

A Striking Case Study in Respect to the Construction Project Management Aspects of an Ongoing Large Scale Industrial Construction Project

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Abstract

This paper highlights the extraordinary difficulties and resulting impacts in respect to the organization, overall management, logistics, and equipment and manpower supply encountered during the implementation of a large scale industrial construction project involving very stringent Safety-Health-Environment-Security (SHES) and QA/QC requirements and tight completion schedule under the unfavourable climatic conditions of Qatar including the impacts of unprecedented events and circumstances to the smooth and proper implementation.

The project is located at Ras Laffan Industrial City (RLIC), about 80 km north Doha, Capital of Qatar. The scope includes the execution of civil works, steel structure and equipment erection, pipe prefabrication and installation, painting, insulation and Electrical-Instrumentation (E/I) installation of Utilities, Offsite and Offplot of Train-6 and Train-7 Facilities of Natural Gas Treatment Plant. The progress is about 63% and manpower available at site is about 7,200 as end of December 2008. The peak manpower is foreseen as about 8,500. The overall direct manpower to be spent is expected to be more than 33 million manhours. The revised scheduled completion is end of 2009.

The measures taken and put into effect in order to mitigate and/or overcome the above mentioned impacts to the project execution to the maximum possible extent have also been presented.

Most important than all above, the lessons learned, worthwhile to be emphasized are concluded for similar cases.

Keywords

Organization, Overall management, Logistics, Equipment and manpower supply, Unprecedented events

1. Scope and Description of the Works and Locations

The works comprises construction of Temporary Site Facilities (TSF) and Camp Facilities, and execution of the Main Works.

1.1 Temporary Site Facilities (TSF)

Originally a limited area of about 200,000 m² was allocated for the temporary facilities. However, during execution, as per actual requirements for pipe spool storage, Non Destructive Testing (NDT) bunkers, Post Weld Heat Treatment (PWHT), precast concrete finishing works and storage, long curing period of painted spools, slug catcher preassembly and main utility area intermediate lay down, additional 283,000 m² of area was required and provided at 4 different locations acquiring additional manipulation and efforts between different areas.

1.2 Camp Facilities

Originally the peak manpower (direct plus indirect) was foreseen as 3,750 men (RLIC Camp-1) and the camp facilities were planned and constructed accordingly spread over an area of about 115,000 m². However, as per actual need during execution, an additional camp at RLIC (RLIC Camp-2) with a capacity of 2,600 men spread over an area of about 83,000 m² was constructed. The rest of the peak manpower is accommodated at the facilities arranged in Al-Khor and other neighboring towns (ref to Article 5.2).

1.3 Main Works

Summary of the main works and direct manpower requirements are given in Table 1.

Table 1: Summary of Main Works

Item	Description	Quantity	Unit	Originally Planned Manpower	“Actual + Revised Planned” Manpower (including bill of quantity increases)
1	Civil works	75.500	m3	13,760,000 manhour (55,036 manmonths)	33,089,000 manhours (132,360 manmonths)
2	Steel structure erection	14.800	tons		
3	Equipment erection	17.200	tons		
4	Pipe prefabrication	805.000	wdi		
5	Pipe erection	512.000	wdi		
6	Painting	375.000	m2		
7	Insulation	162.000	m2		
8	E/I works	--	--		
Wdi : Weld diameter inch					

1.4 Locations

The main works job site area, TSF area and the camp area are all located in RLIC. The plot area, relative locations and some key distances are summarized below:

- Ras Laffan Industrial City plot area: 8 km by 20 km.
- The main works job site area: 2.5 km by 2.8 km.
- The distance from TSF area to the main entrance of the main works job site: 7 km.
- The distance from camp area to the main gate of RLIC: 5 km.
- The distance from camp area to TSF area: 17 km.
- The distance from camp area to the main entrance of the main works job site area: 10 km
- The distance from the main entrance of RLIC to the closest town (Al-Khor): 27 km.

2. Schedule, Phases of Construction Activities, Manpower-Plant-Equipment-Vehicles Requirements and Some Key Figures

The Subcontract Agreement was signed in January 2006 and Completion of Train-6 and Train-7 facilities were originally 15.09.2008 (33 months) and 15.05.2009 (41 months) respectively. The original handing over of the areas and start of construction were scheduled as follows:

- Camp Area: March 2006 (First occupancy originally scheduled by October 2006)
- TSF Area: March 2006
- Main Works: May 2006 (Completion as stated above)

As can be seen from the phases of the construction activities given above, construction works firstly shall start at the camp and TSF areas and two months after that the main works shall be started practically resulting in working almost at the same time at three different work fronts spread over a plot area of 8 km by 20 km with distances of about 5 to 17 km. Contractor did not have any previously constructed TSF or Camp Facilities. Therefore, all such facilities are needed to be constructed from grass root level which was really a big challenge.

