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PLANT MAINTENANCE TECHNIQUES

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RESUME

Cet exposé décrit les différentes techniques de maintenance continue, maintenance préventive, systèmes de contrôle et le rôle de l'atelier central. Il décrit aussi la programmation des arrêts, l''utilisation des pièces de rechange et le soin apporté à la conservation de l'énergie. La performance est contrôlée régulièrement pour assurer une opération sans à-coup.

Enfin, il y aura une brève description des expériences dans la réhabilitation de l'unité d'ammoniac et le débridage de l'unité d'acide formique.

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1. INTRODUCTION

Gujarat Narmada Valley Fertilizers Company Limited (GNFC) was launched by Government of Gujarat, India and Gujarat State Fertilizers Company Limited on 10th May, 1976. GNFC has the largest single stream ammonia and urea plants based on fuel oil technology. We established ammonia, urea, and other facilities, which include boilers, water treatment plant, coal handling plant, bagging plant, electric power supply, railway siding and water supply and commenced production in 1981.

Since after commissioning its ammonia and urea plants, GNFC has embarked upon a huge expansion and diversification programme. We have added methanol - I & II, captive power, butachlor, formic acid, nitrophosphate consisting of ammonium nitrophosphate, calcium ammonium nitrate, concentrated nitric acid and weak nitric acid plants. At present, we are going ahead with the acetic acid project. We also have entered into joint venture Videocon Narmada Electronics Ltd (VNEL) and Narmada Chemathur Chemicals Ltd (NCPL) both promoted by GNFC. We are also working on Corporate Plan for the next 10 years. **(Table 1)**.

2. ORGANIZATION STRUCTURE AT GNFC

At GNFC, operations of plants is under Executive Director (Operations), who is responsible for the operations, maintenance (mechanical, electrical, instrumentation and civil), materials management (purchase and stores) and logistics. Under him, there are 3 General Managers and operations and services is divided between them. Planning and procurement group headed by a Chief Manager directly reports to ED (0). This group looks after the procurement of spares and consumables, import substitution, codifications and inventory control.

Plant mechanical maintenance is divided into two groups each headed by Additional General Manager. One group looks after the high speed rotation equipment like compressors, turbines, generators etc. Mechanical maintenance of all other rotation/stationary equipments including central workshop and materials handling equipments, piping etc. is handled by second group. **(Table 2 A and B)**.

3. INSPECTION OF PLANT/EQUIPMENT

3.1 Condition based monitoring

Each important rotating equipment in the plant is monitored for the vibrations and checking the condition of the bearings at a regular interval. The frequency of vibration checking depends on the criticality of the equipment. The equipment is taken for maintenance as and when the condition is deteriorated beyond acceptable vibration limit fixed by the Inspection Group. For checking and analyzing the condition of the equipment, the Inspection Group has procured different types of vibration analyzers.

Wear measurement on parts like chains, grinding rollers, bull ring segments of the bowl mills etc. are being done on regular basis. By checking wear measurement on the chains, we are deciding on the replacement of the teeth on the spockets for the complete chain. Similarly, the replacement of the grinding rollers, bull ring segments is done on the wear measurement.

3.2. Inspection during shutdown

All important equipments should be checked during the shutdown. Complete list of the equipment to be checked in shutdown should be identified well in advance wherever required. The expert services like eddy current testing, ultrasonic testing should be organized. As the plant become older, more equipment must be taken for the inspection. The equipment should be selected for inspection based on their performance and criticality. The pro-inspection approach should be adopted where the plants are 8 to 10 years old, as the postponement of inspection may result into poor performance and unforeseen breakdowns.

3.3. Statutory requirement - period inspection

There should be periodical inspection as per the statutory requirement, government bodies, factory inspectorate requirement etc. We are carrying out periodic checking of material handling equipments, chain pulley blocks, slings and shackles as per the requirement. The testing of LPG bullets, hydraulic testing of ammonia unloading system, IBR inspection of boilers and waste heat boilers etc. is done periodically.

