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# **Why Petrochemical Projects Are Usually Late?**

## **"A Case Study"**

- **Presenting Delay Analysis under the Procedure of Shargan**
- **Conclusion & Recommendations**

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**Version 1**

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## **Why Petrochemical Project Are Usually Late? "A Case Study"**

### **1- Introduction**

Have you ever worked on a petrochemical project that was completed on time? Probably not. When a project is late we usually feel badly about it. The problem is that our intuition about scheduling is misleading us. It is all so avoidable – if only we understand what is really going on, we can dramatically improve our ability to project schedules.

In March 03 we were appointed on behalf of Bandar Imam Petrochemical Company "BIPC" to review Engineering and Procurement Services of retrofitting of existing Olefin Plant in the Masher close to Persian Gulf. A few days later information stated in table 1 were issued to us by owner with the aim to achieve 12 percent in efficiency saving and to enhance plant output from 311MTPY to 411 MTPY or 32 percent increasing plant capacity after construction.

In this case a key factor was gaining a detailed understanding of the design in particular the interactions between the process, electrical, instrumentation, structural, piping and mechanical design disciplines and the way in which these were affected by a change in any one discipline or in Existing drawing.

We used process drawings to identify and understand the interaction of the design disciplines in the production of key engineering design deliverables.

The work, for a major engineering group, involved process and the impacts of changes in the engineering design, assessed on the follow on procurement and construction activities. Our involvement was preparing a detailed as - built schedule from a review of engineering design deliverables across multiple engineering disciplines (in particular, process, instrument, electrical, mechanical, piping and structural), procurement and shipping records, vendor correspondences and construction records from the site.

This paper discusses the analysis and presentation of delay from the viewpoint of scheduling Engineer witness, and provides brief recommendations on how to effectively demonstrate the causes and effects of project delay.



Project information and status

**Table 1: Project Status Sep 03**

Project Start Date		14 Jan 2002					
Project Finish Date "Forecasted"		30 Feb 2005					
Duration		38 Month					
Budget		€ 65 Million					
No.	Scope Of Work	Contractors	Present Month		Overall		Deviation %
			Plan	Actual	Plan	Actual	
1	Overall Project	-	2.12	0.11	20.71	19.41	-1.3
1-1	Basic Engineering	ABB	0.81	0	12.19	11.83	-0.36
1-2	Detail Engineering "Furnance"	ABB	0.87	0.11	5.51	4.72	-0.8
1-3	Procurement	ABB	0.89	0	3.01	2.86	-0.15
1-4	Construction / Erection	-	0	0	0	0	0
1-5	Precommissioning	-	0	0	0	0	0

- Delay on Detail Engineering Contractor assignment due to lack of budget
- Down Payment Delayed for caustic unit Basic Engineering
- Delay on DCS/FCS Basic Engineering Contract Award due to money shortages
- Lack of Vendors' data for preparing Furnaces Detail Engineering

Since March 03 some other contractors have been involved in the project; moreover, their scope, start and finish dates are shown in the below table (Table2).



**Table 2: Contractors, Start and Finish dates**

NO	Scope Of Work		Contractor s	Start Date		Finished Date		
				Plan	Actual	Rev(1)	Rev(2)	Rev(3)
1	Basic Engineering	Overall Project	ABB	Jan-2002	Jan-2002	Sep-2002 2003	-	-
		DCS/FCS	ABB	Mar-2003	Jun-2003	Aug-2003	-	-
		Caustic Oxidation Unit	ABB	Mar-2003	Apr-2003	Aug-2003	-	-
2	Detail Engineering	Heaters	ABB	Aug-2002	Aug-2002	Jan-2003	Jul-2004	-
		Control System	Pars Hassas	Jan-2003	Jan-2003	Nov-2003	Aug-2005	Dec-2005
		Other Equipment	Sazeh	Feb-2003	Nov-2003	Oct-2004	Jun-2005	Apr-2006
3	Procurement Engineering	Heaters	ABB	Nov-2002	Nov-2002	Aug-2003	Jul-2004	-
		Long Delivery	ABB	Mar-2003	Dec-2002	Oct-2004	Aug-2005	Oct-2005
		Other Equipment	Sazeh	Jun-2003	Aug-2003	Oct-2004	Oct-2005	Apr-2006
4	Construction/ Erection	Heaters	Shakhes	Aug-2003	Oct-2004	Dec-2004	Nov-2005	May-2006
		Control System	-	Sep-2003	Sep-2005	-	-	Sep-2006
		Other Equipment	Rampco	Sep-2003	-	Feb-2005	Jan-2006	Sep-2006

