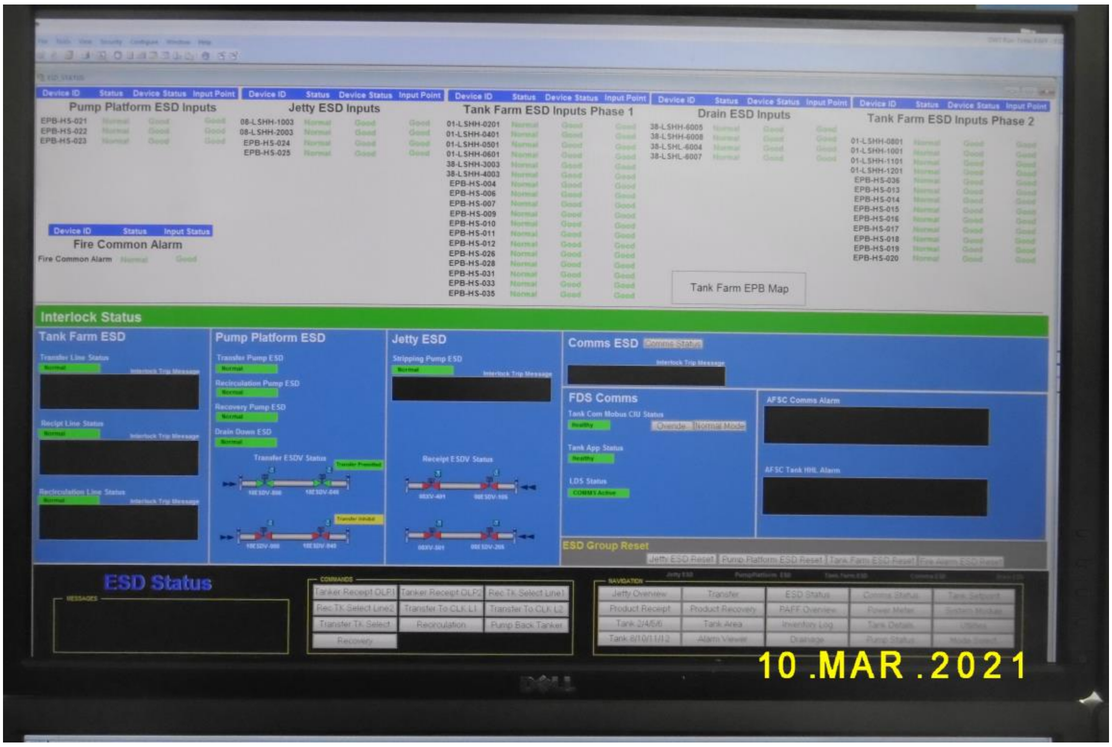


(27) Leak detection “COWI Stat Leak System” installed into computer

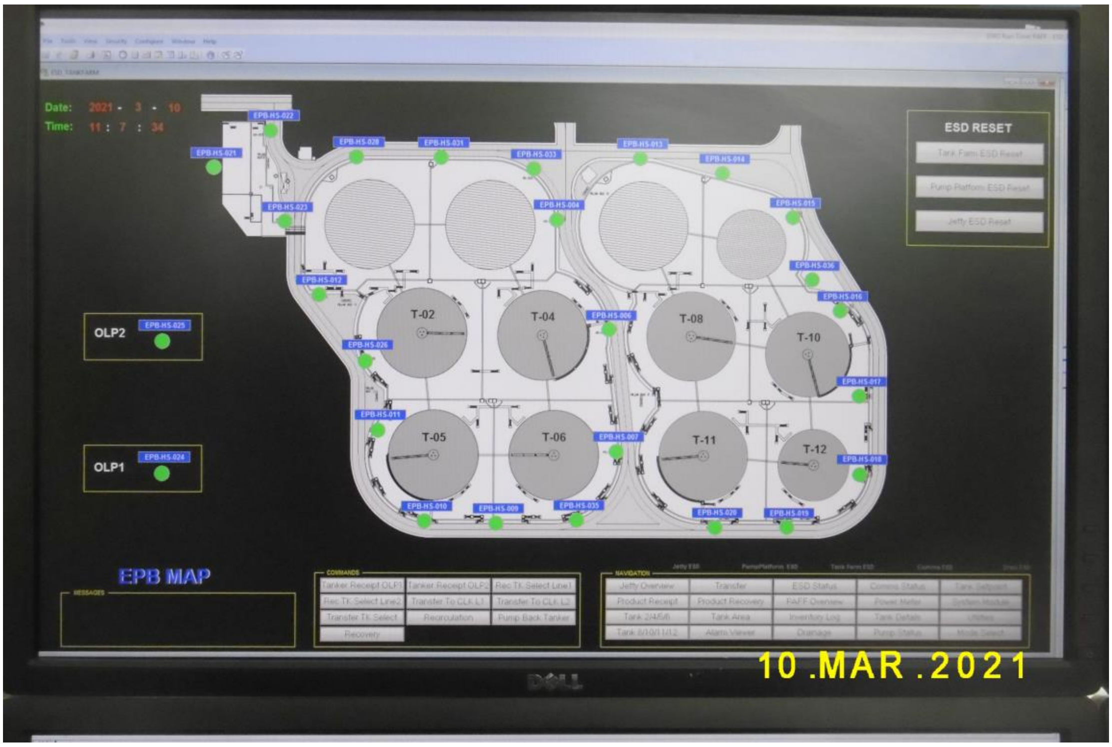
(28) Leak detection tell-tale pipe underneath the storage tank opens out to a collection chamber

(29) Collection chamber located adjacent to tank foundation is maintained in good condition with periodic inspection

