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QUALITY ASSURANCE REVIEW OF EETPL LNG TERMINAL PROJECT DOCUMENTS

GAP ANALYSIS OF SUBMITTED DOCUMENTS AGAINST US NFPA CODE 59 A - 2013 TEMPLATE

February 2015

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1.0 General

The documents in the below listed inventory were received from PQA through AEAI and ECIL for our review and assessment, as part of Quality Assurance Process, for compliance of the EETPL LNG Terminal Project with all the International Codes, Guidelines, Regulations as well as the Industry Best Practices stipulated under the Pakistan LNG Policy 2011 that governs the Implementation of LNG Projects in Pakistan. The reports (released by LRS) and subsequent letters from EETPL claim compliance of the Terminal design, construction and operation with SIGTTO, PIANC, NFPA and other Standards stipulated in the Pakistan LNG Policy 2011. The LR Report concludes that "the EVTL's FSRU based LNG Terminal is adequately safe for other than normal/usual Risk and Hazards for Operability". The gaps noted between the claimed and actual level of compliance with the PIANC standards and recommendations are identified and shown in the appended Gap Study which is confined to NFPA Code 59 A – 2013 Edition. Additional Gap Studies have been conducted to evaluate the contents of the documents against the requirements of the SIGTTO and PIANC codes and have been forwarded previously.

The documents were supplied by the PQA progressively. Some documents appear to be incomplete since the attachments / appendices were not annexed to main document. In some case, drawings and sketches also appear to be missing. After continuous requests and reminders for three months, the MET OCEAN Data Collection Report was finally received towards the end of January, 2015 – although was released by the vendors in July, 2014. This report is largely based on historical data of the PQA channels and the FOTCO Terminal Weather Station and is neither recent nor site specific. Accuracy of the studies and the basis of design of moorings and the jetty is therefore questionable – to say the least. However, the documents received were examined and compared with the prescribed Standard and Codes and the best practice. The main documents so received are listed as under:-

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2.0 The Document Inventory

REF. # DOCUMENT DESCRIPTION

1. QRA REPORT…….. .April 2011

This was a 260 pages generic QRA Report - issued by Lloyd's Register of Shipping in April, 2011 - of three possible sites identified by Engro – VOPAK for an LNG Terminal. The report included results of Hazard Identification Study, Risk Assessment Study and Maneuvering Simulation Study for the three identified possible sites.

2. HAZID/HAZOP STUDY……March 2014

This was a part of 74 – Page documents dated March 14, 2014 with a cover letter Ref. PQA/DGM (PSP)/253/2007 dated March 24, 2014 From ENGRO ELENGY TERMINAL PRIVATE LIMITED along with the following attachments:

- **Attachment 1:** Letter ref: TK/EVTL/March/01 issued by Lloyd's Register of Shipping dated March 19, 2014 summarizing the findings on Consequential analysis Report Doc. No: OLG/DA/10080 Rev.1
- **Attachment 2:** Letter from SEPA dated March 20th, 2014 approving the orientation of the proposed Jetty of the new LNG Terminal from perpendicular to parallel to the main channel of Port Qasim subject to a number of conditions.
- **Attachment 3: HAZID/HAZOP STUDY** – Ref: OGL/DA/10078 dated March, 2014 issued by Lloyd's Register of Shipping.

3. UPDATED QRA REPORT. ……..31st March 2014

5- Page letter titled **Updated QRA for proposed ETPL Project Site** from ENGRO ELENGY TERMINAL PRIVATE LTD. dated March 31, 2014

4. COSEQUENCE ANALYSIS REPORT…….22nd Feb. 2014

43 Pages document with a one page cover letter from ENGRO ELENGY TERMINAL PRIVATE LTD. And the attached **Consequence Analysis Report** dated February 22, 2014 issued by Lloyd's Register under Reference # OGL/DA/10080

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5. UPDATE ON HAZID/HAZOP STUDY RECOMMENDATIONS. ……26th Dec. 2014

Two Excel Work Sheets giving **update on the HAZID – HAZOP Recommendations** received from PQA through ECIL on December 26, 2014. Most of the open items on the work sheets are claimed to have been closed. The Operability S.O.Ps. are still not finalized. Target date for closing a number items was December 15, 2014. Current status of these items is not known at this time. Annex C was not received.