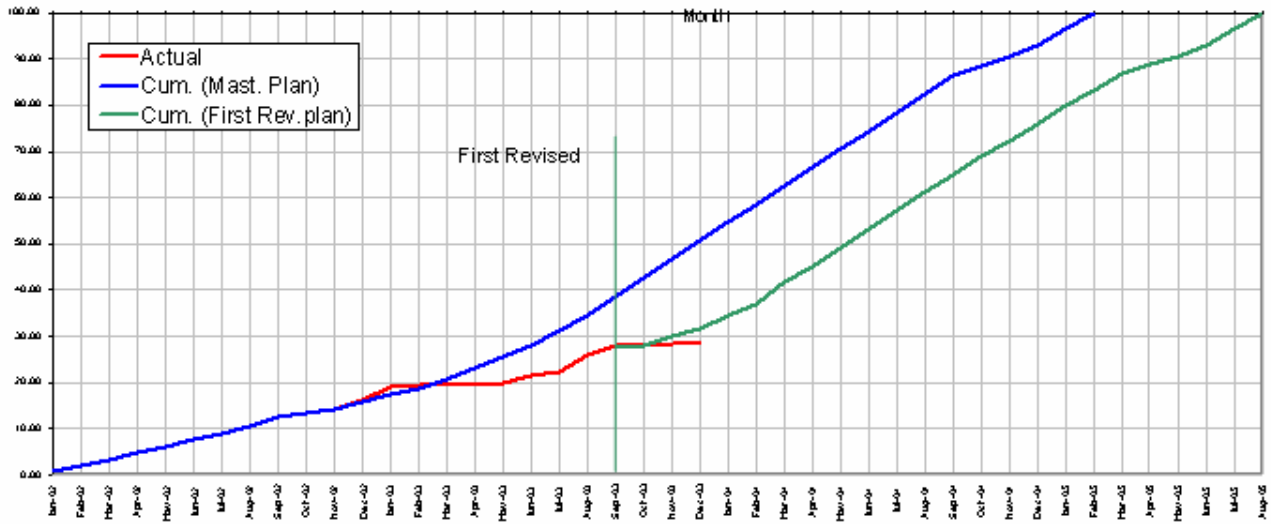
**Note:** Vendor selection is OWNER'S obligation after issuing Technical Bid Analysis by **contractors**.

## 2- Project Time Schedule and Delay Analysis

The project time schedule was revised in Sep 03 as shown in below figure, while much equipment except furnace equipment facilities had not been ordered.



Fig1: Project Time Schedule Revision "Sep 03"



In Sep 04, our client was involved in a dispute over the project and asked us to act as an expert witness on their behalf. We undertook a detailed analysis of delaying events and analyzed their impacts over a period of 3 years using the all contractor's contemporaneous programmed updates. Our analysis included the investigation of grid load delays, where we implemented a database system for determining the cause and effect of delays from the time OWNER planned up to Sep 04.

*From our analysis we provided our client with a board level report as to the true critical path, the cause of engineering and construction delays and opinion on the validity of substantial prolongation and disruption claims.*

#### PRESENTING AND PROVIDING DELAY CAUSES UNDER PROCEDURE OF SHARGAN ARBITRATION

First a few word of back ground information.

Whether or not a Company provides guidance to the parties and their experts, we must obviously base the analysis on the contract agreement between OWNER and CONTRACTORS.

Given the long history of scheduling in Engineering and construction, we always find contracts which are inadequate on the use of the Contract Schedule.

The lack of an adequate data, information and specification for the analysis of delay is usually due to the contract parties not wishing to explain on the potential problems of delay. However this is unwise because in this situation, delay should be identified as soon as possible, and more likely to result in disputes in the real world of Engineering and construction work.



So, what should a scheduling expert do when faced with an assignment to present suggestion to a tribunal appointed to arbitrate an engineering dispute?

