USAID ENERGY POLICY PROGRAM

MONTHLY PROGRESS REPORT
APRIL 2015

ESTABLISHMENT OF
FAST TRACK LNG IMPORT TERMINAL

May 2015

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FAST TRACK LNG IMPORT TERMINAL

Contract No: AID-EPP-I-00-03-00004
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Establishment of Fast Track EETPL LNG Import Terminal

Monthly Progress Report
April 2015

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Establishment of Fast Track EETPL LNG Import Terminal at Port Qasim on BOT Basis

PROGRESS REPORT

FOR THE MONTH OF APRIL 2015

1. Introduction:

1.1 This report covers the activities and progress of the work at the captioned project for the month of April, 2015, includes updated status of field works as well as the Desk Studies carried out during This month. The Sub-consulting Services Contract for Study and Review of past Studies Reports and Quality assurance of project works was awarded to Engineering Consultants International Limited (ECIL) and Granada Group (GG) by main Consultant "Advanced Engineering Associates International" (AEAI). M/s. Sellhorn, Germany were associated with ECIL for review of Structural Works and overview and design of Navigation Channel.

The Subcontract No.EPP-C1-SC-010 included description of services and LNG Specific Services. By Delivery Order No.EPP-C1-DO-001. The First Task Order covered a period from October 20, 2014 to March 31, 2015. Consultants commenced work after having the kick off meeting with PQA officials on October 20, 2014. The tenure of the first Task Order was completed on March 31, 2015.

The second Task Order under the existing Sub-contract, covering a period from April 01, 2015 to August 31, 2015, is awaited.

1.2 Location of Project

The newly established EETPL LNG Terminal is located in the Port Operation Zone of Port Qasim, between the existing Engro Vopak (EVTL) Liquid Chemical Jetty and PQA's Iron Ore & Coal berth (IOCB). The distance between the LNG jetty and the open sea is about 40 Km. measured along the navigation channel (refer Fig. A, B, C). The berthing line of the (EETPL) LNG Jetty is about 150m from toe line.

The RLNG pipeline 24" dia. runs from Loading Platform of jetty to the Custody Transfer Station (CTS) with a length of 6.5 Km. 42" dia. Pipeline (SSGC) runs from CTS to SMS Pakland. The total length of both the pipelines is 23.98 Km.

1.3 FSRU, LNG Carriers and Gas Delivery

a) The first loaded FSRU arrived at the new LNG Terminal on March 26, 2015. Testing of the FSRU, RLNG pipeline and installations at CTS, was carried out by concerned stakeholders including SSGC, PQA (through their consultants), EETPL, PSO, etc.

b) As provided in the IA between PQA and EETPL and as planned LNG carriers had to be berthed to make the project complete for testing and commissioning. However, LNG carriers have not yet started up trips between Export Terminal of the source of LNG purchase country and Import Terminal at Port Qasim to feed FSRU. Currently the designated FSRU is serving dual purpose of LNG Carrier as well as storage and regasification unit for onward transmission of RLNG to CTS (custody transfer station) and then to SSGC network.

2. Salient features of the Project:

2.1 General

a)	Client	:	Advanced Engineering Associates International (AEAI)
b)	Consultants	:	▪ Engineering Consultants Intl. (Pvt.) Ltd. Pakistan (Sellhorn of Germany were associated by ECIL). ▪ Granada Group of Companies Inc. USA.
c)	Developer	:	Engro Elengy Terminal (Private) Limited, Pakistan.
d)	Award of Construction Contract	:	May 5, 2014
e)	Commencement of Bathymetry Survey	:	May 5, 2014
f)	EPC Contractor (Civil Works)	:	China Harbour Engineering Company (CHEC)
g)	Date of signing of Implementation Agreement between PQA and EETPL	:	June 23, 2014
h)	Date of deployment of Consultants	:	October 20, 2014
i)	Tendered Cost of Infrastructure	:	Confidential.
j)	Completion date of civil construction work as per developers programme.	:	12-15 March 2015
k)	Actual completion	:	As per schedule approximately

2.1.1 Other main Parties engaged by EETPL for Project Work

a)	TUV (Austria)	:	Third Party supervision.
b)	Artelia (Spain)	:	Mooring simulation work.
c)	Exelerate (USA)	:	FSRU related work.
d)	Technica (UK)	:	All engineering design works.
e)	Siport 21 (Spain)	:	FBMS simulation.

2.2 Major Components of the Project:

a) Dredging of Berthing Basin.
b) Construction of coffer Dam and disposal of dredged material,(reclamation of land keeping due consideration of environmental protection aspects)
c) Loading Platform supported on Steel Tubular piles.
d) Breasting Dolphins supported on Steel Tubular piles.
e) Mooring and supporting Dolphins, supported on steel tubular piles.

f) Loading arm installed on loading platform.

g) Trestle supported on prestressed concrete piles.

h) Walkways – prefabricated steel sections resting on supporting dolphins constructed on steel tubular piles.

i) RLNG pipelines and allied works at CTS.

j) Electrical Power Supply, Lighting and Control System

k) Miscellaneous Items:
   - Fenders
   - Bollards
   - Quick Release Hooks

l) Electro-Mechanical Works mainly including:
   - Metering System
   - Water Bath heater
   - Back Pressure Skid
   - Fire Protection / Fire Fighting Arrangement
   - Construction of Generator Room
   - Construction of Transformer Room
   - Laying of Fiber Optic Cables
   - Lighting Poles

m) FSRU brought and berthed at the Jetty.

3. Updated Physical Progress of Field Work (till April 30, 2015).

3.0 Overall Progress

Overall physical progress of the project is almost 100% and is more or less same as that of March 2015. Completion dates of major items are stated as hereunder:

3.1 Dredging and Related Works

Dredging was carried out during the period from 20th Aug to 1st October 2014. The designed dredged depth is -14m CD which may be increased later to -15m CD depending upon requirement felt by Terminal Operator. Post dredging survey was conducted by PQA. (Note No.5 in Design Drawing 145400-DD-DWZT-2001). Allied works were carried out as indicated below:

3.1.1 Bathymetry and topographic surveys were carried out during the period of 5th to 18th May, 2014.

3.1.2 Geotech studies were carried out during the months of May and June 2014.

3.1.3 Construction of coffer dam was carried out during 15 May 2014 to 5 August 2014.

3.2 Jetty Structure:

A) Status of work
All the activities related to Steel Tabular Piles, Concrete works and miscellaneous elements of jetty, Trestle and walkway were substantially completed by the end of February 2015.

During the span of time after mobilization, available to the Consultants w.e.f. October 20, 2014, to end March, 2015, activities were monitored by Consultants in the light of quality assurance requirements only and documents / information / access made available to them on work days during day time.

B) Issues of concern which were recorded during construction work are as under:

- The STP were driven not to the designed toe level of – 30 meter. EETPL to get a confirmation with supporting calculation from their designers, that the reduced driven depth of STP satisfies the required factor of safety based on geotech studies. They may also carryout study to determine the effect of scouring particularly when the pile depths are not as per original design and the soil conditions below the hard strata as mentioned in Sellhorn Inception Report.

- EETPL did not provide to Consultants various documents related to civil works despite repeated requests and follow ups and those provided were unsigned / unauthentic / untimely and mostly after completion of works..

- EETPL did not submit the Factory Test Certificates from the manufacturer of Fenders and other fixtures installed at LNG terminal and various 3rd party inspection reports during construction monitoring period of RLNG. A number of documents furnished later were in Chinese language against the provision of Implementation Agreement (IA).

3.3 Pipeline Works

RLNG pipelines were substantially completed by end of February 2015.

3.3.1 Major items of RLNG Pipeline Works

- Survey, demarcation, and acquisition of land for 15 meter wide ROW, for laying of pipelines in PQ area and outside PQ area.
- Excavation of trenches for laying of pipeline.
- Sand blasting as per Swedish standard SA-2.5 and wrapping up of Heat shrink sleeve application on welding joints.
- Laying of pipelines in trenches and their testing.
- Thrust boring and horizontal drilling at road, railway track, nallahs and other crossings.
- Installation of Cathodic Protection (CP) System.
- Hydrostatic testing from LNG Jetty to CTS and from CTS to SMS Pakland.
- Overall Testing & Commissioning of completed pipelines.

3.3.2 Status:

A. Pipeline

All the activities related to installation of pipelines of 24” dia and 42” dia including welding of joints, radiography, application of heat shrink sleeves and allied works, were completed substantially by the end of February 2015, and were monitored in the light of quality assurance requirements with whatever documents were furnished. This stands true for all civil, mechanical, electrical, RLNG Pipelines and HSE.

Observations:

a) Monolithic Insulating Joint:
Steel Truss was placed on Intake Channel of Pakistan Steel for crossing of 24” dia RLNG pipeline without installation of insulation joints. The suggested joints are used for ensuring proper functioning of cathodic protection system and providing electrical safety to the pipelines.

b) Backfill in trenches:
It was noted that inside EVTL premises, excavation & back filling was not done as per code of API-1104 / ASME B31.8, It was back filled with top cover of earth / back filled material of about 1.5 feet over the pipeline instead of about 1 meter or 3.3 ft. as per Quality Inspection Plan (QIP) submitted by EETPL.

B. Custody Transfer Station (CTS):

Works comprised of construction of metering skid, intake manifold assembly, filter vessels, pig receiver for 24” dia pipeline, water bath heaters, including civil foundation works, etc.

Observations:

Proper monitoring / QA has been difficult without timely access to the documents which have been requested a many times.

4. Electrical & Mechanical Works

4.1 Review of relevant documents including specification, drawings, methodology, manufacturers' instructions regarding installation and field activities related to compliance of quality assurance, could not be accomplished to Consultants satisfaction. Post authentication of documents and installations could, therefore, be done only, at this stage, as an option available to consultants after completion of the works.

4.2 FSRU Arrival and Berthing at EETPL LNG Terminal.

The first FSRU arrived and berthed at EETPL LNG Terminal at Port Qasim on March 26, 2015.

In respect of Performance and Acceptance test for the LNG Terminal, Granada Consultants witnessed proceedings of the events during March 27&28, 2015. The check of RLNG sendout capacity, reliability, retainage / fuel consumption and storage capacity of FSRU, were completed successfully. The performance as regards the unloading rate of LNG from LNG vessel to FSRU and ship to ship operation, is yet to be assessed on arrival of the loaded LNG Carrier at the terminal.

5. Review of Reports, Studies and Comments.

5.1 Health Safety Environmental (HSE):

- Following HSE related documents received from AEAI pertaining to USAID Environment Expert close out meeting were reviewed.

  i) SHE (27 documents).
  ii) UA & UC doc. Dec 2014.
  iii) Training Plan.
  iv) CDGK Contractor for EETPL HSE and waste disposal / wastewater management.
  v) IUCN Contract & Scope covering.
  vi) Lab Tests September to November 2014.
  vii) QTS certificate.
  viii) Close out meeting dated March 25, 2015.

- All issues related to construction have been concluded by Mr. Sadaf with EETPL. Furthermore, Sindh Environmental Protection Agency's NOC states that during operations phase EETPL will comply with National Environmental Quality Standards through IMC for air emission, wastewater and noise. These reports i.e. Monthly Environmental Monitoring Report will be required from EETPL for review. While sharing of the environmental monitoring report prepared by IMC during operation phase is requested, the updates on status of post construction clean up and mangroves rehabilitation will also be required.

- Annex-2 may be referred for comments on related documents received.

5.2 Hydrographic Studies:

There has been no specific activity during the month of April 2015.

5.3 Pile Report of Loading Platform

1. The EVTL Report was reviewed. The note of the supervising engineer of EETPL states that ”approval is subject to survey of coordinates confirming to design”. No subsequent document was received from EETPL confirming correctness of coordinates of piles. Therefore, the report could not be termed as fully conclusive.

2. The dia. of piles stated as 12.50 of pile test report is conflicting with the design dia as 1200m.

3. Design depth of piles is -30m CD. Since the piles have the driven depth less than -30m, it is necessary to confirm with supporting calculations that the embedded lengths provide safe bearing capacity.

5.4 Painting Specification

The titled document received from EETPL was reviewed. General methodology of application of paint is okay. A few comments are as under:

a) The document is not signed / stamped i.e. not indicative of its source of issuance / preparation.

b) Manufacturer’s recommendation was not available regarding the material.

c) The document does not indicate the structural elements for which the specifications have been adopted.

d) It is not indicated which code / standard has been followed for using 250 microns for Epoxy primers and 60 microns for finish coat.

6. Synopsis of Overall Activities of Consultants

6.1 ECIL Input

1. Consequent upon arrival of FSRU on 26th March, 2015, and commissioning of the Pakistan's first ever EETPL LNG Terminal at Port Qasim on 26th March, 2015, the project as the part of the assignment related to monitoring of construction activities came to an end since no work was ongoing. The activities were therefore limited to collection and general review of design documents.

2. Activities of design review continued throughout the month of April 2015, mainly by Mr. Nobert Peetz of Sellhorn and at ECIL. Comments after review of documents were submitted as part of 33 pages Inception Report, which was also circulated to PQA through AEAI. The report is very comprehensive one and divulges upon pertinent topics of the civil structure such as its design basis, designed life and stability of the structure in particular.

