

afa

الإتحاد العربي للأسمدة
Arab Intl. Organization
هيئة عربية دولية
Arab Fertilizers Association

Since 1975

BEST PRACTICES

An insight into the best manufacturing practices of
AFA AMMONIA AND UREA PLANTS

May 2011

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An insight into the best manufacturing practices
of AFA ammonia and urea plants

Message from **AFA Board of Directors**

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AFA Board is pleased to issue this booklet to all its members and would like to thank the AFA member plants who have participated in the 2007 AFA Ammonia and Urea Plants Benchmarking and Best Practice Study.

AFA Board and General Secretariat would also like to convey its thanks and appreciation to the AFA Technical Committee, which has endorsed this work and special thanks goes to Mr. Ahmed Nuruddin - GPIC General Manager Manufacturing who headed the special team in preparing and finalizing this valuable booklet.

Message from **AFA Technical Committee**

■ **Message from AFA Technical Committee**

Welcome to the booklet on Best Manufacturing Practices of the Arab Fertilizer Association (AFA) Ammonia and Urea plants. This is a compilation, highlighting the most important and critical practices that have been identified by the eleven participating AFA companies as their best practices during the benchmarking survey carried out by Plants Survey International Inc. for years 2007 and 2008.

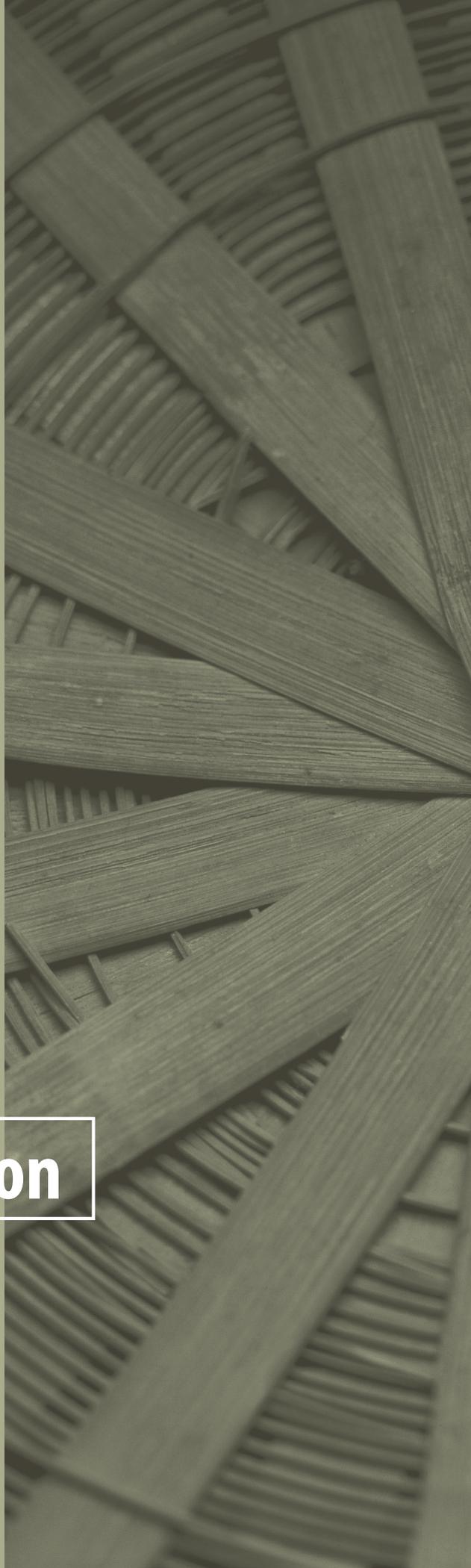
The goal is to have each organization benefit from a cross section of ideas and practices in order to further enhance business performance at their facilities.

We trust that by sharing the Best Practices, the AFA companies will attain further heights in Safety, Reliability, Environmental Care and Productivity.

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Introduction



Introduction..

One of the objectives of the Arab Fertilizer Association-AFA, ammonia and urea plant benchmarking project is to identify “best manufacturing practices” of business and work flow procedures utilized by the eleven participating companies at their manufacturing sites. The intent is to arrive at a common, and where applicable “Best Manufacturing Practices”, in order for all parties to benefit and improve all phases of their process. The idea is not to list entire best practices but to highlight the most important and common ones that are considered key to effective management of processes.

The areas covered under this compilation of best manufacturing practices are:

- Manufacturing excellence and management best practices
- Human resource management best practices
- Asset management and maintenance best practices
- Environmental, health and safety management best practices

Before presenting the best manufacturing practices as reported by the participating companies, we would like to touch briefly on the subject of best practices.

What is best practice?

Best practice is a process, technique or innovative use of resources that has a proven record of success in providing significant improvement in cost, production process, quality, performance, safety, environment or other measurable factors that impact the health of an organization.

Best practice through benchmarking

Applying best practice means learning from and through the experience of others. One way of doing this is through benchmarking, which allows one to compare their business practices with other successful businesses to highlight areas where improvement could be achieved.

Best practice through standards

Standards are fixed specifications or benchmarks, which are established by independent bodies such as the British Standards Institution (BSI). BSI develops both technical and management standards. Technical standards are precise specifications against which a business enterprise can measure the quality of its product, service or processes. Management standards are models for achieving best business and organizational practice.

Applying the appropriate standards to business will enable the enterprise to apply best practice across the organization, and to work against objective criteria to achieve manufacturing or service quality.

What are the benefits to my business?

A best practice strategy can help a business enterprise to:

- become more competitive
- increase sales and develop new markets
- reduce costs and become more efficient
- improve the skills of workforce
- use technology more effectively
- reduce waste and improve quality
- respond more quickly to innovations in the sector
- Reduce emissions and improve HSE performance

Manufacturing Management Systems



Manufacturing Management Systems



Manufacturing Management Systems

Best Practices come in many forms. Some are high profile, dramatic and large scale. Others, such as those used by leading fertilizer industries, tend to be more pragmatic than experimental and are implemented one small step at a time.

Objectives and Targets

Companies set corporate objectives based on their Vision and Mission and individual departments develop their own from corporate objectives. Management programs are prepared reflecting these objectives. KPIs are established and targets set for tracking level of performance. The performance is measured and reviewed at regular intervals through management review meetings held at section, department and company levels.