The actual hand over of camp area was by the end of August 2006 with a delay of about 6 months, and after construction of RLIC Camp-1 facilities, the first occupancy for the construction manpower was realized in May 2007. The actual hand over of TSF and Main Works Areas was realized with a delay of about 3 months.

The overall original, revised and actual manpower requirements are given in Table 2.

Table 2: Overall Manpower Requirements

Totals	Manpower	3			2			1			Item Work Descr.	
		Main Works			Camp			TSF				
		Schedule & mppwr	Schedule & mppwr	Schedule & mppwr	Schedule & mppwr	Schedule & mppwr	Schedule & mppwr	Schedule & mppwr	Schedule & mppwr	Schedule & mppwr		
		O	R	A	O	R	A	O	R	A	20 Mar	2006
		R									40 Apr	
		A									164 May	
74	120	402	80	80							200 Jun	
131	182	596	122	122							352 Jul	
309	447	683	149	267							331 Aug	
535	627	597	346	397							115 Sep	
725	1,407	1,014	383	891							50 Oct	
1,255	1,966	1,558	1,465	1,485							Nov	
1,424	2,378	2,088	388	2,039							Dec	
2,230	2,811	2,590	1,080	2,555							Jan	
2,799	2,775	2,642	1,684	2,642							Feb	
3,041	2,719	2,660	2,100	2,650							Mar	
3,264	2,715	2,660	2,549	2,660							Apr	
4,018	3,129	3,089	3,764	3,089							May	
4,320	3,246	3,246	4,114	3,246							Jun	
4,838	3,780	3,880	4,724	3,780							Jul	
4,913	3,896	3,896	4,913	3,896							Aug	
5,941	4,050	3,731	5,941	4,050							Sep	
6,054	4,360	3,550	6,054	4,360							Oct	
6,350	4,870	3,545	6,246	4,870							Nov	
6,455	5,210	3,540	6,173	5,210							Dec	
6,472	5,670	3,290	6,116	5,670							Jan	
6,021	6,443	2,653	5,763	6,443							Feb	
5,928	6,540	2,639	5,808	6,540							Mar	
5,804	6,634	2,128	5,714	6,634							Apr	
5,744	6,750	1,646	5,731	6,750							May	
5,946	6,943	1,148	5,946	6,943							Jun	
5,981	7,650	645	5,981	7,650							Jul	
6,068	8,350	466	6,068	8,350							Aug	
6,592	8,480	327	6,592	8,480							Sep	
6,788	8,480	205	6,788	8,480							Oct	
7,326	7,681	173	7,326	7,681							Nov	
7,190	7,525	147	7,190	7,525							Dec	
	7,513	118		7,513							Jan	
	6,946	96		6,946							Feb	
	5,866	105		5,866							Mar	
	4,394	104		4,394							Apr	
	3,161	69		3,161							May	
	2,571			2,571							Jun	
	1,418			1,418							Jul	
	1,098			1,098							Aug	
	607			607							Sep	
	428			428							Oct	
	169			169							Nov	
	148			148							Dec	

O: Original, R: Revised, A: Actual

Table 3: Some Key Figures

<u>1. Work disciplines – Peak direct manpower requirement (men)</u>					
Civil works	2,400	Piping prefabrication and erection	4,400	Insulation	670
Steel structure erection	850	Painting	260	Welders	650
Equipment erection	650	E/I installation	850		
<u>2. Total number of engineers at the peak (men)</u>					240
<u>3. Total number of engineering documentation (pcs)</u>					4,500
<u>4. Piping works total key figures</u>					
Length (km)	378	Number of engineering isometrics & sheets		19,300	
Weight (tons)	23,000	Number of spool drawings & sheets		26,000	
Number of test package (pcs)	5,500	Number of spools includi. straight pipes (pcs)		114,500	
<u>5. Major plant, machinery and equipment peak requirements (pcs)</u>					
Batching plant (100m3/hr)	2	Tower cranes	4	Trailers	58
Ice unit for batching plant	1	Gantry cranes	5	Manlifts	23
Chilled water unit for batc. plant	1	Crawler cranes	4	Diesel generators	91
E.O.T cranes	21	Mobile cranes	85	Welding machines	700
Heat treatment machines	38	Welding columns & Automatic SAW machines		2	
Compressors	22	Diesel welding generators		40	
<u>6. Peak number of vehicle requirements (pcs)</u>					
Cars	23	Pick-ups	141	Midi/mini buses	53
				Buses	78

