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Code of Practice as a Tool to Improve Safety

presented by

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About the IFA Technical Committee

The IFA Technical Committee encourages the development and adoption of technology improvements that can lead to greater production efficiencies and reduced emissions, as well as better health and safety standards throughout the fertilizer industry. Our mission is to actively promote the sustainable development of efficient and responsible production, storage and transportation of all plant nutrients. The Technical Committee accomplishes these objectives through a variety of channels, including:

- Technical and policy-oriented information materials. The committee regularly conducts surveys and produces reports on key industry metrics, including the IFA Energy Efficiency and CO₂ Emissions Report, the IFA Safety Report, and the IFA Emissions Report. This work enables member companies to assess their operations over time, make comparisons with similar facilities on an established level of performance, determine the need for technology improvements and identify good industrial and management practices.
- Regular exchange of information on technology developments and industrial practices. A key role of the IFA Technical Committee is to encourage ongoing technical innovation in the fertilizer industry through the development, compilation and exchange of technical information between members, researchers, engineers, equipment suppliers and other industry associations. To this end, the committee organizes a Technical Symposium every other year to examine progress in the production technology of fertilizers. Each Symposium traditionally features the presentation of 30-40 new technical papers from member companies worldwide, providing members with information on the latest technological developments. In the intervening years, the committee holds a variety of meetings to assess current industrial practices and standards, with an eye toward identifying key developments of interest to members.
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(as provided by the author for distribution in Vilnius)

Code of Practice as a Tool to Improve Safety

Abstract

The minimum requirements for safe production and supply of fertilizers and intermediate chemicals are given in national and international laws and regulations. Standards, whether technical or related to management systems, contribute to making the development, manufacturing and supply of products safer. Guidelines given by the manufacturers associations set out recommendations for the producers. Without clear guidance from the management of a company that has operations in several countries, the implementation rate of these numerous, non-mandatory recommendations could vary a lot from plant to plant.

In 1990 Kemira GrowHow started to create a set of in-house Codes of Practices (CoP) that combine various industry guidelines and collections of best practices. Today there are five CoPs:

- Code of practice for the safe production of ammonium nitrate-containing fertilizers.
- Code of practice for the safe storage, handling, transport and sale of solid nitrate-containing fertilizers.
- Code of practice for the safe manufacture and handling of nitric acid.
- Code of practice for the use of Personal Protective Equipment.
- Code of practice for work permits.

The owner of the codes is the person responsible of the risk management in the company. The codes are mandatory for all employees of Kemira GrowHow. Deviations can only be approved after an appropriate hazard study.

CoPs have proven to be a powerful management tool to guarantee that the best practices of the industry are taken into use. The safety level of the operations has increased remarkably, one evidence of which is the LTA number dropping from 11,9 (1998) to 2,1 (2005).

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All papers and presentations prepared for the IFA Technical Symposium in Vilnius
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Code of Practice as a Tool to Improve Safety

1. Introduction

Kemira GrowHow's roots date back to 1920, when Kemira, Finland's first fertilizer producer, was established in 1920. In 1970s Kemira's fertilizer and agrochemical business included seven production sites in Finland. In the 1980s, Kemira began to expand globally through acquisitions of fertilizer plants in several European countries. The 1990s was not only marked by restructuring of the business in Europe, but also investments in joint venture production companies in the Middle East and Asia. Today Kemira GrowHow Oyj is a European producer of fertilizer and feed phosphates. The company has 2,900 employees worldwide and in 2004 net sales were 1155 million euros. Kemira GrowHow Oyj is listed on the Helsinki Stock Exchange.

Table 1: Fertilizer production units of Kemira GrowHow in 2005.

Country	Location	Production of
Finland	Uusikaupunki	Fertilizers Nitric acid
Finland	Siilinjärvi	Fertilizers Nitric acid
Finland	Harjavalta	Fertilizers
United Kingdom	Ince	Ammonia Nitric acid Fertilizers
Belgium	Tertre	Ammonia Nitric acid Fertilizers
France	Ribecourt (Joint Venture)	Fertilizers
Lithuania	Kedainiai	Fertilizers
Hungary	Peremarton	Fertilizers

Through the years the safe production of ammonium nitrate-containing fertilizers has been a basic concern of Kemira GrowHow as many fertilizers made by the company contain AN. Already in early 1990s, after the first wave of globalisation of the company, the need to collect the best practices related to safe production of ammonium nitrate-containing fertilizers was recognized. Due to acquisitions, a lot of experience from different companies was merged together, and this offered a good basis to such a work. Work permits and use of personal protective equipment followed the collections of best practices.

