International Fertilizer Industry Association

IFA Technical Conference

Marrakech, Morocco
28 September-1 October 1998

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Date of receipt: 7 May 1998

POLICIES AND CONCEPTS FOR IMPROVING PLANT PERFORMANCE AT INDO-JORDAN CHEMICALS COMPANY LTD. (IJC), JORDAN[1]

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SUMMARY

As a supplement to the traditional approach of improving the plant performance by way of preventive maintenance techniques, inventory management etc., a multidimensional novel approach is adopted at IJC, right from the conceptual design of the project, with the objective of maximising the on stream factor of the plants.

This paper addresses the policies and concepts adopted at IJC for achieving high levels of production and productivity.

RESUME

En supplément de l'approche traditionnelle pour améliorer la performance d'une unité par des techniques préventives de maintenance, état des lieux, etc., une nouvelle approche multidimensionnelle est adoptée à IJC, dès la conception d'origine du projet dans le but d'améliorer le facteur opérationnel des unités qui entraîne sans conteste une production et une productivité supérieures.

L'exposé traite des politiques et des concepts adoptés à IJC pour réaliser des hautes performances de production et de productivité.

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PREAMBLE

Indo-Jordan Chemicals Company Ltd. (IJC), which is a joint venture company promoted by Southern Petrochemical Industries Corporation Ltd. (SPIC) - India, a leading fertilizer manufacturer and consumer of phosphoric acid, Jordan Phosphate Mines Company Ltd. (JPMC) - Jordan, the third largest exporter of rock phosphate in the world and Arab Investment Company SAA - Saudi Arabia, a Pan Arab financial institution, has established a Phosphoric Acid Complex in the Special Industrial Free Zone in Eshidiya - Jordan.

The phosphoric acid complex consists of a 2,000 MTPD sulphuric acid plant based on Monsanto Double Conversion Double Absorption process, a 700 MTPD P_2O_5 phosphoric acid plant based on Hydro Agri single stage hemi-hydrate process and associated utilities and offsite facilities.

While the main plants were executed by Krebs, a French contractor on a turnkey basis, the other nonplant facilities were executed by IJC through local contractors.

IJC commenced its commercial production on 1st August 1997 after it successfully implemented and commissioned its complex well within time and cost.

Taking the fullest advantage of the expertise and experience in operating sulphuric and phosphoric acid plants of its parent companies, IJC developed and adopted various policies and concepts right from the conceptual stage through project implementation to commercial production with the objective of maximizing “On stream factor” of the plants.

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[1] *Politiques et concepts d'amélioration de la performance de l'usine d'Indo-Jordan Chemicals Company Ltd. (IJC), Jordanie*

As a supplement to the traditional approach of improving production performance and reducing down time through preventive maintenance techniques, inventory management etc. the following policies and concepts have been adopted at IJC.