3. RLIC and Project Related Specific Aspects

For the proper execution at site, a number of very stringent RLIC and project related specific aspects were needed to be fulfilled as listed below:

3.1 RLIC Regulations

- Camp, cafeteria and kitchen facilities construction, operation and maintenance criteria (These were applicable also to the rented buildings used for these purposes in Al-Khor and other neighboring towns)
- Traffic rules
- Gate passes
- Escort services rendered by RLIC for Long Trailer traffic within RLIC
- Catering services must be received from RLIC approved catering company already operating in RLIC
- Crane operators without approved Qatari Third Party license are not allowed to work
- Drivers without Qatari driving licence are not allowed to work

3.2 SHES requirements

- HSE Inductions and trainings
- Incident Injury Free (IIF) Trainings
- Defensive Driving Trainings, Safety Belt Encouragement Study/Trainings
- Ratio of SHES supervisor to the total manpower
- Heat stress and hot weather working and rest time limitations
- Cranes, manlifts and banksman requirements
- Requirement for certified riggers particularly for piping works and trainings for certification of the riggers
- Scaffolding requirement

3.3 QA/QC Requirements

- Extremely tight concrete production and pouring requirements: The temperature of the concrete at the outlet of the concrete pump in pouring is not allowed to be higher than 32 degrees C and 25 degrees C for lean concrete and structural concrete respectively. After long discussions, the temperature of structural concrete during extremely hot days is relaxed to 30 degrees C.
- Surface finishing requirements of precast concrete members
- Extremely long curing period of the paint system selected for the painting of piping
- Enormous number of the steps for Request for Inspection (RFI) for a given activity: For instance, 14 RFIs are needed to be issued and completed starting from the excavation until the backfilling of a typical concrete foundation.

3.4 Permit to Work (PTW)

Prior to the start of a particular work item, PTW is required for all subareas which is valid for a certain period and need to be renewed periodically. More than 5,200 PTW have been issued as end of December 2008. Moreover, the issue of PTWs have been taking quite longer times than normal practice resulting in time and cost impacts.

3.5 Inspection and Permits for Construction Plant, Machinery and Equipment and Site Transportation Means

- Inspections to allow entrance to RLIC (Yellow sticker), to allow entrance to the non-restricted parts of the job site (Blue sticker), to allow entrance to the restricted parts of the job site (Red sticker),
- Once issued, regular inspections for the stickers,
- Regular inspection of hand tools and follow-up the monthly color codes,

3.6 Restricted Areas and the Particular Requirements

- Among the main works areas, inlet facility (where the natural gas is introduced to the system), slug catcher and the synergy area are the restricted areas where no gasoline engine driven equipment is allowed. The engines must be either electrical or diesel. Diesel engines must be equipped with chalthorn valve and spark arrestors. Cellular phones to be used in the restricted areas must be of special design.
- The names and the qualification of staff and workers working in the restricted areas should be submitted in advance for the entrance and work permits to be issued to the name of the applicant. Similar permission is also required for the PMC (Premechanical and Commissioning) and SIMOPS (Simultaneous Operations) Activities in all areas.
- Once the natural gas is introduced into a particular area, i.e. gas-in, these particular restrictions and permissions are duly to be fulfilled, otherwise, no work is permitted.

3.7 Diesel Shortage in Qatar and RLIC

As per contract stipulations, the diesel is to be purchased from the local company Woqod having the storage and distribution facilities in RLIC. During the execution, the project has suffered seriously from the shortage of the diesel and also from the drastic price increases.

3.8 Requirements to Employ the NDT, PWHT and Scaffolding Subcontractors Already Approved by Qatar Gas and Working in RLIC

Obtaining approval from Qatar Gas for new companies for NDT, PWHT and Scaffolding works is extremely long process, therefore, the contractors have to employ those already approved by Qatar Gas for such operations. Moreover, the approval and certification of the scaffolding material has the

same difficulty. For a new comer contractor, there is no other solution than employing the already approved ones, thus, resulting in limiting not only the commercial flexibility but also the proper and timely sourcing.

3.9 Obstructions at the Jobsite, Difficulties, Inconveniences and Interfaces With Other Contractors and Companies Such as Qatar Gas II

In RLIC, in addition to the plants already in operation, there are more than eight different new projects in construction resulting in more than one hundred thousand workers being employed by different contractors and accomodated in the camp facilities within the boundary of RLIC.

3.10 Number of Technical Queries and the Long Decision Making Process For Clarifications

During execution more than 2,400 Technical Queries were needed to be issued as end of December 2008 and the decisions for clarifications have been taking considerably long time resulting in time and cost impact.