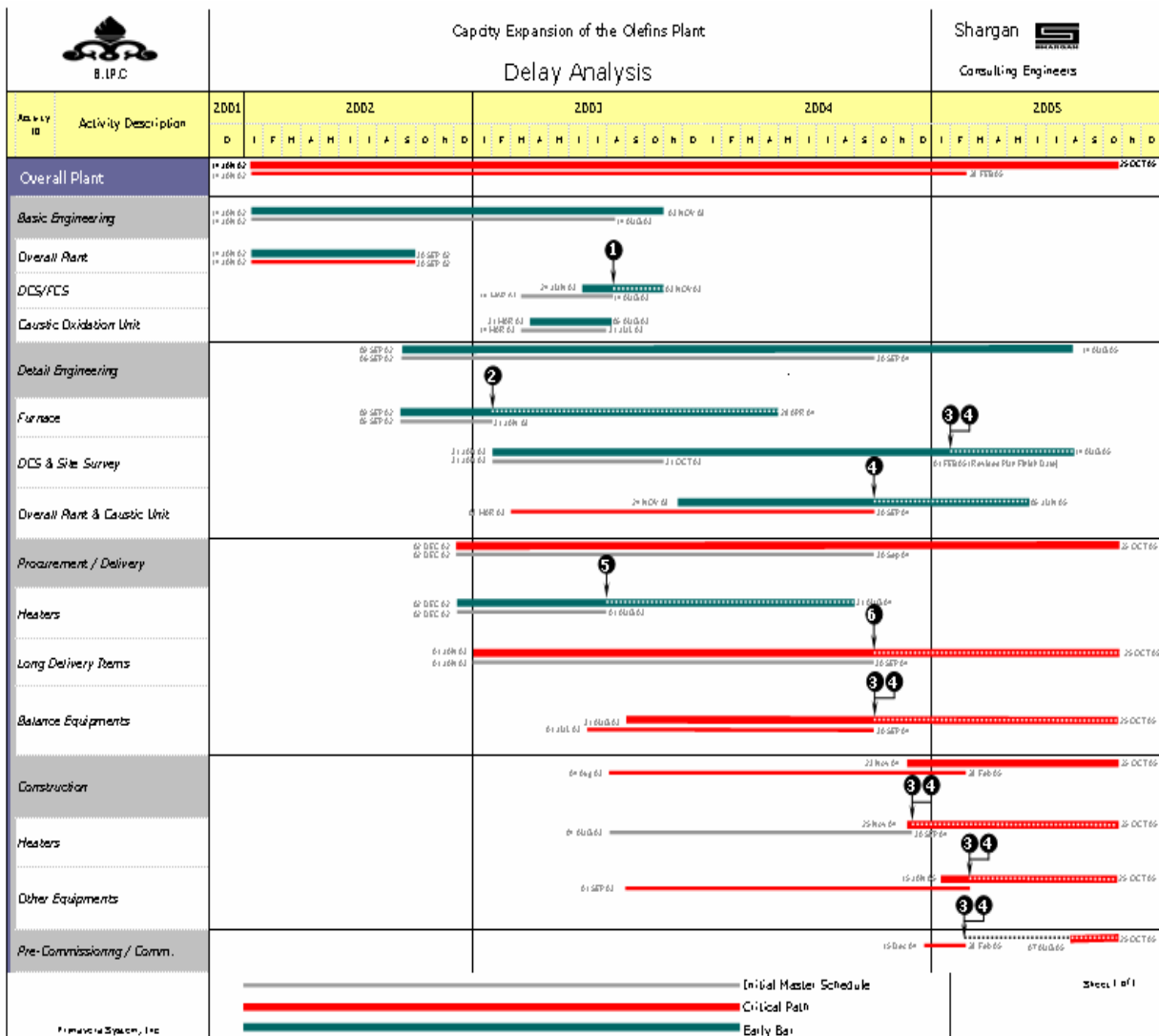
As you may know, delay claims and defenses are significant in much arbitration, in fact, often no specific guidance is provided to as to the, analysis, or documentation required for the identification and proof of delay. Shargan is left to his own ability to analyze and present his answer to the questions:

- Who and what delayed the project?
- Was the delay critical to completion?

### Delay Analysis in Sep 04

Fig 2 shows and compares the initial master schedule, the critical path (C.P) and the early bar chart extend, indicating the various time associated with each phases of the project along project life. The axis labeled 1-6 computes the delay occurred here in illustrated form.