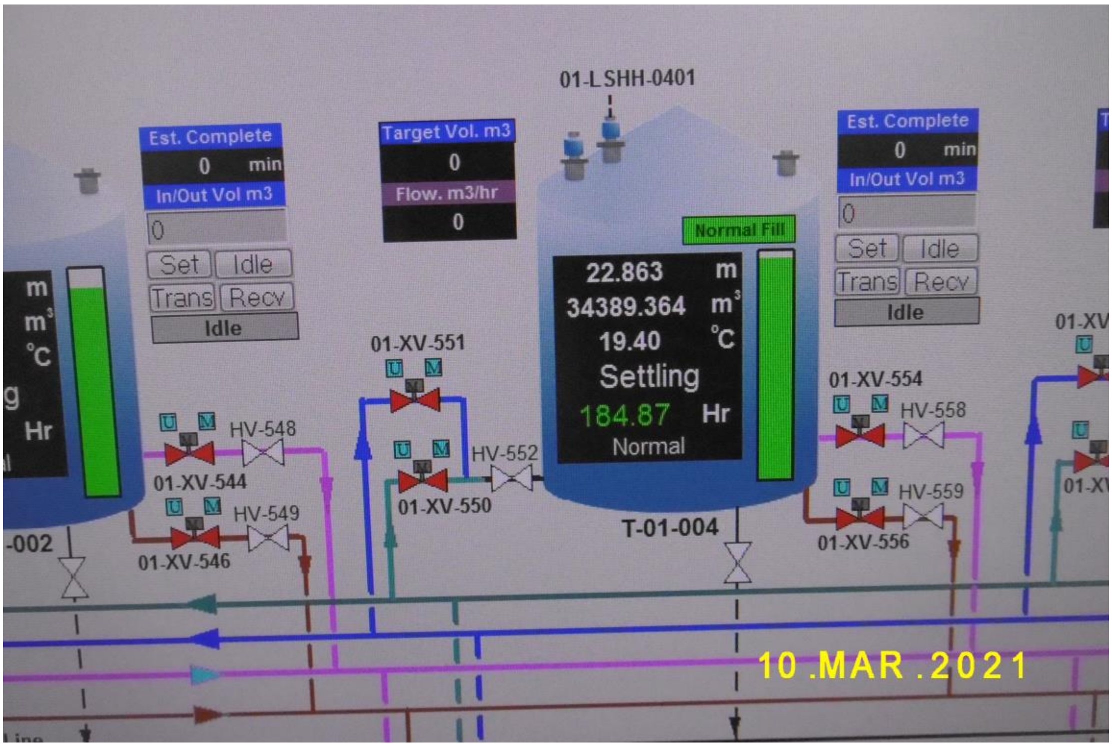
(30) ESD device is maintained in good condition and being tested periodically



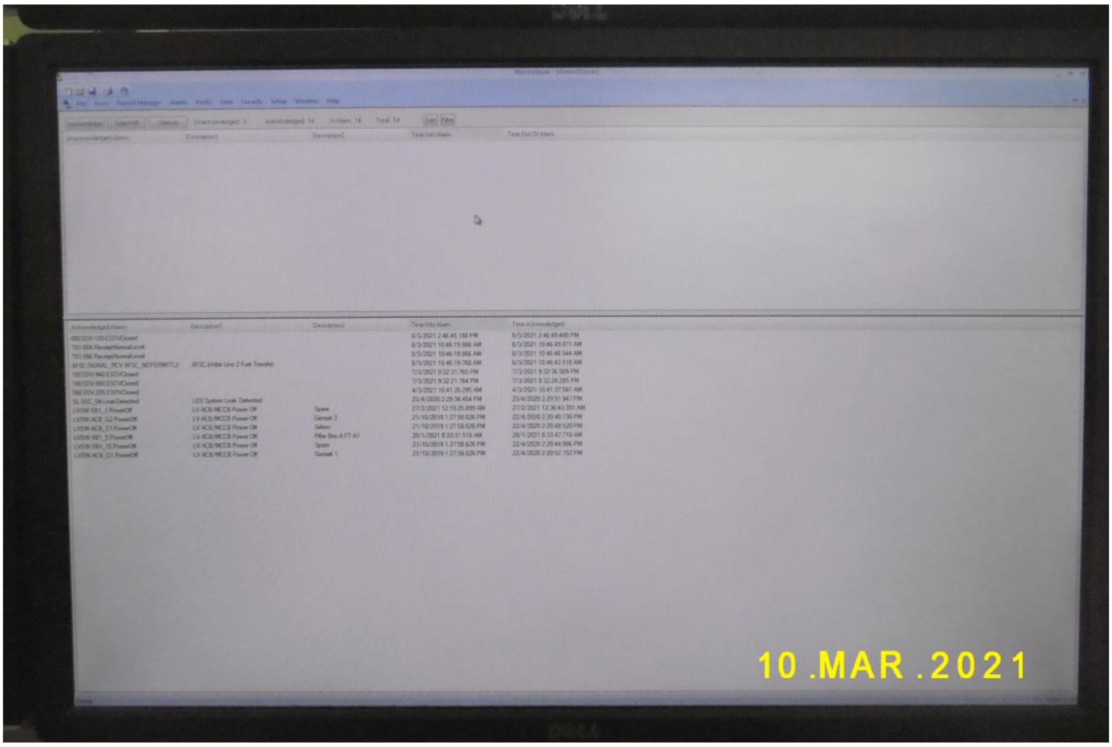
(31) The ESD regular testing as shown in SCADA System



(32) The ESD regular testing as shown in SCADA System



(33) The ESD test signal as shown in SCADA System



(34) Once the system received ESD test signal, the valves will be closed automatically and shut down the operation as shown in SCADA System

PAFF Emergency Shutdown Devices (ESD) Testing Report

Pump Platform ESD Inputs

Device ID	Task	Condition
EPB-HS-021	C/R	N/F
EPB-HS-022	C/R	N/F
EPB-HS-023	C/R	N/F