3.4. Materials of construction

With the operating experience of the plant, we find that the corrosion/erosion on some of the equipments/pressure vessels is much higher than the normal. This results in premature failures of parts and heavy expenditure on repeated replacement. We have replaced carbon steel tubes with stainless steel tubes in many of the heat exchangers in all the plants with very good results. The MOC for the ducting in ANP/CAN plants was carbon steel, which frequently cracks. Therefore, the complete ducting in both the plants is replaced with the stainless steel in a phased manner. We have also provided protective coatings on steam pipings in nitrophosphate group of plants as the CAN dust was passing through the insulation and affecting the piping material, where we have now applied anti corrosive tape. Anti-corrosive tape is also applied in the DM plant piping which was badly corroded due to the fumes of acid even after couple of years of service and is now absolutely corrosion-free. To prevent the leakages of underground pipings, cathodic protections are provided and they are regularly monitored by the Inspection Group.

3.5. Failure/vibration analysis and trend monitoring

Each abnormal or major failure is analyzed for the root cause and the corrective actions taken to prevent recurrence. One of the most important jobs of the Maintenance Managers is to carry out analyzis of the repeated problems. Any problem, which recurs for the second time, is analyzed in detail. Here the operation, mechanical and inspection team put their efforts together for corrective actions.

The trend monitoring in certain equipment like water wall tubes thicknesses or vibrations on pumps/compressors are recorded and reviewed from time to time and the corrective action taken based on the condition of the plant/equipment. Here the computer is used. Complete data is stored in the computer from time to time and reviewed as and when required.

4. BREAK-DOWN VERSUS PREVENTIVE MAINTENANCE

A lot of attention is being paid for carrying out preventing maintenance on equipment at a regular interval. During the continuous running of the plant, the performance of the equipment is monitored very closely by taking rounds in the plant and following the technique of L.L.F. (Look Listen and Feel). The Daily Round Reports are prepared jointly by maintenance technicians and operators and if there is any abnormality observed it is reported. The corrective actions are taken at the earliest opportunity. The preventive maintenance of equipment is planned based on the daily round reports and the condition based monitoring report **(Table 3 A and B)**.

If the breakdown is frequent in any plant, it is a direct indication of the poor maintenance. The maintenance personnel is advised to eliminate or reduce the frequency of the break-downs efficiently. The emphasis is to improve the quality of maintenance work. Systematic/scientific procedure is developed to ensure that the right job is done at the first time and there should not be any **repetition** of the maintenance work.

5. PLANT MAINTENANCE TECHNIQUES AN OVERVIEW

The performance of the chemical/petrochemical plant depends on excellent plant maintenance. The plant maintenance technicians should be aware and equipped with the latest development and techniques available in the field of maintenance. Techniques described below are very useful for improved plant performance. These techniques are being used by us on day-to-day basis for get best results.

5.1. On-line maintenance

5.1.A. Furmanite

Furmanite technique is used for on-line sealing of the leakage of steams, gases, hazardous chemicals etc. by injecting resins at high pressure. Special clamps may also be required before injecting the resins. We are using these techniques for arresting the leakages from the steam lines, boiler feed water system and other hazardous chemicals.

This is a very good technique to arrest the leakages in running plant. We have successfully used furmanite up to a maximum of around 2 m. diameter and pressure of 100 bar in case of steam service for the waste heat boiler in ammonia plant.

5.1.B. Boxes/clamps

We are extending the continuous running of the plant by providing boxes/clamps on pipings in the running plant. These are specially used for steam/gas leakages. The boxes are made in different shapes and sizes, which are assembled and welded in the running plant.

While providing the boxes needing welding, we have to ensure that the boxes are manufactured with proper thickness and welding procedure to match with the parent pipe.

5.1.C. Safety valves calibration

With the latest technique of **in situ calibration** and testing of valves by **Trevitest**, we are in a position to carry out the testing of safety valves in running plants. This plays a very important role when we are not in a position to remove the safety valves in running plant. We are using this technique for testing the safety valves for main boilers, waste heat boilers and also in the other plants.

5.2. Cold welding application

Many important repairs are done with the help of cold welding compound. The cold welding compounds give molecular bonding with the metals/alloys and they are substituted for conventional welding. The application and setting time for different grades of the compound is different. Compounds are available which can be set in five minutes. They are also used in the running plant or with a short shutdown. They are very useful in certain applications of the welding of cast-iron. They are generally suitable up to a temperature of 250°C and a pressure of 25 kg/cm^2.