- Objectives and targets are set collectively by the management group.
- Yearly objectives set by management groups that include Operations, Maintenance and Marketing Managers, are communicated across the organisation well before the beginning of the year.
- Strategic or budget plans are set by the management committee at the beginning of the year. Thereafter each departmental action plan is set for follow up.
- Periodic review of performance, the objectives and targets and alignment to the track are carried out by the management team.

- KPIs for each part of the business are set collectively and monitored on a monthly basis. Additionally, pending KPIs of key selected fields in each section are updated by those concerned and communicated to management on a periodic basis.

Budgets:

A yearly, strategic or budget plan are set by the management committee and once approved by the board of directors is put in place for departmental action plan, implementation and follow up.

Effective practices on Budgets

Budget proposals are user driven and are based on Departmental/Division objectives and targets which are aligned to fulfill the overall company Objectives.

After the approval from the board of directors, the budget provided for use in the manufacturing divisions is set for:

Capital Expenditures (CAPEX)

This is a budget prepared to plan and control spending on certain capital projects in the coming year(s).

Operating Expenses (OPEX)

This is what is needed to spend in order to keep the business running and is deducted from revenue to get the operating profit.

Annual budgets for capital expenditure (CAPEX) and operating expenses (OPEX) are requested by each department, reviewed by the management group committee and approved by the board of directors.

Strategic Plans for long term outlook

Five Year Production Plan

The five year production plan is part of the strategic planning and proactive approach that helps any company in producing quality products as per the schedule in a safe and environmentally friendly manner. This plan is prepared to complement the long term turnaround plan and the long term CAPEX (Capital expenditure) plan. The plan gives the forecast of cash flow to the company and accordingly allows the management to plan its future business, such as upgrading existing systems and expansion. This plan also provides the basis for long term marketing strategy and exploring new avenues for marketing.

Five Years Capex Project Rolling Plan

A five years Capex project rolling plan (CPRP) is prepared to list capex projects for the next five years. This plan has the following benefits:

1. It ensures that capital expenditure projects are planned well in advance.
2. It provides sufficient time to evaluate each proposal and prepare an adequate cost estimate for projects.
3. It ensures that important projects are not missed.

The following factors are considered while preparing the subject plan

- 10 years rolling turnaround plan.
- Obsolescence of equipment (including spare parts or services).
- Plant safety, reliability and efficiency.

This list includes catalyst, mechanical, instrument and electrical capital projects.

Rolling Ten Years Turnaround Plan

Member companies recognize the need for a long term perspective in terms of turnaround planning, hence a document " Rolling ten years turnaround plan" is prepared and updated after every turnaround and is required to:

- Optimize the work load and planned outage for each of the next five turnarounds.
- Determine equipment replacement schedules for each of those turnarounds and give input for project capex items.
- Ensure uninterrupted production by eliminating potential problems.

Tools and systems used to track inventories, maintenance, costs etc:

Many of the member companies use advanced technology and tools related to asset management and other business processes. While some are using an in-plant designed system others are preparing to establish ERP solutions such as SAP. Computerized Maintenance Management systems (CMMS) such as MAXIMO, SAP, ORACLE are used by most of the organizations to communicate between operations and other departments for maintenance, procurement, inventory control, preventive and corrective maintenance, data history etc.

Communication

Generally the member companies feel the communication within the company and with other stake holders is direct and effective.

Best practices of member companies in this regard are:

- **Meetings**, being one of the most effective and direct means of communication, are used by all the companies.

- **A Daily operations morning meeting** is held in the main control room, chaired by the plants operation manager and attended by senior employees within the technical departments including managers and superintendents. As it is a cross discipline meeting, all major issues are discussed and decisions taken. Minutes of the meeting capturing key issues, are posted on the company's internal network for effective follow-up.

- **Shift talks** are held regularly, at least once a week between operators and shift supervisors on topics related to technical, safety, health and environment, process incidents and lessons learned are also discussed in addition to other miscellaneous subjects.

- **Departmental management review meetings and staff meetings** provides an interface for effective communication between the management and the employees.

- **Other forums** for quick and effective dissemination of information such as E-mails, memos and company intranet are widely used.

- **Regular reporting** in the form of formal reports by each section on periodic basis is another effective form of communication used by AFA companies. The reports reside on the company's intranet system and can be viewed at any time.

- **Log books in electronic and manual form** are used to record the plant conditions, major proceedings and issues at

operator, supervisor and senior supervisor level. The e-log books are remotely accessible to plants superintendents and managers, even during silent hours, and keep them updated on plant conditions even whilst off duty.

- **Some companies are using video conferencing** between plant and Head Quarter and find it quite effective with regard to time and resource management, and prevention of avoidable travels.

- **The AFA companies have well set coordination procedures** to interface with other divisions of the company. The interface is based on flat organization structure.

- **The operations supervisors communicate with the** maintenance department daily to review problem areas.

- **All outside communications** are taken care of by the external relations manager, public relations manager or shared services.

- **Communication through organizational networks**, including built in systems such as lotus notes and cutting edge systems related to ERP and CMMS such as SAP, is used very effectively.

Management Quality Systems

Management standards are models for achieving best business and organizational practice.

Applying the appropriate standards to the business will enable the company to apply best practice across the organization and to work against objective criteria to achieve manufacturing or service quality.

Keeping this in view, most of the AFA member companies are certified to appropriate management system standards such as ISO 9001, ISO14001, ISO 27001, OHSAS 18001, RC 14001 and implementation of PSM, six sigma and ERM.

Recently, some companies have integrated their management systems under PAS 99, a publicly available standard. It draws together the common requirements in management systems standards/specifications. It can integrate ISO9001, ISO14001 and OHSAS 18001 or other systems.

The effectiveness of management systems is gauged through periodic audits, both internal and external.

International accreditations being followed by AFA companies:

ISO 9001:2000

The ISO9001:2001 management system certification proves that the company is working diligently to establish quality and performance objectives.

The ISO9001:2001 norm contains a commitment to continual improvement and a process-oriented approach. The overall aim is to achieve customer satisfaction through consistent products and services.

ISO14001:2004

Outlining the requirements for an environmental management system, a certification according to ISO 14001 covers all the environmental activities of the organization, helping to minimize the negative effects on the environment and to comply with applicable laws and regulations.

OHSAS 18001:2007

Compatible with the ISO 9001:2000

and ISO 14001:2004 standards, BS OHSAS18001:2007 stands for an implemented occupational health and safety management system. The certification helps to identify hazards and to evaluate and control risks. Furthermore, lost work days and accidents are reduced, while recognition by insurers and employee satisfaction are improved.