Jetty ESD Inputs

Device ID	Task	Condition
08-LSHH-1003	C/R	N/F
08-LSHH-2003	C/R	N/F
EPB-HS-024	C/R	N/F
EPB-HS-025	C/R	N/F

Tank Farm ESD Inputs Phase 1A

Device ID	Task	Condition
38-LSHH-3003	C/R	N/F
38-LSHH-4003	C/R	N/F
EPB-HS-004	C/R	N/F
EPB-HS-006	C/R	N/F
EPB-HS-007	C/R	N/F
EPB-HS-009	C/R	N/F
EPB-HS-010	C/R	N/F
EPB-HS-011	C/R	N/F
EPB-HS-012	C/R	N/F
EPB-HS-026	C/R	N/F
EPB-HS-028	C/R	N/F
EPB-HS-031	C/R	N/F
EPB-HS-033	C/R	N/F
EPB-HS-035	C/R	N/F

Tank Farm ESD Inputs Phase 1B

Device ID	Task	Condition
EPB-HS-036	C/R	N/F
EPB-HS-013	C/R	N/F
EPB-HS-014	C/R	N/F
EPB-HS-015	C/R	N/F
EPB-HS-016	C/R	N/F
EPB-HS-017	C/R	N/F
EPB-HS-018	C/R	N/F
EPB-HS-019	C/R	N/F
EPB-HS-020	C/R	N/F

Status Definitions : C = Check, R = Repair/Replace, N = Normal, F = Failure

Company Name: ECO Aviation Fuel Services Limited
Location: Permanent Aviation Fuel Facility
Test Performed: T C NG
Signature: [signature]
Date: 18 Feb, 2021

(35) Record for regular testing performed on ESD device

(36) Fenders are installed at sea side of the jetty

(37) Fenders are installed at sea side of the jetty

(38) Fenders are installed at shore side of the jetty

(39) Slop collection utilities are used for coupling and de-coupling of the loading arms

Appendix 4 - Seabed Level Survey Result

EARTH SCIENCES & SURVEYING

BATHYMETRIC SURVEY OF SUBMARINE PIPELINE ROUTE,
JETTY BERTHING AREA & SEAWALL AREA OF
THE PERMANENT AVIATION FUEL FACILITY (PAFF), TUEN MUN

SURVEY REPORT

EGS JOB NUMBER: HK259521

10th February 2021
(Ref.: T\HK259521\Report\2595tf.doc ccl)

1 INTRODUCTION

1.1 THE PROJECT

Twin submarine pipelines are buried several metres under seafloor from the Permanent Aviation Fuel Facility (PAFF), Tuen Mun to Sha Chau and to the nearby off-loading jetty, OLP1 & 2. In order to ensure the navigation/berthing safety and to monitor the condition of the armour rock-fill covered along the as-laid pipeline, bathymetric surveys are required to measure the seabed levels in details in regular basis. EGS (Asia) Limited is appointed by Eco Aviation Fuel Services Limited (EAFS) for undertaking the required survey. An overview of the survey area is shown as below:

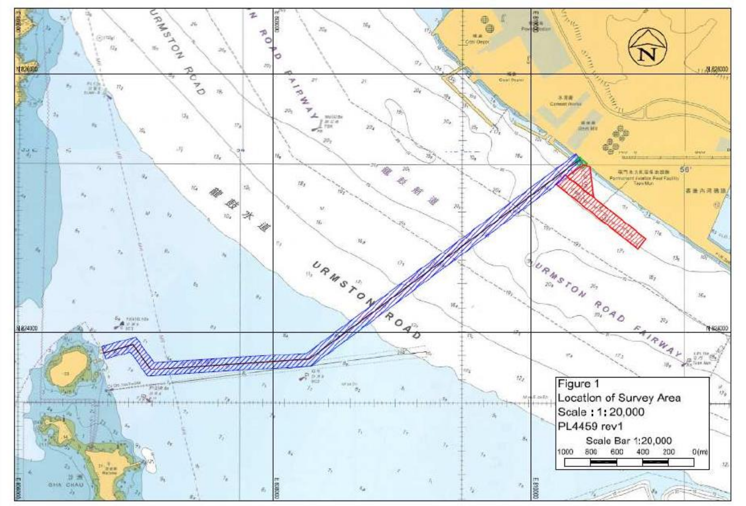


Figure 1: Overview of the Survey Area

1.2 INSTRUCTIONS

On the instruction of EAFS, their Purchase Order PO-2021-015 dated 13th January 2021 refers, a bathymetric survey is carried out over the survey area.

1.3 OBJECTIVES OF THE SURVEY

The objectives of the survey are to measure the seabed levels in great details with a high resolution multi-beam echo sounder to provide subsequent seafloor information for the monitoring of the changes in seabed/rock-fill levels to evaluate any potential harm to the pipeline and to the vessels; and for the submission to relevant Government authorities as part of the permit requirement.

1.4 SURVEY PERIOD

The survey was carried out on 9th February 2021.

1.5 WEATHER AND SEA CONDITION

The weather was windy and cloudy during survey. Beaufort Force 4 wind speed from E to NE was generally observed. The sea condition was moderate with occasionally excessive waves generated by ships passing nearby.

2 SURVEY AREA

The survey area is located off the shore of Tuen Mun Area 38 including the sea front of the shore facility, off-loading jetty and submarine pipeline to Sha Chau. The survey corridor across the Urmston Road which is one of the busiest channels in Hong Kong where heavy marine traffic causes obstruction to the survey operation and various kind of vessel were observed such as cargo vessels, work barges and tug boats.

Plate 1: Off-loading jetty area

Plate 2: Sea front of the shore facility at Tuen Mun

3 SURVEY VESSEL AND EQUIPMENT

3.1 SURVEY VESSEL

The survey was carried out by the Class II licensed workboat, Profiler.

