World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:14, No:2, 2020

Daily Site Risks Associated with Construction Projects and On-spot Corrective Measurements: Case Study of Revamping Projects in Kuwait Oil Company Fields Area

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***Abstract*—**The growth and expansion of the industrial facilities comes proportional to the market increasing demand of products and services. Furthermore, raw material producers such as oil companies usually undergo massive revamping projects to maintain a synchronized supply. These revamping projects are usually delivered through challenging construction projects held and associated with daily site risks related to the construction process. Henceforth, a case study related to these risks and corresponding on-spot corrective measurements has been made on a certain number of construction project contractors at Kuwait Oil Company (KOC) to derive the benefits and overall effectiveness of the on-spot corrective measurements during the construction phase of a project, and how would the same help in avoiding major incidents, ensuring a smooth, cost effective and on time delivery of the project. Findings of this case study shall have an added value to the overall risk management process by minimizing the daily site risks that may affect the project lead time, resulting in an undisturbed on-site construction process.

***Keywords*—**Oil and gas, risk management, construction projects, project lead time.

I. Introduction

GLOBAL population growth, the rapid rise of the middle class and the continuous emergence of new technologies which can be defined as the current market demand have a direct effect on how industries should set their targets in a fast-paced industrial world. Hence, the demand for resources fueling up industries is constantly increasing. Although industries may defer by the end products or services they deliver or produce, they mainly unite by the raw materials and energy resources used to run the facility. Petrochemicals (acetylene, benzene, ethane, polymers, etc.) are known to be one of the main raw materials that the majority of the products nowadays are produced from. Starting from a pencil eraser all the way up to an airplane, it is all about petrochemicals. Hence, petrochemicals industries face a great challenge to maintain and keep up with the worldwide growing demand. Since petrochemicals are mainly the refined products of crude oil, oil industries go through continuous expansion and development projects (revamping projects) to ensure un-interrupted operations and final product delivery. Most of these revamping projects are held to develop the facilities in terms of capacity, effectiveness or to perform better against the continuous changes in the oil fields challenging parameters. Delays or downtime is not acceptable in these industries, since if the same occurs it may have a direct or an indirect effect on the supply chain of the end product. Delays in construction projects [1] may occur due to multiple known or unexpected reasons, but can be mainly due to the following:

I. Contractual issues causing delays
II. Construction issues causing delays

Point (I) is a very common cause of delay due to the unforeseen and unexpected variations that may arise to the project scope or funds. Such reason of delay may stall part of the project or in other cases may stall the whole project in which heavy losses may affect both parties of the contract. Contract scope variations may arise because of the change in the initial parameters stated in the contract, or may occur due to some additional technical requirements caused by the lack of initial design. Point (II) has a wide range of reasons causing construction delays, since the same is linked to several parameters and conditions. This case study will focus mainly on the daily site risks associated with construction projects and how would the on-spot corrective measurements during site works have a significant effect in minimizing the delays and incidents [2], [3]. The area considered of this study is the construction area of the revamping projects held in the Southern and Eastern part of Kuwait inside the premises of KOC, which are known as Burgan and Magwa Oil fields. The diversity in the geographical characteristics of both fields is somehow noticeable and makes it challenging. Some of these characteristics can be summarized as follows:

I. Relatively moderate to high ground elevation differences.
II. Diversity of soil type within 500 Meters radius in some areas.
III. Contaminated soil & oil lakes.
IV. Unidentified underground pipes and services.

The above stated points can all be considered as potential risks that even if identified ahead shall have a considerable impact on the construction process [4]. KOC as other major upstream companies has its own set of safety & working standards which shall be followed and abided by all parties coming into contract or working within the premises of the company. Nevertheless, these standards exist and are strictly followed but they are manmade documentations and even though being updated regularly all safety precautions and

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corrective measurements cannot be identified or anticipated ahead. Therefore, project engineers of both KOC & contractors identified some common incidents that occurred and may occur during working at site considering the above points in addition to the nature of their projects. Consolidated data with regards to these findings as well as corrective measurements shall be elaborated through this case study [5].

II. Background

KOC was established in 1934 by the Anglo-Persian, which is known today as BP (British Petroleum), and Gulf Oil Corporation, now known as Chevron. Since its inception, KOC's activities have included exploration operations, onshore and offshore surveys, drilling of test wells and the development of producing wells in addition to crude and natural gas exploration. On February 22nd, 1938, oil was discovered in the Burgan field occupying an area of 780 km^2 in southern part of Kuwait. Discoveries followed in Magwa area (574.51 km^2) in 1951 [6]. Knowing the fact that Burgan oil field is the second largest oil field in the world, the lessons learned and experience gained from the continuous site construction works shall have a great value if implemented on other similar areas of operations. This case study sheds the light on the most likely to occur site risk along with the corrective measures taken to avoid the same since all risks in the area of operation cannot identified even though surveyed ahead.