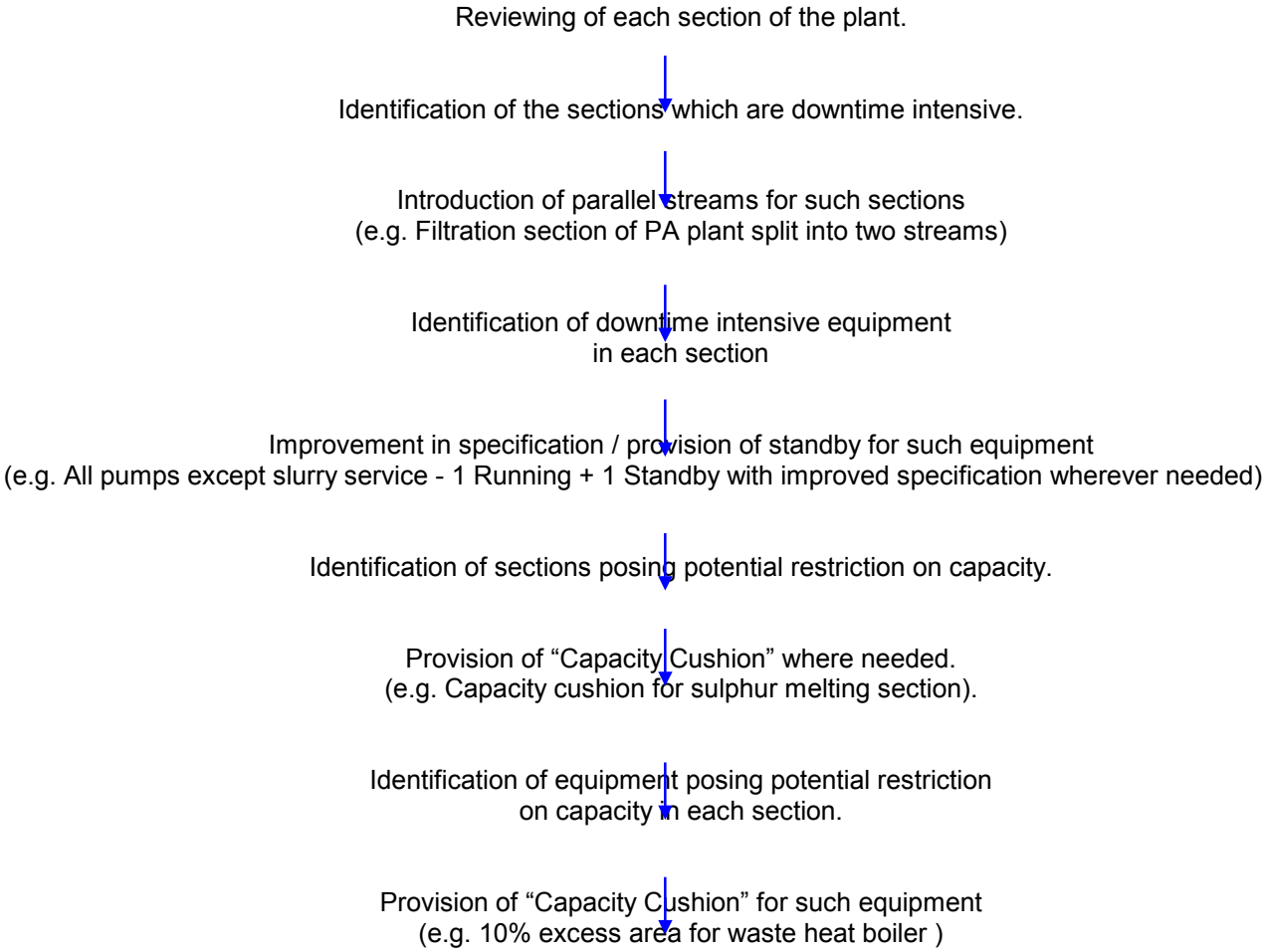
- Emphasis on reliability right from concept to commissioning.
- Full-fledged-participation of the owner during project implementation.
- Effective participation of the employees.
- Plant upkeep and safety.

EMPHASIS ON RELIABILITY

1. Conceptual Stage

The basic fabric for plant reliability is essentially the process flow sheet.

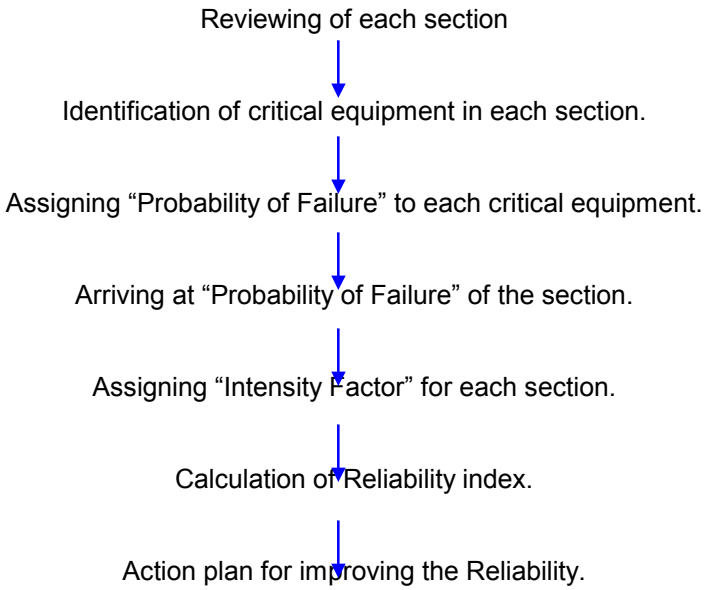
IJC, based on its experience in operation of similar plants, adopted and followed its own methodology to identify the areas of “Intensive Downtime" and “Potential Capacity Restriction” as illustrated below:



On the basis of above methodology, all the required features were identified and specified in the “Invitation To Bid". The same were subsequently incorporated in the basic design of the contractor. Some of such features incorporated for SA and PA plants as well as utilities and offsites are brought out in Exhibit-1.