RC 14001

Responsible Care is a cutting edge voluntary initiative of the global chemical industry to achieve excellence and beyond in Safety, security, environment and health management.

Businesses in the chemical industries can use RC14001 to implement a single environmental, health and safety management system that meets best practices, encourages stronger performance and provides a route to business success. Responsible Care® is a valuable tool to demonstrate to customers and stakeholders that a company is committed to corporate and social responsibility.

ISO 27001

Specifies the requirements for establishing, implementing, operating, monitoring, reviewing, maintaining and improving a documented Information Security Management System within the context of the organization's overall business risks. ISO 27001 is designed to ensure the selection of adequate and proportionate security controls that protect information assets and give confidence to stakeholders.

PAS 99

PAS is publicly available standard which specifies common management system requirements. It is intended to be used

as a framework to integrate two or more management systems as it draws together the common requirements in management systems standards/ specifications. It can integrate ISO 9001 with ISO 14001 and OHSAS 18001 or other systems.

ERM

Enterprise Risk Management (ERM) is being used by the AFA companies. The purpose is to add to the existing system and to install a mechanism to identify key events and circumstances that have the potential to threaten achievement of the mission and strategic objectives at the organizational level and devise a formal framework to monitor and manage risks

Quality Improvement Programs (QIP)

In general, all the AFA companies have a formal management quality improvement program (QIP) and a profit improvement program (PIP) and comprehensively cover all aspects related to process improvements, cost reductions, quality etc.

Salient best practices in this segment are:

Methodology

- A suggestion improvement program (SIP) with active participation from all employees is a comprehensive program that covers improvements related to quality, productivity, environment, health and safety, cost reduction and others. It gives an equal opportunity to all employees to unleash their creativity and innovative skills.
- The suggestions are evaluated by the relevant committee and approved suggestions are prioritized and implemented. If they fall under Manage-

ment of Change (MOC), a Request for Change (RFC) is initiated. The best suggestions are rewarded on monthly and yearly basis.

- The QIP is a very structured program where employees can freely raise suggestions without requesting for approval from the immediate superiors through the online system built on the Lotus Notes platform.
- The QIP and PIP incorporates cost saving programs in addition to increasing revenue via production increases and better sales management. These Programmes deal with all sorts of initiatives in operation, maintenance, marketing, export, etc. In fact almost everywhere in the company.
- For EHS & Quality management systems, ideas are generated at the customer's requirement/ Environmental aspects/ Health and Safety hazards identification. In addition, ideas are generated via external and internal audits. Six Sigma brainstorming sessions for ideas are held and management evaluates and ranks those ideas based on set criteria.

Interface of R&D, Operations & Engineering to implement technical and / or process improvements

- Most of the AFA companies are manufacturing units and hence do not have an independent R & D section. Instead, technical services or the engineering section are responsible to interface with operations with respect to technical studies and process improvements.
- The technical services department is equipped with specialists from each discipline. Once a request for change (RFC) is initiated by operations or any other concerned section (MOC form is-

sued electronically,) it is studied by the engineering section for implementation. All changes in plants and its facilities shall go through MOC process.

Monitoring and Rewards

- Management support is strong and monitored for results and action. Progress is monitored quarterly by the SIP committee. Rewards, gifts or acknowledgements are generally given monthly. Best suggestion of the month and best suggestion of the year awards are given
- In some companies employees performances are measured and monitored through well established Employees Performance Appraisal System (EPAS) and is reviewed annually and rewards are linked to the performance.
- Six sigma master black belts are available to coach potential green belt project leaders where progress is presented to top management on a monthly and quarterly basis.
- Project leaders are rewarded based on their project success, by up to three basic salaries. HSE&Q management system internal auditors are rewarded on their performance as well.

Tracking and auditing

Tracking and auditing the programs is critical to ensure compliance to systems and standards

- Effective action tracking significantly increases the effectiveness of the quality programs to keep things rolling.
- Effective auditing with effective corrective action process (where a planning phase is checked by experts prior to implementation, tools for identifying root causes are provided to owners, etc) shall ensure the requirement of continual improvement of programs.
- It is a best practice that companies have no shortage of funds for implementation of projects enhancing plant reliability, improving plant operation and safety.



Human Resources Management Systems



Human Resources Management

Talent management challenge

Giving talent management a very high priority, supported with appropriate tools and resources at every stage of the talent management is the need of every successful industry

AFA member companies have numerous best practices in this regard:

• Recruitment

Recruit the right people – that is people who fit their jobs and have the right attitude, skills and knowledge

AFA companies are equal opportunity employers and provide equal employment opportunity for all applicants for vacancies, subject to applicable rules and regulations.

Priority in recruitment is to the locals of that country and in case of non-availability of suitable candidates the company recruits from overseas.

The standard practice adopted by the companies in recruitment is to do a talent search in house first followed by locally within the country and then externally outside the country.

The shortlisted candidates have to undergo written tests, followed by interviews with the relevant management team.

Training and development

Develop employees with the goal of (1) bringing out their highest contributions and (2) keeping them on the leading edge of performance.

A typical training and development programme used by the member companies for their technical staff is competency based and not time bound. A Trainee employee will be inducted into regular job only after ascertaining his competency for the role through rigorous tests and evaluations. However the following time span is allowed for training:

- New Operator (24 months): 4 months classroom training program followed by 20 months of on the job training. Operator trainees undergo rotation in all sections of the plants. After gaining experience and confidence, they assume the role of field operators in different sections for rest of the 20 months. Upon satisfactory completion of the two year training program, the operator is confirmed as a unit operator.
- For a direct operator, after the orientation program of the company, (typically three days,) he is inducted to the respective department and On-the-Job-Training (OJT) is allocated in that section or unit.
- Maintenance Technicians (24 months): 6 months basic and 18 months OJT. Frequent maintenance workshops are conducted on skilled jobs.
- There is a personal development plan for each employee which is reviewed yearly.
- Experienced operators are cross trained in other units to make them more flexible in utility. A yearly cross training program for operators is available.

EHS related training

• Internal Programmes

A plan is made annually to train a specific percentage of employees in each department or division, so that all personnel are trained in a determined period of time and as planned for.

An annual report is made for review by top management with the requirement of a response by department heads. This is used as a performance measurement for each department.