Already from the start it was recognized that if the company aims at implementing the best practices throughout the production units, the best practices must be made as the so-called company laws. Today they are called Codes of Practice, and they all include both obligatory and advisory requirements and practices. Today there are five Codes of Practice:

- Code of practice for the safe production of ammonium nitrate-containing fertilizers;
- Code of practice for the safe storage, handling, transport and sale of solid nitrate-containing fertilizers;
- Code of practice for the safe manufacture and handling of nitric acid;
- Code of practice for the use of Personal Protective Equipment;
- Code of practice for work permits.

2. General about the codes of practice

2.1. Liability and scope of the Codes

The Codes are mandatory in all sites of Kemira GrowHow. For the case of a joint venture where Kemira GrowHow, participates as a minority partner, the applicability of the Codes shall be decided by the Board of Directors of that venture. If Kemira GrowHow has the majority share then the application of the code becomes mandatory.

Within the Code, certain requirements are obligatory and some are advisory. Any deviations from an obligatory requirement shall require the express written consent of the Site Manager following an appropriate hazard study, the results of which shall be reported to the Owner of the Code. The owner of the Codes is the company's President of Risk Management.

The obligatory and advisory requirements are defined in the Codes as "shall", "should" or "it is recommended" as follows:

'Shall' Where the Code specifically states that a practice **shall** be followed then the requirement is binding and no freedom of choice is allowed. An obligatory requirement.

'Should' Where the Code advises a preference by the word should, then an appropriate risk/task analysis and management judgement shall be carried out to define whether or not a requirement will be implemented.

'It is recommended that'
Indicates a preferred solution (which may not be applicable to all installations).

The Codes emphasize that the Code shall not be taken to replace, modify, override or supersede any Statutory Instrument.

None of the Codes is meant to be an operating manual, neither is it intended to replace manufacturers' handbooks and instructions.

The Codes are applicable to both new and existing plants.

2.2. Auditing of the implementation of the Codes

Regular auditing is performed in conjunction with the normal safety inspections of Kemira GrowHow, such as safety walks, senior management safety audits and planned safety inspections.

Special audits with a given focus-area have been performed by the Corporate management. To systematise this, the intention is to include the auditing of the Codes in the scope for Corporate audit plan that covers the internal audits of existing managements systems, such as ISO 14 000 and ISO 9000.

2.3. Amending the Codes

Any person wishing to make changes to the Codes of Practice shall submit details of the proposed changes, in writing, to the Owner of the Codes. Reasons for the proposed changes shall be given.

If appropriate, the Owner will appoint a Working Sub-Group whose role will be to:

- Review each section of the Code prior to submission for approval;
- Consider any amendments to the Code and decide whether they are valid and, if so, progress them through to a revision of the Code;
- Interpret the Code to users.

3. Highlights of the different codes of practice

3.1. Code of practice for the safe production of ammonium nitrate-containing fertilizers

The Code is intended as a general reference document which incorporates all aspects of safe manufacture of AN-containing fertilizer.

'Safe' includes regards for:

- The delivery of safe products to our customers;
- The avoidance of hazards to the environment;
- The health and safety of personnel and neighbours;
- The risk of damage to equipment.

The code covers the following areas:

- General guidance to all personnel concerned in the safe production of AN-containing fertilizers within the Kemira GrowHow Group;
- Safe and practicable design, construction, operation and maintenance of plant and equipment used in the manufacture and storage of ammonium nitrate solutions;
- Safe pumping of AN-containing liquids and slurries in Kemira GrowHow and in particular preventing explosion of any pump operating on AN-containing materials;
- Safe production of Class B fertilizers;
- Safe production, handling and classification of AN-containing fertilizers not duly specified within the existing legislation, i.e. NDS fertilizers.

It is also intended to systemise and maximise safety in the development of a new product, even though it may mean delay or additional cost in the development of a new fertilizer.

The five above-mentioned areas of the Code are discussed in the following sub-chapters.

3.1.1. General procedures for the safe production of AN-containing fertilizers

Examples of obligatory requirements:

- Written approval from the Site Manager shall be given before beginning the first commercial run of any new Class A grade of fertilizer. To achieve his approval a comprehensive safety study and review on production and product safety shall be prepared;
- All non-Class A fertilizers shall be considered to be Class B unless tested to be safe by use of the trough test;
- For AN-containing fertilizer productions where the AN content exceeds 10% of the product the Code emphasizes that the site shall have written procedures regarding control of delivered raw material against specifications, control of contamination of raw materials and raw material delivery locations. No additives shall be introduced before a safety review is carried out. There shall be written procedures concerning the identification of off-spec material before storing and recycling.