6. NAVIGATION SIMULATION MODEL TEST……...Dec. 2014/Jan. 2015

37 Pages document entitled **Mooring Layout Verification and Mathematical Mooring Model** prepared and issued by Artelia Eau and Environment Consultants for CHEC on December 01, 2014 and received from PQA through ECIL on December 26, 2014. The basis of Model Test was verbal information given by two witness Pilots only. The result involves conditions for Q_{Flex} only and prohibits Q_{Max}. Part B of this Study was received last week along with the MET-OCEAN Data comprising mainly of historical environmental and hydraulic data collected in the PQA channels and in the weather station near the FOTCO Terminal. Site Specific data measured and presented is insufficient to conclude the accuracy of the model and studies based on this data. Accuracy of the Mooring Study and the Mooring layout Verification Mathematical Model can neither be accepted nor denied.

7. EXCELERATE SECURITY ASSESSMENT REPORT (SAR)……Dec. 2014

13 - Page document issued by Excelerate Energy on December 17, 2014 and received from PQA through ECIL on December 26, 2014. The report reveals insufficient security and incapability of PQA on a number of security issues. It recommends deployment of a lot of security equipment and personnel/training.

3.0 Development of NFPA Code 59 A 2013 Template

It is to be noted that whilst majority of clauses of NFPA 59A standard are concerned with LNG plant, its storage, processing and distribution, there are certain particular requirements that govern the marine terminals and related infrastructure that is involved in the handling of LNG that is offloaded from the LNG delivery ships in to the Terminal storage for re-gasification and supply to the shore pipelines. Some of these requirements were considered during the HAZID-HAZOP workshop and covered in the open items of the HAZID-HAZOP worksheets. These 'OPEN' items remain to be closed by independent or Class Surveyors prior to final testing and commissioning of the ETPL LNG Terminal

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4.0 Conformance Coding System

We encountered multiple versions of the reference documents which were provided to us during various stages of the evaluation. Furthermore, at the time of report writing the LNG project continues to be in final state of implementation. As such it was considered essential to develop a conformity coding system where current status of each activity could be marked out giving subject-wise status of project element / component reviewed such that corresponding inferences can be drawn. Rationale adapted in achieving the coding method is explained at beginning of template.

5.0 Application of Template on Documents

The template was applied on the references together with citations of the NFPA Code 59 A – 2013 standard clauses. The "gaps" identified were remarked in a manner that inferences can be drawn in a collective manner. Based on these findings specific recommendations can be drawn for scoping the outstanding work such that the gaps on conformity are rectified.

6.0 Summary of Findings

Principal Areas of partial / non-conformance observed in the referenced documents were site selection considerations, location of jetty, approaches and navigation channel, collection and use of site specific data, computational hydrodynamic models.
It seems EVTL considers it sufficient that since some studies have been carried out, the LNGCs Operations may commence without implementing the recommendations of the studies and those of the subsequent Gap Analysis carried out on these studies. Functioning of LNG Terminal is highly sensitive engineering operation at Sea and Land, which depends on strict adherence to the safety standards during the planning, construction and operational phases of the project. Therefore, compliance of the Standards / Codes, Regulations and Industry Best Practice which is also stipulated in the Pakistan LNG Policy 2011, is extremely essential. From the information available to us we notice that PQA and EVTL have so far not implemented Conditions and Recommendations conveyed to them by the LRS during the HAZID-HAZOP exercise and SEPA. It is very difficult to understand that in the absence of crucial information that remains to be obtained through the remaining studies and implementation of their own recommendations, how LR have gone ahead and declared the Project to have acceptable risk level and permitted the developers to proceed with the construction of the Terminal. Obviously, functioning of the LNG Terminal under these conditions raises concerns about the safety of the Terminal operations. It is therefore recommended that prior to commencement of LNGC's Operation the identified Gaps be addressed satisfactorily. If the non-compliances in the HAZID-HAZOP worksheets have been closed out then EETPL should forward the evidence of CLOSE out by an independent auditor or a recognized Class Society Surveyor.