• External Programs

The EHS department (in coordination with training department) selects EHS training sessions, (general and specific) ones, and determines jobs and occupations and levels of personnel who should attend. Accordingly, annual external training programmes are established and distributed to all departments concerned to nominate individuals who should attend.

An annual report is made indicating the success of these programmes including department's commitment to plan progress.

• New Employees Training

When a new employee is employed a training programme is established for him by the EHS department within the first week of employment.

The programme includes all rules, company policy, practices, safety information, the emergency plan, and the duties of every person in case of an emergency. Practical training in the basics of fire fighting

and how to use fire extinguishers is also conducted.

Specific Training Programs

After orientation training programme completion for an employee, and the assignment to his job, a training program relative to his work is given to him with the hazards associated, such as welding and cutting operations, radiography, sampling, tank cleaning, manned entry to confined spaces, storage of chemicals and gas cylinders, hazardous waste disposal, issue of work permits, gas detection and emergency plans, risk assessment, HAZOP, ... etc.

Competency Based Training (CBT)

CBT recognizes that individuals learn new information and skills at different rates and that they can acquire these in different ways. Competencies are defined levels of skills and knowledge. CBT differs from the traditional approach to learning in that it focuses on skill development relative to the need of industry. Each employee is given a competency map of his knowledge and skills, the competencies are checked bi-annually according to the PMS- Performance Management System and training programs are needs-based and provided accordingly.

Employee turnover

Most of the AFA member companies feel that employee turnover is not a significant issue for them because they have developed themselves as CARING EMPLOYERS by implementing several best practices, including retaining employees by providing them a suitable work atmosphere, caring for their

families, providing employees opportunities for further development and growth and by recognizing and rewarding their contributions.

Moreover most companies have 1-2 extra operators per shift in training to address the turnover issue.

Succession Planning

Companies need to define their long term human capital needs by using business goals for the next five to ten years as a guide.

In line with this industrial best practice, AFA member companies have succession planning of some type for supervision and management. There is an established succession plan and maintenance programme for supervision and management and a mentoring program for key employees. Mentoring role is played by heads of departments, superintendents and supervisors for their juniors.

Performance Management System

Employee performance measurement and evaluation is carried out by all employers in one way or another. Over the years the performance appraisal system has evolved into an objectives and targets oriented performance monitoring system. Best practices in this regard are:

- **The Performance Management System (PMS)** is used by AFA companies to comprehensively evaluate the performance of an employee throughout the year. This system provides the employee with regular feedback about his performance. The employer reaches agreement with the individual in setting targets and

objectives at the beginning of the year. These are tracked during biannual performance reviews. The PMS system is supported by SAP HR module.

- Some companies are using the Employee Performance and Incentive Compensation (EPIC) system for employee performance measurements and rewards.

Management System Style

Most of the AFA companies enjoy a management system that is a good mix of top-down/ bottom-up with good participation across the groups.

Asset Management Systems





Asset Management

Maintenance Management Practices

Effective Maintenance Organization:

- Generally all the AFA companies have a typical maintenance line organization headed by the maintenance manager. There are section heads and supervisors in various disciplines, supported by technicians.

Maintenance interface with operations and engineering

- An automated Work Flow process built in a CMMS (SAP, Maximo, etc) provides the interface between operations and Maintenance. It starts with a Work request for asset maintenance by Operations. The Work Flow covers all the aspects of life cycle of asset's maintenance including work authorization, planning and execution.
- Work execution is controlled by Work Permit system. Emergencies are directly handled and regularized afterwards in the CMMS for asset's history.
- Engineering modifications RFCs are raised by the requester and implementation is planned by maintenance planning.

Request for change (RFC) is a procedure to interface with engineering in regard to process changes, material of construction changes, equipment changes etc.

The procedure is initiated with an engineering request (request for change) submitted by operations and mainte-

nance departments for any changes in the plants, whether minor or major.

Engineering has an established procedure for addressing the changes under Management of Change procedure, including any changes in material of construction and process expansions. Major changes are discussed by the technical team and necessary approvals are obtained from the management. All changes undergo HAZOP review and approval prior to implementation.

- Trade-wise field engineers are responsible for the maintenance coordination with operations on daily basis.
- Design requirements are identified jointly and the maintenance/ operation departments work with projects to implement the changes.
- Emergency jobs are handled by a dedicated group comprising of maintenance personnel who are nominated on a weekly basis.

Maintenance Planning

Any maintenance job that is required by operations, maintenance and engineering is normally categorized into three types:

- Routine or preventative maintenance which is generally considered to include both condition-monitoring and life-extending tasks are scheduled at regular intervals and are intended to prevent failures or to detect incipient failures.
- Corrective maintenance is any maintenance activity which is required to cor-

rect a failure that has occurred or is in the process of occurring. This activity may consist of repair, restoration or replacement of components. Job priorities are fixed by the requestor against a criterion predefined in maintenance planning procedures. A weekly meeting is conducted by the maintenance planning supervisor and plant operations to discuss all day-to-day activities and plan next week's jobs.

- Turnaround maintenance is a major feature in the process. It is carefully planned and systematically implemented. It is considered the most effective way of preventing breakdowns. This can only be done when the unit is completely taken out of service.

Strategy

Turnaround strategy runs on a two year cycle based on two main factors. These are the statutory inspection requirement pre defined by inspection section and the preventative maintenance of the main machines normally, two or four years.

10 Years Rolling Turnaround Plan

Normally, turnarounds are planned every 2-3 years, depending on the condition of the plants. To optimize the workload and the duration of plant outages at each turnaround, to determine equipment replacement schedule and effectively enforce periodic overhauling of items covered under preventive maintenance is of a great importance. Therefore the need for long term planning of turnarounds (10 years) is essential.

Normally, in manufacturing companies, the level of manpower in maintenance necessitates that additional contractors are used during turnarounds. The job is divided into three categories: manpower supply for TA work, lump sum jobs and vendors for work execution.

Life assessment and integrity compliance programs

Most of the AFA companies do not have a formal program of equipment life assessment. However, they have other practices that ensure equipment integrity and reliability.

- Monitoring is done through Enterprise Asset Management (EAM) through which preventive maintenance is done and conditions monitored.
- A risk based program for life assessment and integrity compliance is followed.
- Periodic inspections are conducted on safety critical equipment and the remaining life assessment is made based on these inspection findings. At times, OEM / Licensor assistance is sought in estimating the remaining life for critical equipments.
- Maintenance is scheduled in the CMMS (Maximo, SAP, etc) system on a weekly basis and reviewed daily by the plant maintenance coordinator and maintenance planning engineer. Priorities are set by the reliability engineer in the CMMS (Maximo, SAP, etc) system based on an equipment criticality hierarchy. Reliability based inspection software (RBI) is used for inspection programs.