**Fig2: Bar Chart and Delay**





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- ① Basic Engineering "BE" contract for control system awarded on Jun03 with 3 months delay due to some money –wise problem.
- ② ABB complied furnace Detail Engineering "DE" on time. Only the issuing furnace DE package remained due to lack of Vendor Data. Therefore, this activity extended up to end of Apr 04 in the bar chart.
- ③ Based on initial "Forecast" schedule, Pars Hases's (PH's) job should have been finished on 31 Oct 03. But some delay occurred due to technical limitation from ABB (Late delivering control system BE) side and also OWNER'S requirement on P&ID's. In spite of above and in addition of procurement engineering services on PH'S scope of work (on 3 06 04), the planned finish date of this contractor extended from 31 Oct 03 to 01 Feb 05. Regarding all above, and due to lack of information related to compressors layout and some other technical and instrumentation data, finish activity date of this part of work extended to 14 Aug 05.

*Note: All delayed caused (1, 2&3 in above) didn't impact on overall project delay directly, since these activities were not in the CP at the time of preparing this report.*

- ④ Bid delayed 8 months to assign experienced DE contractor. This phase of work was predicted to be performed within 19 month time in initial time schedule. Regarding predecessor tasks, related activities were on CP and affected on overall project delay directly. Duration time for DE completion agreed to be performed within 17 month after contractor assignment. Late assignment of DE contractor caused delay on procurement services under the scope of Sazeh and PH and indirectly affected on balance equipment supply\* to the end of 25 Oct 05. Project faced 8 month delay in comparison with initial scheme.
- ⑤ This activity faced with 13 month delay due to lack of budget resource for purchase order placement of furnace equipments.
- ⑥ Limited number of vendors caused some delay for compressor supply also, there after purchase order placement delayed and delivery time extended to 25 Oct 05.

*As noted above you can see our delay analysis included consideration of impacts on engineering, additional and change works and their impact on the time for delivery of key items of equipment and some significant delays.*

All it was taken was a few of those long-tailed distributions in the CP to dramatically lower the accuracy of the project estimates. Their effects minimized since estimates lied far out on the tails of their duration distribution. This sort of delay caused an indirect impact on overall project duration.

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\* Balance equipment here in this project means all equipment (except furnaces' facilities & compressors) and facilities associated with Mechanical, Piping, Civil, Instrument and Electrical.



Fig 3 clearly illustrates the matter and further illustrations are given in Fig4. As you can see only the number of key items delay reflected 8 month delay almost.