Plate 3: Class II licensed workboat, Profiler

3.2 SURVEY EQUIPMENT

Type	Equipment
Multibeam Echo Sounding System (MBES)	R2Sonic Sonic 2024 Multi-beam echo sounder
	Applanix POS MV Wavemaster II Inertial Navigation System (for Attitude and Heading)
Single beam Echo Sounding System (SBES)	Knudsen 320M dual frequency echo sounder
	Kongsberg Seatex MRU-Z Dynamic motion sensor
Speed of Sound	Valeport MIDAS CTD (for measurements through the whole water column)
	Valeport Mini-SVS (installed at the MBES transducer for providing real-time surface sound velocity measurements)
Positioning System	C-Nav 3050 RTK-GNSS system
Survey Software	QPS QINSy for Navigation and MBES data acquisition
	CARIS HIPS & SIPS for MBES data processing
	C-View Bathy processing and charting software
	AutoCAD & Bentley Inroads Suite

Table 1: Survey equipment list

4 LOCATION CONTROL

4.1 HORIZONTAL

4.1.1 Method

The survey vessel is located by C-Nav 3050 GNSS system receiving a proprietary Precise Point Positioning message broadcasting from their processing centres which provides decimetre positioning to terrestrial users all over the world. With the reception of Network Real-Time Kinematic (RTK) correctional data produced by the "Hong Kong Satellite Positioning Reference Station Network" (SatRef), the system further improves to centimetre accuracy in this survey.

The system consists the following:

- A geodetic-quality dual frequency C-Nav receiver which tracks and locks onto the code and carrier phase signals from GPS and GLONASS satellites.

- The Networked Transport of RTCM via Internet Protocol (NTRIP) implemented by Survey & Mapping Office, Lands Department transmits the SatRef RTK correctional data to users via the Internet. The NTRIP-enabled C-Nav receiver accesses to the internet and obtains such correctional signals for positioning in centimetre accuracy.

During the survey, the C-Nav receiver is connected to the internet and receiving the correctional data continuously via NTRIP server. The positions are corrected in real-time.

4.1.2 Computerized Navigation

The QPS Qinsy computerized navigation system is added to the positioning system to control the steering of the boat along the traverses specified, and to log all horizontal and vertical control data. This system provides the user with a dynamic screen display on which the following are continuously updated:

- Skewed grid set parallel to the desired line direction
- The water depth
- Date and Time
- DGPS diagnostics enabling quality control

Other information displayed for the assistance of the hydrographic surveyor includes, course, speed, fixing status, coordinates on the Hong Kong Metric Grid, as well as a number of other user-defined options including a graphical 'left and right' offset indicator and a numerical display of water depth along the survey line.

4.1.3 Accuracy and Quality Assurance

The accuracy of the positioning system is checked by comparing the coordinates logged by the navigation system with the known coordinates whilst the GPS antenna is set up at a previously coordinated point at Tuen Mun Typhoon Shelter. An accuracy of ±1m or better is ensured by carrying out the above quality assurance procedure before the survey commences.

The result of the position check is set out in Appendix A.

Plate 4: DGPS check at Tuen Mun Typhoon Shelter

4.2 VERTICAL

4.2.1 Datum

The definitions of vertical datum in Hong Kong are as follows:

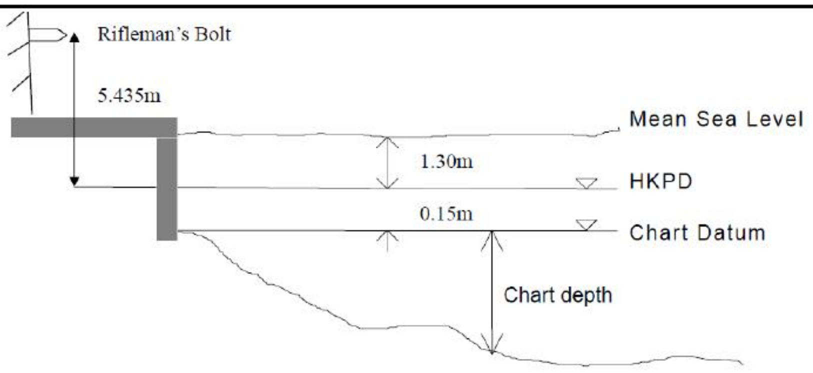


Figure 2: Definitions of Vertical Datum in Hong Kong (SMO, Lands Department HKSAR, 2018)

Both the Hong Kong Principal Datum (HKPD) and Chart Datum (CD) are used in this survey with charts in different purpose. The tide data is used to reduce all soundings to required datum.

4.2.2 Method of Tidal Observation

Tide data is collected by a Valeport 740 recording tide gauge installed at Tung Chung Development Pier which is used to reduce the sounding data to the specified datum. A benchmark is established next to the tide gauge, the distance from the benchmark to the sensor is measured and a correction has been input into the logging program to reduce the sensor readings to the specified datum.

	
Plate 5: Project tide gauge installed at the shore of Tung Chung Development Pier	**Plate 6: Temporary benchmark (TCBM4) is the survey nail next to the tide gauge at the pier**

4.2.3 Operation of the Tide Gauge

The tide gauge is operated continuously to collect tide data throughout the survey period and is fitted with a GSM modem to upload data onto a server. Tide data can be viewed in real time and downloaded by users using a PC with Internet connection.

The gauge is maintained and checked regularly as follows:

- The distance between the temporary bench mark (TBM) and the gauge sensor is known from the installation setup
- The distance from the TBM to the sea surface is measured
- The gauge measures the distance between the sensor and the sea surface
- The sum of these two measurements must equal to the distance between TBM and sensor as shown in the installation record
- Any difference between the measurements presents the tolerance of the tide gauge

The tide gauge installation record and the benchmark record are given in Appendix B.

4.2.4 Accuracy and Quality Assurance

The tide gauge is calibrated, inspected and maintained regularly to ensure its accuracy is better than 0.05m. In addition, the tide data at Tung Chung is compared with the dataset obtained from another EGS operated tide gauge at West Hong Kong Airport. Generally the tidal difference between the two datasets is less than 0.1m.