3. After detailed review of Inception Report, comments of PQA and ECIL were compiled and forwarded to the consultants for considering them while preparing the final documentation.

4. As a result of the Desk Study Sellhorn gave detailed report on the navigational aspects in the Port Qasim channel in the light of SIGTTO, PIANC and TERMPOL codes with the help of tabulation, comparative statement, pros and cons and suggest way forward available to Port Qasim.

5. Recommendations and further steps shall be given by the consultants in the final report which will interalia briefly cover the following:

   a) Summary list with remarks and comments to be forwarded to Engro Elengy Terminals with regard to jetty design.

   b) Modeling studies.

   c) The layout drawing of access channel.

   d) Recommendations on additional Metocean data collection (type and location)

   e) Navigation Channel design.

6. Inception Report is enclosed herewith (Annex-4).

7. The other most important activity was the preparation of financial model of tariff. A number of meetings were held and many versions of financial model were prepared, explained and submitted, through AEAI, based on the parameters every time desired and given by PQA after determining most appropriate figure on the basis of no loss to PQA and yet not burdening the rates of imported gas.

8. Port Qasim regulations for handling of LNG vessels finalized earlier and partially incorporated in the SOP by Granada Group were further reviewed to the extent of incorporating ECIL comments before submission of final version.

9. The review was carried out of the documents received from AEAI pertaining to the close out of the outstanding actions by Environmental Specialist of AEAI / USAID. Following is the list of documents which were reviewed and comments offered by Environmental Specialist.

   a) SHE
   b) Unsafe Act and Unsafe Conditions (UA & UC) doc. Dec 2014
   c) Training Plan
   d) CDGK Contractor for waste disposal.
   e) IUCN Contract & Scope covering
   f) Lab Tests Sept to Nov. 2014.
   g) QTS (Quality Testing Service) Certificate.
   h) Close out meeting dated March 25, 2015.

6.2 Granada Group Input.

During this month, both consultants of Granada Group have been providing the necessary support and the consulting services to AEAI clients including the PSO, Ministry of Petroleum and the PQA.

During this month priority was given to all those items that needed to be completed and verified prior to the arrival and berthing of FSRU and subsequent commissioning of the LNG Terminal. These items included:

1. Progress on 91 Open items in the Action Register received from Qatar after their initial visit to Port Qasim and the LNG Terminal.

2. Attended meetings alongside the Director General Operations – Port Qasim Authority with Qatargas Operations, Shipping, Commercial and Technical Teams at Doha to discuss and resolve the following issues:

3

   a. Issues related to the guarantees required by Qatargas regarding the depths of various sections of the Port Qasim navigation channel and waterways

   b. Details of dredging program and maintenance of depths in the navigation channel.

c. Discussions of findings of the FMBS studies carried out at SiPort, Spain related to navigation of QFLEX LNG Carriers owned by Port Qasim.

d. Issues related to requirement of waivers from the compliance with Pakistan LNG Policy required by Port Qasim Authority prior to allowing the entry of QFLEX LNG carriers in the navigation channel in order not to be in non-compliance of the SIGTTO guidelines.

e. Findings of the last security assessment audit of the PQA waterways and infrastructure as well as the EETPL Terminal and planning the next visit of the Qatargas Security Assessment Team for finally clearing the security plan and arrangements.

f. The PQA tariff for Qatargas owned LNG carriers calling at Port Qasim. Structure of the tariff was discussed along with the Financial Model showing the details of the calculations. Basis of Tariff proposed by Qatargas were discussed and a convincing case was made with the Qatargas about the proposed tariff of Port Qasim Authority for the Qatargas vessels.

g. After the meetings it was agreed to provide further information and follow up of a total of 18 remaining items of the Action Register appertaining to actions by Port Qasim with planned close-out of these items by the end of April, 2015. Minutes of the Meeting were prepared and signed by the attendees and circulated with the report of the meetings to all the stakeholders.

4. Prepared the Joint Security Plan for the Port Qasim waterways and infrastructure and the EETPL Terminal with inputs and ownership of Port Qasim Authority Security Team, Pakistan Navy, Pakistan Coastguard, Pakistan Marines and the EETPL Terminal Operational and Security Staff.

5. Meetings were held with the management and staff of EETPL to agree on Joint Security Plan, Drills and deployment of Armed Forces for providing the security of the Terminal.

6. Meetings were held with the Pakistan Navy, Pakistan Marines, PQA Security Team and the Pakistan Coastguard in order to form a well coordinated security team for providing the security and response to any threats to the LNG shipping within the Port and handling it at the EETPL LNG Terminal under a unified command structure. Responsibility and roles of each branch of the armed forces, the Terminal management, Port Qasim Security Team and the civilian authorities were identified and clarified to each of the stake holders under various emergency scenarios which were reinforced through a number drills.

7. The security drills to practice and improve the response of all the parties under different scenarios were conducted in line with the Joint Security Plan, with participation of the PQA Security Team, the local police, fire brigade, ambulances and the assigned Armed Forces combined contingent. These drills were carried under observations of Granada Consultants who provided debriefing and critique after each drill in order to identify any shortcomings and improve the coordinated response to any threats under various scenarios.

8. Assisted the PQA and the Armed forces in the Security Assessment Survey of the Port Qasim and Terminal Security arrangements, deployment of security assets and the preparedness in dealing with any threats. This survey was carried out in a three day audit conducted by the visiting Qatargas and the ConocoPhillips Security

Assessment Team and the acceptance of security arrangements of both the PQA and the EETPL were cleared for the calls of Qatargas vessels.

9. Drafted the Standard Operating Procedures for LNG vessels calling at Port Qasim, Conditions of Use and the Marine Service Certificate documents with input and information from the Operations and Technical Departments of Port Qasim Authority. The navigational procedures of the LNG carriers included in the SOPs were based on the findings and recommendations of the Siport FMBS study and the PQA Pilots who attended the simulations at Siport in Spain and also spent time on the Qatargas owned QFLEX vessels at Qatar for familiarization with the maneuvering of these vessels during berthing and un-berthing at Ras Laffan.

10. The initial drafts of the above documents were forwarded for information and review by all the stakeholders and management of Port Qasim. Comments were received from the PQA Operations and Hydrography Departments that were incorporated in the First Revised Version of the Documents.

11. Subsequently, the revised version of the documents were forwarded to Qatargas as per the agreed Minutes of the Meetings dated April 8th , 2015 for their review and comments which were received and incorporated in the final version of the documents. The final versions were handed over to Port Qasim Authority for publication and display on their website.

12. Assisted PQA with the calculation of tariff for the Port service charges to be levied on LNG carriers calling at Port Qasim. A financial model was created with all applicable costs provided by the PQA finance department to calculate and determine the tariff which was also discussed with Qatargas. The presentation of the Tariff calculations was made to the Board Members of Port Qasim at the invitation of the Chairman of Port Qasim Authority. Provisional charges for each call of the FSRU were agreed by the Board which was programmed to ship in the initial spot cargoes of LNG. Finalization of the Tariff rates was deferred to the approval of the same by the Government of Pakistan which is expected shortly.

13. A number of meetings were held with PQA, SSGC and AEAI to update status of the project and assist PQA as well as PSO in meeting their commitments towards completion of their assigned tasks under the Qatargas Action Register. Assistance was provided in correspondence with Qatargas and the Ministries in order to make the Government decision makers aware of the critical issues affecting the safety, security and the commissioning of the Project.

Going forward the program for verification of close-out of the non-compliant items identified during the SIGTTO, PIANC and NFPA Gap Studies will be resumed to progress the quality assurance process that was put on hold to give priority of assisting with bringing the Terminal in operation for direly needed imports of LNG in the country.

Routine correspondence was carried out through emails and telephone calls with AEAI, ECIL, SSGC, the ISGS, Qatargas and the PQA representatives in order to resolve day to day issues related to LNG Procurement and smooth completion and commissioning of the Terminal Project.

Annex-3 may be referred to for perusal of the Minutes of Meeting of PQA officials and Granada Experts with Qatar Gas Officials at Doha.

6.3 Activities of Sellhorn

6.3.1 Review of the jetty design and desk study on anchorage area, existing navigational channels and alternate channel and suggestions to upgrade the channel by Sellhorn of Germany was done.

6.3.2 Based on the initial observations Sellhorn submitted an Inception Report to PQA and ECIL, refer Annex-4.

6.3.3 ECIL comments on the Inception Report prepared by Sellhorn are given are given in Annex-5.

6.3.4 Further review of documents and desk type studies are in progress.

7. Consultants Staffing:

List of Local and Expatriate staff involved for the project work, is attached as Annex-1.

8. Contractor's Field Establishment & Staffing.

Demobilized from Site in March 2015.

9. Main Equipment and Construction Facilities used at the Site during construction.

Demobilized from Site.

10. Weather Report.

Monthly Weather Report not received from the EETPL.

Date	Weather		Temperature		Remarks
	Rain	Wind	Maximum	Minimum	

11. Tidal Observations:

Not received from EETPL.

12. Status of Documents Received from EETPL.

No documents were received this month. Therefore, the status remained same as that of previous month.

13. Documents yet to be received from EETPL

The status is same as that of previous month.

14. Project Progress Photographs

Refer Annex-6.

15. Conclusion

- The construction works, pertaining to establishment of the Pakistan's first ever dedicated Floating LNG Terminal, carried out on fast track basis, are complete. A FSRU as per IA had been successfully navigated and berthed on the new LNG Jetty on February 26, 2015. The progress of work has been almost as per construction schedule. No major adverse observations regarding quality of the field work have so far been received from the Consultants' field staff. However, observations of Sellhorn mentioned in the Inspection Report and Civil Engineer's comments / observations stated under items 3.2B, 3.3.2B, need attention / necessary action.

- The appointment and hence deployment of the Consultants for QA (Quality Assurance) of the project, was done at a belated stage i.e. much after the design and actual commencement of work. Therefore review and comments on various reports, studies and finalization of some vital documents are still outstanding although the construction works are already completed. Moreover, all observations will be only for record. After having mobilized and lot of pursuance, various reports and documents were received by the consultants but very late, in the disjointed position, piecemeal and mostly after the completion of the particular activity.

- The consultants have been mobilized about six months by now whereas the physical work was substantially completed by end of February 2015, because the work commenced much earlier than the appointment and mobilization of the Consultants. They had to carry out QA monitoring work on whatever was remaining without required documents being made available to them. Some of data / reports are even now to be furnished by EETPL for post authentication of compliance of specifications, codes and standards.

- Foreign associate consultants Sellhorn of Germany could not be mobilized before February 17, 2015, when civil works, laying of RLNG pipelines and allied works including most of the E&M works were already complete. Therefore, Mr. Nobert Peetz, the visiting Sellhorn engineer virtually saw substantially completed structures.

- The consultants continued the review of post authentication of various items of works already completed. Most of the documents were forwarded to Sellhorn for their study & review. They have submitted an Inception Report and have continued review of documents.

- Based on initial available information Sellhorn submitted their Inception Report (refer Annex-4). The Inception Report in few cases highlight adoption of less factor of safety by

the developers' consultants, and termed them as a matter of concern requiring explanation by the developers.

- The initial observations are yet to be finalized on comprehensive study of various documents received from EETPL.

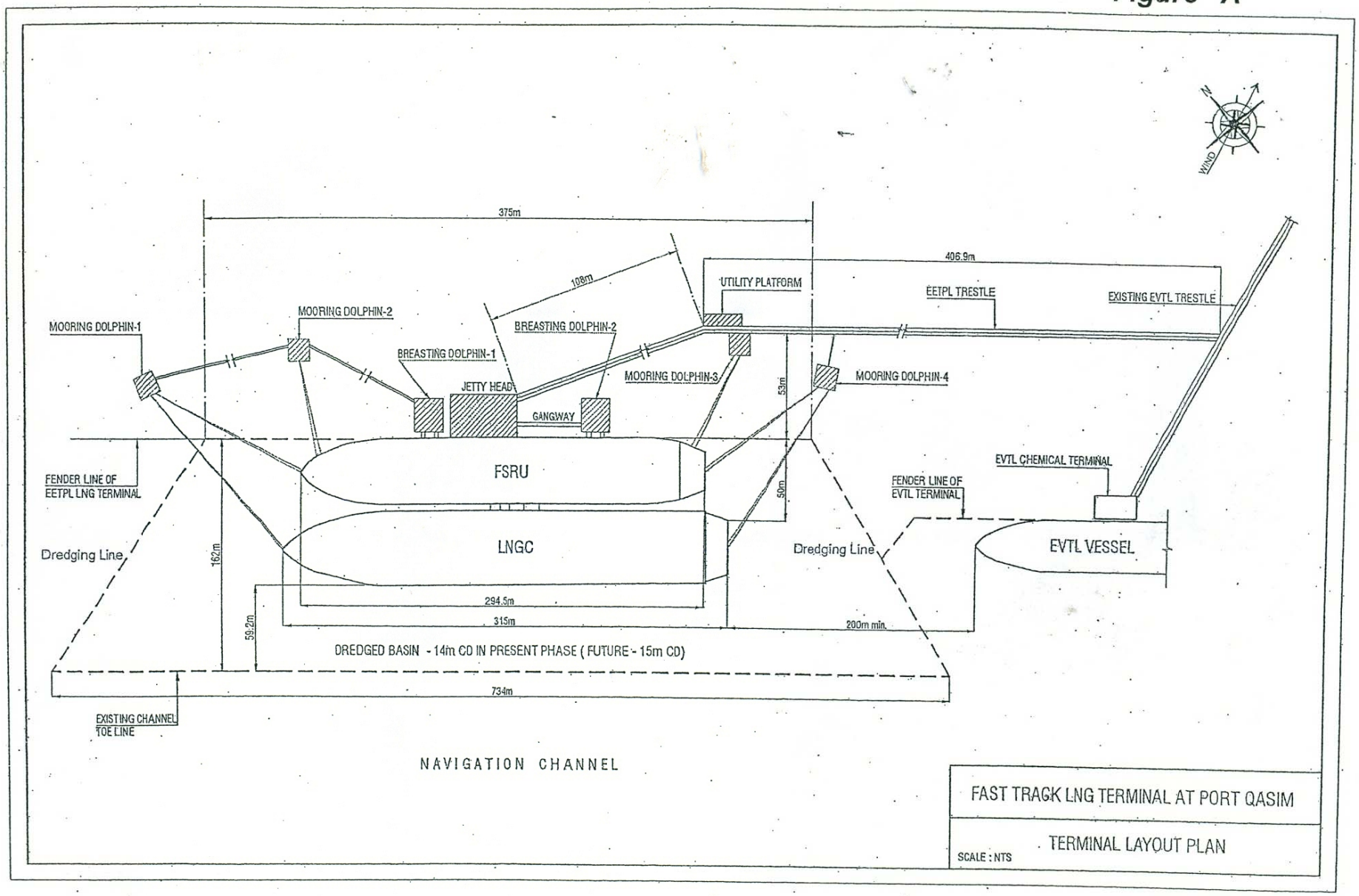
- The FSRU which berthed first time at the newly constructed LNG Terminal at Port Qasim is presently being shuttled as LNG Carriers till such time arrangements with Qatar Gas are finalized to feed the RLNG Pipelines.