Fig 3: Delay Analysis in Sep 04

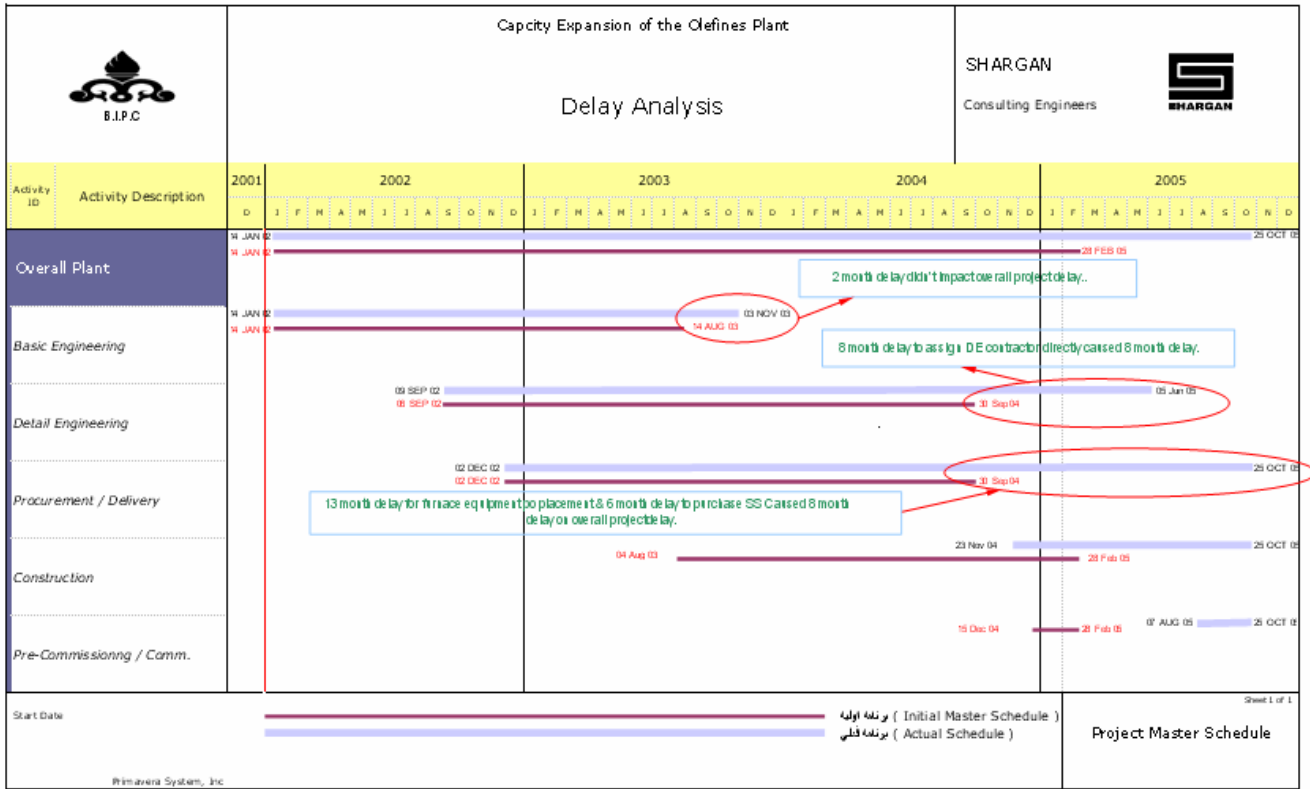
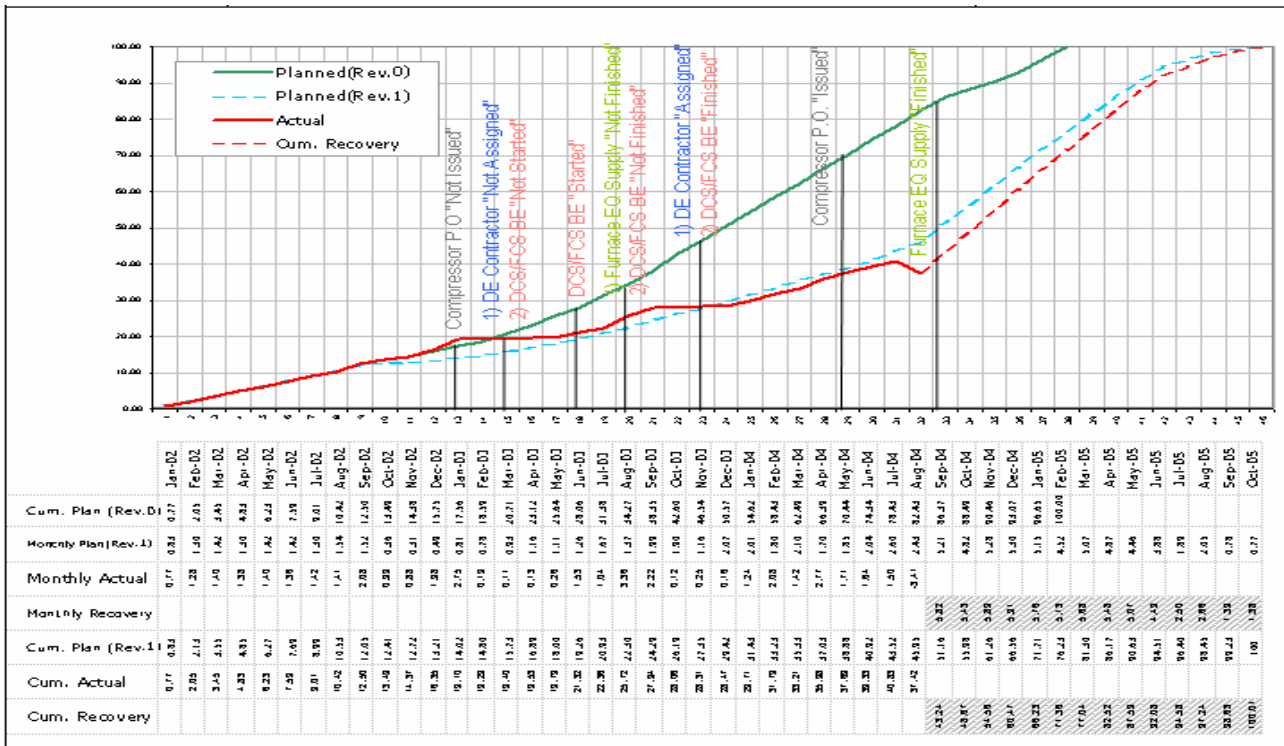