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7.0 Conclusions & Way Forward

i. In initial review it was strongly recommended that above studies identified by Gap analysis be carried out in parallel to LNG terminal implementation and permanent project record for the LNG Project (the first of its kind in Pakistan) is formulated and kept in par as regards to compliance with international planning, safety, and operability standards.
ii. Possibility of infringement on safety envelopes and operations on other terminals and operators in the vicinity is a liability which not only ENGRO is to carry but also Port Qasim, as hosting port, will have to deal with the same. Impact of ENGRO LNG Terminal on nearby terminals and industrial installations, populations must therefore be carefully re-evaluated with factual information and realistic mitigations implemented.
iii. Lastly, the LNG terminal by ENGRO is first of its kind being implemented in Pakistan and this project must set the correct pace and precedence for other LNG terminals to follow. As such it should meet or exceed international best practices and conform to industry codes and standards available as of date.

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TEMPLATE BASED ON US NFPA Code 59A 2013 FOR
Berthing & Offloading Operations of LNG Carriers
AT EETPL LNG Marine Terminal at Port Qasim
January – February 2015

As a part of the Quality Assurance program, the above inventory of documents is to be reviewed and the level of their compliance with the required codes and standards will be determined through gap studies between the actual work carried out against templates of the relevant codes and standards. Appended below are the findings of the gap study highlighting the level of compliance of the above studies with US NFPA Code 59A – 2013:

Glossary / Abbreviation, to indicate the level of CONFORMANCE & THE REFERENCES:

OK	The item has been adequately addressed as per practice and SIGTTO/NFPA Standard.
TEA	To elaborate and /or Add to fully comply the SIGTTO/NFPA Standard.
NC	Not Considered. Not Addressed. The item has been either ignored or inadequately addressed.
NR	Not Required or Not Relevant.
IC	Incomplete or needs adjustments to comply the SIGTTO/NFPA Standard..
NK	Not Known. No information available, viz a viz the study recommendation present / latest state.
SC	Study completed and verified. Acquired data is available and utilized in QRA.
SNA	Study not available. Data used in QRA is not verifiable or source of data unknown.
SM	Missing study which needs to be carried out and data required to authenticate the QRA assumptions.
SE	Essential Study to be carried out that has been ignored so far.

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Sr. No.	Best Practice as per US NFPA 59A Standard	Level of Response	Remarks	Reference
1	2	3	4	5
	NOTE-II: THE ABBREVIATIONS USED IN THIS COLUMN ARE : NA = NOT APPLICABLE NO = NO WORK / NOT TAKEN INTO ACCOUNT / NOT CONSIDERED. IC = INCOMPLETE WORK / WORK WITHOUT BASIS OR DATA NK = NOT KNOWN AND /OR NOT CONFIRMED. OK = COMPLIED WITH THE REQUIREMENTS			
1.0	**Clause 5.3.7 ,NFPA LNG Terminal Planning Considerations…** As regards to Loading and Unloading Facility Spacing, are the following conditions satisfied: a. Minimum 30 m clearance required from any bridge crossing a navigable waterway?.....NA b. Is the loading or unloading manifold at least 61 m from such a bridge?.....NA c. Are the LNG / flammable refrigerant loading and unloading connections at a minimum 15 m away from uncontrolled sources of ignition, process areas, storage containers, control buildings, offices, shops ?.....NO/NK.	**…….** **NA** **NK** **NC/IC/SM**	…… No consideration of these distances.	**1,2,3,5,6,7**
2.0	**Clause 11.5.1,Berth Design Requirements .....** In design of the LNG terminal (jetty and pier), have the Developers taken into account following Met-Ocean data / design parameters specific to the ELENGY terminal site:? a. Wave characteristics……..NO b. Wind characteristics……NO c. Prevailing currents……NO d. Tidal ranges……NO e. Water depth at the berth and in the approach channel……IC/NO f. Maximum allowable absorbed energy during berthing and maximum face pressure on the fenders……IC/NO	**…….** **NC/SM** **NC/SM** **NC/SM** **NC/SM** **IC/SNA** **TEA/SNA**	…….. Assumed Met-Ocean data was used in the design of the jetty and the Mooring Dolphins. OPTIMOOR Analysis could therefore not be carried out due to side by side berthing configuration of the FSRU and the LNG Delivery Vessel. Depth and Energy	**1,2,3,5**