We have carried out many important repairs in last 8 to 10 years, which have helped us in running of the plant on continuous basis. One of the 42" dia. air line in ammonia plant has simultaneously leaked at 30 places due to stress corrosion cracking and welding was impossible, but we have run the plant for 3 months by arresting leakages by cold welding applications. In urea plant crank, case of condensate injection pump has broken in 5 pieces and new spare was not available. We have run the plant for more than one year by repairing the damaged crank case with the help of cold welding.

5.3. In situ repair/maintenance

5.3.A. Machining by portable machines

In situ machining is required where the equipment or the job is too heavy and cannot be taken to central workshop, instead, the machine is taken to site for the repair work. Many equipments like Matra portable machines, Pipe Hawksaw cutting machine, Key way milling machine, machines for edge preparation on pipes and flanges, in situ machining and lapping of welded vales and **All Do Unit** etc. are available for machining the equipment or the parts of the machinery in plant. This helps in saving lot of valuable time and money for the transportation of these items to manufacturer's shop to central workshop.

With the increase in the number of plants, machining/maintenance facilities should be developed on continuous basis to meet the challenging maintenance requirement from time to time.

5.3.B. Repairs by grinding and welding

In situ repairs on large size equipment involving welding and grinding is organized as and when required. We are carrying out in situ repairs on the high pressure gasifiers, spiral wound, heat exchangers in ammonia plant, urea reactor and other pressure vessels in plant. The welding and grinding in hazardous areas required utmost care to avoid untowards incident during the repair work. Good co-ordination and involvement of the operation, mechanical, fire and safety, inspection and electrical people plays a very important role.

The repair of glass lined equipment is commonly carried out by providing Teflon nozzle/bushes or by providing tantalum plugs. On short term basis, we are also using special cold welding compounds. These are very specialized repair techniques and we have to take the help from the suppliers of the glass lined equipment. In absence of proper repair, we may have to replace the complete equipment which is generally very costly.

5.3.C. Balancing

We are carrying out in situ balancing of parts of the bowl mills, cooling tower fans and big size blowers, which is being extended for more and more equipment now. This helps in keeping the equipment available continuously for a long time, as very little time is required for in situ balancing.

6. ROLE OF CENTRAL WORKSHOP

Central workshop plays a very important role in repairing worn out/damaged parts, manufacturing of spares/equipment and making them available in emergency. We cannot depend only on getting the components from the equipment suppliers, as many a time deliveries are delayed or the parts are rejected once they are received. Therefore, the central workshop is fully equipped to meet the challenges posed by the plant from time to time.

The spare parts can be repaired by welding, rotatech, plasma spray, detonation cladding, crome plating or by roto-fusion process. The workshop should be equipped with the latest equipment for repairs. In case the central workshop cannot cope with the requirement of the plant, we have developed outside parties in the nearby region to meet the requirement.

Stelliting, ceramic coating, coating with tungsten carbide, boron carbide or chromium carbide are utilized to increase the life of the spare parts. FRP coating, Teflon coating and application of special paint like polyurethene paint are used to protect the equipment/piping and other engineering components and extend their life.

The equipment can be given lining of stainless steel, rubber or Teflon material depending upon the requirement. In case of repeated failures of the materials of the equipment/piping, we have to look out for a proper material of construction, which can extend the life and improve the reliability and plant performance.

7. SHUT-DOWN PLANNING/PLANNING FOR MAJOR REPAIRS

Each service group and the plant maintenance group is asked to plan for the shut-down well in advance. We plan a long shut-down of three weeks and a short shut-down of ten days every alternate year. The planning for the annual shut-down is started three months ahead of the shut-down. During this period, we prepare an exhaustive list of the jobs to be taken up during the shut-down. We also make an over all schedule for the shut-down. The over all schedule is prepared based on the important jobs to be taken up in different plants. There is comprehensive review on fortnightly basis to give the final shape to the schedule and to finalise the list of jobs to be done during the shut-down.