- It is understood that the FSRU while in service must be navigating to and fro under agreed operating parameters and regulatory requirements,

FIGURE

SHOWING TERMINAL LAYOUT PLAN

Figure "A"


375m
108m
406.9m
UTILITY PLATFORM
EETPL TRESTLE
EXISTING EVTL TRESTLE
MOORING DOLPHIN-1
MOORING DOLPHIN-2
BREASTING DOLPHIN-2
BREASTING DOLPHIN-1
JETTY HEAD
GANGWAY
MOORING DOLPHIN-3
MOORING DOLPHIN-4
53m
50m
FSRU
LNGC
FENDER LINE OF EETPL LNG TERMINAL
Dredging Line
162m
59.2m
294.5m
315m
200m min.
FENDER LINE OF EVTL TERMINAL
EVTL CHEMICAL TERMINAL
EVTL VESSEL
DREDGED BASIN - 14m CD IN PRESENT PHASE (FUTURE - 15m CD)
734m
EXISTING CHANNEL TOE LINE
NAVIGATION CHANNEL
WIND
FAST TRACK LNG TERMINAL AT PORT QASIM
TERMINAL LAYOUT PLAN
SCALE : NTS

A N N E X U R E S

ANNEX – 1

LIST OF STAFF

LNG TERMINAL AT PORT QASIM

LIST OF STAFF

Sr.No.	Name	Nationality	Position
ECIL			
1.	A.N. Qabulio	Pakistani	Project Director
2.	Tanweer A. Khan	Pakistani	Port & Harbour Development Engineer
3.	Capt. Hashmat Ullah Shah	Pakistani	Port Operation Expert
4.	Zafar H. Ismail	Pakistani	Financial Expert
5.	Agha Taimur Khan	Pakistani	Port Charges, Royalty, Tarrif Expert
6.	Tufail Ali Zubedi	Pakistani	Environmental Engineer
7.	Shahid H. Mirza	Pakistani	Civil Engineer
8.	Mohammad Shoaib	Pakistani	Electrical Engineer
9.	Jamiluddin	Pakistani	Mechanical Engineer
10.	Zahid Ali Mahesar	Pakistani	Pipeline expert
11.	Muhammad Bakhtiar Hussain	Pakistani	Hydrographer
12.	M.A.G. Siddiqui	Pakistani	Legal Advisor
Sellhorn			
13.	Nobert Peetz	German	Civil & Structure Engineer
14.	Birgitt Brinkmann	German	Civil Engineer
Granada Group (Foreign Consultants)			
15	Mohsin M. Siddiqui	USA	Project Coordinator, LNG and FSRU Specialist
16	Capt. Farooq Hussain	USA	LNG Marine, Navigation & FSRU Terminal Specialist
Support Staff			
1.	Sheikh Shahid Hussain	Pakistani	Coordinating Engineer
2.	Shaikh Abdus Salam	Pakistani	Office Secretary

ANNEX – 2

COMMENTS ON HSE DOCUMENTS

COMMENTS ON HSE DOCUMENTS

Annex-2

Documents Received	Comments
1. Attach 1. EETL HSE and Waste Management.zip	
a. SHE-MSP-001-Risk Management Plan.doc	All documents prepared for operations phase Documents are Standard operating procedures and contain good working practices It is more important to evaluate the implementation of this system by checking their records, non-compliances, corrective / preventative actions etc.
b. SHE-MSP-002-Communication.doc	
c. SHE-MSP-003-Control of SHE Documents.doc	
d. SHE-MSP-004-Control of SHE Records.doc	
e. SHE-MSP-005-Legal Requirements.doc	
f. SHE-MSP-006-Monitoring & Measurement.doc	
g. SHE-MSP-007-Internal Audits.doc	
h. SHE-MSP-008-Non Conformance Corrective & Preventive Action.doc	
i. SHE-MSP-009-Management of Change.doc	
j. SHE-MSP-010-Waste Management.doc	
k. SHE-MSP-011-General Procedure For Spill Control.doc	
l. SHE-MSP-012-Job Safety Analysis .doc	
m. SHE-PPE-001 PERSONAL PROTECTIVE EQUIPMENT.doc	
n. SHE-PPE-002 HEAD PROTECTION.doc	
o. SHE-PPE-003 EYE AND FACE PROTECTION.doc	
p. SHE-PPE-004 HEARING PROTECTION.doc	
q. SHE-PPE-005 HAND AND BODY PROTECTION.doc	
r. SHE-PPE-006 FOOT PROTECTION.doc	
s. SHE-PPE-007 RESPIRATORY PROTECTION.doc	
t. SHE-PPE-008 FALL PROTECTION.doc	
u. SHE-PPE-009 PPE FOR ELECTRICAL SWITCHING WORK.doc	
v. SHE-PTW-001 (PERMIT-TO-WORK SYSTEM POLICY AND GUIDELINES).doc	
w. SHE-PTW-002 (LOCK, TAG AND TRY PROCEDURE).doc	
x. SHE-PTW-003 (WORK ON SCAFFOLDS).doc	
y. SHE-PTW-004 (SAFE PRACTICES FOR EXCAVATION).doc	
z. SHE-SWP-001 (TEMPORARY BARRICADE PROCEDURE).doc	
aa. SHE-SWP-003 (PROCEDURE FOR MAINTENANCE WORK).doc	
bb. SHE-SWP-004 (SAFETY INSTRUCTIONS FOR WORKING AT HEIGHT.doc	
cc. SHE-SWP-005 (PROCEDURE FOR FIXED LADDERS).doc	

2. Attach 2. UA & UC dec 2014 LNG.xlsx	UNSAFE CONDITIONS REPORTING LOG as of Dec 2014. All observations are reported to be closed. The requirement to conduct this assessment and its assessment frequency is missing; hence it is unclear when such assessment will be carried out in future. Some conditions listed may reoccur such as “oil spill near generator no dip try found”. It is unclear who will be reporting this at what frequency.
3. Attach 3. Training Plan.xlsx	Internal & External Training calendar. All of the scheduled trainings will have been conducted. Actually training records should have been forwarded instead of calendar.
4. Attach 4. CDGK Contractor for waste disposal.zip	
a. Garbage - Sludge - Valid Licence.pdf	The registration is from 17-nov-2014 and the project initiated in Jun 2014. Solid waste / sludge was not collected from Jun to Oct i.e. 5 months
b. Picture 006.jpg	Certificate is only valid for collection, transportation and safe disposal of waste material (sludge oil and garbage non-hazardous waste from ships vessels) EETPL needs to share quantities / types of waste it disposed through this contractor. Furthermore, EETPL has always maintained that KMC-CDGK has disposed their waste. This is a controversy.
c. Picture 007.jpg	No comments
5. Attach 5. IUCN Contract and Scope Covering.pdf	Contract states that 500 ha of linear mangrove plantation will be done. SEPA required 1:10 ratio for mangrove replantation. In my opinion, Environmental Monitoring reports stated much more area was disturbed than 50 ha.
6. Attach 6. Lab Test Sep to Nov.zip	
a. EETL sep results.pdf	Waste water do not comply with NEQS in Sep/ Oct Drinking water contains coliforms Efforts done to comply with NEQS are missing. SEPA requires that Environmental Monitoring be carried out during operations phase. Test Results from Dec 2014 to date are missing.
b. EETL Testing Report Nov.pdf	
c. EETL Testing Reports October.pdf	

7. Attach 7. QTS Certificates.zip	
a. Certificate Environmental Laboratory.jpg	No comments
b. QTS Certificate First Surv. Audit.pdf	
8. Closeout Meeting EETPL Project_25Mar15Rev2.docx	

ANNEX – 3

Minutes of Meeting on 07 / 08 April’15
at Doha (Qatar)

Port Qasim Meeting Minutes for 07/08 April'15

Subject of Meeting: Port Qasim discussions

Location: 41-02 Qatargas Doha HQ
Location: 03-01 Qatargas Doha HQ

Attendees:

S.NO	Name/Position	Organization	Position	07/03	08/03
1	Capt. Vishal Chaudhary	Qatargas	Head of Marine Terminals & Fleet Compatibility	X	X
2	Capt. Vineet Chawla	Qatargas	Marine Specialist	X	X
3	Mr. Doured Ali	Qatargas	Marine Specialist	X	X
4	Capt. Drazen Predovan	NAKILAT	Fleet Operations Superintendent	X	-
5	Capt. Nouman Hassan	Port Qasim	DG (Operations)	X	X
6	Mr. Mohsin M. Siddiqui	Granada	Consultant	X	X
7	Capt. Farooq Husain	Granada	Consultant	X	X

1) PQA management is to provide a formal letter of assurance confirming minimum channel depths of 13mtrs below CD that will be maintained all the year round. This letter is to be supported by the applicable IA page excerpt and bathymetry survey report covering the full channel length. {OPEN} {EXPECTED CLOSURE 23rd APRIL}

2) PQA to provide the latest bathymetry of the complete channel by 20th April'15. {OPEN}{EXPECTED CLOSURE 23rd APRIL}

3) PQA confirms the channel bathymetry survey results shall be made available on 6 monthly basis (March and October) each year and they shall provide feedback on monthly (average) silt build up in the channel. {OPEN} {EXPECTED CLOSURE BY 23rd APRIL}

4) The passing ship's speed is to be managed as per conclusions of the Artelia study* copied below. {OPEN} {EXPECTED CLOSURE 20th APRIL}

Passing distance (from toe line)	Passing by Speed (Ground Speed)	Differential motion in reference to the berth	Max wind speeds	Remarks
0 meters	6kts	0.6 meters	25kts from SW	-
0 meters	8kts	< 2 meters	25kts from SW	-
0 meters	8kts	< 2 meters	25kts from any direction	-

Passing distance (from toe line)	Passing by Speed (Ground Speed)	Differential motion between the 2 moored vessels	Max wind speeds	Remarks
0 meters	6kts	1 meters	25kts from SW	-
40 meters	6kts	< 2 meters	15kts from any direction including NE	Will be confirmed in final version of study

** Study conclusions received by Qatargas on 16th March'15*
This limitation is for the vessel greater than or equal to 310 meters LOA vessel, for smaller vessel (total 85% of Port Operations) results for passing by vessels will be much better.