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	g. Arrangement of breasting dolphins……OK h. Vessel approach velocity……IC i. Vessel approach angle……IC J. Minimum tug requirements, including horsepower……OK k. Safe working envelope of the loading/unloading arms……IC l. Arrangement of mooring dolphins……OK.	**TEA** **TEA** **TEA** **TEA** **TEA** **TEA/SNA**	calculations need to be reliable and factual.	
3.0	**<u>Clause 11.5.2</u>, <u>Piping and Pipelines</u>……**	**…….**	**……**	**1,2,3,4,5.**
	a. Are the pipelines located on jetty deck or pier susceptible to damage from vehicular traffic or other possible causes of physical damage?.....OK b. In case of underwater pipelines no exposure to damage from marine Traffic?.....OK c. Have the isolation valves and bleed connections been provided at the loading/unloading manifolds, liquid lines and vapor return lines……NK d. Are liquid isolation valves equipped with both manual and auto operations?.....OK e. Are Power-operated valves capable of being operated from minimum 15 m from manifold area?.....OK f. Are valve actuators and power supply protected against 10 minute fire exposure?.....NC/NK g. Are valves adequately located at point of hose or arm connection to the manifold?.....NC/NK h. Do the bleeds or vents discharge to a safe area?.....NC/NK i. Has an independent and accessible isolation valve been provided on shore near approach to LNG jetty?.....NK j. For Multiple lines has grouping been made for valves?.....NK k. Have Valves been properly identified for their service?.....NK l. Are over 200 mm valves equipped with powered system?....NK m. Have manual operation methods provided?.....NO/NK	**NC/SM** **NC/SM/SE** **IC/SM/SE** **IC/SM** **TEA/IC/SM** **TEA/SNA** **TEA/SNA/SM** **TEA/SNA/SM** **TEA/SNA/SM** **TEA/SE** **TEA/SE** **TEA/IC** **TEA/IC/SE**	Drawings and SOPs have not been made available for review. Compliance to the Codes/Industry best practice remains to be confirmed.	