The planning of resources, men, material and the machinery is done well in advance. Each plant maintenance group is required to give the list of spare parts/other materials required during the shut-down. The consumables available in the stores are also reviewed for suitable action to replenish the stock outs. The manpower requirement of the individual group is worked out and given to the planning department. Any outside experts required including the guest house accommodation and the transport facilities is finalised. All concerned are communicated of the shut-down well in advance. Every effort is made to ensure the completion of the shut-down jobs ahead of the schedule irrespective of the increase in the quantum of work. Always a provision of 20% to 30% of the extra work load, not anticipated earlier is kept.

While planning for major repairs, it is necessary to organize the job on round the clock basis. The manpower requirement both temporary and permanent and supervisors are organized. Site meetings are organized near the job and the problems are sorted out on day-to-day basis. It is important that activity-wise schedule is prepared and circulated to all concerned. Good coordination from all concerned including operation, mechanical, inspection, electrical, fire and safety is a must.

In certain cases, the services of consultants, outside experts, designers, suppliers of equipment may be required, which is decided in advance.

8. SPARE PARTS MANAGEMENT

We have formed a separate group responsible for the procurement of all spare parts. They are also responsible for the inventory control. All procurement activities including import substitution, vendor development, qualifications of vendors, ensuring the availability of spares is looked after by this group. The development of drawings and procurement of parts indigenously has resulted into enormous saving for the company. We compare the running of our plant with a jumbo jet where the reliability of the spares is very important. We use good quality spares and consumables.

We have established a scrap utilization cell with our planning group, who is basically responsible to take regular rounds in the plant and make use of scrap materials like plates, pipings, structural materials etc. and reuse them wherever required.

We always go for three prong attack strategy to be adopted by the maintenance personnel. This includes arrangement of the parts through the planning department, manufacturing in our central workshop or directly organizing the plant personnel from local parties.

9. RATE CONTRACTS/SERVICE CONTRACTS

For ease of maintenance, we have finalised **rate contract** with outside parties. We have the **Annual Rate Contracts (ARC's)** for the piping work, structural work, insulation jobs, maintenance of bowl mills, FRP and HDPE work, rubber lining, opening and closing of equipment etc. Against these contracts, the manpower and the material is organized on short notice to take up the job as per the requirement of the plant. We have also entered into the **service contract** for various equipment like locomotives, bulldozers, terex loaders and other mobile equipment. Against the service contract, the experts from outside parties are visiting regularly and checking the performance of the machinery at regular intervals of time. Their expertise service is available on short notice.

The objectives for entering into the annual rate contract/service contrat is to keep minimum manpower on permanent role and also to reduce overtime. A proper feed back, in time, about the condition of the equipment from the specialist may prevent a major failure in future.

10. RELIABILITY BUILDING EFFORTS

10.1. Modifications/action plan/suggestions

During the regular meetings of the operation and service groups from time to time, the modifications and the action plans are prepared and reviewed. The list of modifications and action plans is available to all managers and the date for procurement of the material and the implementations are fixed in advance.

The **replacement of equipment** having poor performance is also reviewed during the meetings and the actions are taken for procurement and the replacement at suitable opportunity. The technical **suggestions** given by the employees are awarded suitably and encouraged by the management. The suggestions are implemented from time to time.

We pay maximum attention on reliability building efforts and have developed a **Five Year Up-Keen Plan** about the major work/replacement to be undertaken. Up-Keep Plan is reviewed and up-dated on regular basis.

10.2. Revamping, modernization and debottlenecking

We always make efforts to improve the capacity of the plant and discuss action to be taken during the regular meeting. The **modernization, revamping and debottlenecking** of the plants are discussed. Technical services group is asked to recommend suitable actions to implement the necessary changes to be done from time to time. At present, we are carrying out revamping of our ammonia plant and also the debottlenecking of our formic acid plant.

11. MANAGEMENT BY OBJECTIVES

To review the plant performance, we have regular plant meetings of senior officers which also includes the technical services, inspection and material management group, which are directly connected with the production. Here day-to-day, problems are discussed and decisions are taken.