III. Method Used

Consolidated data were obtained through a survey made [Tables I, II] and distributed among the contractor concerned personnel. This contractor is executing a revamping project known as the Remote Header Manifolds Project, where this project area of operations and construction is distributed over 25 different locations in Burgan and Magwa Oil Field area covering the area of this study, the data obtained focused mainly on:

I. On-spot corrective measurements against daily site risks
II. Implementation of corrective measurements either made by KOC or the contractor to avoid unforeseen risks.

TABLE I
Site Risks along with On-Spot Corrective Actions

Sr No.	Observation	Type of related hazard	Recommendation	Corrective action at sight
1	Found crane jerked while lifting the crash barrier because operator immediately downs the load.	Lifting plan/Lifting gears	Proper care to be taken while lifting activity and operator need to be trained	Given Proper instruction to operator and informed to supervisor
2	Workers working on incomplete scaffold and without safety harness	Working at Heights/Safety harness condition	FBH is mandatory while working at height and scaffolds having the proper tag	Stop the work and strict warning given to workers and supervisor then they rectified that issue
3	Using lifting belt without third party certificate	Lifting plan/Lifting gears	Given proper instruction to site supervisor and rigger regarding the third party of lifting tackles	instructed to supervisor for change the lifting belt on urgent basis and supervisor agreed that
4	Found one open hole without any barricade	Open holes/Grating removal	All open holes needs to be covered properly and this point discussed with daily tool box talk	Given correct instruction to site supervisor then rectified that issue
5	It was observed that workers are working on the scaffold without safety harness and without scuff tag	Scaffolding/Working Platforms /Ladders/Inspection Tag	FBH is mandatory while using man lift to perform elevated job	Stop the activity and informed to the supervisor
6	One crane plate no:32103 not able to lifting due to non-availability of lifting plan.	Lifting plan/Lifting gears	Lifting plan need to available compulsory in all crane while lifting activity	Informed and advice site supervisor to arrange and proceed the lifting plan on work location as urgent basis
7	One crane plate no:19621 was working that lifting tackles having no monthly inspection color coding and fire extinguisher along with the crane also not updated.	Color coding	All equipment's should be followed the quarterly inspection colour coding system.	Informed to related supervisor to maintain safety procedure and requirements properly then he provided the colour coding
8	Found crane positioned and working without wooden base plate on front out rigger	Other	Instructed crane operator and rigger, ground should be leveled and out rigger positioned on wooden base plate	Stop the activity and warned rigger then they provided the base plate
9	It was observed that bitumen coating paint kept very near to the hot work area	Fire Precautions – Office/Site	Flammable materials keep safe distance from hot work area.	Stop the activity and clear all flammable materials then work started
10	Found one excavation with no edge protection against cave in they excavated vertically	Excavations/Barricades	Proper excavation safety protection system need to be followed	Instructed supervisor to provide slope on edge
11	Found edge of the trench was cracked	Excavations/Barricades	Proper excavation safety protection system need to be provided	Instructed to super visor then provided the step cutting
12	It was noticed that there was no benching provided in excavation area.	Excavations/Barricades	Benching to be proved in excavation area, Refer and follow, KOC.SA.026 - Excavation Safety Procedure	Instructed civil foreman and benching provided.