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4.0	**<u>Emergency Shutdown System (ESD)</u>……** Do ESD system allow following: a. Allow manual activation?.....NK b. Allow safe shutdown of LNG transfer components on vessel and at the berth……NK c. Do design of Hoses or arms account for temperature and pressure conditions of loading or unloading system?.....NK d. Are hoses designed for bursting pressure of five times working pressure?.....NK e. Are Flexible metallic hose or pipe and swivel joints specified for operating temperatures below 51°C?.....OK f. Have alarms for arms approaching limits of extension envelopes, been provided?.....NK g. Have hoses specified and tested annually to maximum pump pressure or relief valve settings?.....NK h. Provisions for testing of marine loading or unloading operations by PQA?.....NK	**…….** **NK/TEA/IC/SM** **TEA/IC/SM** **TEA/IC/SM** **NK/IC/SM** **NK/IC/SM** **NK/IC/SM** **NK** **NK**	**……..** Drawing and Operating parameters and workability of ESD System are not available. Scenario, after ESD actuation is not known. Compliance to the Codes/Industry best practice remains to be confirmed.	**1,2,3,4,5**
5.0	**<u>Clause 14.6.7 Marine Shipping and Receiving of LNG</u> ……** Vessel Arrival a. As regards to safe arrival of vessel has ELENGY terminal set out procedure that individual Emergency Response Procedures (NFPA 59A 14.4.7) will be communicated to vessel operators?.....NK b. Have sufficient provisions been made for warning signs to highlight LNG transfer operations in progress?.....NK. c. Have vessel-specific mooring plans been developed?.....OK d. Do provisions exist for certification by Developers in writing that training requirements of NFPA are duly met?.....NK. Have following pre-transfer checks been provisioned: e. Inspection of transfer piping and equipment for worn or inoperable parts?.....NK.	**…….** **NC/SM** **NC/SM** **TEA/SE** **NC/SE** **IC/SM**	**……** Relevant SOPs remain to be reviewed and confirmed. The Action Item Worksheet/Updated Hazop does not address these issues. In view of this Clause the Action Item Worksheet/updated Hazop may be reworked after taking into consideration all items of this Clause.	**1,2,3,4,5,6**

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	f. Checking for safe pressure, temperature, and volume values?...NK g. Agreed procedures and sequence of transfer operations with vessel operator?.....NK. h. Agreed procedures and transfer rate with vessel operator?.....NK i. Agreed duties, location, watches with vessel operator?.....NK j. Review of emergency procedures?.....NK. k. Agreed communication aspects with vessel operator?.....NK l. Ensuring that transfer connections remain within limits of moorings?.....NK m. Ensure normal operating envelope of loading arms are not exceeded?.....NK n. Ensure alignment of LNG transfer system?.....NK o. Ensure purging of oxygen from liquid and vapor lines, loading arms, shore side piping systems?.....NK p. Warning signs are in place?.....NK q. Verify no source of ignition exists in marine transfer areas?.....NK r. Ensuring presence of personnel on duty as per operating manual?.....NO s. Testing of sensing and alarm systems, ESD system, Communication systems?.....NO/NK	**IC/SM** **IC/SM** **TEA/SNA/SE** **TEA/SNA/SE** **TEA/SNA/SE** **NC/SM/SE** **NC/SM/SE** **NC/SM/SE** **NC/SM/SE** **NC/SM/SE** **NC/SE** **NC/SE** **IC/TEA/SNA** **IC/TEA/SM**	Compliance to the Codes/Industry best practice remains to be confirmed.	
6.0	**<u>Operating Specifics</u>**……	**…….**		
	a. Do procedures specify that during marine loading or unloading, on marine connections all bolt holes in flange to be used?.....NK b. Have use of blind flanges been specified for arms not engaged?..NK c. Purging and draining requirements for marine loading or unloading arms?.....NK d. Provisions for marine loading or unloading operations at atmospheric pressures?.....NK	**IC/SM/SE** **NK/SE** **NC/TEA/SM/SE** **IC/TEA/SNA.**	Operations Procedure manual of the Teminal remains to be reviewed and evaluated. Status of Action item worksheet / updated Hazop is also not known. Close-out of the OPEN items by LRS remains to be confirmed.	**1,2,3,4,5,,6**