Every year, some concept is put into the practice with thrust areas. Over the years, we have paid attention toward the following thrust areas:

Year	Concept	Thrust
1982-83	Management by objectives	Struggling for production
1983-84	MBO in pursuit of excellence	Break-down maintenance
1984-85	SIMBO (self imposed MBO) Management by walking around	Reliability building
1985-86	Management by survey	Relationship and team building
1986-87	Management by example	Performance monitoring
1987-88	Management by PRIME (planned reduction in maintenance expenditure) and PRICE (planned reduction in consumed energy)	Review of past/present/future
1988-89	Management by innovation Management by difference	Can do approach
1989-90	Management by WAR (working for astonishing results)	One up five year upkeen plan
1990-91	Management towards productivity improvement	Exercises to improve productivity of men, materials and machines
1992-93	All attention towards FOCUS (Fresh outlook and commitment for ultimate success)	
1993-94	Major thurst is on cost reduction	

12. PERFORMANCE MONITORING GROUP

The performance of all important equipment is monitored by a separate group called **Performance Monitoring Group (PMG)**, who also reviews the problems faced in different equipment during the running condition. They are also responsible for the **trip report** and the **failure reports** which are reviewed and discussed to improve the performance of the plant.

This group reviews specific consumption of major raw materials and utilities and also studies comparison with past data. Specific studies on the plant problems and recommendation is made by this group. System studies and modification are suggested by them. Each trip in plant is analyzed, studied in detail and recommendation is made in order to build up reliability to prevent similar trips in future. Over all shut-down schedule, lube oil audit, production plant, energy conservation record and insurance matters are also looked after by this group.

13. HAZARDOUS IDENTIFICATIONS AND RISK ANALYZIS

We have formed a committee of the operation, mechanical, electrical, instrumentation, inspection and fire and safety groups to take regular visits in each plant once in six months and to identify **hazards and risks** in plant. This group checks for the testing of safety valves, leakages in plant, if any, a record of the routine test like thickness measurement, chain pulley blocks testing, EOT cranes testing etc. The team identifies the deficiencies present in the plant and gives their recommendations. **Corrosion survey and house keeping** is also checked by this group.

14. ENERGY CONSERVATION

We pay a lot of attention on the leakage of products, steam etc. Leakages in the plants are kept to minimum by using on-line furmanite techniques, using boxes, clamps, making use of the cold welding compound, tightening of flanges in running plant etc. There is a regular **leak survey and insulation survey** to identify the energy losses and to attend them from time to time. We have a regular **energy audit** and compare the **specific consumption** with the actual consumption. The efforts are put to identify the areas where there are energy loss, which is kept to the minimum.

As a energy conservation effort, we have replaced aluminium/solid FRP blades with hollow FRP blades for cooling fans in our ammonia plant. This has resulted into more than 30% power saving. Wherever required, we are organizing trimming of impellors of pumps to suit the plant requirement.

We have completely revamped insulation of one of our main boilers where the energy loss was very high. In ANP/CAN plant, we have completely replaced the insulation with light resin bonded mineral wool. Due to rotation of drums, the insulation used to come out frequently but for last one year there is not problem. At present, we have taken up the job of insulation of 35 ammonia rail tankers owned by us. At present, they are uninsulated and energy loss is high.

15. TRAINING AND DEVELOPMENT

Any expenditure on **Training and Development** of people in an organization is an investment, which is returned with the interest. At least, once in 2 to 3 years, each person is sent for training in our organization and we keep a record and review from time to time. The senior officers are sent for **Training on Management Courses** and the junior officers on **technical/functional training**. We also send our people to other similar plants for exchange of information and to identify good practices followed in other plants. Based on the feed back from other plants, corrective action is taken by us.

This builds the confidence of the young officers and motivates them. We have a team of highly skilled motivated young people, who always wants to perform better. We have a system of **job rotation** of our people based on the aptitude of the individual, skill acquired and plant requirement. We develop **multi-craftsmanship** among the technicians and they can utilized in a better way.

16. COST CONSCIOUSNESS

We try to achieve maximum production and capacity utilization, but at what cost? All input expenditure is controlled at appropriate levels. Procurement proposals, modifications, action plants, debottlenecking, etc. is done based on sound judgement and detailed cost benefit study.