5) PQA confirms that one tug with FiFi capability shall be available at all times during the cargo operations and the second designated tug is to be stationed in close proximity, ready for deployment in case of any emergency. {CLOSED}

6) Final FMBS report with supporting Annexes and recommendations needs to be provided urgently to Qatargas. {OPEN} {TO BE CLOSED BY 14th APRIL}

7) In line with Feb'15 FMBS studies and discussions, Pilot Positioning Unit (PPU) with vessel transverse approach speed measuring capability is to be provided within the time line proposed in the action register (3-4 months after the first Q-Flex call at the terminal). PQA confirm that the DGPS stations shall be made available for use by visiting LNGc's during port calls. {OPEN} {PPU TO BE PROVIDED BY 31st JULY}

8) The latest edition (revision #5) of the BA chart # 59 (Port Muhamad Bin Qasim and approaches) was published in March'13 and since its published date there have been no corrections issued. PQA to confirm that the required information from local hydrographer has been passed to British Admiralty to update the BA chart in order for it to reflect the current applicable depths and indicates the correct position of the terminal. {OPEN} {TO BE CLOSED BY 15th APRIL}

9) Latest Notice to Mariners announcing the permissible drafts and maintained depths to be made available to QG and involved stakeholders before the 15th of May'15 (last issue dated 28th Dec 14 sighted, expiring on 15th May'14). {OPEN} {TO BE CLOSED BY 15th MAY}

10) PQA to provide the updated local port chart for use by the calling LNGc vessels at least one week prior to vessel's scheduled loading at Ras Laffan through QG's local agent. {OPEN} {TO BE CLOSED BY 15th MAY OR A WEEK BEFORE VESSEL'S LOADING DATE-WHICH EVER IS EARLIER}

11) PQA after discussions with Engro to jointly advise on a suitable date for the SRA-QG team's verification review visit. {OPEN} {TO BE CLOSED BY 10th APRIL}

12) PQA to confirm if there are any relevant clauses in IA (Port Qasim and Engro terminal) that may impact Qatargas business and share the same with Qatargas. {OPEN} {TO BE CLOSED BY 20th APRIL}

13) As discussed during the meeting, PQA need to urgently share the copy of Port's Conditions of Use (COU) for required approval - which is contrary to the email dated 25th Feb from PSO representative. {OPEN} {C.O.U TO BE SUBMITTED BY PQA SOONEST FOR OWNERS REVIEW AND CLOSURE}

Port Qasim Meeting Minutes for 07/08 April'15

14) Updated Standard Operating Procedures (SOP) of Port Qasim to be incorporated in the EETL Terminal Regulations addressing the following points: {OPEN} {PQA TO PROVIDE SOP's TO ENGRO BY 20th APRIL FOR INCLUDING SAME IN EETL TERMINAL REGULATIONS}
    - Day light transit only requirement
    - One way traffic only
    - Weather criteria in line with SIPort recommendations
    - Passing ship table
    - Water density
    - Contingency anchorage
    - Pilot boarding positions in line with SIPort recommendations

15) PQA shared Port Qasim's vessel (large vessel) historical call data with Qatargas for information purpose. {CLOSED}

16) Qatargas requests that the identity of the PQA pilots expected to handle the LNGC vessel's is shared with Qatargas during SRA review visit. {OPEN} {TO BE CLOSED DURING THE SRA REVIEW VISIT}

17) Local tide tables to be followed up by Port Qasim for the following year and is to be provided to Qatargas by September of each year. {OPEN} {PQA TO CHECK WITH PAK HYDROGRAPHIC DEPT AND REVERT}

18) It has been mutually agreed that an operational review meeting should be considered after the first five Q-Flex calls at the EETPL terminal in order to share gained experience and review the applicable procedures for any required changes/amendments. {CLOSED}

All the points above are subject to review and approval of the respective management of the attending parties.

Capt. Nouman Hassan | *Mr. Mohsin M. Siddiqui* | *Capt. Farooq Husain*

Capt. Vishal Chaudhary | *Capt. Vineet Chawla* | *Mr. Doured Ali*

Annex - 4

INCEPTION REPORT
FOR GENERAL REVIEW OF JETTY DESIGN
AND
DESK STUDY OF NAVIGATIONAL CHANNELS

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1 INTRODUCTION

In December 2012 the USAID Energy Policy Program (EPP) was launched and includes the services of an international LNG Company to construct a new LNG Terminal at Qasim Port, Pakistan. Together with Engineering Consultants International (Pvt) Limited (ECIL) as the main consultant, Sellhorn Ingenieurgesellschaft mbH, Hamburg, Germany (Sellhorn) provides consultancy services and is reviewing the structural designs concerning marine and civil structures.

In addition, Sellhorn has been requested to carry out a desk study in which the Port Qasim Authority (PQA) anchorage area, the existing navigational channel and alternative channels will be reviewed and suggestions for upgrade will be given.

The present report summarises the results of the above mentioned tasks. It is divided into two parts concerning the following aspects:

Part 1: General Review of Jetty Design

This part is a general observation report on jetty design comprising document review and quality assessment. It investigates the design approaches and particular applied design parameters of trestle, loading platform, mooring and breasting dolphins, and their foundations.

Part 2: Desk Study of Navigational Channels

This part encompasses the study and review of PQA anchorage area, existing navigational channel and alternative channels. Available documents have been collected and investigated and relevant results of hydrological and geological studies compared. Based on this, recommendations for upgrade (straightening, passing bays for two way traffic, widening, and dredging, etc.) are given on conceptual basis. In addition, position and content for additional field measurements, such as waves, currents, and tidal data at the inner and outer channel have been elaborated.

2 GENERAL REVIEW OF JETTY DESIGN

2.1 Scope

As already quoted in Introduction, this observation report investigates the design approaches and particular applied design parameters of trestle, loading platform, mooring and breasting dolphins, and their foundations primarily made by or on behalf of the construction company China Harbour Engineering Company Ltd. (CHEC).

2.2 Received and Reviewed Documents

From January 2015 to March 2015, Sellhornreceived several documents regarding the new LNG terminal at Port Qasim. Table 1 shows the selection of documents directly concerning the jetty design.

Table 1: List of received and reviewed documents concerning jetty design

Internal Doc. No.	Description	Latest Rev.	Document Date	Author	Author's Document Number	Pages	Received
	Studies / Specification						
01	Manoeuvring Simulation Study	2	Oct 2014	Siport21		130	28.01.2015
02	Specification for Quick Release Hook	B	Jul 2014	CCCC	14S400-DD-SP-SG-1004	7	28.01.2015
03	Specification for Test of Tubular Steel Pile	0	Sep 2014	CCCC	14S400-DD-SP-SG-1007	12	28.01.2015
04	Corrosion Protection Coating of Tubular Steel Pile Technical Submission	A	Jul 2014	CCCC	14S400-DD-SP-SG-1008	11	28.01.2015
05	Specification for Dredging (incl. List of STS Activity)	1	Oct 2014	CCCC	14S400-DD-SP-ZT-0001	20	10.03.2014
	Design Documents						
06	Basis of Design - Marine and Structural Engineering	4	Jun 2014	Technica	E-10100111-C-0500-004	38	10.03.2014
07	Marine Structure Calculation Sheet for Mooring Dolphin Foundation	A	Jul 2014	CCCC	14S400-DD-CL-SG-1001	56	28.01.2015
08	Marine Structure Calculation Sheet for Breasting Dolphin Foundation	A	Jul 2014	CCCC	14S400-DD-CL-SG-1002	40	10.03.2014
09	Marine Structure Calculation Sheet for Loading Platform Foundation	A	Jun 2014	CCCC	14S400-DD-CL-SG-1003	39	10.03.2014
10	Marine Structure Calculation Sheet for Trestle Foundation	0	Sep 2014	CCCC	14S400-DD-CL-SG-1004	50	10.03.2014
11	Marine Structure Calculation Sheet for Prestress Longitudinal Beam	A	Jul 2014	CCCC	14S400-DD-CL-SG-1005	45	10.03.2014
12	Marine Structure Calculation Sheet for Longitudinal Beam (non-prestress)	A	Jul 2014	CCCC	14S400-DD-CL-SG-1006	47	10.03.2014
13	Marine Structure Calculation Sheet for Transverse Beam	0	Sep 2014	CCCC	14S400-DD-CL-SG-1007	45	10.03.2014
	Drawings						
14	List of Drawings		Dec 2014			5	28.01.2015
15	Pile Location of Loading Platform	A	Jun 2014	CHEC	14S400-DD-DW-SG-1007	1	28.01.2015
16	Structure of Φ1200 Tubular Steel Pile	A	Jun 2014	CHEC	14S400-DD-DW-SG-1013	1	28.01.2015
17	Pile Location of Trestle	B	Jul 2014	CHEC	14S400-DD-DW-SG-2003	1	28.01.2015
18	Detail of Pile of Trestle	B	Jul 2014	CHEC	14S400-DD-DW-SG-2004	1	28.01.2015
19	Structure of PHC Pile and PHC Pile Shoe	A	Jun 2014	CHEC	14S400-DD-DW-SG-2005	1	28.01.2015
20	Dredging Work	B	Jul 2014	CHEC	14S400-DD-DW-ZT-2001	1	28.01.2015
	Construction Records and Reports						
21	Pile Reports of Breasting Dolphin 1		Oct 2014	CHEC		17	10.03.2014
22	Pile Reports of Breasting Dolphin 2		Oct 2014	CHEC		18	10.03.2014
23	Pile Reports of Loading Platform		Oct 2014	CHEC		20	10.03.2014
24	Pile Reports of Mooring Dolphin 1		Dec 2014	CHEC		14	10.03.2014
25	Pile Reports of Mooring Dolphin 2		Dec 2014	CHEC		9	10.03.2014
26	Pile Reports of Mooring Dolphin 3		Nov 2014	CHEC		9	10.03.2014
27	Pile Reports of Mooring Dolphin 4		Nov 2014	CHEC		14	10.03.2014
28	Pile Reports of Supporting Dolphin 1		Dec 2014	CHEC		2	10.03.2014
29	Pile Reports of Supporting Dolphin 2		Dec 2014	CHEC		2	10.03.2014
30	Concrete Test Report / Concrete Mix Design		Sep 2014	CHEC		29	10.03.2014
31	Data Sheet of Curing Admixture - BASF Masterkure 107		Sep 2005	BASF SE		2	10.03.2014
32	Quality Certificate of 100 PHC Piles		Aug 2014	CHEC		3	10.03.2014
33	Quality Certificates of Structural Steel - Grade Q235B		Aug 2014	misc.		10	10.03.2014

Authors

BASF	BASF SE
CCCC	CCCC-FHDI Engineering Co., Ltd.
CHEC	China Harbour Engineering Company Ltd.
Siport21	Siport21 - Port Engineering and Maritime Safety Consulting
Technica	Technica Ltd.

2.3 Review of jetty design

2.3.1 Studies and Specifications

2.3.1.1 Manoeuvring Simulation Study

Doc 01 is the "Manoeuvring Simulation Study for the New Re-Gasification Terminal in the Port of Qasim (Pakistan)" by Siport21. In this comprehensive technical study the feasibility of access and departure manoeuvres of LNG carriers is analysed from a navigational point of view. Full-bridge real time simulation is used to assess safe navigation and manoeuvring conditions of LNGC vessels in the study area.

The study is inter alia based on bathymetry data from British Admiralty Chart 59 since data from detailed soundings has been received after the study had already started and many manoeuvres executed. Nevertheless, a comparison of obtained bathymetry data and those from detailed sounding has been conducted.

Remarks:

Sellhorn did not receive any bathymetry study or related drawings until completion of this report.

2.3.1.2 Mooring Layout Verification and Mathematical Mooring Model Study

Doc 02 is Report A of the "Mooring Layout Verification and Mathematical Mooring Model Study" by Artelia. It is the draft report of a desk study and berthing energy study to confirm the terminal general layout and the fender characteristics. It presents the methodology used and the results obtained in terms of validation and recommended modification concerning mooring layout and mooring equipment.

Remarks:

Conclusions of the desk study say that

- Mooring Dolphin MD-1 has to be moved 12 m towards NNW
- Fenders on each breasting dolphin have to be replaced by 2 systems (1+1 spare), composed each of one SCK2500H E1.4 fender linked by a panel of at least 20.8 m²
- Layout and mooring configurations will possibly be further improved according to the results of the DIODORE simulations

Since this Report A is dated 1st December 2014, it has to be checked whether these results have been implemented in general layout and finally in construction of the jetty.

Report B, a mathematical mooring study to get tension in each mooring line, breasting force between FSRU and the berth face, and force between the FSRU and the LNG carrier moored to the FSRU to further validate the mooring layout, is not included in this document.

2.3.1.3 Specification for Quick Release Hook

Doc 03 "Specification for Quick Release Hook" by CCCC covers technical requirements for the mooring hooks to be installed by the contractor. It comprises technical requirements (weather and ignition proof, operation in hazardous environment) and codes to be applied (essentially British standards). Details are given for properties, assemblies, coating, and

testing of triple hook and quadruple hook mooring units. Design load for hook design shall be at least 1.25 times the maximum breaking load of mooring lines.

These specifications comply with our assessment.

Remarks:

Sellhorn did not receive any documents regarding construction of quick release hooks until completion of this report. Hence, an evaluation of compliance with the specification is not possible.

2.3.1.4 Specification for Test of Tubular Steel Pile

Doc 04 “Specification for Test of Tubular Steel Pile” by CCCC covers requirements for tests of tubular steel pile for the marine works of LNG terminal. Key objectives of pile tests are to establish the bearing capacity and provide design parameters for tubular steel pile foundation. Provisions are made for test setup and test procedure, and analysis and evaluation of test data. Two types of tests (axial compression and tension test and high strain dynamic test) shall be performed strictly in accordance with BS EN 1997-2:2007 (Eurocode 7).

Remarks:

Sellhorn did not receive any reports or records regarding test of tubular steel pile until completion of this report. Hence, an evaluation of compliance with the specification is not possible.

2.3.1.5 Corrosion Protection Coating of Tubular Steel Pile Technical Submission

Doc 05 “Corrosion Protection Coating of Tubular Steel Pile Technical Submission” by CCCC defines requirements of the materials, surface preparation, application, and inspection of steel tubular pile external corrosion protection coating, including above ground and immersion zone. Provisions are made for corrosion protection coating design, construction process, paint system, product characteristics, and physical and chemical properties.

