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**SAMPLES OF IRAQI RECONSTRUCTION
EFFORTS DURING THE PERIOD 1991-2002**

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**Samples of Iraqi Reconstruction
Efforts During the Period 1991–2002**

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Samples of Iraqi Reconstruction Efforts During the Period 1991 - 2002

1. Introduction

The war during Jan./Feb. of 1991, followed by the upheavals in twelve of the eighteen governorates of Iraq, resulted in enormous damage to both public and private property. More than 100 kilotons of high explosive ordnance was delivered by coalition missiles and air-forces that flew over 100000 sorties during the 42 days of the war. Anglo-American air-forces as well as their cruise missiles attacked Iraqi industrial facilities on a number of subsequent occasions during the period 1992 - 1998, the largest of these attacks was during a four day period in Dec. 1998, when a large number of industrial establishments were substantially damaged.

It would be impossible to dwell on all the reconstruction projects that were implemented in Iraq during the period 1991 - 2002. Simply because this paper relies on the author's memory and in any case the time allocated to it is somewhat limited. Therefore, this paper shall concentrate on personal experiences (and reminiscences) in implementing reconstruction projects and attempt to point out the essential common factors that usually impact large scale reconstruction efforts. Proper consideration of these factors should be beneficial in current and future circumstances in Iraq and possibly elsewhere.

It should be stated at the outset that even before the ceasefire, on Feb. 28, 1991, went into effect concrete steps towards reconstruction were being implemented. The extent of the destruction of the power and service sectors was enormous and mostly served no clear military purpose related to the stated objectives of that war. However, it must have been intended to bring the Iraqi people (and the Government) to their knees. In view of this, almost no help was offered by any outside party (except from some NGO's, a few personal initiatives and some humanitarian relief). Self reliance, clearly understood by all of us in Iraq, was the order of the day. Kellog, Brown and Root (KBR) were not offering any help neither was Halliburton. UN agencies did not hold any workshops, such as this one, in support of reconstruction. Two committees, the first was headed by Mr. Martti Ahtisaari and the second by Prince Sadruddin Aga Khan, were despatched by the UN Secretary General during 1991 to review the humanitarian situation in Iraq. Their reports were published and are available in the public domain.

in retrospect, it was perhaps fortunate not to have KBR (or some similar high class engineering company) breathing down our necks at that time for two reasons. Firstly, they would not have adopted some of the repair options that were actually implemented simply because they were non-standard and did not appear in their engineering manuals. Of course, the proper repair option would be to write-off the damaged equipment and order a replacement (with several months delay or more). Secondly, the cost of repair would have been astronomical running into several billion dollars for both equipment and engineering effort (the UN reports estimated ten billion dollars would be needed for the service sectors, mainly for electricity). Incidentally, similar estimates are being made now!

2. Important factors that impact reconstruction

These factors are in two categories, the first is at the global level and the second at the project level.

a) At the global level

- The general security situation (law and order).
- Marshalling of all available (on hand) resources.
- Assignment of priorities at the sector level and then at the project level within each sector.
- Allocation of human resources consistent with the priorities adopted.
- Allocation of material resources in conformity with the adopted priorities.
- Quick resolution of conflicts related to the allocation of resources as soon as they arise.
- Availability of the required funds.
- High motivation of the personnel involved.
- Morale boosting actions.

b) At the project level

- Clearing up of the rubble.
- Detailed damage assessment reports.
- Listing all the options for repair.
- Selection of the proper option allowing for improvisation.
- Proper repair planning and follow-up using CPA techniques.
- Quality control and full testing of all repair work plus the documentation of any departures from standard engineering practice.

- Implementation of all relevant safety standards and documenting any departures that may sometimes be necessary.
- Frequent reporting of the progress of work (daily/weekly).