2. Project Implementation Stage

Soon after freezing the Basic Engineering package, an in-depth study was carried out for SA plant, PA plant and utilities to predict the reliability of each section of the plants by employing the following analysis.



The reliability analysis carried out for SA plant is tabulated in Exhibit-2.

3. Production Stage

Improvement in reliability is a continuous process, even when plants run normally.

This philosophy is being adopted at IJC through periodical review of the plant performance - i.e., once a week, exclusively for improving the reliability of the plants by identification of problematic or potentially problematic areas and initiation of suitable actions.

In order to expeditiously implement the modifications/augmentation proposals emerging from such meetings, a dedicated team led by a senior engineer swings into action.

FULL - FLEDGED - PARTICIPATION OF THE OWNER DURING PROJECT IMPLEMENTATION

Contrary to the conventional " Observer Role" played by the owner, under any turnkey jobs, IJC adopted the policy of full - fledged - participation through out the project implementation.

1. Design Stage

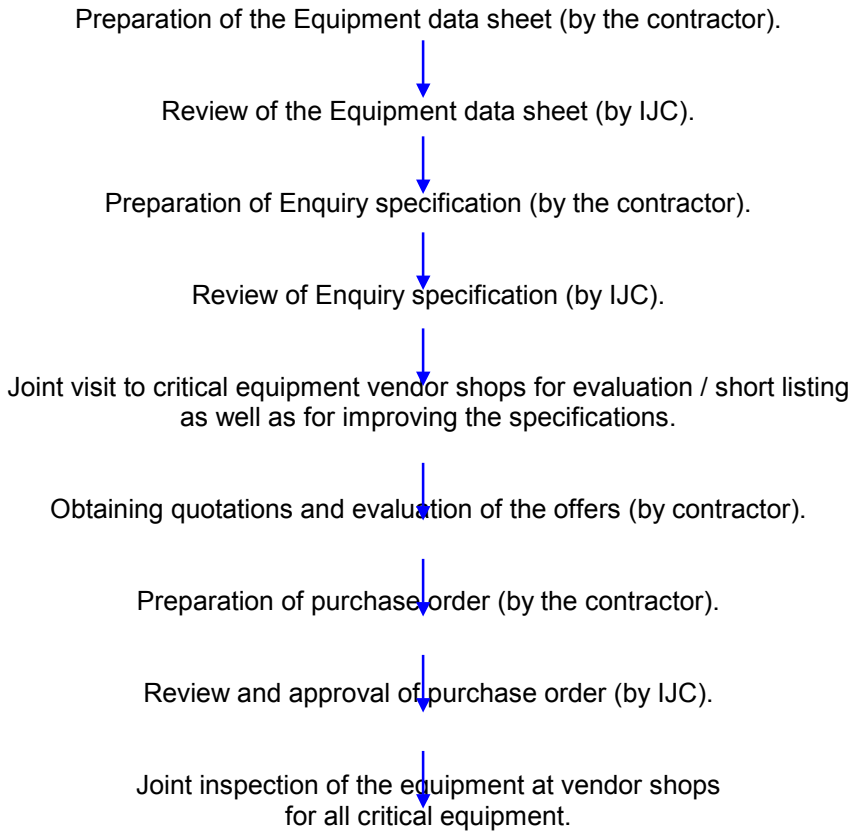
The design basis for the project was jointly evolved, based on the experience of the owner as well as the contractor, giving due importance to the following aspects:

- Superior Material of construction for all the "potential corrosion/erosion" equipment/piping.
- Improved design specification for equipment identified to be of potential bottlenecks.
- Optimisation of steam and power balance.
- Minimisation of water consumption.
- Optimum storage capacities for the products, intermediate chemicals and utilities.
- Safe and ease of operation and maintenance.

Special emphasis was given while evolving the plant layout aiming at unhindered maintenance and safety. Some of the features of the plant layout incorporated in the design are listed in Exhibit-3.

2. Engineering Stage

The extent of the involvement/participation of IJC is best demonstrated by the following sequence of activities resorted to for procurement of all the equipment.



In addition, IJC and the contractor jointly finalized the list of vendors almost for every equipment on the basis of detailed evaluation to ensure high quality and timely delivery of the equipment.