Remarks:

Coating is designed for an effective period of protection of 30 years; design life time of the jetty is 50 years. For remaining 20 years steel thickness surcharge is 2 mm. According to Doc 6 “Basis of Design - Marine and Structural Engineering” an annual corrosion rate of 0.15 mm/year on each exposed face is adopted. Based on that, the thickness surcharge should be at least 3 mm.

2.3.1.6 Specification for Dredging

Doc 06 “Specifications for Dredging” by CCCC covers technical specifications for dredging work in basin area. It does not include turning area and approach channel. Related drawing is Doc 20 “Dredging Work”. Provisions are made for contractor’s dredging plant, submission of methods of working, tolerances, and general marine works requirements (i.e.

surveys for dredging, spillage and siltation monitoring, bathymetric surveys, and their presentation).

Remarks:

Besides “Specification for Dredging” and one single drawing named “Dredging Work” Sellhorn did not receive any survey and monitoring records nor related drawings until completion of this report.

2.3.2 Design Documents

2.3.2.1 Basis of Design - Marine and Structural Engineering

Doc 07 “Basis of Design - Marine and Structural Engineering” by Technica Ltd (UK), shall be design basis for all marine structures of the jetty and their foundations. The document provides relevant information on facility layout and mooring parameters like mooring arrangement, expected vessels, deck levels, and mooring equipment.

The chapter Metocean Parameters covers a desk study on tides and tidal current, wind, waves, and tsunami at Port Qasim. As a result three different metocean design cases are derived for mooring equipment and hooks (FSRU Only and Ship2Ship Arrangement) as well as for dolphins and platform (Structures Extreme).

In chapter Marine Structures design philosophy and design criteria based on British standards are provided for mooring and berthing dolphins, platform, trestle, and walkways. The definitions for surface finish state that steelwork used for installations should generally be hot-dip galvanized for durability. Items within the splash and intertidal zones may be coated. For determination of losses due to corrosion of unprotected steel plates, it is recommended that an annual corrosion rate of 0.15 mm/year on each exposed face is adopted.

Furthermore, some seismic criteria are recommended. The values Peak ground acceleration (PGA) is derived from Unified Facilities Criteria UFC 3-301-01 by Department of Defence of United States of America (DoD). For Karachi a PGA of 0.158g with a probability of exceedance of 10% in 50 years (or equivalent reference return period of 475 years) is given. This complies with our assessment.

Mooring line load philosophy is based on minimum breaking loads (MBL) of mooring lines. For in-place analysis, one winch shall be considered to be stuck (100% MBL), and the remaining winches slipping (60% MBL). For seismic analysis, all lines shall be considered to have reached 60% MBL, with no winches sticking. This approach corresponds to recommendations of EAU, taking into account 25% increase in line pull due to strong currents (5 knots).

Remarks:

In chapter Geology it is stated solely that geotechnical design parameters are to be provided by CHEC. Sellhorn did not receive them until completion of this report.

There are no provisions made regarding the following aspects:

- Increase of design depth for foundation design because of scouring and over-dredging.

- Limitation of crack width in concrete structures to prevent corrosion induced by chlorides from sea water; Sellhorn recommends to use a crack width for reinforced concrete structures in quasi-permanent load combination, and decompression for pre-stressed concrete members in frequent load combination according to Eurocode 2 (exposure class XS3: tidal, splash and spray zones).

2.3.2.2 Marine Structure Calculation Sheet for Mooring Dolphin Foundation

Doc 08 “Marine Structure Calculation Sheet for Mooring Dolphin Foundation” by CCCC covers the calculation of tubular steel pile foundation for mooring dolphins MD-1 and MD-4 (12 m x 12 m) and mooring dolphins MD-2 and MD-3 (9 m x 9 m). Applied design codes and standards are API RP2A, Eurocode 3, EAU 2004, OCDI and BS 6349-1-6.

Geotechnical data is taken from geotechnical report, which has not been received by Sellhorn until completion of this report, but some relevant results of borehole MT31 are summarized in calculation sheet in hand.

Modelling of pile foundation and superstructure using linear-elastic 3D finite element analysis, load application, and derivation of internal forces look reasonable, although load direction could not be checked because of missing detailed mooring-plan showing mooring lines for different mooring scenarios of FSRU and LNGC vessels.

Stress results are assumed to be right.

Safety factors are derived according to API. For ultimate static capacity loads are multiplied by a factor of 2.0 (seismic 1.3); for working stress of steel a factor of 1.0 (seismic 1.7) is applied. Seismic force is calculated based on design ground acceleration being 1.4 times the proposed peak ground acceleration. For internal resistance of tubular steel piles this safety concept corresponds to Eurocode. Additionally, remaining safety for external pile resistance is derived. Calculated values are greater than 3.0, but are based on over-estimated axial bearing capacity (see remarks). After re-calculation remaining safety for external pile resistance shall not be less than 1.5.

Remarks:

Detailed soil identification from geological report is missing. Summary of adopted soil parameters provides subsoil data down to pile tip level at -30 mCD (referred to Chart Datum). Sections of mooring dolphins show minimum level of coarse gravel of -31.74 mCD only. To activate pile tip resistance to derive ultimate bearing capacity for compression piles it has to be verified that there are no soft soil layers or depositions within a range of three times the pile diameter underneath the pile tip. Hence, existence of soil type ④1 (hard sandy CLAY) has to be proven down to -34 mCD at least.

Additionally, portion of pile bearing capacity resulting from shaft friction is derived taking into account subsoil layers ②4 (-11.5 mCD to -15.2mCD) and ②5 (-15.2 mCD to -16.3mCD). Constructed dredging bottom level is –14 mCD (according to drawing 14S400-DD-DW-ZT-2001) to accommodate Q-Flex vessels. Proposed dredging level by CHEC is -15 mCD. Design depth for piles should be at least -17 mCD, taking into account scouring and over-dredging. Hence, vertical pile resistance in compression and tension is slightly over-estimated (max. 10%). Furthermore, no calculations are made to proof lateral pile bearing capacity and pile group effects.

Results for static and calibrated dynamic load tests have not been received.

2.3.2.3 Marine Structure Calculation Sheet for Breasting Dolphin Foundation

Doc 09 “Marine Structure Calculation Sheet for Breasting Dolphin Foundation” by CCCC covers the calculation of tubular steel pile foundation for breasting dolphins BD-1 and BD-2 (16 m x 18 m). Applied design codes and standards are API RP2A, Eurocode 3, EAU 2004, OCDI and BS 6349-1-6.

Geotechnical data is taken from geotechnical report, which has not been received by Sellhorn until completion of this report, but some relevant results of borehole MT04 are summarized in calculation sheet on hand. Summary of adopted soil parameters provides subsoil data down to pile tip level at -30 mCD (referred to Chart Datum). Sections of breasting dolphins show minimum level of coarse gravel of -33.8 mCD.

Modelling of pile foundation and superstructure using linear-elastic 3D finite element analysis, load application, and derivation of internal forces look reasonable, although load direction could not be checked because of missing detailed mooring-plan showing mooring lines for different mooring scenarios of FSRU and LNGC vessels.

Stress results assumed to be right.

Berthing load is based on rubber fender SCK2500H E1.4 resulting from “Mooring Layout Verification and Mathematical Mooring Model Study” (Doc 02).

Safety factors are derived according to API. For ultimate static capacity loads are multiplied by a factor of 2.0 (seismic 1.3); for working stress of steel a factor of 1.0 (seismic 1.7) is applied. Seismic force is calculated based on design ground acceleration being 1.4 times the proposed peak ground acceleration. For internal resistance of tubular steel piles this safety concept corresponds to Eurocode. Additionally, remaining safety for external pile resistance is derived. Calculated values for compression piles are greater than 3.79, but are based on over-estimated axial bearing capacity (see remarks). After re-calculation remaining safety for pile resistance shall not be less than 2.0. At berthing dolphin BD-2 the factor of safety against pullout is only 1.9 (less than 2.0), based on over-estimated axial bearing capacity.

Remarks:

Detailed soil identification from geological report is missing.

No calculations are available to proof lateral pile bearing capacity and pile group effects.

Pull-out capacity of tension piles at BD-2 should be re-evaluated in more detail (including consideration of pile group effects) in order to achieve safety of 2.0 for ultimate static capacity.

2.3.2.4 Marine Structure Calculation Sheet for Loading Platform Foundation

Doc 10 “Marine Structure Calculation Sheet for Loading Platform Foundation” by CCCC covers the calculation of tubular steel pile foundation for loading platform (40 m x 18 m). Applied design codes and standards are API RP2A, Eurocode 3, EAU 2004, OCDI and BS 6349-1-6.

Geotechnical data is taken from geotechnical report, which has not been received by Sellhorn until completion of this report, but some relevant results are summarized in calculation sheet on hand. Summary of adopted soil parameters provides subsoil data down to pile tip level at -32.6 mCD (referred to Chart Datum).

Modelling of pile foundation and superstructure using linear-elastic 3D finite element analysis, load application, and derivation of internal forces look reasonable. Stress results assumed to be right.

Safety factors are derived according to API. For ultimate static capacity loads are multiplied by a factor of 2.0 (seismic 1.3); for working stress of steel a factor of 1.0 (seismic 1.7) is applied. Seismic force is calculated based on design ground acceleration being 1.4 times the proposed peak ground acceleration. For internal resistance of tubular steel piles this safety concept corresponds to Eurocode. Additionally, remaining safety for external pile resistance is derived. Calculated values are greater than 2.7, but are based on over-estimated axial bearing capacity (see remarks). After re-calculation remaining safety for pile resistance shall not be less than 2.0.

Remarks:

Detailed soil identification from geological report is missing.

Portion of pile bearing capacity resulting from shaft friction is derived taking into account subsoil layers ②3 (-15.0 mCD to -16.1 mCD) and ③2 (-16.1 mCD to -21.7mCD). Constructed dredging bottom level is –14 mCD (according to drawing 14S400-DD-DW-ZT-2001) to accommodate Q-Flex vessels. Proposed dredging level by CHEC is -15 mCD. Design depth for piles should be at least -17 mCD, taking into account scouring and over-dredging. Hence, vertical pile resistance in compression and tension is slightly over-estimated (max. 10%). Furthermore, no calculations are made to proof lateral pile bearing capacity and pile group effects.

2.3.2.5 Marine Structure Calculation Sheet for Trestle Foundation

Doc 11 “Marine Structure Calculation Sheet for Trestle Foundation” by CCCC covers the calculation of the trestle foundation made of precast, pre-stressed tubular concrete piles (PHC piles Ø1000 mm, wall thickness 130 mm). Length of trestle is 515.1 m, width is 7.9 m. Applied design codes and standards are API RP2A, Eurocode 2, EAU 2004, OCDI and BS 6349-1-6.

Geotechnical data is taken from geotechnical report, which has not been received by Sellhorn until completion of this report, but some relevant results are summarized in calculation sheet on hand. Summary of adopted soil parameters provides subsoil data down to pile tip level at -23.0 mCD (referred to Chart Datum).

Modelling of pile foundation and superstructure using linear-elastic 3D finite element analysis, load application, and derivation of internal forces look reasonable. Stress results assumed to be right.

Safety factors are derived according to API. For ultimate static capacity loads are multiplied by a factor of 2.0 (seismic 1.3). Seismic force is calculated based on design ground acceleration being 1.4 times the proposed peak ground acceleration. For internal resistance of tubular steel piles this safety concept corresponds to Eurocode. Additionally, remaining safety for external pile resistance is derived. Calculated values are greater than

3.2, but are based on over-estimated axial bearing capacity (see remarks). After re-calculation remaining safety for pile resistance shall not be less than 2.0.

Partial factors and combination factors for Limit State Design (ULS and SLS) are derived according to BS 6349, what corresponds to Eurocode.

Remarks:

Detailed soil identification from geological report is missing.

Portion of pile bearing capacity resulting from shaft friction is derived taking into account subsoil layers ②4 (-12.0 mCD to -16.3 mCD) and ③2 (-16.3 mCD to -22.0 mCD). Constructed dredging bottom level is –14 mCD (according to drawing 14S400-DD-DW-ZT-2001) to accommodate Q-Flex vessels. Proposed dredging level by CHEC is -15 mCD. Design depth for piles should be at least -17 mCD, taking into account scouring and over-dredging. Hence, vertical pile resistance in compression and tension is slightly over-estimated (max. 10%).

Furthermore, no calculations are in hand to proof lateral pile bearing capacity.

Pile group effects may not be considered here.

2.3.2.6 Marine Structure Calculation Sheet for Prestress Longitudinal Beam

Doc 12 “Marine Structure Calculation Sheet for Prestress Longitudinal Beam” by CCCC covers the design of the prestressed longitudinal beams for the trestle. Applied design codes and standards are Eurocode 2, BS 6349-2 and EN 10138.

Modelling of precast, prestressed concrete beams using linear-elastic 2D finite element analysis, load application, and derivation of internal forces look reasonable. Stress results assumed to be right.

Design calculations of pre-stressed concrete structure are done according to Eurocode 2 for ultimate limit state (ULS) and serviceability limit state (SLS); crack width calculations and prestress loss are included. Partial safety factors for jetty structures are derived from BS 6349-2. Specified concrete cover for prestressing strands and ordinary reinforcement is sufficient for the exposure of the structure to chlorides from sea water.