3. Particular aspects that hampered reconstruction work in Iraq

The following factors hampered all reconstruction work in Iraq:-

- a) The sanctions imposed by the Security Council (SC) in August 1990 that were lifted only recently.
- b) The lack of foreign currency that made the importation of goods, spare parts and services almost impossible until the "Oil for Food" program was implemented late in 1996. Even then, this program had limited success in the procurement of spare parts in the energy, communications and oil sectors due to the substantial delays in contract approval that were imposed by the 661 Committee (mostly by US/UK representatives) of the SC.
- c) Difficult communications (in the early months immediately after the war) because all major telephone exchanges were bombed and microwave links were out of service and remained so till the end of 1991.

4. Assignment of priorities

Before the end of February 1991, the priorities for reconstruction were clearly established. The first priority was assigned to the oil refineries at Daura and the North. The second priority was assigned to electricity generation, transmission and distribution. The third priority was assigned to the reconstruction of the transport and building sectors (e.g. cement production). Followed by communications and other industrial establishments. Any resources that were not required by first priority projects were automatically assigned to the second priority and so on.

Some exceptions were necessary, for example the Jumhuriya bridge in the centre of Baghdad was assigned first priority in reconstruction and this task was implemented by construction companies attached to the Ministry of Housing within about four months.

5 Reconstruction of two oil refineries

The capacities of the three major oil refineries in Iraq are shown in table 1. The nominal refining capacity at Daura (Baghdad) is 100 kb/d and that in the North is 310 kb/d. First priority was assigned to the reconstruction of both these refineries since their oil products were deemed to be necessary and sufficient to meet demand for the remainder of 1991 and perhaps well into 1992. This was primarily due to the low demand level anticipated immediately after the war, in view of the destruction sustained by many industrial complexes that are normally end users of oil products.

The DG of Daura refinery was instructed during the last week of the war (around February 22, 1991) to prepare a damage assessment report and submit a plan for urgent rehabilitation of the refinery. The report was submitted within a few days, which was based on the manpower resources available at the refinery and concluded that the refinery could be in service within about 18 months. Of course, this project would need some essential spare parts such as pipes, pumps and control equipment. A large percentage of these essentials were not available at the refinery.

After some heated discussions and promises of support from other Ministry of Oil entities (e.g. the State Company for Oil Projects SCOP), the time line for rehabilitation of the refinery was reduced to about 12 months.

At this stage it became abundantly clear that any significant reduction in project execution time could only be achieved by engaging substantial additional resources (both manpower and material) from entities outside the Ministry of Oil. For example, the number of welding teams that could be initially fielded from Daura and SCOP resources was only four.

It was fortunate that Petrochemical Project No. 3 (PC3) (which was the code name for the Iraqi Nuclear Program) had a large trained manpower and also significant material resources. No less than 40 welding teams were available with expertise in all types of welding techniques (Arc, TIG, MIG, electron beam etc.). Also, some entities within the Military Industrialisation Commission (MIC) could field additional resources.

In the case of the Daura refinery, a large field engineering office was set up on site. Piping and instrumentation diagrams were produced as well as piping layouts and working isometric drawings. Particular attention was paid to crossing points. The reconstruction project at Daura was

dissected into nine nearly autonomous sectors. PC3 was responsible for four sectors and later took charge of two additional sectors. MIC entities were responsible for three sectors. Refinery personnel were responsible for services, quality control and general coordination between the various working groups. The work continued around the clock with 2 shifts of 12 hours each. All personnel remained on site and were allowed one off day per week. Additional pay of 10 ID/day, which was later increased to 15 and then to 20, was handed out to all personnel and implemented in all subsequent reconstruction projects. Morale was very high and the work progressed extremely well. Eventually the refinery commenced operations on April 28, 1991, barely two months after the start of reconstruction!

A similar story could be told for the reconstruction of the North refinery, whose capacity was three times larger. Operations there commenced in mid July 1991. At that point oil products were made available throughout the country and satisfied demand. Exports of some surplus products to neighbouring countries resumed (outside the oil for food programme).

6. Available capacities in the electricity sector before the 1991 war and its aftermath

In 1990 Iraq's electricity organisation comprised a total of about 26000 employees within three public sector enterprises (State companies). One state company was responsible for the generation and transmission of electricity at high voltage (HV) and ultra high voltage (UHV), whereas the other two had the task of distribution of electricity from an intermediate voltage (11 or 33 kV) down to the public consumer level of 400V.