- The code gives guidance on the AN-containing slurries, and the following requirements are obligatory:
 - Clear written instructions are given for the maximum acceptable slurry vessel temperature;
 - Each slurry vessel is equipped with a temperature alarm system;
 - Each slurry vessel is equipped with a temperature trip system;
 - Each slurry vessel is fitted with sufficient venting capacity for the decomposition gases and steam;
 - Any reactor overflow or vent is designed so it does not in itself constitute a safety hazard to the operators.

- For AN-containing slurries/liquids containing more than 10% AN, each production unit shall have written procedures stating that:
 - During production the pH of tank reactors shall be measured on-line or manually at least every 2 hours and the results recorded.
 - During production the pH of mixing tanks shall only be measured on-line or manually each 2 hours if any acidic material is added to the tank.
 - During stops the pH and temperature of all tank reactors/mixing tanks shall be measured at least every 4 hours and the results recorded.
 - For acidic NPK Tank Reactors with a content of AN >45% special attention shall be given to pH and temperature during all stops.

- If the solution is required to be acidic during normal operation, such as in a scrubbing system and if the AN content is above 10% then solution pH shall always be monitored and controlled at least every 2 hours.

- Detailed obligatory requirements are given for the control of the drier/spherodizer, such as:
 - Flow deviation alarms on all liquid process flows containing water;
 - A written policy concerning the maximum acceptable drying air inlet temperature to the drier/spherodizer (may be grade dependent);
 - Independent high temperature alarm and trip (of the burner or heating system) on the inlet drying air to the drier/spherodizer;
 - If the Drier/Spherodizer stops the burner shall trip or go to a minimum fire position to reduce the inlet air temperature quickly to less than 100oC;
 - If the main extraction fan from the drier/spherodizer trips, the burner shall trip;
 - Drying gas is normally produced by the mixing of combustion gases with quench air. As the mixing of these two gases is often difficult the temperature profile of the hot gases entering the Drier/Spherodiser shall be checked for dangerous hotspots. If the temperature deviations are more than 20°C above or below the set temperature then precautions shall be taken to reduce the deviations by the use of stationary mixing equipment. The thermocouples used for alarm and control of the air temperature shall be positioned in that area where the highest temperature occurs.

- The Code requires some obligatory measures to avoid or reduce the impact of local decomposition:
 - Written procedures shall exist;
 - Fire water shall be available for rapid action to stop the decomposition;
 - Screws or conveyors shall be equipped with rotation detecting device, tripping the equipment in case of a mechanical malfunction or failure.

- Deluge systems:
 - Shall be in place where AN-containing slurries/liquids can reach temperatures above 120oC or AN-containing fertilizers are exposed to temperatures above the temperature at which decomposition would occur if the product remained in continuous contact with this temperature.
- The decomposition fighting system for driers/spherodizers shall be based on these principles:
 - Water availability at the inlet is a must;
 - Water availability at the exit is recommended;
 - It is recommended that the driers/spherodizers are kept in operation whilst fighting the decomposition but of course the heat supply shall be switched off;
 - Exhaust fans shall be kept in operation whilst fighting the decomposition;
- During repair of process equipment, the production/maintenance organisation shall note in written procedures about the risk of trapping AN in confined spaces.
- The Code gives also obligatory requirements for the case of repairs to refractory brickwork in combustion chambers.

3.1.2. *Manufacture and storage of ammonium nitrate solutions*

This part of the code gives guidance to general properties of AN solutions and melts. It advices in materials of construction, production, storage and export facilities of AN solutions.

3.1.2.1. General properties of AN solutions and melts

- Examples of obligatory requirements for controlling pH of AN solutions and melts:
 - For safe handling of AN Solutions, free ammonia should be present. Where this is unavoidable because of the technology used (as in an acidic neutraliser process), the pH shall be corrected immediately after that processing step has been completed by sparging with ammonia gas, aqueous ammonia or some other suitable means;
 - When a weak AN solution (less than 60%) is required to be acidic (such as in a scrubbing system), then solution pH shall be monitored and controlled at least every 2 hours;
 - A suitable means shall be provided for measuring and correcting the free ammonia content/pH of AN solutions throughout the AN manufacturing process, handling and storage system. In particular, the free ammonia/pH shall be measured after neutralisation, after post-neutralisation and in any pump tank or main storage tank.
- The Code gives contaminant limits that shall not be exceeded (limits are related to 100% AN):
 - Combustible Material: less than 100 mg/kg total as expressed as Carbon;
 - Chlorides: less than 10 mg/kg;
 - Metal Ions: The concentration of metal ions should not exceed 50 mg/kg in total. Transition metals to be included in this total are: manganese, iron, cadmium, nickel, chromium and cobalt;
 - Copper: less than 1 mg/kg;
 - Nitrites: The colour of the AN solution shall be checked and recorded during routine operator plant inspections.