IJC and the contractor jointly looked in to the minute aspects of the equipment and piping GAD's to improve the engineering aspects that facilitate safe and ease of operation and maintenance. Some of these aspects are:

- Modular design of internals of the equipment to facilitate removal through the manholes.
- Optimum slopes for slurry piping.
- Use of long radius elbows for slurry lines.
- Independent suction nozzles for the standby slurry pumps.
- Interconnection of storage tanks for flexibility.

EFFECTIVE PARTICIPATION OF THE EMPLOYEES

1. Employee Accountability Mechanism

A well conceived "Employee Accountability Mechanism" undoubtedly paves the way for effective participation of the employees, which in turn translates into high productivity.

This "Employee Accountability Mechanism" is one of the management devices which fixes the operational responsibility of the employees at relevant levels both in monetary terms and in quantitative terms through budgeting exercise, measures their actual performance with reference to the budget and makes them responsible and accountable for the variances.

Supervisory employees in all operational functions and service functions are responsible for revenue expenses as well as income from production/sales.

Under this system each function is treated as a 'Responsibility Cost centre (RCN)' and the supervisory employees responsible for carrying out the functions are identified. A unique 3 digit code called 'Responsibility Center Code' (RCN CODE) is assigned to all such supervisors who are delegated with necessary authority with respect to the revenue expenses and income.

Typical identification and allocation of major RCN's for various functions related to all activities of IJC's phosphoric acid complex is enumerated in Exhibit-4.

At the end of each month, an RCN Report is generated for the following heads in which the Budget vs. Actuals are compared and the variances are brought out. The RCN heads would need to furnish necessary explanations for both favorable and adverse variances.

> Sales Quantity; Sales Revenue; Production Quantity; Raw Material Consumption; Chemicals Consumption; Utilities Consumption; Spares Consumption; Overtime Expenses; Other Administrative Overheads.

The company has been able to achieve the following benefits through this "Employee Accountability Mechanism".

i **Costs / Profit:** Employees perceive their functional requirements in terms of "Costs / Profit ".

ii **Cost Reduction:** Facilitates distribution of cost control and resultant cost reduction at multi levels resulting in a significant cumulative cost reduction.

iii **Sense of responsibility and belonging**: By a clear definition of individual's share of accountability and contribution, the sense of belonging to the organisation of the individual employee gets boosted.

iv **Quality of Budget**: Improves the accuracy of budgeting exercise per se.

2. <u>Employee Incentive Schemes</u>

Employee incentive scheme helps to sustain the desired level of production and also strive for better results over the budgeted targets in terms of level and cost of production.

The incentive scheme at IJC has been structured such that it would not be a "Give Away", but would need to be strictly earned through a concerted effort by everyone concerned. The details of this scheme are:

(A) Production / Productivity Incentive

While the Company's performance relies, in general on the performance of all the plants in the complex, the most "demanding" plant/section is the one related to P_2O_5 production. Further, between 'on-stream efficiency' and the 'on-stream factor' of the PA plant, it is the 'on-stream factor' that calls for every one's focus and the best efforts to yield the desired result. This, in other words, means that surpassing the budget targets can be achieved only by reducing 'the down time hours'. Hence the incentive scheme was formulated on the basis of reduction in 'down time hours' in a month and accordingly the incentive (as a percentage of salary of the employees) is payable depending on the actual reduction in 'down time hours' subject to achieving the budgeted production in the relevant month.

(B) Specific Consumption / Variable Cost Incentive

The company has also formulated an incentive scheme for achieving the best specific consumption thereby reducing the variable cost. This scheme has considered a certain percentage of monthly salary as incentive to the employees on containing the variable cost of production at the budgeted level. The company has also considered an additional percentage of incentive for achieving the reduction in the variable cost of production on a 'pro-rata' basis.

(C) Complex Up-keep Incentive

This incentive is aimed at ensuring an up-keep of the 'first order' of the total complex including plant and non-plant facilities which would in turn clearly reflect on the productivity, safety and the well-being of every one concerned in the long run. The company has formulated a novel system of assessment/evaluation of the complex up-keep with the incentive being pro-rated to the rating on the complex up-keep.

By means of linking the incentive amounts payable on account of the above three schemes to the employee's monthly attendance, the Company has also benefited from an excellent 'attendance record' of the employees.