On the generation side, the following three types of systems were installed-

a) Hydroelectric – table 2 lists the main parameters of all the hydroelectric power stations (HPS) that were operational in Iraq in 1990 (i.e. pre-war) as well as their status in April 1991 (i.e. after the war and the following upheavals). The overall hydropower installed was 2.5 GW in six major power stations. Only about 60 MW (or 2.4% of the installed capacity) remained operational in April 1991. It is worth pointing out that roughly 2.4 GW of additional hydropower was under construction at that time, which would have doubled the hydropower capacity. All of these projects, which are listed in table 2, were planned for completion during the period 1993-1995. The largest project was the Bakhma dam on the upper Zab tributary of the

Tigris in the Kurdish region of Iraq. The hydroelectric power potential in Iraq for both the Tigris (and its tributaries) and the Euphrates was estimated to be 14 GW. All the hydroprojects built thus far in Iraq were primarily intended for water control and irrigation purposes. Therefore, control of the water flow was always under the auspices of the Ministry of Irrigation. Electricity generation was essentially considered to be a useful by-product. In recent years, Iraq experienced a strong decline in the water run-off from both the Tigris and the Euphrates thereby affecting the energy output from all HPS's.

b) Steam – table 3 lists the main parameters of all the steam power stations (SPS) that were operational in 1990 as well as their status in April 1991. The overall capacity installed was 5.52 GW in eight locations. Only about 220 MW (or 4.2% of the installed capacity) remained operational in April 1991. Also, there were four major SPS projects under construction in 1990 that could have nearly doubled the available SPS capacity by the end of 1993.

c) Gas Turbines – table 4 shows the parameters of the major gas turbine power stations (GTPS) that were operational in 1990 as well as their status in April 1991. The overall installed capacity was 1.76 GW in more than twenty locations (since the mobile units were widely distributed). About 440 MW (nearly 28% of the installed capacity) remained operational in April 1991. Only one GTPS project was signed during 1990 and actual work on the ground had not commenced by August 1990. In the early days gas turbine units were generally considered to be useful for peak cover and not as base load units.

Table 5 summarises the overall power situation in Iraq. The installed power generation capacity in 1990 was 9.8 GW and the remaining capacity intact in April 1991 was only 770 MW (or only 7.8%). It should be pointed out that the damage inflicted was not limited to the power generation side, but there was extensive damage to some UHV and HV sub-stations as well as some transmission lines especially in the South of Iraq. The distribution networks were also damaged extensively in the Governorates that suffered serious upheavals in the immediate aftermath of the war.

7. Reconstruction of the electricity sector

Reconstruction work commenced early in March 1991. Again, extensive support from PC3 and MIC was provided. Several thousand personnel

from outside the electricity sector were engaged in reconstruction at all HPS, SPS and GTPS sites that were damaged. At each site a separate project was set up and managed by an experienced engineer, not necessarily from the electricity sector. He had full control over on site resources and was given adequate administrative and financial authority to ensure the timely execution of work. A central bureau specialised in the allocation of resources was set-up. It was tasked with marshalling all available resources and allocating them according to the adopted priorities on a first come, first served basis. Many tasks, that were never before attempted by Iraqi electricity personnel, were carried out with good success, such as interchanging, repairing and aligning large steam rotors, repair of large power transformers up to 240 MVA and 400 KV etc. The personnel themselves gathered wide experience and became technically much more confident of their own ability. Eventually, they could take on any technical task with a reasonable success rate. The repair of the HV and the UHV transmission network was less demanding and was implemented in parallel. The distribution network was repaired by the staff of the two distribution companies without much assistance from entities outside the sector.