Reliability, Preventative maintenance and Inspection Programs

All the AFA companies consider reliability as the key to operational continuity and profitability and have effective organization and programmes in this regard.

- Reliability and Plant Support(R&PS)Departments have different sections: Inspection, Process, Reliability and Plant support, which provide support to running plants in the improvement of equipment and plant reliability.
- All preventive maintenance and inspection programmes are managed thru CMMS (Maximo, SAP, etc). The maintenance planning section is responsible for preventive maintenance programme whereas inspection programmes are managed by the inspection team.
- The reliability or the inspection section works on the methodologies of: RCM, RBI, RIS and RCA. Under these methodologies, operating equipment and systems are studied using reliability software by a team consisting of cross functional members led by a reliability engineer. Recommendations, insured spares, enhancement and reliability improvement projects are identified for the improvement of equipment and plant reliability. For deciding the PM plan RCM methodology is used. For inspection frequency and the scope of critical equipment, RBI is used. For improving reliability and safety integrity level of instruments in the plant, RIS is used. RCA is used for any plant incident by the team, appointed by management and its recommendations are tracked on a continuous basis.

Miscellaneous Routine Maintenance:

Best practices

- An effective preventative maintenance program is in place, covering all sections of maintenance. However, drive is more towards predictive maintenance.
- Vibration monitoring of rotating equipments follow a strategy wherein equipments with stand bys are monitored with portable hand held data collectors fortnightly (or on demand) and critical equipments with no stand by are monitored on-line round the clock (24 x 7 basis) with advanced tools like System1, etc.

Performance evaluation of rotating equipments is carried out quarterly or on need basis.

The drive is towards more:

- Critical joints are identified and listed. Special attention is given to these flanges during tightening.
- A productive maintenance concept is in place to allow operators to carry out minor maintenance activities.
- Condition monitoring includes lube oil systems that are checked regularly with oil analysis both in- house and at outside labs.
- In- house manufacturing of spare parts. The high cost of spare parts, the time required for replenishment and procurement and the lead time for availability are contributing factors in higher production costs and the risk on plant reliability and equipment availability. In- house manufacturing of spare parts is visualized as an alternative means to reduce these impacts.

Maintenance turnarounds

‘Giving much care to turnarounds, which are done on regular basis, minimizes downtime as much as possible’

- In general all the AFA companies have well- established turnaround procedures, plans and strategy in place
- Plant turnarounds are generally on a 2-3 year interval
- There is an opportunity shutdown (OSD) plan and a turnaround plan. Turnaround management procedures address three types (priorities) of turnaround jobs/ activities:
 - Planned turnaround
 - Opportunity shutdown
 - unit/ equipment shutdown

Opportunity shutdown jobs are meant to be attended whenever an opportunity arises. Besides this there is a formal 5 and 10 year rolling turnaround plan for carrying out major maintenance jobs to ensure sustained reliability.

- The turnaround activities are evaluated at each emergency shutdown to select the jobs that may be carried out during the emergency plan.
- All unforeseen plant shutdown opportunities are utilized to attend to all the pending jobs which can be completed in that period.

Miscellaneous turnaround- related best practices by AFA companies

- To have a turnaround that is safe, on time and within budget requires me-

ticulous planning and comprehensive preparation and management of AFA companies have, over the years, developed numerous best practices.

- Pre-turnaround main rotating machines critical spare parts physical inspection and clearance checks.
- Third party inspection: Quality controllers for rotating and stationary equipment.
- Critical joints tightening: Dedicated team with specialist supervisor. Vendors recommendation tracking system.
- Blinds control and management.
- Detailed Risk assessments.
- Certified scaffolders and riggers.
- Established procedure for manpower trade tests.
- Review of all integrated management procedures prior to turnaround.
- Awareness presentation by maintenance superintendents prior to turnaround.
- Early appointment of area leaders.
- Presentations by maintenance area leaders to operations, inspection, and other technical sections.
- Workshops, arranging technical meetings with contractors.
- Early arrangement of visas for contractors and vendors.

- Turnkey project management and supervision by In- house maintenance area leaders.
- Contingency maintenance team to take care of unforeseen issues.
- Early mobilization of resources.
- Detailed preparation and planning for critical path jobs.
- Acoustic valve leak test.
- Computerized relay testing unit for the calibration of protection relays.
- Modern electrical testing techniques: Thermography/ Motor Circuit Evaluator.
- Effective use of Pre- start up safety reviews (PSSR) of significant modifications and new installations.
- Identification of Turnaround HSE Challenges and implementation of Turnaround HSE Assurance Plan
Comprehensive Permit to Work audits during the turnaround.
- Safety audits during the preparatory phase and implementation phase of turnaround.
- Periodic audits at all stages of turnaround, planning, preparatory, implementation and post- turnaround phase.
- Mechanisms to capture all process- related incidents in addition to general safety incidents. These are used as lessons learned across the company.

- A Custom built turnaround web site absorbs all turnaround related documents, reports and presentation.

Manpower for turnarounds:

As a rule, the level of manpower in maintenance necessitates that additional contractors are used. The job is divided into two categories: manpower supply for turnaround work and lump sum jobs for work execution. General shutdown jobs and maintenance activities on most of the equipment are handled by manpower contracts working under company supervision. Critical jobs and projects (replacements, refurbishments, etc) are carried out as lump sum contracts.

- During a turnaround, services of Original Equipment Manufacturer (OEM) and other skilled contract agencies are sought.
- In a turnaround, all of the static and rotating equipment overhauling jobs are awarded on LSTK basis to outside vendors under the supervision of company engineers. There are many minor modification jobs or additional jobs raised after LSTK PO placement. These jobs, along with PM schedules, are handled internally during a turnaround.
- For a turnaround, manpower is contracted from outside—after offering tenders / bids. For special work internal manpower is used. Contractors for a turnaround are selected based on technical and commercial evaluations. For specific tasks, OEM's supervisors are called for assistance.

What companies do to minimize outages and maximize the on-stream factor?