Many minor problems not attended in time may become major after sometime leading to stoppage of plant, replacement of parts and huge investment. We should look for **Zero Investment Improvement** by nipping the problems in the bud thereby saving large expenditure.

We make lot of investment every year on importing of spares and equipments but good effort is put on import substitution without sacrificing the technical requirement.

17. CONCLUSION

Plant performance is kept high by keeping the plant running most of the time at highest capacity without compromising on the operating parameters. We have developed the tools and tackles, which can be used for attending plant problems in running condition or carrying out in situ repairs in shortest possible time.

When the plant is in operation, the performance of each equipment is closely monitored. In each shut-down, maximum jobs are organized and postponement of the jobs is avoided.

Each major breakdown analyzed critically to look for the cause of the problem. The emphasis is to reduce the number of breakdowns rather than attending breakdowns efficiently. Daily round of the plants are taken regularly to check for the condition of the equipment.

At present, we are concentrating on establishing computer based maintenance network for the maintenance group in different plant which will be connected with centralized computer system planning, purchase and stores. We are also adding up new facilities like 100 T telescopic crane, balancing machine, hydraulic press of 250 MT & zirconium welding facilities to meet the changeling requirement of future.

TABLE 1 - GNFC AT A GLANCE

Sr.	Plant	Production Capacity	Year of Commissioning	Approx. Expend. (Rs. Million)
1.	Ammonia	445,500 MTPA }		4270
2.	Urea	595,000 MTPA	1981	(including off-sites/ utilities)
3.	Methanol-I	20,000 MTPA	1985	136
4.	Methanol-II	100,000 MTPA	1990	830
5.	Captive power	50 MW	25 MW 1987 } 25 MW 1989 }	632
6.	Butachlor	600 MTPA	1987	60
7.	Formic acid	5,000 MTPA	1989	135
8.	Nitrophosphate			
	Ammonium nitrophosphate	475 MT/D }		
	Calcium ammonium nitrate	475 MT/D }	1991	3250
	Concentrated nitric acid	100 MT/D }		
	Weak nitric acid	630 MT/D }		
9.	Electronics	PAX/PCB		125
10.	Acetic acid	50,000 MTPA	1995	2300
11.	TV glass shell	1.7 million coloured 0.25 million B & W		2500
12.	Aniline and TDI	20,000 MT - aniline } 10,000 MT - TDI }		3200

(Exchange rate: 1US$ = 31.3 rupees, June 1994)