By mid May 1991, electricity was available from the national grid in all Governorates of Iraq (including the three Kurdish ones). By July 1991, the countrywide demand for electricity was satisfied and more than 3000 MW were available. In July 1992, a peak load of 4500 MW was met and later in 1994 the load climbed to 5200 MW, which exceeded the peak load recorded in July/August 1990 (i.e. pre-war levels). There was practically no load shedding throughout the country until the Summer of 1996. Electricity demand was, however, increasing at an annual rate of 5-7%. The sanctions imposed on Iraq from August 1990 did not allow for additional power generating capacity to be installed, nor did it allow for essential spare parts to be imported in order to suppress the power limitations that was experienced in most SPS and GTPS units due to the lack of spares necessary for scheduled maintenance, in order to keep the unit power output at the design value. Eventually, the system frequency of 50Hz was compromised and serious load shedding was necessary. In the period 2000/2001 the supply gap reached 30% in July and August with some improvement in 2002.

8. The completion of North Jazira Irrigation Project

The North Jazira irrigation project (NJIP) is situated West of Mosul bordering Syria. The project objective is to provide complementary irrigation for 160,000 donums (1 donum = 2500 m²) of arable land.

This highly fertile area of Iraq depended on rainfall for the production of strategic crops such as wheat and barley. The required rainfall could not be guaranteed neither in tempo nor in quantity, thereby resulting in crop failure for some seasons. Therefore, the need for complementary irrigation. During the sanctions era, such projects received high priority in an effort to achieve self sufficiency in strategic crops. The first phase of the project, which comprised the installation of a large pumping station with 12 electric pumps (each requiring 4 MW) under the reservoir of Saddam Dam, was completed by a foreign company in 1990. The amount of water lifted to a height of 85 m was 40 m³/s in order to irrigate 50000 donums of the first phase, and the water balance would be lifted again in the next two phases.

The second phase of the project was hardly started in August 1990 and entailed the construction of a second pumping station in order to lift water at a rate 27 m³/s to a height of 22 m in order to irrigate another 75000 donums. The third phase required the construction of a third pumping station to lift 9 m³/s to a height of 23 m in order to irrigate the remaining 35000 donums of the project. None of the second or third phase equipment were imported before August 1990 when all the staff of the foreign contractor left Iraq.

It was fortunate that the Nasiriyah SPS had two separate cooling circuits installed, one was based on the open loop concept and the other was closed loop. The closed loop circuit was operated briefly when the SPS was first commissioned in 1979 but was found to be problematic because water vapour from the associated forced draft cooling towers was wind carried straight into the downwind switchyard thereby causing frequent sparking and consequent shut down of the UHV equipment. The open loop cooling system worked well and was entirely sufficient for normal operation thereby rendering the closed loop system not only redundant but useless.

Close inspection of the hydraulic parameters of the eight pumps comprising the closed loop circuit showed that they would be entirely satisfactory for the second and third phases of the NJIP. Each pump could deliver 6.6 m³/s at a maximum lift of 27m and needed 2MW of electric power at this operating point. It was decided to remove these eight pumps from the SPS at Nasiriya and install them in the two purposely built lifting stations at NJIP. Five pumps were installed for the second phase, two pumps were installed for the third phase and the last pump was held in store. This project was completed in April 1994 and

was implemented in about 18 months. It was one of the major irrigation projects completed during the sanctions era.

9. What can be learnt from the previous reconstruction experience?

Under stable security conditions, the following may be concluded:-

- Any major reconstruction effort must commence by pooling all the resources of the industrial sector as a whole.
- Priorities must be clearly defined at the sector level and also at the project level.
- Separate projects must be set-up and experienced managers named with sufficient administrative and financial authority.
- With sufficient motivation and good organisation Iraqi personnel could implement any reconstruction project with little or no help on site help from foreign contractors.
- Essential spare parts and replacement items would have to be imported and foreign suppliers should strive to reduce the lead times before delivery.
- The overall cost of reconstruction is expected to be much lower when primarily Iraqi personnel are engaged. Moreover, a significant reduction in project execution time is also to be expected.