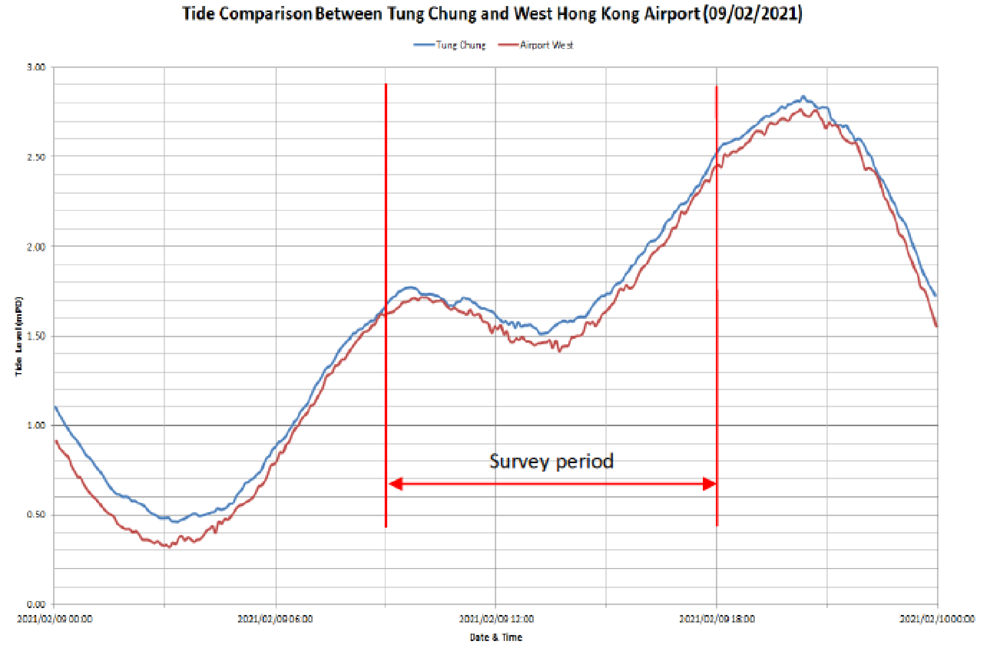


Figure 3: Comparison of tide levels between Tung Chung and West Hong Kong Airport

5 FIELD PROCEDURES

5.1 LINE SPACING

Survey lines are planned at 40m interval off PAFF and Channel area and 20m interval off Sha Chau with necessary infill lines to obtain 100% seafloor coverage and the crosslines (check line) are planned at 500m interval for data quality check.

5.2 MULTI-BEAM ECHO SOUNDING SURVEY

5.2.1 System Description

A multi-beam echo sounder (MBES) is used in this survey. Instead of a traditional echo sounder transmitting a single vertical pulse which provides a record of water column thickness along the vessel track, the MBES system measures the same type of data over a 'fan' on both sides of the vessel. With suitably selected survey line spacing and vessel speed, the resulting data density can be more than 20 soundings per square metre.

The MBES transducer is mounted over the port side of the survey vessel. The C-Nav GPS antenna is mounted directly above the transducer. This setup minimises the positional error caused by the offset between the GPS antenna and the MBES transducer. The system is operated at 400 kHz frequency and 130° swath angle with vessel speed not more than 5 knots during survey.

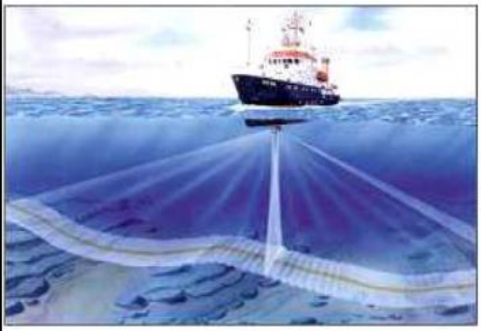


Figure 4: Illustration of the operation of a multibeam echo sounding system

Plate 7: The transducer of the R2Sonic Sonic 2024 multibeam echo sounding system

5.2.2 Calibration

For errors to be avoided, the MBES system requires careful calibrations. A significant (potential) source of error relates to the speed of sound in water; the MBES system requires the speed of sound to be measured through the water column, and for these data to be entered into a file which is accessed by the MBES acquisition and processing software. There, these parameters are converted by calculation into compression wave velocities, to make the correction. The speed of sound was measured at the start and end of every survey period.

In addition, a patch test was required to calibrate system components, as follows:

Roll Offset
A survey line was set over an area with a flat and featureless seabed. The line was run in opposite direction at the same speed

Pitch Offset
A survey line was set exactly over a distinct seabed feature. The line was run in opposite directions at the same speed

Yaw (Heading) Offset
Two parallel lines were set to either side of a distinct seabed feature with the feature positioned in the middle of the two lines. The off-track distance between the feature and the lines were selected according to water depth and the fan width of the MBES system, so that the features were detected at the outer part of sounding 'fan'. The lines were run in the same direction at the same speed, once passing the feature to Port and once to Starboard.

Navigation Delay (Latency)
A survey line was set exactly over a distinct seabed feature, such as a rock outcrop, a significant slope or a man-made structure. The line was run twice in the same direction at different speeds of 2.5 knots and 5 knots.

By applying appropriate algorithms to match the apparent differences in the positions of the selected seabed feature and topography measured in the individual calibration line, these calibration factors were determined and then entered into the acquisition system to correct the sounding measurements in real-time.

In the survey, the calibration has been carried out at the mud pit off northeast Chek Lap Kok. The water depth of the flat area for roll offset calibration is about 24m. The distinct seabed feature selected for navigation delay, pitch and yaw offset calibration is a steep slope with depth range from 11m to 24m. The MBES calibration report is given in Appendix C.