Fig4: Plan & Actual Dates of Some Main Activities And Assignments



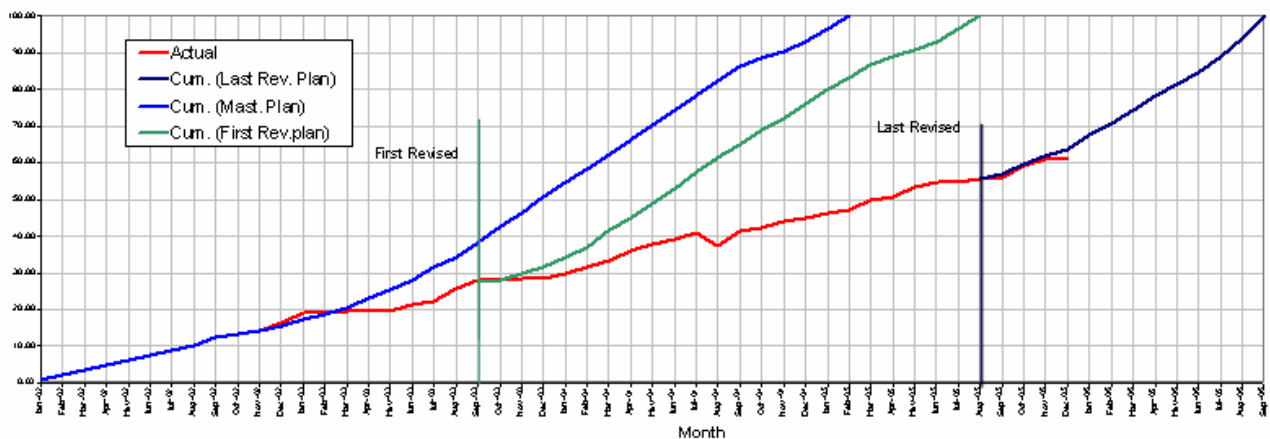
### 3- Project time schedule in Aug 05

- Bid Repeated due to wrong estimation of construction cost and because of changing control system delivery date, we had to revise the schedule as given in Fig 5.

- At this time some other delay occurred on purchase order placement of some equipment after Technical Bid Analysis "TBA", and detail design work because of DE contractors due to the issuance of a large volume of design changes during engineering issues associated with the existing equipment and therefore TBA of some equipment remained to be issued to OWNER.

These delays disappeared temporarily when Bid Repeated and took long last until calling bid again.

**Fig 5: Project time schedule in Aug 05**



### 4- Why Delay Now “16 Jan 06”

On 16 Jan 06, OWNER asked to present him and his guests an overview of the project. We produced a board level report setting out all document for proceeding with the resolutions of the matter. Therefore, we attended this meeting comprising Technical Managers and Project Planning Engineer.

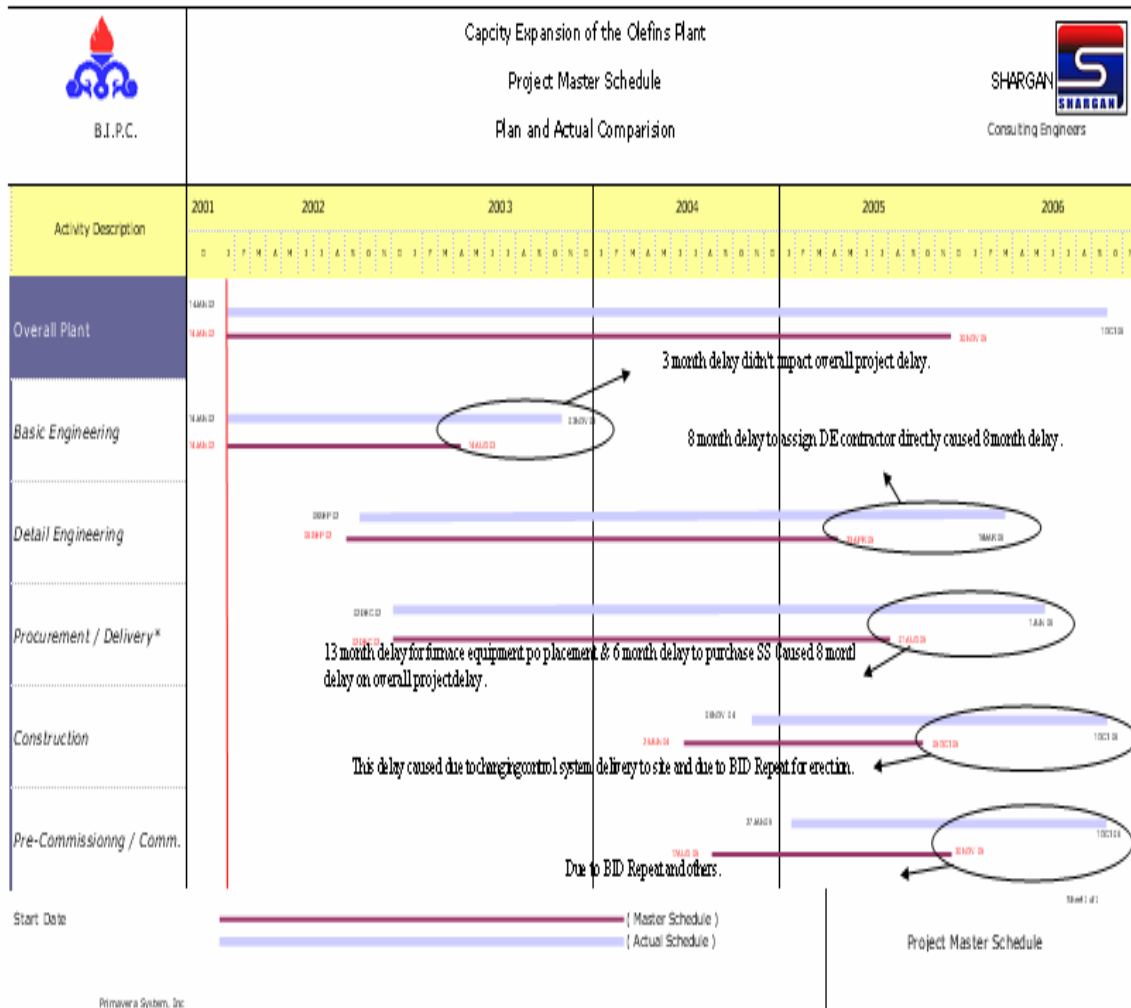
After introducing and presenting project progress status (table3), updated delay was clearly illustrated as given in Fig 6.