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Table 1

Installed Oil Refining Capacity in Iraq by December 1990

No.	Oil Refinery	Capacity (b/d)	Total (b/d)
1	Daura/Baghdad	70000 + 3x10000	100000
2	North/Baiji	150000 + 2x70000 + 2x10000	310000
3	South/Basra	2x70000 + 10000	150000
4	Scattered small refining units	14x10000	140000
		Total	700000

Table 2

Installed Hydroelectric Power Stations (HPS) in Iraq by December 1990

No.	Name of HPS	No. of Units	Max Unit Power (MW)	HPS Total Power (MW)	Status in April 1991
1.	Saddam Dam	4	187.5	750	Bombed
	Main Dam	6	15	90	Bombed
	Regulator Dam	2	120	240	Bombed
	Pumped Water Storage				
2.	Dokan	4	100	400	Vandalised
3.	Derbendikhan	3	80	240	Vandalised
4.	Samarra	3	27	81	Bombed
5.	Himreen	2	25	50	O.K.
6.	Haditha	6	110	660	Bombed
7.	Other			< 10	O.K.
Total				2521MW	

HPS Projects Under Construction in August 1990

1.	Bakhma	6	250	1500	Vandalised
2.	Baghdadi			300	O.K.
3.	Badoosh			400	O.K.
4.	Makhool			250	O.K.
Total				2450MW	

Note:

- a) Total Installed HPS Capacity in Dec. 1990 = 2521 MW
- b) Remaining Operational HPS Capacity in April 1991 = 60 MW (2.4%)
- c) All work on HPS Projects was stopped in August 1990 and has not commenced to date.

Table 3

Installed Steam Power Stations (SPS) by December 1990

No.	Name of SPS	No. of Units	Max. Unit Power (MW)	SPS Total Power (MW)	Status in April 1991
1.	Baiji	6	220	1320	Bombed
2.	Dibois	4	15	60	Bombed
3.	Doura	4	160	640	Bombed
4.	South Baghdad	6	60	360	Bombed
5.	Al-Mussaib	4	320	1280	Bombed
6.	Al-Nassiriya	4	210	840	Bombed
7.	Al-Hartha	4	200	800	Severely Bombed
8.	Al-Najibia	2	110	220	O.K.

Total 5520 MW

SPS Projects Under Construction in August of 1990

1.	Al-Shimal	4	350	1400	O.K.
2.	Al-Yusufia	8	210	1680	O.K.
3.	Al-Anbar	4	400	1600	O.K.
4.	Al-Nasiriya II	2	300	600	O.K.

Total 5280 MW

Note:

- a) Total Installed SPS Capacity in Dec. 1990 = 5520 MW
- b) Remaining Operational SPS Capacity in April 1991 = 220 MW (4.2%)
- c) All work on SPS projects was stopped in August 1990. Some work on projects 1 and 2 commenced after 2001 on the "Oil for Food" Program.

Table 4

Installed Gas Turbine Power Stations (GTPS) in Iraq by December 1990

No.	Name of GTPPS	No. of Units	Max. Unit Power (MW)	GTPS Total Power (MW)	Status in April 1991
1.	Mosul	12	25	300	Bombed
2.	Dibbis	3 3	35 25	105 75	Bombed
3.	Taji	8	25	200	Bombed
4.	Daura	4	35	140	O.K.
5.	Hilla	4	25	100	Bombed
6.	Najaf	3	70	210	Bombed
7.	Shiaba	2	25	50	O.K.
8.	PC1	4	25	100	O.K.
9.	Khor Al-Zubair	4	70	280	Bombed
10.	Mobile I	10	12	120	O.K.
11.	Mobile II	10	8	80	O.K.

Total 1760 MW

GTPS Projects Under Construction in August 1990

1.	Khor Al-Zubair II	4	120	480	O.K.
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Note:

- a) Total Installed GTPS Capacity in Dec. 1990 = 1760 MW
- b) Remaining Operational GTPS Capacity in April 1991 = 490 MW (27.8%)
- c) All work on the GTPS projects was stopped in August 1990. Some new projects were approved on the "Oil for Food" program and partially implemented.

Table 5

Summary of the Installed Power Generating Capacity in Iraq in December 1990 and the Net Remaining Capacity in April 1991

No.	Type	Installed Capacity (MW)	Remaining Capacity in April 1991 (MW)	Percentage of Capacity Intact
1	HPS	2521	60	2.4
2	SPS	5520	220	4.2
3	GTPS	1760	490	27.8
		Total 9801	770	7.8