- To minimize the outages of the equipment and improve reliability, RCM, RBI and RIS methodologies are implemented each failure case (specially repeated ones) is investigated in depth and root cause findings are carried out and recommendations are implemented after proper study and with consultation of OEM. All modifications are routed through the MOC system.
- Instrumentation and controls reliability enhancement is implemented to eliminate spurious shutdowns. The implementation of voting trip logic systems ensures minimizing of spurious trips.
- Effective preventative and predictive maintenance are carried out through a developed periodic maintenance program.
- Giving much care to turnarounds, which are done on a regular basis (every two years), minimizes downtime as much as possible.
- Guarantee and maintain the sources of raw materials like chemicals, spares, maximizing natural gas and electrical grid reliability.
- In-house power generation, in addition to power supply from national grid.
- AFA companies focus on continual investment on reliability and safety related items including replacement of major equipment in a phased manner. This strategy is considered as one of the keys to operational continuity and reliable operation of plants.
- For any design or material improvement, licensor's opinion is sought and changes are implemented thru MOC study.
- Equipment / piping which requires repair or replacement during TA are planned ahead providing a lead time for procurement activities.
- All critical equipment are ordered on OEM supplier. If OEM supplier is not available, alternate supplier is selected in consultation with Licensor.
- Manufacturing drawings, procedures are reviewed and approved
- A reputed independent third party inspection company is appointed to control the quality of the activities during manufacturing the equipment. Company representative attends kick off meeting and witness critical milestone inspection.
- For equipment/ piping which requires heavy rigging at site for installation, a task force team is formed and prepare the scope of work in co-ordination with local contractors. After P.O. placement, a method statement developed by contractor is reviewed by concerned department for safe execution of the job.
- Job safety analysis by in-house team for critical activities is carried out.
- PSVs are handled in a wooden box / cage in an upright position during fixing and removal.
- Action for procurement of new PSV is initiated for obsolete items.

PSVs with overdue for calibration is routed through deferment procedure.

- Lifting equipment and tools are inspected and certified by a third party inspection agency.
- Utility hoses and hydraulic hoses connected to the equipment are inspected periodically.
- Incoming material are inspected on receipt at warehouse to confirm that it meets the Purchase order / specification requirements.
- For aged plants, Plant integrity study is required to identify the high risk / consequence items in the plant. Accordingly action taken.
- Radiation survey monitoring for the radioactive isotopes installed in process lines, redundant isotopes in pits and alloy analyzer equipment are done periodically.

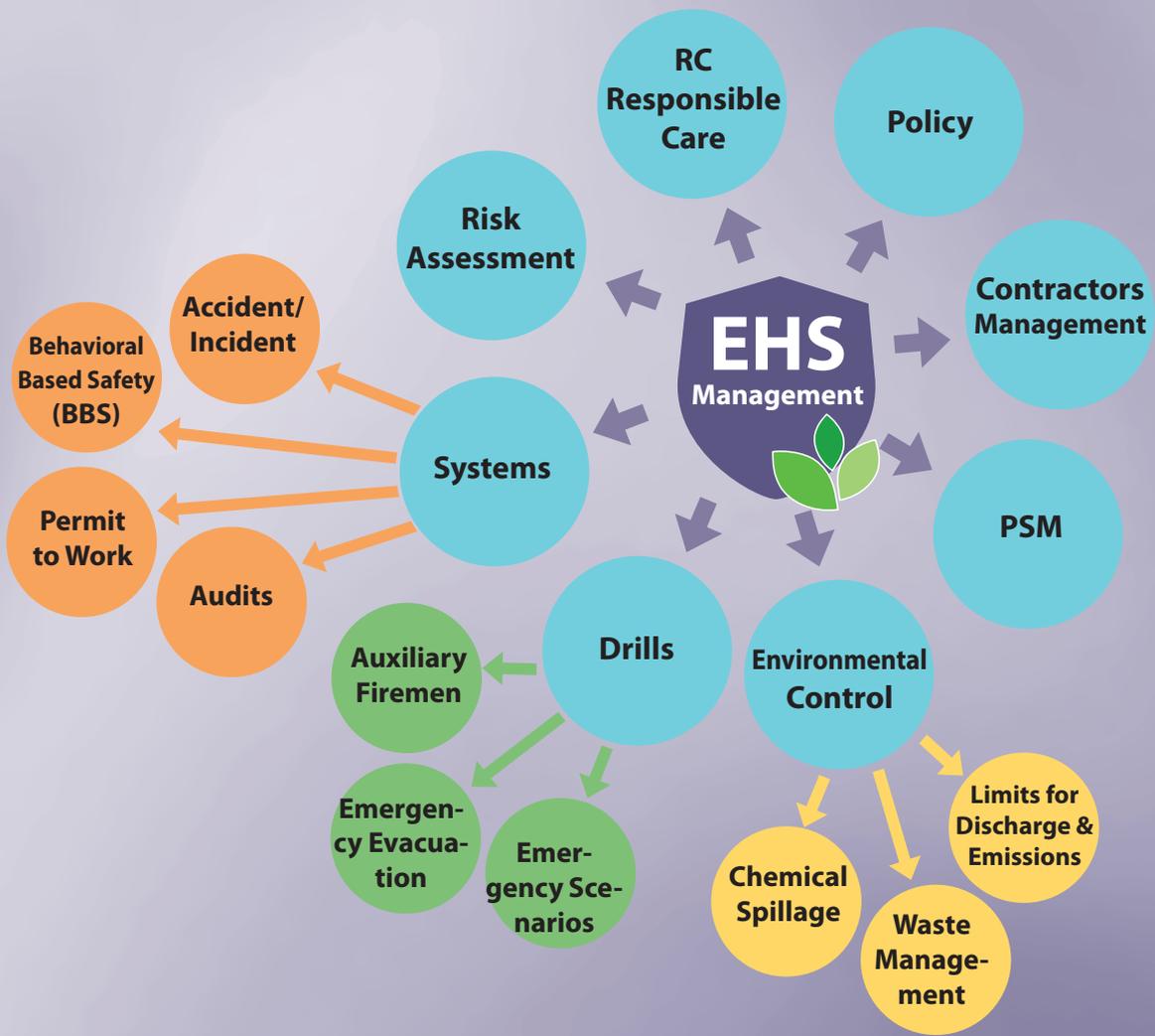
Spare Parts Management

In general, AFA companies are maintaining two types of spare parts pool.

1. A centralized spare parts pool, which is a common warehouse for all the plants, especially when the plants are the same design and are in close proximity.
 2. A Separate Spare parts pool; each plant maintains its own spare parts pool due to different models and designs and the distance of some plants from the common spare parts warehouse
- Insurance spares for compressors and turbine rotors and critical motors and pumps are maintained to meet any contingency.
 - The spare parts pool is monitored in the ERP system.