Table 3: Project Statuses "end of Dec 05"

No.	Scope of Work	Contractors	Present Month		Overall		Deviation%
			Actual	Plan	Actual	Plan	
1	Overall Project		0.49	1.97	61.37	63.65	-2.28
1-1	Basic Engineering	ABB	0	0	100	100	0
1-2	Detail Engineering	ABB SAZEH PARS HASAS	0.89	1.88	97.36	96.36	1.39
1-3	Procurement	*	0.71	3.92	80.85	89.77	-8.92
1-4	Construction / Erection	RAMPCO	0.33	1.41	16.95	17.60	-0.65
1-5	Precommissioning	RAMPCO	0.31	2.22	13.54	15.41	-1.87

\* Procurement Engineering are contractors' scope and supply is OWNER'S obligation

Fig6: Overall Delay "end of Dec 05"



با توجه به تأخیر حادث شده (دلیل تأخیر بر زمین) در حمل کمبرسورهای واحد، زمین حمل (F.O.B) از ژانویه ۲۰۰۴ تا ژوئن ۲۰۰۵ تغییر یافت.



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Based on latest time schedule, construction work supposed to be started with the project mobilization on 1 Jan 06, whereas the project had not started yet.

*According initial plan construction should have been completed on Aug 05, whereas in revised plan schedule, the completion date forecasted in Sep 06.*

### **Particular considerations to prevent more delay again:**

- Mobilization acceleration by construction contractor.
- Contractor and schedule acceleration preparation.
- Expedite to procure control system DCS/FCS.
- Expediting purchase order placement for remained TBA
- Expediting to assign contractor for instrumentation work.
- Managing proper and well equipped warehouse and OPI shipped equipment as soon as arriving at the site.
- Availability budget for custom clearance
- Document acceleration issues as soon as purchase order placement
- Oral modification prevention
- Approval of supervision personnel chart and with sufficient of supervision personnel work hours
- Making well equipment office for supervision personnel at site.

### **6- Conclusion & Recommendations**

When the project was revised in Aug 2005, OWNER accused shargan of lathery and incompetence. OWNERS usually have many different perspectives on the nature of the value we provide. Some quantify the benefits in financial terms, while others focus on-the expertise of our Engineers, or the way we connect parties involved in the project, or the quality of our advice and ideas while in today's business' world , we need to effectively manage critical events that have the potential to cause significant business interruptions and generate media coverage. Here in below you will find the root of the problems associated with the project progress delays:

- For a right justification of any delay it is necessary to know "how did this contract get started? And how did the parties scheduled the project before disputes arose?
- If a schedule were updated accurately and the issues clearly demonstrated by reference to the schedule updates and the parties had agreed to their use and application, it is unlikely that a scheduling dispute will go to arbitration.
- If a contract dispute goes to arbitration, it is common that the contemporaneous updates are also disputed, and there will then be a need for an independent expert scheduling analysis and presentation.