TABLE 2 A ORGANIZATION STRUCTURE AT GNFC

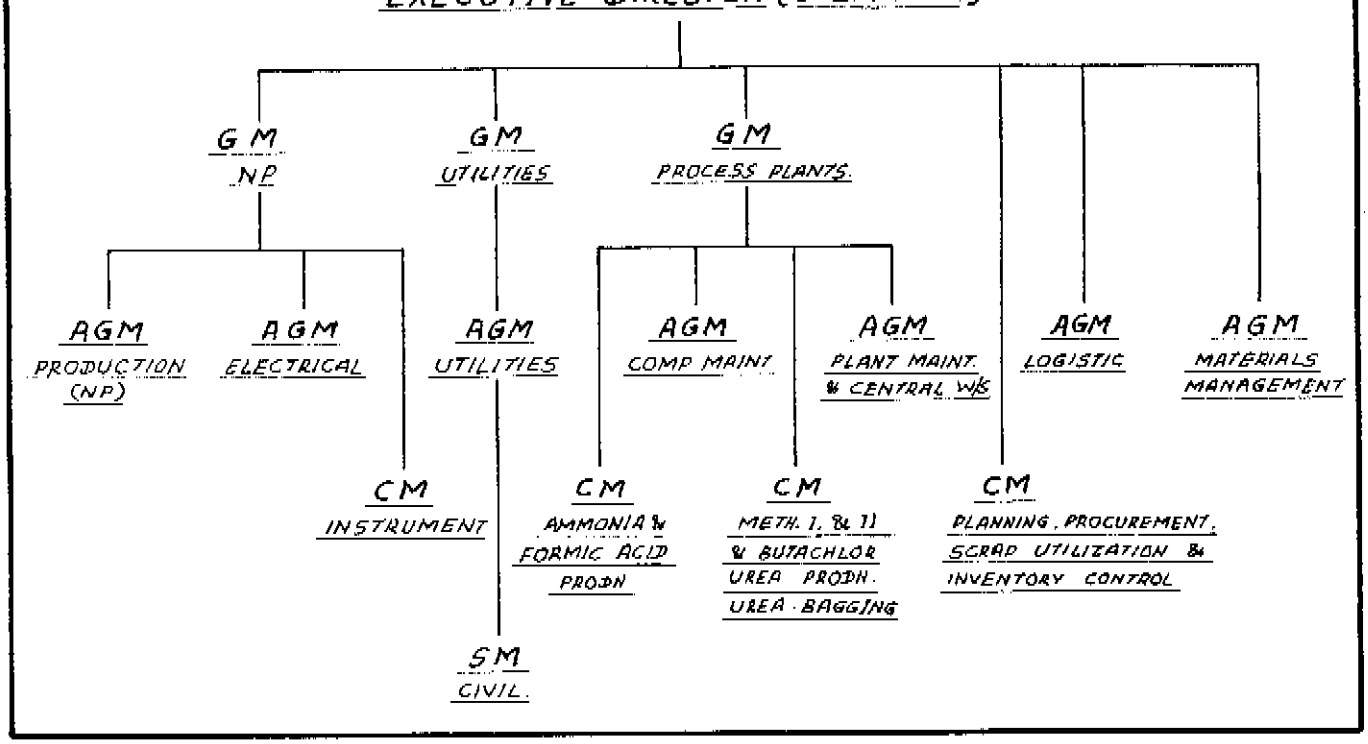

TABLE 2 B ORGANIZATION STRUCTURE AT GNFC

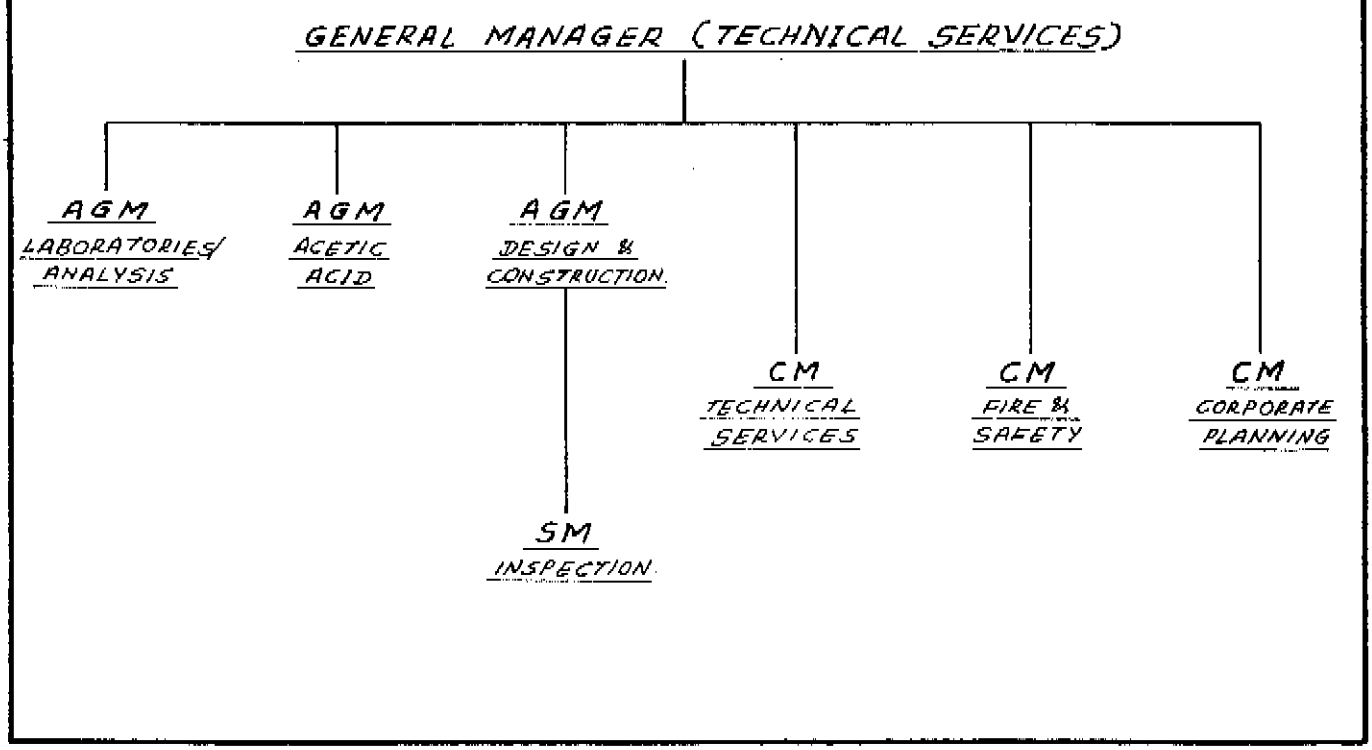

TABLE : 3 A - DAILY ROUND REPORT.

UREA BAGGING PLANT.

Date _____

Check points	ET-3 vibrofeeder FD-1/FD1R	Check Points	ET-4 Gearbox	ET-5 Gearbox.
- Travelling mechanism gearbox:		- Ampere - Gear box:	Hunting/Normal	Hunting/Normal
- Oil level	High/Low/OK	- Oil level	Low/High/OK	Low/High/OK
- Temperature	Hot/Not/OK	- Abnormal/Sound/ Vibration	Yes/Not	Yes/Not
- Abnormal sound/vibration	Yes/Not	- Temperature	Hot/Normal	Hot/Normal
- Its chain/sprocket cond.	OK/Allowable	- Gearbox coupling		
- Vibrating springs operation	Vibration Low/High/ Medium	- Coupling pin/sprocket chain condition	OK/Allowable	OK/Allowable
- Travelling wheels condition	OK/Allowable	- Head pulley condition		
		- Its bearing temp.	Hot/Normal	Hot/Normal
		- Grease cup level	Low/High/OK	Low/High/OK
		- Tail pulley condition		
		- Its bearing temp.	Hot/Normal	Hot/Normal
		- Grease cup level	Low/High/OK	Low/High/OK
		- Condition of belt		
		- Whether going off centre	Yes/Not	Yes/Not
		- Cond. of troughing roller	OK/Allowable	OK/Allowable
		- Cond. of impact roller rings.	OK/Allowable	OK/Allowable
		- Condition of return roller	OK/Allowable	OK/Allowable