PLANT UP-KEEP AND SAFETY

Plant upkeep and safety go hand in glove with production and productivity.

Considering the fact that the operating culture of any plant stems from its commissioning phase, tremendous efforts were made to inculcate the habit of plant upkeep and safety even in the midst of hectic commissioning activities.

Top priority was accorded by establishing an independent section/department exclusively for plant upkeep to ensure that good practices of plant upkeep are adopted and implemented.

Various safety features adopted at IJC right from the design stage of the project are brought out in Exhibit-5.

Hazop study was conducted for all sections of the plants and the outcome of such study was incorporated suitably during the project implementation itself.

An emergency preparedness manual was prepared after identifying the probable emergencies. More importantly, mock drills are being conducted once a month to ascertain the preparedness of the employees as well as the systems.

CONCLUSION

"Proof of the pudding is in the eating of it".

Yes, IJC has commenced production fairly recently. The multidimensional policies and concepts evolved and adopted, based on the experience and expertise of the multinational team involved in the project implementation as well as the plant operation, has started showing positive results, as evidenced by the performance of the plants during the very early stage of operation.

It is hoped that the soundness of these multidimensional policies and concepts together with traditional concepts of preventive maintenance techniques, inventory management, etc. adopted would achieve the desired goal of the same high order of overall plant performance in the years to come.

EXHIBIT-1

FEATURES INCORPORATED DURING DESIGN STAGE

A. Sulphuric Acid Plant

i 'Capacity Cushion' of the Equipment

1.	Sulphur melting tank agitator power overload capacity	**:**	50%
2.	Capacity of the equipment for sulphur handling, melting and filtration	**:**	50%
3.	Sulphur burners	**:**	15%
4.	Number of sulphur burners - rated / installed	**:**	4 / 5
5.	Waste heat boiler	**:**	15%
6.	Air blower capacity and clean condition head	**:**	15%
7.	Plate heat exchangers area	**:**	10%

ii Other Features

1. Above grade level molten sulphur tanks - both unfiltered and filtered.
2. First bed catalyst at the bottom of the converter.
3. Dump condenser to condense steam during TG tripping.
4. All sulphuric acid and sulphur pumps are of special material of construction.
5. All valves on SA lines are of special material of construction.
6. SX piping for sulphuric acid lines.

B. PHOSPHORIC ACID PLANT

i 'Capacity Cushion' of the Equipment

1.	Capacity of rock phosphate conveying system	**:**	50%
2.	Filter feed pumps	**:**	2 x 60% capacity
3.	Belt filter	**:**	2 x 60% capacity
4.	Concentration units	**:**	2 x 60% capacity

ii Other Features

1. Slope of belt conveyors limited to 15^{o}.
2. Use of 98.5% sulphuric acid to do away with dilution cooler.
3. Active reactor volume at 2 m^3/MTPD P_2O_5 to ensure flexibility on rock feeds.
4. Two totally independent streams of filtration units.
5. Two totally independent streams of concentration units.
6. Delta "T" across calendria limited to 3.5°C.

C. OFFSITES AND UTILITY PLANTS

i 'Capacity Cushion' of the Equipment / System

1.	Instrument air and service air compressors	**:**	Capacity 150% of design requirement.
2.	Coolers and condensers	**:**	10% higher than design cooling water supply temperature.

ii Other Features

1. Cooling Towers

- Induced draught fan for SA/utility cooling tower and forced draught fans for PA cooling tower.
- Flooded suction for cooling tower pumps for SA/utility cooling tower and suction lift for cooling tower pumps for PA cooling tower.

2. Auxiliary Boiler

- Capacity to run PA plant at 60% load when SA plant is shutdown.