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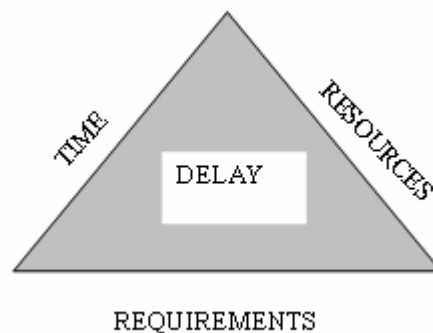
- Essential steps in this independent analysis of delays included, a thorough research of the Baseline Schedule, and checking for consistency with the contract requirements, inclusion of all the contract work, reasonable logic and durations, time for contracts award, etc.
- It is always helpful to follow the Baseline Schedule in its essential detail, while still reflecting the nature and difficulty of the project now.
- Not only were the start-and-finish dates of actual activities (both original and new plan), and periods of no-work documented, but also the actual logic of work activities had been determined.
- Detailed and careful research into the actual day-to-day work activities obviously conducted by one or two experienced persons in the scheduling program, identified and analyzed the as-built critical path, and evaluated delays.
- It is rare that contemporaneous updates will tell the whole story, and the independent preparation of an As-Built analysis is always recommended. However, there is a danger in simply preparing an as-built analysis and ignoring the dialog during work between the parties on the subjects of the project. All the communications between the parties during work have been considered on the sequence, duration, and resources applied to specific activities and thoroughly dealt with, and presented in the scheduling expert testimony.
- Output, and performance of the projects to progress optimistically, are dependent on the nature, formation and interaction of organization, experts and engineered technology (as a chain) involved in the project, reflect on contractors assignment, bid repeat and bid delay as well as engineering delay. The longer we wait to realize the importance and problem of each item of that chain and consequently the delays and take action, the greater we risk of delays we will have to face. Any delay, due to the lack of enough scientific breakthroughs, would only compound the complexity of the problem. Therefore enough effort should immediately be initiated for the honest examination of expert, organization, and capabilities of all parties involved in any project.
- Preparing plant assessment report and updating all documents and drawings are strongly recommended before starting any retrofitting project. This step did not take place in the project. The target of the assessment is to enable contractors to quote for the services related to further execution of the rehabilitation/revamp project such as amongst other engineering, procurement services, erection supervision and start up assistance.

- When the requirements of OWNER changes after months starting the plan, it is obvious to face delay. These requirements consist of changing control system, ethylene cooling capacity and environmental aspects in this project. Not only must the contract be followed but it is also important to include a detailed review and account of the scheduling procedures used by the parties during work: including the joint acceptance of the Baseline Scheduling, and their analysis of delays, Change Orders and claims and formal revisions of the Baseline. All actual progress information reported in the schedule has been checked and verified / corrected by detailed reference to the most accurate records available.

Following results have been achieved based on the initial scheme, and contract requirements due to the incomplete scope and changing requirements. It is taken into consideration, as one of the main delays.

The below diagram illustrates the way in which requirements time and resources impact the overall project delay.

If requirements change, there will be an impact on time and resources or both. This in fact will have impact on delay.



For a set number of resources, for a fixed period of time, there is only a determinate set of requirements that can be delivered.

- The tasks in this sort of project are somehow complex, so if we were to repeat them under identical conditions, the time required to complete them would vary. After all, parties are involved in performing these tasks and the behaviors of parties are non-deterministic. So when we estimate or guess the duration of a task, we are really dealing with a range of possible outcomes, because in our plan we always have a minimum duration or most likely duration, not a maximum duration. Therefore careful / precise consideration should be taken into account.

- Contractors should be assigned carefully by considering all their aspects (for example, their experiences, performances, number and value of contracts in had) since, liquidated damage in our typical control text is less valued when we face with delay and calculate the amount to be enforceable.



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- Unavailability of the budget at the right time and the right place was one of the reasons of delay also.

*Our client required board level advice as how to proceed with the situation where delay had occurred in this project and where the prospects of recovery of monies had not been researched and therefore is currently in discussion to determine how to proceed further with the matter for the better achievements and the better results in future.*