TABLE II
SITE RISKS ALONG WITH ADDITIONAL CONTROLS TAKEN

Sr No.	Activity	Occupational Safety hazards	Sources	Additional Controls
1	Working at Height	Falling from height, Dropped objects	Error of judgment, lack of or poor inspection and maintenance routine for working platforms or access systems. No boarding out of scaffold (kick boards)Lack of or poor system for transferring tools and equipment to work area	Continuous supervision to be ensured at site all times. Fall prevention, fall arrest, harness to be inspected and color coded and visual inspection to be done every day before using at site. Area to be barricaded. The personnel working will be told to hook the harness at the Anchor point
2	Excavation Work and Backfilling, Entry into Excavations	Blast, personal injury, asset damage, trip and slip, MVA oxygen deficient atmosphere flammable atmosphere toxic atmosphere collapse of trench wall vehicles falling into trenches	EOD, Inadequate shoring, benching tools, equipment, vehicles too close to edge of trench, no barricading, no proper warning signs, unidentified underground facilities lack of adequate ventilation, introduction of gases, gas or vapor from equipment, machinery, plant	Continuous supervision and HSE coverage at site, Scanning for underground utilities before mechanical excavation, Slit trenching for the entire area to required depth before doing excavation to done, Personnel will not be allowed to enter the excavation without proper edge protection measures. If the Soil is loose the trench will be made wider and sloping to be provided. Gas testing at regular intervals will be done, People will not be allowed to enter the trench if it is waterlogged, access to be provided using ladder, shoring to be given were ever required.
	Emergency Evacuation	Congestion, Confusion and Chaos Delay, Not Reaching Assembly Point	Lack of proper space for assembly point, Blocked access Poor Awareness on Emergency Evacuation, Poor Communication (poor alarm/siren system in place)	Emergency evacuation drill will be conducted on regular intervals to make people aware about emergencies
3	Lifting Operations	Dropped object, Moving vehicle, Moving parts Stored energy	Failure of lifting equipment, tackle. Dropped load, poor traffic management, no flagman, poor driver training Inadequate guards on moving parts, untrained operator, inadequate control of personnel not directly in involved in the lifting activity. Inadequate maintenance, uncertified equipment, inadequate operator training	Lifting Plan shall be used Supervision in Lifting Operations and competent Riggers Safety signs to be provided with proper barricades, personnel will not be allowed to work under suspended load, all the lifting tackles to be inspected prior to lifting, crane will not be allowed to lift more than its safe working load. ensure crane is placed on flat and rigid surface, check for hydraulic leaks in crane,
4	Entry into Confined Space	Oxygen deficient atmosphere Flammable atmosphere Toxic atmosphere Limited Entry/Egress	Confined Space Equipment, Machinery, Plant	Safety Signs, Emergency Response Procedure to be communicated to the crew, Gas testing at regular intervals, given rest at regular intervals if the space does not have proper ventilation, Adequate lighting to be provided
5	Driving	Speed, Vehicle, Poor Maintenance, Poor Infrastructure, No proper Signage, Extreme Weather conditions, poor visibility on road	Hazards Identification, Lessons Learned	An awareness training course on defensive driving for all personnel driving. Posters, HSE Alerts & Banners on traffic safety. Sharing lessons learnt with subcontractors on past incidents. safe driving campaign,
6	Desert Driving	Uneven Roads, Water Availability ,Wild Life, Fatigue, Poor visibility, Extreme Weather condition, Oil Lakes	Desert	Adequate Training for desert driving, defensive driving, abide by speed limits

IV. RESULTS

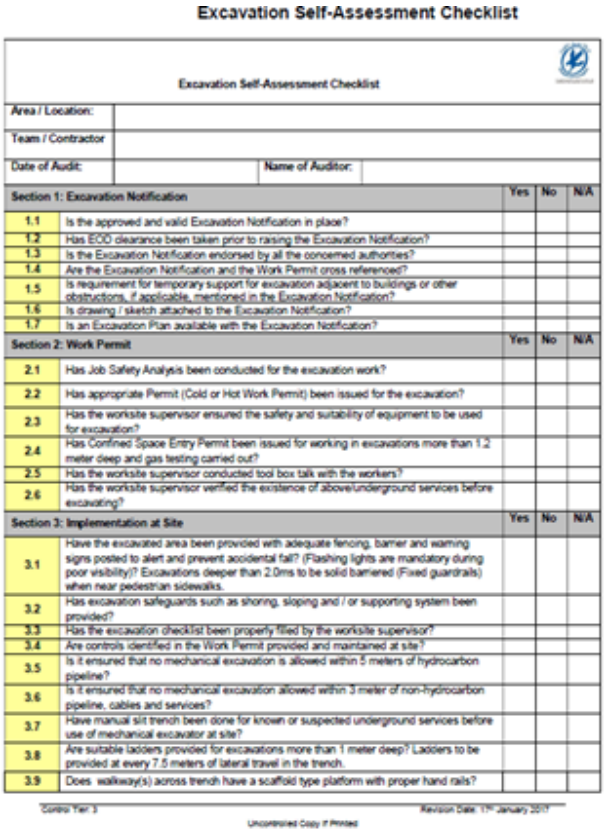
The results shall be made on areas where significant results were achieved and shall be elaborated over three cases although over 100 cases were considered in the study. The first case was made over the first step of physical work on site, which is the excavation process. The process is considered as one of the most critical works due to the un-identified services that may be lying under ground, although multiple surveys are held on the area prior to conducting the work. Therefore, the following on-spot corrective measurements are followed in addition to the company working standards:

I. Manual excavation shall be held in place of mechanical excavation up to a safe certain depth (usually 3 m) in areas where near facilities are identified.
II. Contractor shall not commence any mechanical excavation without the strict supervision of the company assigned supervisor during the whole period of the job
III. Mechanical excavation permits shall be given one at a time. (i.e. each supervisor shall only be allowed to supervise one mechanical excavation process)
IV. Data with regards of unground services shall not only be obtained as instructed by company policies but shall also be shared between contracts
V. In case underground services have been identified at the time of the excavation process, the excavation process shall stop until completely identifying the source of these services.