Remarks:

Crack width of bottom flange is calculated to 0.12 mm under frequent combination; Eurocode 2 recommends decompression for prestressed members with bonded tendons exposed to chlorides from sea water (XS3).

Unusual mix of standards for loads (partial safety factors) and design procedure for precast, pre-stressed concrete beams.

2.3.2.7 Marine Structure Calculation Sheet for Longitudinal Beam (non-pre-stress)

Doc 13 “Marine Structure Calculation Sheet for Longitudinal Beam (non-prestress)” by CCCC covers the design of the shorter, non-prestressed longitudinal beams for the trestle. Applied design codes and standards are Eurocode 2 and BS 6349-2.

Modelling of concrete beams using linear-elastic 2D finite element analysis, load application, and derivation of internal forces look reasonable. Stress results assumed to be right.

Design calculations are done according to Eurocode 2 for ultimate limit state (ULS) and serviceability limit state (SLS); crack width calculation is included. Partial safety factors for jetty structures are derived from BS 6349-2. Specified concrete cover for reinforcement is sufficient for the exposure of the structure to chlorides from sea water.

Shear design of concrete beams is done using angle of compression strut $\theta = 21.8°$ ($\cot\theta = 2.5$); recommended for reinforced concrete beam subjected to bending (no axial compression) is $\theta = 40°$ ($\cot\theta = 1.2$). Hence, required shear reinforcement is $A_{sw,req} = 156.5\ mm^2 \approx 157.1\ mm^2 = A_{sw,design}$.

Remarks:

Unusual mix of standards for loads (partial safety factors) and design procedure for reinforced concrete beams.

Shear design barely sufficient.

2.3.2.8 Marine Structure Calculation Sheet for Transverse Beam

Doc 14 “Marine Structure Calculation Sheet for Transverse Beam” by CCCC covers the design of the transverse beam of the trestle. Applied design codes and standards are API RP2A, Eurocode 2, EAU 2004, OCDI and BS 6349-1-6.

Modelling of concrete superstructure using linear-elastic 3D finite element analysis, load application, and derivation of internal forces look reasonable. Same model as for the design of trestle foundation (Doc 11) is used.

Design calculations are done according to Eurocode 2 for ultimate limit state (ULS) and serviceability limit state (SLS); crack width calculation is included. Partial safety factors for jetty structures are derived from BS 6349-2. Specified concrete cover for ordinary reinforcement is sufficient for the exposure of the structure to chlorides from sea water.

Design is done for uniaxial bending (M_y) and shear (SF_z) only. Due to foundation on three inclined piles bending moments and shear forces about the two cross-sectional axes as well as torque do arise (M_z, SF_y and M_x, respectively). Bending moment M_z is small compared to M_y, hence design calculations might be omitted.

Remarks:

Unusual mix of standards for loads (partial safety factors) and design procedure for reinforced concrete structures.

2.3.3 Drawings

Few drawings have been received by Sellhorn, which do not give an overview of the structure(s) but showing construction details. One general drawing of dredging works and pile locations of loading platform and trestle structural details of tubular steel piles and PHC piles is in hand.

Detailed design drawings, section drawings, and mooring-plan have not been received.

2.3.4 Construction Records and Reports

2.3.4.1 Record Sheets of Piling Work

Docs 22 to 30 provide "Record Sheets of Piling Work" for all structures with steel pile foundations. The tubular steel piles (Ø1250 mm, Steel Grade Q345B) of different length have been driven by Diesel Hammer D180.

Some of the piles did not archive design depth. Hence, high dynamic load tests as specified in Doc 04 "Specification for Test of Tubular Steel Pile" should have been performed.

At some piles coating was damaged and had to be repaired as per specification "Corrosion Protection Coating of Tubular Steel Pile Technical Submission" (Doc 05).

Remarks:

Record sheets of breasting dolphin BD-1 and loading platform LP are wrongly designated as PHC piles.

2.3.4.2 Certificates

Docs 31 to 34 provide various certificates and reports on product quality and material tests. Most of them are written in Chinese language.

2.4 Summary of remarks on jetty design

2.4.1 General

A set of documents has been received by Sellhorn during the months December till March 2015 to be reviewed and evaluated concerning proper design and construction quality. Some of them apply to safe construction (e.g. Construction Site HSE Manual etc.) and proper port operation (e.g. HAZID/HAZOP Study etc.) of the LNG terminal, and therefore they are not part of this review.

Various essential documents have not been received by Sellhorn, so that the design review could not be done as detailed as necessary.

An indicative list of documents which should be prepared is shown below:

Studies and Specifications:

- bathymetry study of mooring basin
- geotechnical investigations / geology / design ground profile

Design calculations

- Structural design calculations for superstructures of dolphins and loading platform including connection of steel piles and superstructure
- Calculation Sheet for Supporting dolphins

- Calculation of lateral pile resistance and pile group effects

Drawings

- Plan of general layout
- Elevation of jetty with level of different structures
- Detailed design drawings
- Detailed section drawings of
  - Trestle and supporting structures
  - Mooring and breasting dolphins
  - Loading platform
- Sequence of working (dredging, drilling, reclamation etc.)

Construction Records and Reports

- Sounding of basin after dredging
- Results of pile tests

2.4.2 Evaluation of Jetty Design

Besides the fact that essential information is missing to completely assess the overall jetty design, remarks and recommendations on jetty design can be summarized as followed:

- Generally, the structural design of the jetty coincides with requirements of European standards and design codes, but is not fulfilling them completely
- Vertical pile resistance has to be re-evaluated considering pile group effects.
- Reinforced and pre-stressed concrete members, where calculated crack width does not satisfy recommendations of Eurocode 2, should be monitored on a frequent basis, and mitigations measures brought in place if found faulty.

This evaluation of jetty design is based the assumption, that all design parameters in the calculation sheets for foundations and superstructures which could not have been cross-checked because of missing documents (especially soil identification from geological report) are correct and accurately applied.

3 DESK STUDY OF NAVIGATIONAL CHANNELS

3.1 Overview

The desk study on the navigational channels aims to explore the current limitations relating to ship size of the existing channel and the required dimensions for the prospected design ships.

Furthermore, recommendations are made for limitations on physical conditions, e.g. wind, waves, tide levels and current, to ensure safe navigation.

It is not the intent of this study to replace real time simulation for the navigation or in depth mooring studies by numerical modelling.

Design guidelines used for the development of the access channel have been published by various organizations that specialize in the transportation of petroleum products and / or navigation safety issues, namely:

- OCIMF – Oil Companies International Marine Forum
- PIANC – Permanent International Association of Navigation Congresses
- SIGTTO – Society of International Gas Tanker and Terminal Operators Ltd
- Transport Canada– TERMPOL review process

3.2 Physical Conditions

3.2.1 General

The port of Qasim is located in the Indus river delta region South East of Karachi on the Arabian Sea. A 45 km long access channel from the sea through the mangroves and mudflats of the Indus River leads to the port.

The channel can be divided in to four main stretches:

- The Ashan channel compromises the entire entrance channel from the ocean up to the Phitty Creek entrance. See Figure 1.

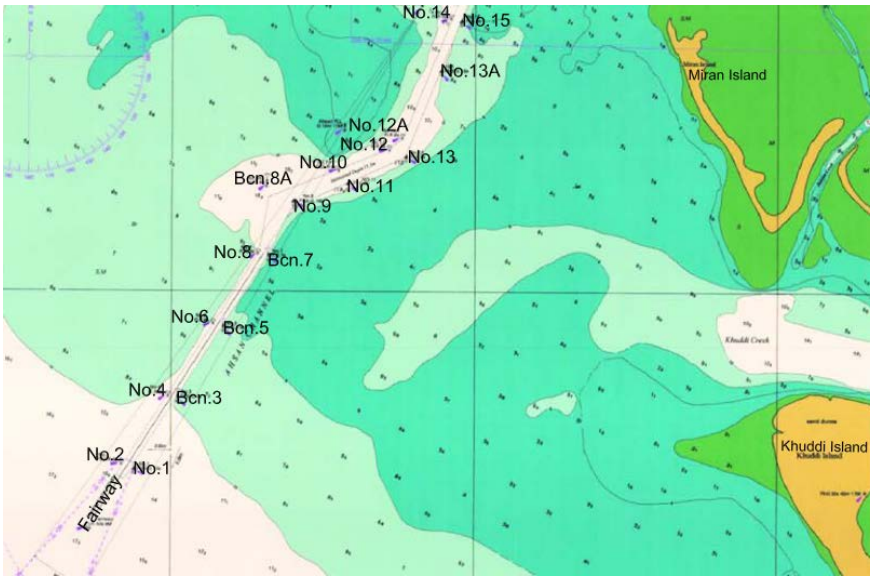

Figure 1: Entrance and Ashan channel

Source: Admiralty Nautical Chart 20 Port Muhammad Bin Qasim and Approach

- Phitti Creek comprises the beginning of the inner channel from the start of the Phitti Creek to the start of the Kadiro Creek. See Figure 2.

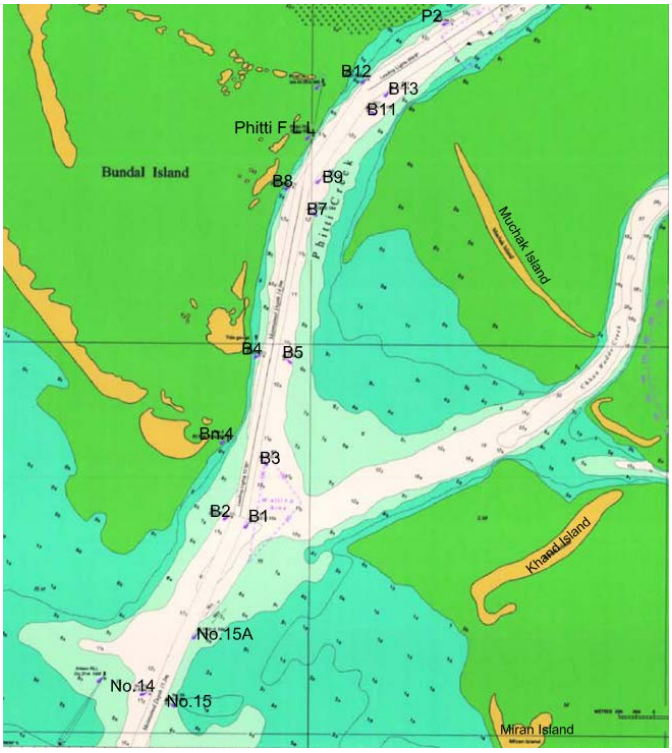

Figure 2: Phitti Creek

Source: Admiralty Nautical Chart 20 Port Muhammad Bin Qasim and Approach

- Kadiro creek comprises the last part of the inner channel before reaching the port. See Figure 3.

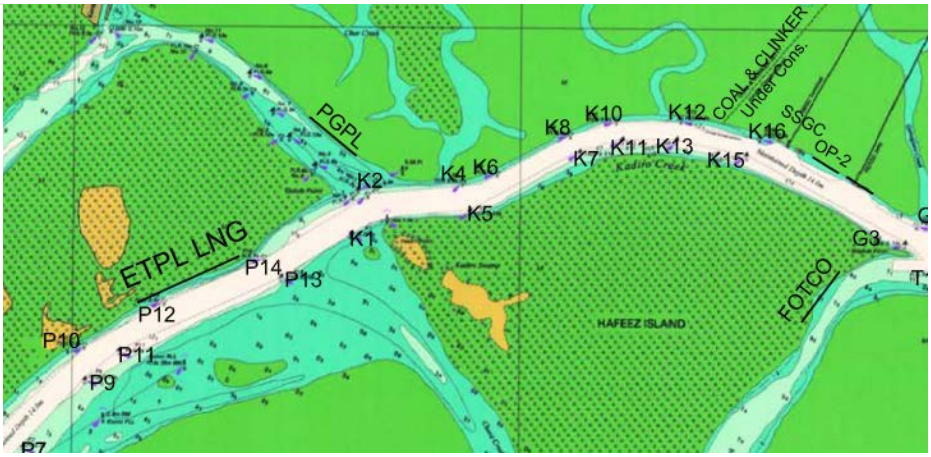

Figure 3: Kadiro Creek

Source: Admiralty Nautical Chart 20 Port Muhammad Bin Qasim and Approach

- At the end of a 45 km long access channel lies port Qasim. See Figure 4.