4. Unprecedented Events and Circumstances

Throughout the execution, the project has been suffering already incurred and ongoing serious impacts due to the reasons highlighted herein below being totally unprecedented, unforeseable and out of control:

- Restrictions in the availability of experienced supervisory staff and skilled labour due to tremendous global boom in large scale investment projects particularly in oil and gas sector all over the world and as well as in Qatar and in the Peninsula, and, if found, much higher wages and salaries than originally foreseen
- Sound inflation rate increase in Qatar (from 2 % to 15 % during last 3 years)
- Restrictions in the availability of major construction materials and consumables such as iron, cement and argon gas in the local and regional market and the price fluctuations
- Drastic price increases in the market for almost all materials,
- Drastic price increases for the rental and purchase of construction machinery and equipment
- Drastic price increases in local subcontractor services
- Weakness of USD against Turkish Lira and Euro currencies
- Exceptionally inclement weather

5. Measures Taken and Put into Effect

In order to mitigate and/or overcome the impacts of the reasons presented in Section 3 and 4 above, the following measures have been taken and put into effect:

5.1 Organization, Supervisory Ratios for Direct Manpower

Originally, the Site Organization is considered in conventional way as shown in Figure 1 below.

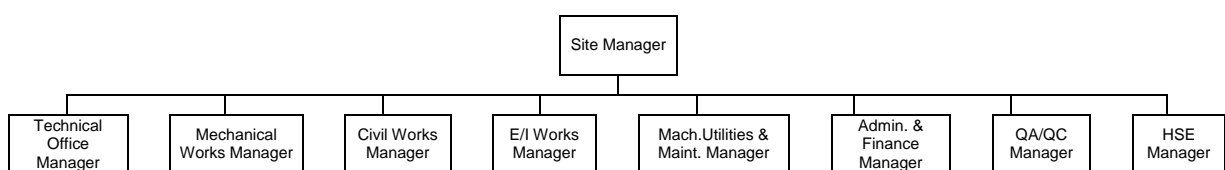


Figure 1: Original Organization Chart

Later on, the original organization was found to be underestimated and short falling and in order to overcome the difficulties encountered during execution, for proper management the organization has been rearranged and reinforced considerably as shown in Figures 2 and 3 below.

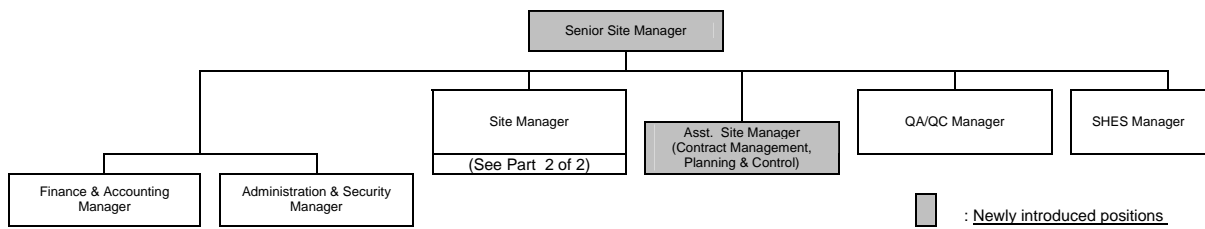


Figure 2: Revised Organization Chart (Part 1 of 2)

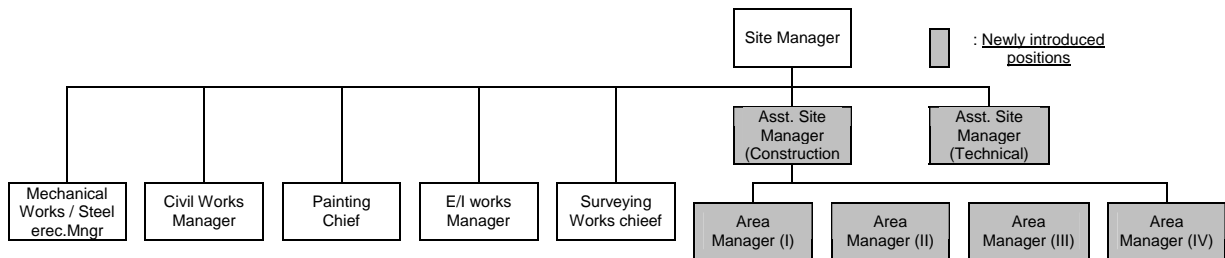


Figure 3: Revised Organization Chart (Part 2 of 2)

The major reinforcements in the revised organization are as follows:

- Senior Site Manager is incorporated on top of Site Management.
- Three Assistant Site Managers are incorporated, namely one for “Technical Issues”, one for “Construction” and one for “Contract Management, Planning and Control”.
- The organization of the Technical Office has been completely reshuffled under the Assistant Site Manager for “Contract Management, Planning and Control” and reinforced with additional number of staff.
- Area Managers being in charge of all work disciplines in their dedicated areas and working in coordination with major work discipline chiefs are incorporated for the 4 major work areas namely, for “Slug Catcher Area”, “Inlet/Waste Water Treatment Area”, “Utility Area” and “Sea Water/Fresh Cooling Water Area”.