Sign. of Mech. Engineer. Sign. of Technician. Sign. of Operator.

TABLE : 3 B - DAILY ROUND REPORT

CARBAMATE PUMPS - UREA PLANT

Date: _____

P-2 A/B

Check Points	P-2 A	P-2 B
- Ampere and if any hunting	No hunting/Slight/Very much	No hunting/Slight/Very much
- Torque convertor	OK/Low	OK/Low
- Oil level	OK/Low/High	OK/Low/High
- Temperature	OK/Low/High	OK/Low/High
- Oil pump pressure	OK/Low/High	OK/Low/High
- Main pump pressure	OK/Low/High	OK/Low/High
- Seal Oil:		
- Oil level	OK/Low/High	OK/Low/High
- Pressure 1,2,3	OK/Low/High	OK/Low/High
- Gearbox Oil level	OK/Low/High	OK/Low/High
- Cooler outlet oil temperature	OK/Low/High	OK/Low/High
- Crank case lubrication pressure	OK/Low	OK/Low
- Temperature	OK/Low	OK/Low
- Level	OK/Low/High	OK/Low/High
- Bearing temperature - Motor	OK/Hot	OK/Hot
- Torque covertor	OK/Hot	OK/Hot
- Gearbox	OK/Hot	OK/Hot
- Pump packing temperature	OK/Hot	OK/Hot
- Carbamate in condensate flushing coming to Sy.	C.R. side/Middle/Boiler side/None	C.R. side/Middle/Boiler side/None
- Condensate enjection pump		
(a) Oil level and quality (forming etc.)	OK/Requires changing	OK/Requires changing
(b) Gland leakage	Normal/Heavy	Normal/Heavy

Signature of Mech. Engineer Signature of Technician. Signature of Operator