Environmental, Health and Safety Management Systems





EHS Management Practices

Environmental, Health and Safety Management System

Excellence beyond compliance Policy:

All the AFA companies have a policy showing their commitment towards excellence in safety, health and environmental management.

Safety, Health and the Environment are a line management responsibility with policy driven by in-house management initiatives rather, than legislation. There is a published, integrated Quality, Safety, Security, Health and Environment Policy with elements to include a safe, secure, healthy and eco-friendly work place. There is compliance with legislation, continual improvement, minimal emissions, a review of objectives and targets and training; an overall improvement in the quality of life.

The policy is communicated to all the internal and external stakeholders and is reviewed periodically.

Environmental Management Systems

Organizational set up and responsibilities

- Most of the AFA member companies have a dedicated section under an EHS /SHE department that oversees all the environment related aspects.
- All of the companies have dedicated and independent committees for environ-

ment, health and safety in addition to the EHS department that adds value to EHS Management systems monitoring and compliance.

Monitoring and reporting of chemical releases:

- There are online SOX and NOX analyzers on the flue gas stacks of auxiliary boilers, ammonia and methanol reformers. Field ammonia, H₂S and CO detection systems are at strategic locations with remote indicators and an alarms facility in control rooms. Liquid effluent quality is monitored on line using pH and conductivity meters. Daily analysis of all process streams and liquid effluents are carried out.
- On line TOC analyzers are used on water streams and are excellent at picking up any organic contamination in the water intake systems in addition to monitoring treated water.
- Mobile air quality monitoring units are used to measure air quality at the perimeters of the plant.
- Some companies are monitoring ammonia, urea, formaldehyde, SOX, NOX, CO, CO₂, H₂S and VOC in air emissions through in-house air quality management systems.
- Bore wells are drilled at potential locations in the complex to collect samples of ground water (sea water) monitoring for any contamination.
- some companies have zero emissions team, established to reduce all emissions from source to air.

- An on line analyzer is installed around fence line to monitor the pollution limit of ambient air.
- An on line analyzer for granulation stack monitors ammonia, urea and formaldehyde emissions from granulators.
- Environmental incidents are captured in a dedicated log and are reported to top management. Government environmental agencies regularly visit the industry. Bi -annual environmental performance reports are sent to government agencies along with comprehensive sample results of both liquid and gaseous effluents.
- A proper environmental waste management plans are put in place prior to any turnaround to ensure no contamination takes place.

Organizational Training:

“Environment Management System(EMS) are well established and implemented to control and monitor all environmental issues through their policies, procedures and regulations which are conducted to all other parties, periodically”

- Standard operating procedures stipulating well defined KPI's are provided to control the environmental releases. Employees are given training on environmental risk assessments and for carrying out HAZOPs. Various EMS training programs are implemented to enhance the awareness of the employees.
- Training includes environmental impact identification and management training as per ISO 14001 requirement as well as

internal auditors (ISO 14001) training. Environmental management systems procedures, general environmental awareness and global environmental issues are also inculcated throughout the company.

- By operating and maintaining the plants in an efficient manner, regular compliance of environmental norms is ensured. AFA companies select the best available technology for their ammonia- urea complexes in which all liquid discharge and gaseous emissions have been well taken care of. Continuous training is also organized.
- Well established operating procedures related to environmental control and operating limits are in use.

Audits and Reviews:

- Periodic internal audits as per the audit schedule are carried out by qualified internal auditors. External audits are carried out by companies such as BSI or DNV to measure the effectiveness of management systems every year. In addition to this, audits are carried out by various audit committees which include audit committees from business partners.
- Various audits and inspections are carried out such as:
 - Routine Inspection/ surveillances on daily basis by EHS officers.
 - Monthly audits are carried out by EHS officers and their findings are listed and tracked for corrective action.
 - Senior management audits and findings are listed and tracked for its corrective actions.

- Internal and external audits.
- Audit findings and appropriate corrective and preventive action status are reviewed in management review meetings, EHS council meetings on regular basis.

Emergency Procedures, plans and training

- All the companies have well established emergency planning and response management systems. These are implemented in the EHS management systems. As per the management systems, response teams (in all shifts) are available. Annual training and reviews are conducted.
- Emergency procedures have been developed and take into account all potential emergency scenarios such as toxic gas release, chemical spill and fires.
- The companies have a mutual aid agreement with neighboring chemical industries for assistance during severe emergencies.
- A major mutual aid exercise is carried out once every year.
- Mock drills are conducted on a regular basis on various upset and emergency scenarios, further enhancing preparedness for swift emergency response.

Practices/ procedures to help minimize potential disasters

- Any design changes should be carefully studied and have a thorough PHA. Current policies and procedures should also have a critical PHA review. Specific training in various management systems

standards and procedures is recommended for all relevant staff from operations, maintenance and engineering.

- PHA revalidation of all plants is carried out once every 5 years.
- Environmental assessment is performed and a registry is developed. All the significant aspects/impacts are covered with appropriate controls. Any changes in design are covered with risk assessment as per management system procedures, PHA, and Environmental assessment and health and hazard risk assessment. The assessment recommendations are prioritized and addressed to ensure keeping all risks as low as possible.
- Job risk assessment is an important tool of analysis that works by finding safety, health, environmental risks and hazards and eliminating or minimizing them before the start of the job. The risk assessment is linked to the permit to work system and an acknowledgement system in place to ensure all the concerned workers are aware of the hazards of the job and the mitigating measures.

All major jobs, for example during turn-arounds have comprehensive risk assessments in place.

Managing Process Safety:

Process Safety Management is the main driver

The AFA companies PSM program is designed to integrate and align under one umbrella, plant related Engineering, Safety, Operation and Maintenance activities, with a clear objective to minimize process related

risks. Through this program the companies intend to achieve the main goal of fulfilling the obligation to protect the employees, **Environment, assets** and the local community

Most of the AFA companies have a formal PSM program and all the key 14 elements of PSM are aligned to the existing management systems. A dedicated committee maintains the PSM programme in line with OSHA standard 29 CFR 1910.119.

PHA & Risk Assessment

Most of the companies conduct Process Hazard Analysis PHA identification and Risk Assessment as per the following steps:

- Identifying Hazard

A method to identify associated hazards to operations or designated units or equipment is called "Hazard identification". In case of existing operations, hazard identification study is made periodically.