5.2.3 Quality Assurance

Cross (check) lines at the interval of about 10x – 15x of that of the main line are run across and perpendicular to the main line pattern. A statistical comparison between the dataset of mainlines and crosslines is conducted to evaluate the accuracy of the MBES data collected.

In addition, the MBES dataset has been compared with that collected by a conventional single beam echo sounder installed adjacent to the MBES transducer which is running and recording simultaneously with the MBES system during survey. The SBES system has been calibrated on site using the 'bar check' method, at the beginning and the end of every survey period.

The 'bar check' records are provided in Appendix D.

5.3 Personnel

The survey team comprised of an experienced surveyor as site representative, 1 technician and 1 coxswain. All members are well trained, qualified and familiar with the field operations.

5.4 Site Safety

Safety policies are generally in accordance with the 'Marine Geophysical Operations Safety Manual' (International Association of Geophysical Contractors, 9th Edition, 2008) and EGS' Health, Safety and Environmental (HSE) manual; and comply with the current edition of the following ordinances and regulations:

- Labour Ordinances and Regulations
- Factories & Industrial Undertakings Ordinance (Chapter 59)
- Shipping and Port Control Ordinance (Chapter 313)
- Occupational Safety & Health Ordinance (Chapter 509)
- Merchant Shipping (Local Vessels) Ordinance (Chapter 548)

6 REDUCTION OF OBSERVATIONS AND INTERPRETATION

6.1 MBES Data Processing

CARIS HIPS & SIPS is used to display data sets for each survey traverse in turn, with sound velocity corrections and tidal corrections applied. The data are subjected to a simple filter defining minimum and maximum seabed level values, to remove obvious 'noise'.

The datasets are then edited manually. Judgement is required at this stage to identify small features which are real reflections from low-level noise; for guidance, two or more mutually consistent soundings which are higher or lower than the general sea bed level would be accepted, especially if the same anomalous soundings are present on separate survey traverses.

6.2 SBES Data Processing

The SBES data are processed using EGS in-house editing software with the following procedure:

- Application of tidal corrections to reduce recorded data to specified datum
- Application of filters to remove obvious 'noise'
- Manual editing to remove low level 'noise'

6.3 Sounding Selection

6.3.1 Size of Data Set

The volume of the sounding data collected is so large that it is necessary to apply appropriate sounding selection before the data is presented. Sounding selection is governed by the usage and reporting scale of the sounding plans. The selection processes are discussed below.

6.3.2 Gridded Sounding

Gridded sounding selection is used for engineering purposes. The selection procedure is as follows:

The processed sounding data, which has been reduced to specified datum, is gridded on to a 1.0m spacing dataset and has been presented here as En, Nn, Zn, in ASCII format on disc. During selection process, median sounding values are used.

The gridded data is imported to Bentley Inroads to generate the longitudinal sections and cross sections; and is plotted at a spacing of 12.5mm & 5mm on chart (25m/5m/1m on ground at the chart scale), to provide a gridded plot for the whole area surveyed.

The gridded data is contoured using C-View Bathy and the contours at 1m interval are added to the gridded plot, to provide the contoured sounding plans on A1 size paper.

7 RESULTS

7.1 PRESENTATION

The results have been presented as follows:

Frontispiece	Location of Survey Area
SURVEY REPORT	Factual Description of Field Procedures and Interpretation of Data
Appendix A	DGPS Check Record
Appendix B	Tide Gauge Installation and Benchmark Record
Appendix C	MBES Calibration Record
Appendix D	Bar Check Record
DRAWINGS	
Drawing No. 1.1 – 1.5	1:2,000 Sounding and Section Plan along Pipeline
Drawing No. 2.1 – 2.2	1:1,000 Sounding Plan at Jetty Area
Drawing No. 3	1:200 Sounding Plan at Seafront Area
DIGITAL DATA	Data Disc containing Digital Format of Survey Report, Drawings, Individual Cross-Sections and Sounding Files

7.2 SOUNDING AND SECTION PLAN ALONG PIPELINE 1:2,000 DRAWING NO. 1.1 – 1.5

The plan shows the seabed levels with contours at 1m interval generated by the selected soundings described in Section 6.3.2. The plan is presented at a scale of 1:2,000 and the soundings are plotted at 25m spacing in the chart scale. All soundings are reduced to Hong Kong Principal Datum (HKPD).

Seabed levels vary between -1.1mPD and -22.3mPD within the survey extent. The seabed descends from the seawall at PAFF at around -5mPD towards Urmston Road where is about -20mPDin the middle of the channel, then it ascends from the channel boundary towards Sha Chau gently until about -8mPD before the AFSC jetty berthing area which had been dredged to about -10mPD. Trench-like features and rock-fills are observed along the pipeline route in the middle of the survey corridor.

Additionally, longitudinal sections and cross sections along the pipeline alignments are plotted onto the plan. These alignments include 1) from PAFF at Tuen Mun to AFSC at Sha Chau, 2) from PAFF seawall to off-loading jetty OLP2 and 3) from off-loading jetty OLP2 to OLP1. The alignments have been indicated on chart with Kilometer Post (KP) values. The alignment from PAFF to AFSC is defined in the middle of the twin pipeline, namely "Design Centre-Line" and is about 4.3km in length. The alignments from PAFF seawall to OLP2 and from OLP2 to OLP1 are defined as the as-laid route of the north pipeline marked as "JN1" to "JN3" and "JN4" to "JN7" on charts and are about 320m and 310m in length respectively.

Longitudinal sections are plotted in a scale of 1:2,000 for horizontal and 1:400 for vertical, i.e. 5x exaggerations for vertical axis. Vertical axis presents the seabed levels in HKPD and the horizontal axis presents the KP along the alignment. In addition to the surveyed seabed profile in this survey, the initial seabed profile in 2007 and the as-laid pipeline profiles of the twin-pipe are shown. Except the surveyed seabed profile, all other profiles are extracted and retained from previous survey records.