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7.0	**Safety Measures during transfer operations…….**	**…….**	**……..**	**1,2,3,4,5.**
	a. Prohibition of Vehicle traffic within 30 m of loading/ unloading manifold?.....NK.	**TEA/SNA**		
	b. Provisions of warning signs / barricades?.....NO.	**TEA/SNA**		
	c. No independent means of egress be present?.....NK	**NK**		
	d. No sources of ignition shall be permitted in marine transfer area during transfer?..... NK.	**IC/SE**		
	e. No handling of general cargo within 30 m of LNG connections?.....NK.	**IC/SM**		
	f. System Maintenance Requirements……NK.	**NC/SM/SE**		
	g. Have procedures been set for annual inspection of foundation system of each component?.....NK	**NC/SNA**		
	h. Has adequate provisions been made for emergency power…..NK	**NC/SM/SE**		
	i. Monthly checking and testing of emergency power source at LNG facility?.....NK	**IC/TEA/SNA**		
	j. Checking methods and system for insulation systems for impounding surfaces?.....NK	**NC/SM/SE**		
	k. Checking of Hoses for LNG and refrigerant transfer?.....NK	**NC/SM/SE**		
	l. Checking of relief valve setting?.....NK	**NC/SE**		
8.0	**<u>Clause 14.9.5 Marine Transfer Training of LNG product…</u>…….**	**…….**	**……..**	**1,2,3,4,5.**
	a. Has provisions been made for Marine Transfer Training of LNG product?.....NO/NK	**TEA/SNA**	The standards of Training requirements, experience and qualification of persons operating and maintaining the Terminal remain to be evaluated and confirmed.	
	b. Have qualifications experience of all persons been verified who will be involved in marine transfer of LNG to possess specific experience in following: -handling of potential hazards……NK -handling of emergency procedures ……NK	**IC/SE**		
	c. Does the proposed training program cover the following: -LNG transfer procedures and exigencies ……NK -Monitoring of training by experienced personnel……NK -Provisions and operatives of contingency plan……NK	**NC/SE**		

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	d. Have shore side transfer operations been evaluated to possess: -Minimum 48 hours of LNG transfer experience ……NK -Knowledge of the hazards of LNG……NK -Knowledge of operational procedures……NK -Knowledge of emergency manual procedures……NK	**NC/IC/SE**		
9.0	**<u>Clause 11.9 Communications and Lighting</u>……**	**…….**	**……..**	**1,2,3,4,5,7**
	a. Has communications equipment provided at loading and unloading locations?.....NK	**TEA/SNA/SE**	The Communication system has not been addressed adequately. The report on Security has missed this issue.	
	b. Have complete lighting arrangements been provided at LNG terminals and all transfer areas during hours of darkness?.....NK	**TEA/SE**		
	c. Has a reliable ship-to-shore communication system and a separate emergency ship-to-shore communication system been provided?.....NK	**TEA/SE**		
	d. Has a monitoring system for monitoring communication system both aboard ship and at terminal been provided?.....NK.	**TEA/SNA**		
10.0	**<u>Seismic Design Requirements</u> ……**	**…….**	**……**	**1,2,3,4,5,6.**
	a. Has selection and use of operating basis earthquake (OBE) been made?..... . NO	**TEA/NC/SM/SE**	In the referred documents the "Seismic Design Requirement" have not been addressed adequately or a recommendation made. It seems to be escaped.	
	b. Have safe shutdown earthquake (SSE) been adapted?.....NO	**TEA/NC/SM/SE**		
	c. Has containment of LNG and prevention of catastrophic failure of critical facilities under an SSE event been taken?.....NO	**TEA/NC/SM/SE**		
	d. Have aftershock level earthquake (ALE) seismic levels been taken into account?..... NO	**TEA/NC/SM/SE**		
	e. During design life of terminal, have the engineering criteria and procedures catered for facilities to remain in operations for above earthquake scenarios?.....NK	**TEA/NC/SM/SE**		
	f. Has instrumentation capable of measuring ground motion been installed at the facility?.....NK	**TEA/NC/SM/SE**		
	g. In case of ground motion equal to or greater than design OBE ground motion do operating procedures allow LNG container to become out of service and OBE stress levels were not exceeded…..NO	**TEA/NC/SM/SE**		

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	h. Has seismic design loading conditions been accounted for structures such as buildings/ process equipment?.....NO/NK	**TEA/NC/SM/SE**		

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