- Assessment of risk

Hazards which need to be assessed, studied and analyzed should take the following probabilities:

- Release of hazard materials.
- Fatalities or injuries.
- Environmental damage.
- Property damage.

- Controlling the Risk

The resultant estimate of the risk is then compared with agreed criteria. If

the consequences are not acceptable, consideration is given to the incorporation of control measures (corrective action) which will prevent an incident.

Risks will be controlled through eliminating hazards by:

- Substituting the hazard with an alternative
- Implementing operational controls
- Installing control equipment.

Management of Change

For any modifications or extension to the existing process, the management of change procedure is generally applicable in order to ensure that the risk reduction measures are not compromised by future changes. The manufacturing companies require strict change control to be applied covering:

- Facilities and Equipments

Any change to the facilities and equipments goes through MOC and therefore PHA. This procedure applies equally to process, physical or system changes.

- Documentation Changes

All documentation changes go through risk assessment as Changes to standards, procedures, instructions, drawings and other documentation may have risk implications and needs to be controlled.

- Staff reallocation

Staff reallocations undergo risk management requirements of the job and the competencies of the staff concerned.

- Handover Practices

In case of transfer of responsibilities for assets or activities from one entity to another (e.g. in case of commissioning of a new facility), hand-over of information, responsibilities and authorities occurs in a controlled way.

Incident Investigation

- Process incidents and near misses can be reported by any employee. The incident, investigation findings, recommendations and actions are recorded and saved in the company's main database. The investigations of any "lost time" incidents are investigated by a dedicated team and recommendations are reported to the executive management.

The multi-disciplinary investigation team is appointed within the manufacturing companies to investigate all classes of incidents by using the available tools such as:

- Root Cause Analyses (RCA): which is the most basic factor or factors that, if corrected, will reduce or eliminate a recurrence of the situation. This technique is applied to identify root and direct causes.
- In some places Fault Tree Analysis using dedicated software (FTA-Pro) is used. Fault tree analysis (FTA) is a failure analysis in which the undesired state of a system is analyzed, combining a series of lower-level events. This analysis method is mainly used in the field of safety engineering to quantitatively determine the probability of a safety hazard.

- Six Sigma analyses is a systematic methodology that utilizes information and statistical analysis to measure and improve a company's operational performance, practices and systems by identifying and preventing defects. This increase in performance and decrease in process variation leads to defect reduction and a vast improvement in profits, employee morale and quality of product.

Training

Process Safety training programs are established by the Safety, Health and Environment Department for all employees and can be conducted in the form of an annual and comprehensive plan every year.

- A structured training program is provided to employees (Including operators, technicians, supervisors and engineers) prior to the assignment of any new responsibility. A refresher training program is also put in place and is designed to update the knowledge, skills and awareness of safety, environment and health hazards. The training program also aims at updating the employees with "lessons learned" on process incidents and accidents that have taken place in other similar plants.

Emergency response & evacuation drills

Emergency procedures are developed by the emergency response committee with members from all departments. They take into account emergency scenarios such as fire, explosion, gas release, chemical spill, etc. . Major drills including total evacuation are planned

once or twice a year and based on the drill findings procedures are reviewed.

Miscellaneous best Practices enhancing AFA companies Process Safety and EHS management systems

Process safety and Lessons Learned

All process incidents, whether major or minor, even near misses, are captured and analyzed. Corrective measures are then suggested and implemented. The incidents are discussed in shift talks to avoid future occurrence. Periodically, the salient incidents are shared with all the employees thru presentations on lessons learned. In plants operation a process incident databank is available on the intranet that covers all the process related issues.

Behavioral Based Safety (BBS)

AFA Companies implemented a Behavioral Based Safety Programme which aims to increase the awareness of employees towards best safety practices and instill these as inbuilt behavior patterns.

BBS is considered one of the cutting edge safety programmes available in the world. In this programme employees gain an increased awareness of good safety practices and these practices then become natural behavior. This in turn ensures the company's activities are carried out in an optimized safe environment, thus raising productivity to a new level

Mutual aid agreement for emergency Response

A mutual aid agreement with neighbor-

ing companies for assistance during emergencies is established

Housekeeping and safety competition
There is a year- long intra unit safety competition that features both in- house and an external review by other companies

Linking Risk assessments to permit to work systems

A Job hazards analysis and a written acknowledgement by all associated parties to the work is made prior to starting maintenance activities, which enhances safety at AFA facilities

Contractors Safety

Contractors are integrated into the work systems and have to undergo safety induction.

HSE Management of Contractors

Contractors are pre qualified and selected based on pre set HSE criteria and ascertaining HSE assurance process.

Safety culture

Off- the- job safety is also encouraged and all employees are required to report formally all off- the- job safety incidents.

Health Care

Smoking is not allowed in buildings/ offices and is only allowed in designated smoking shelters. The first Monday of each month is no smoking day in one of the companies.

EHS Excellence through Bench marking

AFA companies are regularly benchmarked in various areas of business and, in the long run, this provides them a unique opportunity to learn from the best in class and further streamline their processes

Practical demonstration of care for the environment

AFA companies are a role model in the protection of the environment. One of the companies was the first industrial facility to use practical demonstration projects to verify the environmental credentials of its operations; a fish farm and a bird sanctuary. A Palm trees plantation plus a herbal and aromatic plants garden have been established at the company's site

Environment awareness

AFA companies have dedicated environment committees. To enhance environmental awareness, the committee organizes environmental awareness lectures inside and outside the company. The most important of these are environmental lectures delivered at local educational institutions.

School pupils are invited to visit the plants to discuss the company's experience in environmental care and the various environmental projects implemented by them. Companies also sponsor and support the Ministry of Education's environmental research programme.

Responsible care: our commitment to sustainability:

AFA companies are further enhancing their EHS management systems by adopting Responsible care initiatives; a cutting edge global voluntary initiative that further improves and drives excellence towards EHS management systems. One of the AFA companies has been recently accredited to Responsible Care RC-14001 standard.

Mock Drills

Mock drills concept for operation staff on response to process emergencies and upset scenarios is being used. A drill scenario is simulated and instead of actual operation of valves tags are used to indicate the status of valves in case of an emergency.

This methodology has proved to be very effective in improving the awareness level and preparedness of operations personnel for handling emergencies and upset scenarios.



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Since 1975

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