3.1.2.2. Production of AN solution

This section gives general guidance to the production of AN solution. Examples of obligatory requirements are given here:

- All the feed streams into the AN process shall be monitored for contaminants regularly.
- pH measurement:
 - The AN Solution in or from all neutralisers and post-neutralisers shall have continuous pH measurement. Care shall be taken that AN units cannot be started without pH measurement systems being operational;
 - Manual pH checks shall be carried out regularly to check the calibration of the instruments;
 - Should both continuous or manual pH systems be faulty or be under maintenance, then the frequency of manual checks shall be increased to at least every 60 minutes and immediate repairs shall be initiated;
 - Written maintenance and calibration procedures shall be available for these pH measurement systems.
- Temperature:
 - Continuous temperature measurement of the AN Solution in the neutraliser shall be installed providing indication, continuous recording and high alarms in the AN Plant Control Room;
 - An independent neutraliser high temperature trip system shall be provided. This system will trip the plant (shutting off all feeds to the neutraliser) and activate an automatic dilution/deluge system.
- Neutralisation:
 - The neutraliser dilution/deluge system shall be available during start-up, shut-down and at all times during the operation of the plant;
 - The neutraliser shall not be deliberately operated with a pH of less than 2.2, as measured in an AN solution diluted with demineralised water 1:10, taken from the outlet/overflow of the neutraliser.
- Acidic Processes/Neutralisation (Initial neutralisation at pH less than 4.5 and at a 'low' pressure (0.4 - 1.2 bar absolute) followed by a post-neutraliser operated at pH greater than 4.5 and atmospheric pressure:
 - The post-neutraliser shall not be operated with a pH of less than 4.5, as measured in the AN Solution from the reactor;
 - On shutdown/trip of a forced circulation acidic neutraliser the contents of the neutraliser shall immediately be sparged with ammonia to raise the pH to greater than 4.5 (~5.0);
 - On shutdown/trip of a natural circulation acidic neutraliser the contents of the neutraliser shall immediately be sparged with ammonia to raise the pH to greater than 4.5 (~5.0). In this alkaline condition the neutraliser may be held for up to 2 hours before it must be completely drained as the homogeneity of AN Solution in the reactor cannot be guaranteed;
 - Acidic neutralisers/post-neutralisers shall not be operated at temperatures above 160oC.

- Alkaline Processes (Neutralisers operated at pH greater than 4.5 and either at atmospheric or 'high' pressure [4.0 – 5.5 bar absolute]).
 - If either the circulation pump or the pH system is not functioning and the neutraliser pH and temperature cannot be checked or controlled, the neutraliser shall be drained immediately;
 - If the shutdown/trip is longer than 2 hours the neutraliser shall be drained or diluted (to avoid crystallisation);
 - Alkaline neutralisers shall not be operated at temperatures exceeding 200oC.
- Concentrator:
 - The ammonium nitrate feed to a concentrator shall be alkaline, i.e. with a pH greater than 4.5;
 - The maximum temperature of the heating medium shall not exceed 200oC.

3.1.2.3. Storage of AN solution

This section of the Code covers the storage of strong ammonium nitrate solutions of between 60% AN and 97% AN. Examples of obligatory requirements are given here:

- The pH of the storage tank(s) shall be measured either continuously or by measurement of a manual sample taken at least every 4 hours. All results shall be recorded/logged. The ammonium nitrate solution in storage shall not have a pH of less than 5.0. A facility for the addition of ammonia vapour or aqueous ammonia to correct the stored AN Solution pH shall be provided;
- The temperature of the AN Solution in storage shall be continuously measured with high and low alarms reporting to the Control Room. The temperature of the AN Solution in storage shall not exceed 150oC. A means of heating the AN Solution in storage shall be provided;
- Each ammonium nitrate solution storage tank shall be provided with a remotely operated deluge system.