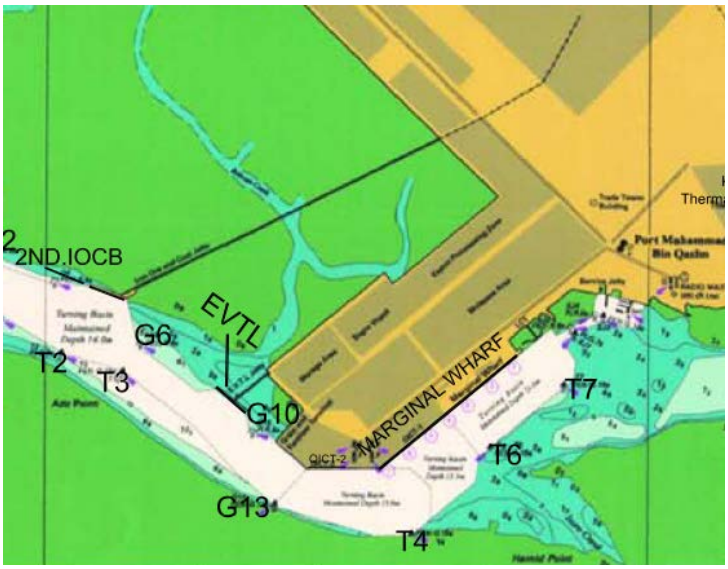

Figure 4: Port Qasim

Source: Admiralty Nautical Chart 20 Port Muhammad Bin Qasim and Approach

3.2.2 Wind

The wind mainly comes from NE during the winter monsoon with a maximum speed of 25 knots. During the summer monsoon the wind comes from the SW and reach speeds up to 35 knots.

3.2.3 Current

Tides affect the intensity of the currents. Tides are generally stronger during ebb than flood. See below Table 2 for current in the channel, based on table 4 in the Manoeuvring Simulation Study.

Table 2: Currents in the channel

Area	Max. Speed (knots)	Orientation relative to ship movement
Turning Basin	1	parallel
Kadiro Creek	2	slight transverse
Phitty Creek	5	transverse
Phitty Entrance	3	transverse
Ahsan Bend	3	transverse
Ahsan Channel	3	transverse

3.2.4 Tide

The port experiences a semi-diurnal tide with a diurnal component. The average tide period is 12,4 hrs. The highest astronomical tide is at +4 m CD (HAT) and the lowest astronomical tide at +0,6m CD (LAT)

3.2.5 Waves

Wave information is not dependable, but PQA pilots estimates that waves in the entrance channel reach heights of 3 to 4 m. The waves break on the flats near the Ashan channel limiting the height of the waves to 0,5 to 0,7 m. Waves in the inner channel are limited to 0,5 m.

Wave data can be obtained by installing wave rider buoys or alternatively doing near shore transformation modelling with data from offshore buoys.

3.2.6 Water Density

The water density used throughout this document is 1025 kg/m³. It is however important to note that the location of the port and access channel is in a transition zone between fresh and sea water. Changes in the water density are possible. This in turn will have an effect on ships draft and channel depth requirements.

3.2.7 Depth

Depths given by the port for the channel sections are given in Table 3.

Table 3: Water depths

Area	Depth (m CD)
Turning Basin	15
Kadiro Creek	14
Phitty Creek	14
Ahsan Channel	15,3

3.2.8 Width

The channel sections have varying width. See Table 4 below.

Table 4: Channel widths

Area	Width min (m)
Turning circle	± 225 m (diameter)
Kadiro Creek	200-250
Phitty Creek	200
Phitty Entrance	200

Ahsan Bend	565
Ahsan Channel	200

3.3 Design Ship

3.3.1 Planned

For the LNG jetty two different types of ships are foreseen:

- FSRU: Floating Storage and Regasification Unit
- LNGC: Liquid Natural Gas Carrier

In the start of the terminal operations a FSRU with a 138,000m³ capacity is foreseen. The FSRU will later be replaced by a larger 150,900m³ FSRU and in the last stage with a 173,400 m³, if the terminal proves sustainable.

See below Table 5 and *Table 6: LNGC dimensions*Table 6 for the ship dimensions.

Table 5: FSRU dimensions

Capacity (m³)	138.000	150.900	173.400
LOA (m)	277	291	294,5
Breadth (m)	43,4	43,4	46,4
Draft (m)	11,5	11,6	11,6
Displacement (t)	100.900	107.000	121.000

Table 6: LNGC dimensions

Capacity (m³)	125.000	217.000 (Qflex)	266.000 (Qmax)
LOA (m)	285,3	315,0	345,0
Breadth (m)	43,7	50,0	53,8
Draft (m)	11,1	12,0	12,0
Displacement (t)	98.546	143.400	175.000

3.4 Channel Nautical Requirements

3.4.1 Depth

Depth requirements given by PAINC consider various factors as shown in Figure 5. SIGGTO recommends a minimum ratio between the ship's draft and UKC, but only considers relatively calm conditions.

Description	Vessel speed	Wave conditions	Channel bottom	Inner channel	Outer channel
Depth, h	≤ 10 knots	None	-	1.10 T	-
	10-15 knots		-	1.12 T	-
	>15 knots		-	1.15 T	-
	All	Low swell ($H_s < 1$ m)	-	-	1.15 T to 1.2 T
		Moderate swell (1 m < H_s < 2 m)	-	-	1.2 T to 1.3 T
		Heavy swell ($H_s > 2$ m)	-	-	1.3 T to 1.4 T
	Add for channel bottom type:				
	All	All	Mud	None	None
			Sand/clay	0.4 m	0.5 m
			Rock/coral	0.6 m	1.0 m

Notes.
1. Assumes ship draught, T, greater than or equal to 10 m. If draught is less than 10 m, then use values for 10 m draught
2. Swell means waves with peak periods greater than 10 s
3. For outer channel, use lower value for northern hemisphere and higher value for southern hemisphere
4. Value of Hs is dependent on required operation, design ship type, level of accessibility, wave period, and relative wave direction
5. Salt-water assumed for ship draught so additional adjustments required for fresh water

Figure 5: Channel depth consideration

Source: PIANC Report 116, 2012

The main ship dimension for determining the depth / vertical requirement for the channel is the draft of the ship. See Table 7 for the required depths for the type of ship and section of the channel. The depths as shown in the table are required water depths and are not to Chart datum. To determine Chart datum levels for the channel tidal restrictions will need to be determined.

Table 7: Channel depth requirements

Area	H_s (m)	Ship	Draft (m)	Depth requirement PIANC (m)
Turning Basin / Kadiro Creek / Phitty Creek	0.5	LNGC 125,000 m³	11.1	12.77
	0.5	FSRU 138,000 m³	11.5	13.23
	0.5	FSRU 150,900 m³ / 173,400 m³	11.6	13.34
	0.5	Qflex / Qmax	12.0	13.80
Phitty Entrance	0.7	LNGC 125,000 m³	11.1	12.77
	0.7	FSRU 138,000 m³	11.5	13.23
	0.7	FSRU 150900 m³ / 173,400 m³	11.6	13.34
	0.7	Qflex / Qmax	12.0	13.80
Ahsan Bend / Ashan Channel	3	LNGC 125,000 m³	11.1	15.54
	3	FSRU 138,000 m³	11.5	16.10
	3	FSRU 150,900 m³ / 173,400 m³	11.6	16.24
	3	Qflex /Qmax	12.0	16.80

3.4.2 Width

Considering the existing channel width for the desk study a one way channel is considered. Due to the 45 km length of the channel safe passing areas will be considered and the possibility of dredging an additional/alternative channel cf. 3.9.

The minimum width recommended by the SIGGTO is 5 times the beam of the ship while TERMPOL recommends a minimum of at least 4 times the beam. PIANC recommends the following calculation be done: $w = w_{BM} + \sum_{i=1}^{n} w_i + w_{Br} + w_{Bg}$

w_{BM} is the basic manoeuvring lane of the ship, w_{Br} and w_{Bg} are bank clearance required to reduce bank effect on ships. For w_i, w_{Br} and w_{Bg} see Figure 6 and Figure 7.

For channel width requirements see Table 8.

Width W_i	Vessel Speed	Outer Channel (open water)		Inner Channel (protected water)	
(a) Vessel speed V_s (kts, with respect to the water)					
$V_s \geq 12$ kts	fast	0.1 B			
8 kts ≤ V_s < 12 kts	mod	0.0			
5 kts ≤ V_s < 8 kts	slow	0.0			
(b) Prevailing cross wind V_{cw} (kts)					
- mild	fast	0.1 B			
V_{cw} < 15 kts	mod	0.2 B			
(< Beaufort 4)	slow	0.3 B			
- moderate	fast	0.3 B			
15 kts ≤ V_{cw} < 33 kts	mod	0.4 B			
(Beaufort 4 - Beaufort 7)	slow	0.6 B			
- strong	fast	0.5 B			
33 kts ≤ V_{cw} < 48 kts	mod	0.7 B			
(Beaufort 7 - Beaufort 9)	slow	1.1 B			
(c) Prevailing cross-current V_{cc} (kts)					
- negligible V_{cc} < 0.2 kts	all	0.0		0.0	
- low	fast	0.2 B		0.1 B	
0.2 kts ≤ V_{cc} < 0.5 kts	mod	0.25 B		0.2 B	
	slow	0.3 B		0.3 B	
- moderate	fast	0.5 B		0.4 B	
0.5 kts ≤ V_{cc} < 1.5 kts	mod	0.7 B		0.6 B	
	slow	1.0 B		0.8 B	
- strong	fast	1.0 B		-	
1.5 kts ≤ V_{cc} < 2.0kts	mod	1.2 B		-	
	slow	1.6 B		-	
(d) Prevailing longitudinal current V_{lc} (kts)					
- low	all	0.0			
V_{lc} < 1.5 kts					
- moderate	fast	0.0			
1.5 kts ≤ V_{lc} < 3 kts	mod	0.1 B			
	slow	0.2 B			
- strong	fast	0.1 B			
$V_{lc} \geq 3$ kts	mod	0.2 B			
	slow	0.4 B			
(e) Beam and stern quartering wave height H_s (m)					
- $H_s \leq 1$ m	all	0.0		0.0	
- 1 m < H_s < 3 m	all	~0.5 B		-	
- $H_s \geq 3$ m	all	~1.0 B		-	
(f) Aids to Navigation (AtoN)					
- excellent		0.0			
- good		0.2B			
- moderate		0.4 B			
(g) Bottom surface					
- if depth $h \geq 1.5\ T$		0.0			
- if depth h < 1.5 T then					
- smooth and soft		0.1 B			
- rough and hard		0.2 B			
(h) Depth of waterway h		$h \geq 1.5\ T$	0.0 B	$h \geq 1.5\ T$	0.0 B
		1.5 $T > h \geq 1.25\ T$	0.1 B	1.5 $T > h \geq 1.15\ T$	0.2 B
		h < 1.25 T	0.2 B	h < 1.15 T	0.4 B
(i) High cargo hazards		See explanation in box(i) overleaf			

Figure 6: Channels width addends w_i

Source: PIANC Report 116, 2012

Width for bank clearance (W_{BR} and/or W_{BG})	Vessel Speed	Outer channel (open water)	Inner channel (protected water)
Gentle underwater channel slope (1:10 or less steep)	fast moderate slow	0.2 *B* 0.1 *B* 0.0 *B*	0.2 *B* 0.1 *B* 0.0 *B*
Sloping channel edges and shoals	fast moderate slow	0.7 *B* 0.5 *B* 0.3 *B*	0.7 *B* 0.5 *B* 0.3 *B*
Steep and hard embankments, structures	fast moderate slow	1.3 *B* 1.0 *B* 0.5 *B*	1.3 *B* 1.0 *B* 0.5 *B*
Note: W_{BR} and W_{BG} are widths on 'red' and 'green' sides of channel			

Figure 7: Width for bank clearance w_{Br} and w_{Bg}

Source: PIANC Report 116, 2012

Transitions between lengths of channel with different widths should be done by straight lines and should not have plan variations greater than 1:10 (preferably 1:20) on both sides of the channel.

Table 8: Channel width requirements

Area	Ship	Ship beam (m)	Channel width requirement (m)		
			PIANC	TERMPOL	SIGTTO
Kadiro Creek / Phitty Creek	FSRU 138,000 m³ / 150,900 m³	43.4	164.92	173.60	217.00
	LNGC 125,000 m³	43.7	166.06	174.80	218.50
	FSRU 173,400 m³	46.4	176.32	185.60	232.00
	Qflex	50.0	190.00	200.00	250.00
	Qmax	53.8	204.44	215.20	269.00
Ashan Channel	FSRU 138,000 m³ / 150,900 m³	43.4	212.66	173.60	217.00
	LNGC 125,000 m³	43.7	214.13	174.80	218.50
	FSRU 173,400 m³	46.4	227.36	185.60	232.00
	Qflex	50.0	245.00	200.00	250.00
	Qmax	53.8	263.62	215.20	269.00

3.4.3 Bend radii, length and width

Bend length should be as short as possible with radii as long as possible. Bends in an access channel should be avoided when possible. Furthermore many bends forming a "S" or "snake" like pattern should be avoided. Long enough distances in between bends should be provided to give pilots time to prepare for turning manoeuvres.

Additional width is required in the bends to accommodate the swept track of the ship. The swept track is reduced with shallower water when compared to deeper water.

Assuming a max rudder angle of 20° a recommended bend radius recommended by PIANC is approx. 7 times the length of the design ship. See Table 9 for the bend radii requirements.

Table 9: Bend radii requirements

Ship	LOA (m)	Bend radius (m)
FSRU 138,000 m³	277.0	1939
FSRU 150,900 m³	291.0	2037
LNGC 125,000 m³	294.5	2061.5
FSRU 173,400 m³	294.5	2061.5
Qflex	315.0	2205
Qmax	345.0	2415

Additional channel width is required in bends to accommodate two factors:

- Response speed of the captain and the ship
- Swept track of the ship when turning

For the concept stage it is recommended that one additional design ship beam be added to accommodate for these factors.