Cross sections are plotted in a scale of 1:2,000 at 25m intervals. Vertical axis presents the seabed levels in HKPD and the horizontal axis presents the distance from the alignment; seabed profiles up to 50m both side of the alignment (100m in total) are presented. In addition to the surveyed seabed profile in this survey, the initial seabed profile in 2007 which is extracted and retained from previous survey record is shown.

7.3 SOUNDING PLAN AT JETTY AREA 1:1,000 DRAWING NO. 2.1 – 2.2

The plan shows the seabed levels with contours at 1m interval generated by the selected soundings described in Section 6.3.2 for the jetty area where the keel clearance is critical to ensure the navigation safety. The plan is presented at a scale of 1:1,000 and the soundings are plotted at 5m ground spacing at the chart scale. All soundings are reduced to Chart Datum (CD).

The seabed around the jetty descends gradually towards southwest from shore. The seabed levels at NE side and SW side of the jetty are about -15mCD and -17mCD respectively. No distinct object has been observed from the bathymetric data. Areas with levels above -16.5mCD are highlighted in red and the contour at -16.5mCD has been plotted in addition to the 1m interval contours.

7.4 SOUNDING PLAN AT SEAFRONT AREA 1:200 DRAWING NO. 3

The plan shows the seabed levels with contours at 1m interval generated by the selected soundings described in Section 6.3.2 for the seafront area. The plan is presented at a scale of 1:200 and the soundings are plotted at 1m ground spacing at the chart scale. All soundings are reduced to Hong Kong Principal Datum (HKPD).

The seabed levels are generally -5mPD to -6mPD within 10m from the seawall of PAFF. The seabed descends gently from the seawall towards southwest to about -10mPD at 50m from shore. The seabed is flat and smooth in general without distinct object. A couple of 3D perspective view images and a cross section image at intake and outfall location of raw MBES soundings are presented below. From these images in which the fire services intake and storm-water outfall are clearly measured by the system and there is not any evidence showing sediment accumulation around these locations.

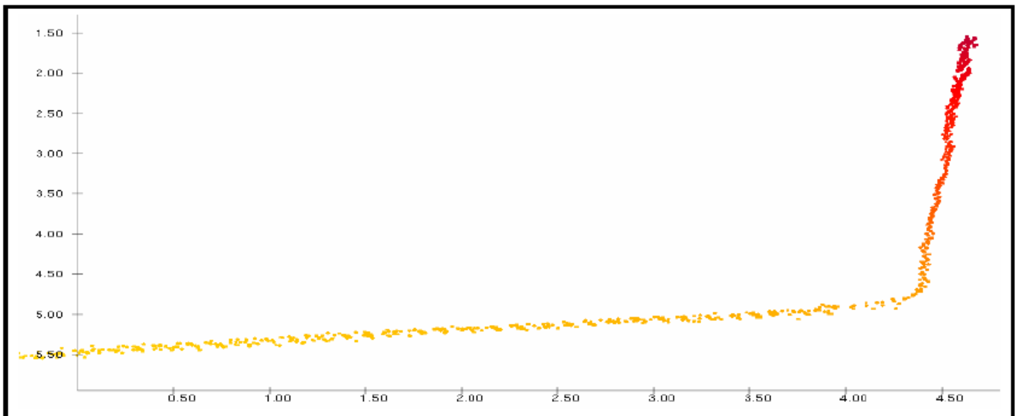


Figure 5: Cross section image at intake location showing no sediment accumulation

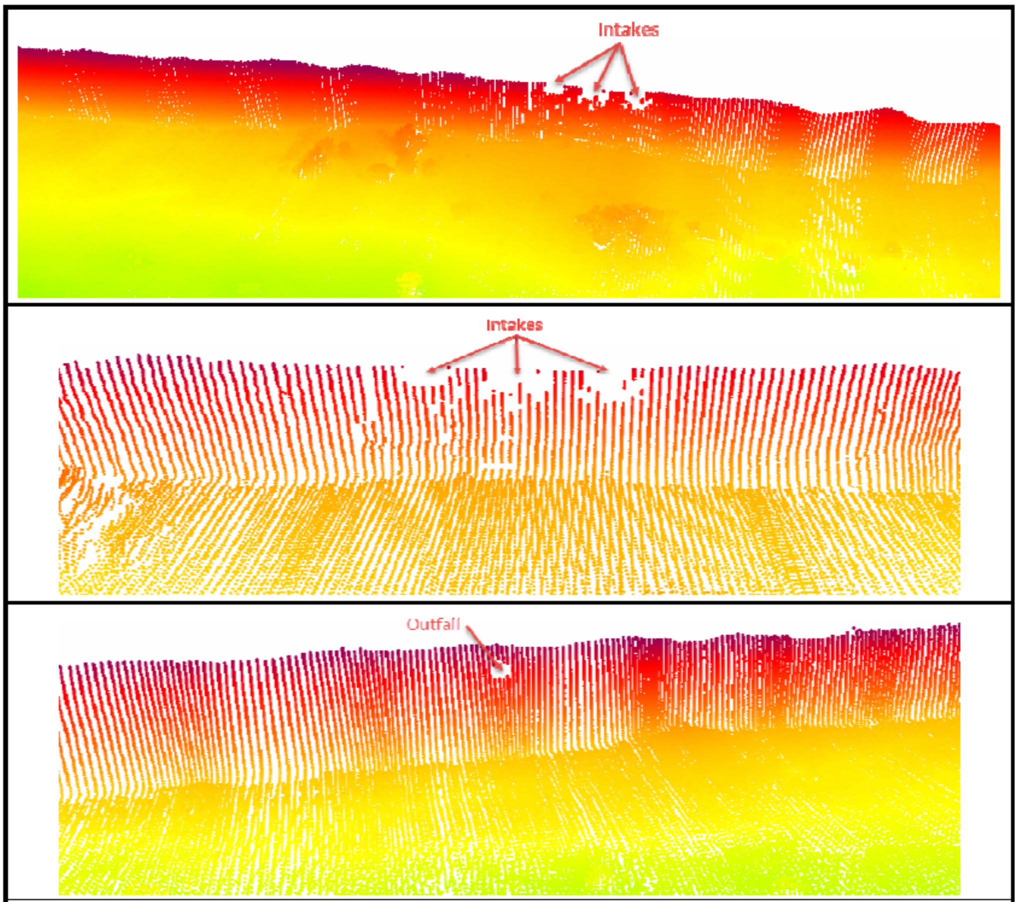


Figure 6: 3D perspective view of raw MBES soundings at intake and outfall location