3.1.2.4. Export facilities of AN solutions

This section of the Code covers the loading of bulk road tankers with ammonium nitrate solutions of between 60% AN and 93% AN. Examples of obligatory requirements:

- The pH of the AN solution for export shall be measured prior to loading into road tankers and shall not be less than pH 5.0;
- The temperature of the AN Solution for export shall be measured prior to or following loading into road tankers. It is recommended that this temperature be at least 10oC above the AN Solutions crystallisation point but shall not exceed 140oC;
- An independent trip system shall be provided to prevent over-filling/overflowing of the road tanker;
- The temperature of the AN Solution for unloading shall be checked prior to or following unloading into road tankers. If the temperature is less than 50C above the crystallisation temperature, unloading can take place only after heating the contents to more than 100C above the crystallisation temperature.

3.1.3. Safe pumping of AN-containing liquids and slurries

This part of the code gives mechanical, pipeline, instrument and operational guidelines for the safe pumping of AN-containing liquids and slurries. Obligatory requirements include:

- Mechanical guidelines:
 - A formal and recorded hazard study shall be performed during the design of any new pump installation. A review and updating of the hazard study shall be performed during any engineering design change and any planned change to the range of operating conditions originally specified.
 - The equipment shall be designed for continuous operation in a hostile environment operating for a minimum of 8000 hours per year.
 - Guidance on what type of a pump handling AN liquids and AN slurry is given.
- Pipeline guidelines:
 - The code recommends that all consumption points are supplied by a single running pump. Where more than one pump is installed for a single duty the electrical, instrumentation and trip systems shall be designed so that only one pump per pipeline can be started and run at a given time. The only exception to this is that the second pump can be run for short periods using overrides to agreed procedures for trip testing.
- Instrument guidelines:
 - Principles:
 - The safeguarding instrumentation shall be made independent of the main control system;
 - Safeguarding instrumentation shall be provided with audible and visual indication of alarms and trips in the control room;
 - Fail-safe construction principles shall be used for the safeguarding instrumentation. This means that all foreseeable single faults shall lead to a safe state;
 - The safeguarding instrumentation shall be designed taking into account the need for testing;
 - Written trip testing procedures shall be available and records shall be kept of trip tests performed.
 - Pump monitoring
 - Each pump shall be provided with at least two separate and independent trip initiators;
 - The first trip shall be low flow on the main discharge line;
 - The second trip shall be high temperature. Where temperature measurement is not appropriate (submerged cantilever or jacketed pump) then another appropriate trip shall be provided (such as low amps).
 - Low flow trip:
 - In an installation where there is a separate flow measurement in each branch line (instead of a single measurement in the common line), the low flow trip shall be designed so that if the combined flow of all the consumption points is not above the low flow value for the pump, the pump will trip;
 - The low flow trip value shall be specified so that any anticipated errors both in the actual measurement (e.g. flow sensor) and in the transmission of the signal are taken into consideration.

- High temperature trip:
 - A temperature sensor shall be placed in or on the main pump casing. In case of a pump with an expeller, a second temperature sensor shall be placed in or on the back of the expeller casing;
 - There shall be no deliberate time delay in the temperature trip. The time response of the sensor shall be very fast;
 - The trip value shall be approximately 10oC above the highest measured temperature during normal operation by the temperature sensor placed in the pump casing.
- Sealing water trips:
 - Low flow of sealing water to the pump shall result in a pump trip. Where sealing water is fed to the pump by gravity, the flow shall be measured in the gravity section below the funnel. There shall be no take-out points from the pipe after the flow measurement.
- Operational guidelines:
 - This part of the code gives detailed instructions about the start up of a pump, monitoring of the pump and pumping system during normal operation, shut down of the pumps, cleaning of the pump and piping, cleanliness of the environment of the pumps as well as inspection and testing of the pumps and pipelines.

3.1.4. Safe production of class B fertilizers

Kemira GrowHow recognises that the production and sale of some Class B fertilizers may be necessary to satisfy market needs. This means that safety precautions are necessary and these are recognised in this Code.

The first target is, wherever possible, to modify a fertilizer from a Class B to a Class C. Where production and sale of a Class B fertilizer cannot be avoided, naturally all national and international legislation shall be applied.

Class B fertilizers are defined by the well known trough test, defined in the UN Transport Code for Class 9 Materials. If the material shows clear tendency for Self Sustaining Decomposition, then it is deemed to be a Class B product. If not then it is either Class A or Class C depending on the AN-content. If the result in the trough test is 'borderline' between Class B and Class C then it shall be treated in production as though it were Class B.