The length of curved legs must not be greater than half the bend's radius (not more than 30° change in ship course), when possible. (PIANC 116, 2014)

The distance between consecutive bends should be more than five ship lengths. Bends in the same direction should be the greater than 3 ship lengths

This recommendation is unfortunately not possible in the bend in the Ashan channel at the entrance and should be investigated in the manoeuvring simulation study.

3.4.4 Turning Circle

Turning circle diameter recommended by TERMPOL is 2 to 2.5 times the length of the design ship. SIGGTO recommends 2 times the length, but to add the distance of the ships drift to the diameter in the case of currents. PIANC also recommends 2 times the ships diameter for the turning circle. The turning circle does not necessarily need to be round and could be elongated in the direction of the expected currents and/or wind.

Depth requirements for the turning circle are the same as for the channels at 1,15 times the ships draft.

3.4.5 Passing Areas

The channel is a one way channel and due to its length it would be preferable to have passing areas where ships can pass each other. The alternative channel Chan Waddo creek can be dredged to be used as a passing area (cf. 3.9.), but will require a substantial amount of dredging.

Alternatively one passing area approx. halfway from the port to the entrance can be created. The first ship to arrive at the passing area will be expected to wait for the second ship to pass. The length required it twice the stopping distance required of the design ship plus the distance travelled during the reaction time and one ship length. Additional width required is 2,5 times the beam of the design ship.

3.4.6 Anchorages

Anchorages should be as close as practical to the channel and should provide good holding ground. Maximum depth at the port entrance should not be more than 100 m. Anchorages' diameters should be atleast 1 nautical mile. It is recommended that PQA pilots be querried on ideal loactions of anchorages outside of the port. Factors to be considered include the quality of the holding ground to reduce anchor drag, protection from wind and sea and maritime traffic in the area.

3.4.7 Safety Domains

Areas around the LNGC's and FSRU's should be kept to ensure timely reaction in case of an unfavourable event. The distance between ships should be greater than the minimum stopping distance of said ships.

3.4.8 Berth

The required depth of the berth is at least 1.1 times the maximum draft of the ship over the length of at least 1 design ship length on each side of the centre of the berth (2 times LOA).

For safe passage of ships TERMPOL, 2001, recommends that the centre of the channel is at least 6 ship beams from the berthed ship's hull. SIGTTO, 1997, recommends for concept stage a passing ship distance of at least 4 times the design ship beam be kept between the moored and passing ship.

3.4.9 Pilot Boarding

Boarding of pilots should be done sufficiently far away from the start of piloting to give the pilot enough time to allow for safe boarding and information exchange.

It is recommended that the PQA pilots be queried on the distance from the channel and area boarding of the ship should take place to allow for the above two aspects before piloting will need to start.

3.5 Channel Navigation Aid Requirements

3.5.1 Buoys

Marker buoys clearly indicating the channel width and the start end and apex of bends should be installed. Care should be taken to ensure theses buoys do not drift / drag on the ground from current, wind or wave action.. The distance between buoys should be less than the minimum visibility range ships will be allowed to access the port. Buoys should preferably be lit.

3.5.2 Leading Marks / Beacons

Leading marks or lit beacons should mark channel centrelines and help facilitate rounding bends.

3.5.3 Electronic Aids

A VTMS / VTS system should be installed to help with navigation during night time or adverse conditions affecting vision and to control all ships coming into the port's operational area.

3.5.4 Tugs

LNG vessels should be accompanied by at least 2 tugs with bollard pull sufficient to overcome the maximum wind force on the ship during the maximum allowed wind / current speed conditions.

3.6 Recommended Limitations on Ship Size

The existing channel dimensions should allow the safe navigation of the FSRU 138,000m³ and the LNGC 125,000 m³ vessels.

It is recommended that the channel dimensions be increased to allow the safe navigation of larges size ships.

See Table 10 for recommended dimensions to allow the safe navigation of the channel by the Qmax ship.

Table 10: Channel dimensions required for Qmax navigation

Area	Ahsan Bend / Ashan Channel	Turning Basin / Kadiro Creek / Phitty Creek	Port
Depth*	16,8 m	13,8 m	13,8 m
Width	270 m	270 m	270 m
Additional Width in Bends	50 m	50 m	-
Bend Radii	2400	2400	-
Bend length	< 30°	< 30°	-
Turning Circle Diameter	-	-	700 m

*Depth requirement is not to CD, but rather the minimum depth requirement. The relation to CD will change depending on the tidal restrictions decided on.

3.7 Recommended Limitations on Physical conditions

3.7.1 Wind

To ensure that tugs, mooring rope strength is sufficient wind speeds for the safe navigation of the channel should be less than 25 knots.

3.7.2 Waves

Waves within the inner channel should not be problematic, but to ensure than the entrance channel has sufficient UKC for safe entrance it is recommended that the significant wave height be less than 3 m.

3.7.3 Current

To ensure safe navigation the cross current speeds should be less than 3 knots.

3.7.4 Tide levels

Limitations on the tide levels should be sufficient to allow passage of the ship through the channel while maintaining the recommended depths.

3.7.5 Visibility

Navigation by sight rather than instruments is advisable when navigating in port areas. Visibility is there for a big factor in determining limitations on navigation of the channel.

It is recommended that visibility be farther than the ship's stopping distance at its maximum speed.

3.8 Passing Ship Requirements

3.8.1 Speed

To reduce the risk of a ship strike that could rupture the LNG containment tanks of a stationary LNGC a speed limit need to be in place. See Figure 8 for speeds of ships colliding with a LNGC without rupturing the containment tanks. With proper speed limits in place the possibility of LNG release due to a ship strike becomes remote.

Hull Resistance for a 135,000 m^3 LNG Carrier	
Displacement of Colliding Ship (tonnes)	Critical Impact Speed (knots)
93,000	3.2
61,000	4.2
20,000	7.3

Figure 8: LNGC hull resistance

Source: SIGTTO, 1997

SIGTTO recommends a speed limit for passing ships during the concept stage of 6 knots at a passing distance of at least 4 times the beam of the design ship (hull to hull).

The determined speed limit applies for LNG and other ships. The speed limit should be enforced by VTMS.

3.8.2 Offset Distance

TERMPOL, 2001, recommends 6 times the ship's beam to the centre of the channel.

SIGGTO ,1977, recommends 4 times the beam hull to hull.

Also see 3.4.8.

3.9 Alternative Channel

Caution is advised with the dredging of a new channel as it could severely change the sedimentation pattern in the channels. Sedimentation modelling is proposed. The channel does not need to be of similar dimensions as the main channel and a much smaller design ship can be chosen.

3.10 Recommendations and further steps

3.10.1 Proposed Channel Layout

To be added

Figure 9: Proposed channel layout

4 NEXT STEPS

As this report presents the findings from the Consultant's first review of documents and initial analyses, the next steps to be carried out are:

1. Preparation of summary list with remarks and comments to be forwarded to Engro Elengy Terminals with regard to jetty design
2. Validation of used input data for modelling studies, in particular Metocean data
3. Finalising the layout drawing of access channel
4. Elaborate recommendation on additional Metocean data collection (type and location)
5. Continuing channel design and merging with layout drawing
6. Required dredging volume calculation
7. Workshop regarding conceptual design
8. Identification of required hydraulic and sediment modelling

Additional proposed tasks

1. Specify and tender of hydraulic and sediment modelling
2. Execution and / or supervision of modelling
3. Nautical simulation

5 REFERENCES

[1] EAU 2012: Empfehlungen des Arbeitsausschusses „Ufereinfassungen", 10th Edition

[2] Eurocode 1: Actions on structures, 2010

[3] Eurocode 2: Design of concrete structures, 2011

[4] Eurocode 3: Design of steel structures, 2010

[5] Eurocode 7:Geotechnical design,2009

[6] Admiralty Nautical Chart 20, Port Muhammad Bin Qasim and Approach

[7] PIANC, 2012, Report 116 "Aspects Affecting the Berthing Operations of Tankers to Oil and Gas Terminals"

[8] PIANC, 2014,Harbour Approach Channels - Design Guidelines

[9] SIGTTO 1997; Information paper no. 14; Site selection and Design for LNG ports and jetties; Society of International Gas Tanker and Terminal Operators

[10] TERMPOL 2001; Termpol Review Process,

Annex - 5

ECIL OBSERVATIONS
ON
INCEPTION REPORT
OF
SELLHORN

Annex-5

Observations On Inception Report of Sellhorn

A ECIL Observations

- INTRODUCTION:

  The 1st paragraph needs a little modification. It may be read as:

  "In December 2012 the USAID Energy Policy Program (EPP) was launched and the Consulting Firm AEAI (Advanced Engineering Associates International) Inc. was engaged to provide broad range of advisory services for a new LNG Terminal planned to be established at Port Qasim on fast track. AEAI contracted ECIL + Granada Group (GG) to provide various services on this LNG Project. ECIL associated Sellhorn to provide consultancy services study of navigation channel issues, upgradation, alternate channel, project monitoring and review of the structural design concerning the marine civil structure".

- Items 2.3.1.1 – Manoeuvering Simulation Study - Remarks:

  PQA bathymetric data and chart already sent.

- Items 2.3.1.2 – Mooring Report:

  Hopefully you have received it by now.

- Items 2.3.1.4 - Specs / tests of tubular piles:

  Pile driving tests reports are already sent to you. We are trying to find any additional information available with like pile specification. Would appreciate if list of information needed is annexed to be sent to EETPL.

- Items 2.3.1.5 – Corrosion Protection:

  Your approach is logically o.k. As regards surcharge of 3mm instead of available 2mm, you may please give your views on combined effectiveness of paint and Cathodic protection. Also please suggest possible mitigation measures which can be taken at this stage, if your final observation indicates a potent deficiency.

- Items 2.3.2.1 – Marine Structures Calculation Sheet:

  - *Your concern regarding lateral pile bearing capacity and group effect is definitely important. When you are in receipt of the geo-tech reports (which has been sent to you currently), perhaps the situation may be more clear. However, we will try to obtain relevant calculations from EETPL.*

  - *After your final review, if the calculated crack width comes up more than the 0.1mm, adopted by EEVTL, in that case you may suggest possible mitigation measures.*

    - Item 2.3.2 -
    - Item 2.3.2.1 -
    - Item 2.3.2.3 -
    - Item 2.3.2.4 -
    - Item 2.3.2.5 -
    - Item 2.4.2 -

    Geotech Report has been sent to Sellhorn. It will hopefully enable you to finalize most of the observations.

- Items 2.3.2.6 – Prestressed Longitudinal Beam:

  - *Remarks regarding crack width of the bottom flange may please be further clarified with reference to "XS3".*

- Items 2.3.3 – Drawings:

  EETPL was requested to provide the as-built drawings. We expect that these drawings will clarify some of Sellhorn queries.

- Items 2.3.4.2 – Certificates:

  EETPL was requested to provide us the same in full English version.

- Items 3.2.7 – Depth:

  Negative sign (-) may be used for depths related to CD.

B. PQA Observations

The observations of Channel Dredging Department (PQA) on desk study of Navigation Channel with respect to Inception Report of Sellhorn is as follows:

1. The HAT & IAT at Bin Qasim (Port Area) are 14.01m & -0.57m respectively.
2. Channel width at Phitti Creek varies from 280 to 310m.
3. Channel width at Kadiro Creek varies from 200 to 280m.
4. Channel width at Gharo Creek abreast LNG Terminal is 250m.
5. The bend radii, length and width need elaboration, preferably by diagram of bends at the outer channel (Siport simulation study report should be taken into account).
6. Did turning circle have no consideration for the Nos of tugs and their total power, just LOA and tidal currents determine its dimensions? Please add / elaborate.
7. Phitti creek with 280 to 310 meter width is generally used for real time crossing of the vessel. Please indicate this width is safe for a vessel of what size beam.
8. What's the safe distance of Navigation Buoys from toe line? PQA observe 25 to 30m for outer channel and 10 to 20m for inner channel. Please guide.
9. LNG terminal is constructed with 153m offset from adjoining toe line (273m from centre line), LNGC will be parked about 50m from toe line (175m from centre line). How much shift in adjoining toe is suggested for the safe passage of passing traffic when LNG transfer process is in operation. Can you please guide?
10. TERMPOL guide line practiced in Canada, suggest channel width 4 times the beam of vassal, why can't we adopt it and width be redefined after some simulation study as suggested by SiPort. Please clarify is this code / guideline used in other countries of the world?
11. Before finalizing the Navigation channel layout, what fresh met ocean data acquisition is mandatory / recommended? Kindly indicate its location and duration.
12. Criteria / Tools for the establishment of geotechnical investigation be indicated (Soil investigation through borehole, sub bottom profile survey or hybrid).
13. Dredging being the most expensive and non friendly activity for environments, what kind of hydraulics study is recommended to have a safe, stable navigation channel with minimum dredging (Numerical modeling, simulation study, …….etc). Kindly indicate minimum time required to complete such study with fresh data. Can any broad guidelines be included? Can Sellhorn do it? Can alternate channel be made part of this exercise?

ANNEX – 6

Project Photographs

FSRU BERTHED ON THE LNG TERMINAL

Catwalk (Steel Walkway) installed

LOADING ARM UNDER TEST

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