8 ACCURACY

8.1 Sources of Error

In theory, at least the following factors can affect the overall accuracy of any type of echo sounding survey. Factors specific to the MBES survey have been identified:

TIDE OBSERVATION AND REDUCTION:

Incorrect benchmark level
Settlement of benchmark between successive surveys
Uncertainties in setting up the tide gauge
Reading off errors of the tide gauge data
The (inevitable) assumption that there is no water surface gradient between the tide gauge and the survey boat from time to time

HORIZONTAL POSITIONING UNCERTAINTIES:

Uncertainty in horizontal control
Deficient satellite or differential signals
Delay in signal reception and processing

FIELD PROCEDURE UNCERTAINTIES:

& Variations in the salinity of the sea water across the survey period which in turn affects the speed of sound in water
# Minor uncertainties in the bar checks
& Variations in boat 'balance'

EQUIPMENT UNCERTAINTIES:

Beam width of the transducer
Manufacturer's stated echo sounder accuracy
& Ambiguity in the nature of the surface being recorded and assumed to be the seabed

DATA PROCESSING UNCERTAINTIES:

Surveyor bias in seabed interpretation
& Incorrect removal of the effects of all kinds of vessel movement caused by waves
& Inadequate removal of the effects of variations in vessel balance

Notes:

& *Factors more specific to MBES survey*
# *Quality Assurance procedure seeks to eliminate/minimize the uncertainties cause the above factors*

In this survey, the MBES dataset has been evaluated using the procedures as described in Section 5.2.3 and the result is discussed in the below section.

8.2 EVALUATION

To evaluate the accuracy of the MBES data, a statistical comparison has been carried out between the dataset of MBES and SBES. Generally, the data collected by the MBES system agrees within 0.2m with the data collected by the single beam echo sounder. In this survey, the mean difference and the standard deviation between two datasets are -0.004m and 0.05m respectively.

In addition, a statistical comparison between the dataset of mainlines and crosslines is conducted to provide the mean difference and standard deviation of the datasets. The comparison result is presented below in tabular and graphical form showing the number of soundings and the distribution of depth difference in different ranges.

The majority depth difference of soundings between main lines and check lines falls in the range of ±0.20m which is more than 99% of total number of soundings analysed. In this survey, the mean difference in depth and the standard deviation between the two datasets are 0.001m and 0.03m respectively.

Depth Difference	No. of Soundings	Soundings Distribution
<-0.5m	0	0.00%
-0.5m – -0.4m	13	0.01%
-0.4m – -0.3m	13	0.01%
-0.3m – -0.2m	148	0.11%
-0.2m – -0.1m	1308	0.97%
-0.1m – 0m	52802	39.15%
0m – 0.1m	78805	58.43%
0.1m – 0.2m	1470	1.09%
0.2m – 0.3m	216	0.16%
0.3m – 0.4m	54	0.04%
0.4m – 0.5m	13	0.01%
>0.5m	27	0.02%
TOTAL	134870	100.00%

8.3 ESTIMATES OF ACCURACY

All pieces of equipment involved in this survey are accurate and are carefully calibrated by the manufacturers and through on-site calibration. The accuracy of the processed MBES data points from this hydrographic survey would be better than:

Horizontal Accuracy	± 1.0m
Vertical Accuracy	± 0.2m

9 RESULTS & CONCLUSIONS

This hydrographic survey for the Permanent Aviation Fuel Facility (PAFF) on 9th February 2021 has been properly and carefully commenced, processed, interpreted and presented to meet the project objectives of measuring and monitoring the seabed levels.

The results are presented in the form of survey plans showing contour plots, longitudinal sections and cross sections and have been plotted in a manner to be directly comparable with the previous survey data, specifically the initial survey record carried out before the commencement of installation works in 2007.

From the results, there is no evidence showing any damage or critical disturbance to the protection rock-fill layer covering the pipelines. The current seabed bathymetry is similar to the original seabed profile (2007) and also to the last survey carried out in 2020.

END OF REPORT

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Appendix 5 – Drawings

List of Drawings

PAFF/BA/02/DWG/C/1452
PAFF/BA/02/DWG/C/1481
PAFF/BA/02/DWG/C/1705
PAFF/BA/02/DWG/C/1721
PAFF/BA/02/DWG/C/1722
PAFF/BA/02/DWG/C/1723
PAFF/BA/02/DWG/C/1724
PAFF/BA/02/DWG/C/1726
PAFF/BA/02/DWG/C/1727
PAFF/BA/02/DWG/C/1728
PAFF/BA/02/DWG/C/1730
PAFF/KG/02/DWG/E/7437
PAFF/LC/01/DWG/M/0202
PAFF/LC/01/DWG/M/0203
PAFF/LC/01/DWG/M/0207
PAFF/LC/02/DWG/M/0266
PAFF/LC/02/DWG/C/0340
PAFF/LC/02/DWG/C/0551
PAFF/LC/02/DWG/M/0875
PAFF/LC/03/DWG/M/0251
PAFF/LC/04/DWG/C/0408
PAFF/MA/03/DWG/C/2807
PAFF/MA/03/DWG/C/2808
PAFF/RJ/02/DWG/G/3015(EX)