3. Instrument / Service air

Provision to draw instrument air from service air system

EXHIBIT-2

RELIABILITY ANALYSIS FOR SA PLANT

SL. NO	DESCRIPTION	PROBABILITY OF FAILURE (a)	INTENSITY FACTOR (b)	RELIABILITY INDEX(PROJECTED) { 1 - (a) x (b) }	IMPROVED RELIABILITY INDEX ✪
1.	SULPHUR UNLOADING / STORAGE SYSTEM	0.1	0.2	0.98	0.9891
2.	SULPHUR MELTING SYSTEM	0.1	0.4	0.96	0.9879
3.	SULPHUR FILTRATION	0.1	0.2	0.98	0.9875
4.	TURBO BLOWER SYSTEM	0.1	0.95	0.905	0.9920
5.	FURNACE SYSTEM	0.05	0.2	0.99	0.9951
6.	HEAT RECOVERY SYSTEM	0.05	0.8	0.96	0.9947
7.	CONVERSION SYSTEM	0.01	0.1	0.999	0.999
8.	ACID TOWERS SYSTEM	0.1	0.9	0.91	0.9941
9.	SA COOLING WATER SYSTEM	0.01	0.6	0.994	0.9964
10	TURBOGENERATION SYSTEM	0.05	0.2	0.99	0.995
11	SA STORAGE SYSTEM	0.05	0.4	0.98	0.9985

✪ ***ACTUAL RELIABILITY FACTOR FOR THE PERIOD JULY TO APRIL '98 WAS INCIDENTALLY CLOSE/EVEN BETTER THAN THESE FIGURES***

EXHIBIT-3

LAYOUT CONSIDERATIONS

1. Two entry points into the complex.
2. Centralized control room at an optimum distance from sulphuric and phosphoric plants.
3. Pipe racks modular design in such a manner that interlinking of various units is achieved and also approach to various plants is not hindered for erection / maintenance purpose.
4. The space beneath the pipe rack left free. A clear horizontal space of 3.5 m made available below the pipe rack for the movement of mobile equipment.
5. Sectional layout in such a manner that crane approach to any area from the roads running all around the plant is possible without any hindrance.
6. In process buildings of multistory construction, different elevation layers used for electrical, instrument and piping. Piping shall be at a lower elevation.
7. All pumps suction lines made as short as possible with easy accessibility. Pumps located on the road side preferably for easy access during maintenance. All suction headers provided with blind flanges on both ends for easy cleaning.
8. Service stations at suitable locations provided in such a manner that all the process areas can be reached with a 15 m hose.

EXHIBIT-4

ALLOCATION OF RESPONSIBILITY COST CENTERS (RCN)

SL.NO.	*RCN CODE*	*RESPONSIBILITY*
1.	210	CHIEF PLANT MANAGER'S OFFICE
2.	220	WORKS MANAGER'S OFFICE
3.	221	SA / PA OPERATION
4.	222	ELECTRICAL MAINTENANCE
5.	223	INSTRUMENT MAINTENANCE
6.	224	S.A MECH. MAINTENANCE
7.	225	C.W.S & H.V.Y
8.	226	P.A. MECH. MAINTENANCE
9.	227	PLANT UPKEEP & CIVIL MAINTENANCE
10.	230	MATERIALS MANAGEMENT
11.	231	PROCUREMENT & STORES
12.	232	MATERIALS HANDLING, ESHIDIYA
13.	233	AQABA STORAGE TERMINAL
14.	240	PROCESS ENGG. & QUALITY CONTROL
15.	250	ENGINEERING SERVICES
16.	251	ENGG. SERV-PLAN, INSPN. & DESIGN
17.	252	SAFETY
18.	260	ADMINISTRATION & PERSONNEL
19.	261	ADMINISTRATION
20.	262	PERSONNEL
21.	263	SECURITY
22.	270	FINANCE

EXHIBIT-5

SAFETY FEATURES OF IJC

1. The layout of plants is such that free and safe access to all the equipment is available.
2. The storage facilities of bulk materials (viz., rock phosphate, sulphur and alumina) are located downstream of prevailing wind direction to avoid dust pollution in the plant zone.
3. Plants are designed to meet Environmental Protection Agency (EPA) standards and World Bank guidelines.
4. Green belt is provided all around the complex to control air pollution and the ill effects of dust storms.
5. Protection measures such as dams and trenches are provided outside the complex to avoid the impact of any likely flash floods.
6. Separate main roads for movement of people and movement of materials respectively with one way routing as necessary and adequate traffic sign boards to avoid traffic hazards.
7. The complete area within plant zone is paved to facilitate better house keeping and to avoid ill effects of dust / sand storm.
8. Hazop study conducted for SA, PA, utilities and offsites and the outcome of such study was included.
9. Safety and fire center equipped with sophisticated and modern fire fighting equipment located at the entrance of plant zone with almost equidistance to all vulnerable sections of the plants.
10. Entire complex is well illuminated with antiglare light fittings.
11. Specially designed barricades are provided for the equipment / pipe lines in traffic prone zones.