For the proper and efficient execution, for the direct manpower of major work disciplines, the required supervisory ratios are given in Table 4 below.

Table 4: Supervisory Ratios for Direct Manpower

Description	Civil	Steel Str. Erection	Eq't Erection	Piping Prefab.	Piping Erection	E/I Works	Painting	Insulation
Foreman	5%	8%	8%	4%	5%	8%	6%	6%
Gang leader	15%	23%	23%	8%	19%	23%	18%	18%

5.2 Camp and Catering Facilities

As can be seen from Table 2, due to the late hand over of the camp area for camp construction and delayed first occupancy in the camps, during the first 12 months of the project execution, starting with 40 men and reaching to 4,000 men, all manpower needed to be accommodated in Al-Khor and in other neighboring towns. In this connection, 61 separate buildings were rented and 22 of them converted into labor camp, 39 of them converted into staff accommodation. Moreover, 1 kitchen for

Turkish labor, 1 kitchen for Turkish staff and 2 kitchens for TCN labor and staff were established. The food is prepared in these kitchens and breakfast and dinners are served in the mess hall buildings in the towns whereas the food is transported to the Site Temporary Cafeteria Buildings and served there for lunch. Such a difficult organization and logistic is continued for more than 12 months until the Camp Facilities has been completed and put into operation in RLIC. These unfavorable conditions adversely affected the turn-over ratio for the manpower due to frustration. During this period of the project, the workers have been paid an additional one hour overtime daily to compensate the travel time and to mitigate the frustration and increase in the turn-over ratio.

5.3 Manpower Recruitment

Only about 20% of the total manpower could be deployed from Turkey whereas the major portion of the rest of the manpower required are recruited and employed from India, Philippines, Nepal and Indonesia. As minor portions Vietnamese and Azeri are also employed. Agreements were concluded with the manpower supplying agencies in these countries. Recruitment campaigns have been conducted. Resident Turkish experts were appointed to these countries for the coordination of the local training facilities and conducting and witnessing the recruitment processes on the spot. As per nature of the works, the piping manpower and the welders have been paramount importance. In the facilities of the contractor in its home country, piping courses have been conducted for a duration of 45 days for training of pipe fitters. 2 weeks additional orientation trainings for pipe fitters were also provided in Al-Khor town facilities. In Al-Khor town and at TSF area welder training schools are established where more than 600 welders were trained and certified for the project. Similar facilities are established for the training of steel fixer and form workers at TSF area.

5.4 Construction Machinery, Equipment, Site and Personnel Transportation Vehicles Logistics

Limited number of own equipment and vehicles could be brought to Qatar due to 7-10 years age limitation depending on the type of equipment and vehicles as per Qatari regulations for importation and use in Qatar. At the time of the start of the project, due to the global boom in large scale investment projects particularly in oil and gas sector, the delivery period of the brand new equipment and vehicles from the supplier were extremely long, therefore, most of them had to be rented locally and/or from Turkey with, as a matter of fact, considerably increased rentals due to circumstances.

5.5 The Overall Time and Cost Impact and Conclusions

All the above presented reasons had serious impacts on the completion schedule and cost. Particularly the productivities have been adversely affected and the actual productivities came out much lower than those foreseen during the tender stage. The project completion schedule has been extended up to end of 2009 with a time extension of 15 months for Train-6 and 7 months for Train-7 facilities and serious additional costs have been incurred. In conclusion, frankly speaking, it may not be possible to forecast the unprecedented events and circumstances listed in Article 4 by any competent contractor. However, working in RLIC for Qatargas and Ras Gas Projects certainly acquires thorough and careful analysis and assessment of RLIC and project related specific aspects described in Article 3 in advance and a strong and proper organization and competent key personnel and management staff, measures for the recruitment and timely mobilization of direct and indirect manpower, provision of training facilities for manpower, required level of SHES minded people and further vocational trainings in SHES during execution, provision of own scaffolding teams and materials, well trained and experienced PTW teams, well organized and staffed contract management, planning and control including the monitoring of claims and legal aspects.