And in order to minimize any incident that may occur due

to the excavation process an excavation self-assessment check list [Fig. 1] has been developed as a corrective measurement. The second case to point out during this study is the oil lakes found in working area along with the contaminated soil. Such condition develops a significant challenge to the contractor if this contaminated area cannot be avoided during work, since most areas in the field are reserved for other operations. The on-spot corrective measurements for this case would be as follows in addition to the company standards:

I. Stopping all hot works.
II. Seeking the feasibility of re-allocating/shifting the work site.
III. Replacing the contaminated soil with clean soil.
IV. If contaminated soil or oil lakes were found underground in a trench, then a layer of clean soil shall be compacted above the same and kept clear of any contamination. This is to avoid contact between installed services and contaminated area.



Excavation Self-Assessment Checklist

Area / Location:				
Team / Contractor				
Date of Audit:		Name of Auditor:		
Section 1: Excavation Notification		**Yes**	**No**	**N/A**
1.1	Is the approved and valid Excavation Notification in place?			
1.2	Has EOD clearance been taken prior to raising the Excavation Notification?			
1.3	Is the Excavation Notification endorsed by all the concerned authorities?			
1.4	Are the Excavation Notification and the Work Permit cross referenced?			
1.5	Is requirement for temporary support for excavation adjacent to buildings or other obstructions, if applicable, mentioned in the Excavation Notification?			
1.6	Is drawing / sketch attached to the Excavation Notification?			
1.7	Is an Excavation Plan available with the Excavation Notification?			
Section 2: Work Permit		**Yes**	**No**	**N/A**
2.1	Has Job Safety Analysis been conducted for the excavation work?			
2.2	Has appropriate Permit (Cold or Hot Work Permit) been issued for the excavation?			
2.3	Has the worksite supervisor ensured the safety and suitability of equipment to be used for excavation?			
2.4	Has Confined Space Entry Permit been issued for working in excavations more than 1.2 meter deep and gas testing carried out?			
2.5	Has the worksite supervisor conducted tool box talk with the workers?			
2.6	Has the worksite supervisor verified the existence of above/underground services before excavating?			
Section 3: Implementation at Site		**Yes**	**No**	**N/A**
3.1	Have the excavated area been provided with adequate fencing, barrier and warning signs posted to alert and prevent accidental fall? (Flashing lights are mandatory during poor visibility)? Excavations deeper than 2.0mts to be solid barriered (Fixed guardrails) when near pedestrian sidewalks.			
3.2	Has excavation safeguards such as shoring, sloping and / or supporting system been provided?			
3.3	Has the excavation checklist been properly filled by the worksite supervisor?			
3.4	Are controls identified in the Work Permit provided and maintained at site?			
3.5	Is it ensured that no mechanical excavation is allowed within 5 meters of hydrocarbon pipeline?			
3.6	Is it ensured that no mechanical excavation allowed within 3 meter of non-hydrocarbon pipeline, cables and services?			
3.7	Have manual slit trench been done for known or suspected underground services before use of mechanical excavator at site?			
3.8	Are suitable ladders provided for excavations more than 1 meter deep? Ladders to be provided at every 7.5 meters of lateral travel in the trench.			
3.9	Does walkway(s) across trench have a scaffold type platform with proper hand rails?			

Fig. 1 Excavation self-assessment check list

In addition, water lakes due to the different elevations of the ground form a great challenge to the site workers, in which the same has to be dewatered in a timely manner in order to install the required services in that area before the water levels rises again due to un-controllable conditions such as heavy rain or leaks in the subsurface layers. The third case to emphasize is the diversity of the geographical characteristics of the fields, in which the soil in some areas is very lose while other areas are almost rocky. These diverse characteristics can sometimes be found in an area no exceeding half a kilometer in diameter. In such case the following measures shall be taken in addition to the company standards:

I. If manual excavation is to be conducted in a rocky area, the area shall be watered to a certain period to loosen up the sand in order to continue the excavation
II. In some area the watering technique may take a long time, then jack hammers may be used instead, up to limited depth, only after thoroughly identifying the nearby and underground services and obtaining all necessary permits.
III. In soft sand conditions, sand steps shall be made every 1 m to avoid collapsing in the trench.
IV. Pipes kept near a soft/loose sand trench shall be kept away at a safe distance to prevent damage to the trench and pipes in case of sudden weather changes or sand collapsing
V. Working area shall be compacted properly, to safely insure the entry of heavy vehicles.

V. Conclusion

Based on a one-year history record with regards to the implemented on-spot corrective actions over the daily site risks, it was concluded that by utilizing the developed check list [Fig. 1] and the corrective measurements [Table I] incidents were significantly avoided in the project. Furthermore, the overall progress of the project was as planned and, in some areas, ahead of the plan.

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