The Code gives the maximum acceptable propagation speeds and testing frequency. It gives guidance in the process safety equipment, personal safety equipment, emergency procedures and conveying and handling of B-class fertilizers. Some of the obligatory requirements are given as examples below:

- Maximum Acceptable Propagation Speed
 - The production and sale of Class B fertilizers of <20% N can be done if the propagation speed is below 15 cm/hour;
 - If the N-content of the fertilizer is <20% and the propagation speed is between 15 and 25 cm/hour authorisation from the Site Manager or his appointed deputy shall be given before production and sale can continue. The target is to eliminate products in this category where the rate is above 15 cm/hour;
 - If the N-content is ≥20% the amount of decomposition gases are greater per tonne of product and therefore it is recommended that the limit of 15 cm/hr is reduced to below 10 cm/hour;

- No fertilizers shall deliberately be produced if the propagation speed is greater than 25 cm/hour. If the limit of 25 cm/hr is accidentally exceeded immediate corrective actions shall be taken.
- The temperature of the solids leaving the drier or the spherodizer shall not exceed either 115°C or [Initiation Temperature minus 50°C] whichever is the lesser. The temperature of product leaving for storage shall not be allowed to exceed 55°C;
- In plants producing Class B fertilizer a reliable continuous gas analyser (for instance N2O) shall be installed on the outlet air from the drier or spherodizer;
- Written and documented emergency procedures and training procedure shall be available to all plant personnel which covers their actions in the event of decomposition. An evacuation procedure shall be available for all personnel on the plant, including those not involved in fighting a decomposition;
- Fluorescent lighting shall be used wherever possible;
- Rollers and transfer points from conveyor belts shall be kept free from accumulated spillage to avoid heating of fertilizer due to friction when in contact with the fertilizer;
- Water hoses shall be available to cover the full length of conveyor corridors;
- Conveyors going to the fertilizer store shall have a remote operation facility in order to allow them to be stopped from a 'safe' location such as the main control room;
- **Everything possible shall be done to prevent any decomposing material from leaving the plant into storage.**

3.1.5. The development of new products and the classification of Not Duly Specified (NDS) fertilizers

A classification scheme (Appendix 1.) has been prepared to ease the interpretation of the existing legislation.

The commercial production of a new Class 5.1 fertilizer shall not begin without written approval from the Site Manager. To achieve this authorisation a comprehensive safety study and review of production safety shall be prepared and given to the Site Manager.

A production safety review shall be carried out for each new fertilizer to define the safe operating parameters and tolerances. Where the production of a new fertilizer requires major plant modifications, a comprehensive safety study (HAZOP) shall be carried out.

Before industrial production a test sample shall be produced for safety tests.

3.2. Code of practice for the safe storage, handling, transport and sale of solid nitrate-containing fertilizers

The need for common rules for the storage, handling, transport and sale of nitrate-containing fertilizers was recognized in 2000. The company had expanded into new countries with storages and blending units. The blending operations had not been included in the Code described in chapter 3.1., although blends were seen important because class A components may be utilised and final products may potentially have class B properties. Many collections of best practices existed, but to assure the implementation of the best practices a Code of Practice was seen as important.

In 2003 a new Code was published. The Code covers the safe storage, handling, transportation and sale of ammonium nitrate based fertilizers. Blending operations are also covered.

Contrary to the AN-production Code that is meant only for internal use, the Code discussed in this chapter can be handed over to distributors or customers for use by them when dealing with fertilizer materials produced and/or sold by Kemira GrowHow.

The Code consists of the following sections:

- Classification of fertilizers;
- Relevant legislation;
- Properties and potential hazards;
- Methods of handling and storage;
- Safety facilities and training;
- Fire-fighting and emergency procedures;
- First aid procedures and properties of toxic gases;
- Disposal of contaminated products, off-spec and waste materials;
- Recommendations and requirements for storage and store design for types A and B fertilizers;
- Recommendations and requirements for storage and store design for types C fertilizers;
- Transportation;
- Sale of fertilizers.

Some of the sections are discussed more in detail below.

3.2.1. *Methods of handling and storage*

The code reminds of regulations related to packages used for hazardous materials, like:

- All packages containing dangerous goods shall be performance tested as required in the relevant transport modes and shall be marked accordingly (e.g. UN certified bags for hazardous materials);
- Bags shall be completely sealed on filling and be of sufficient strength to allow all normal storage, handling and transport operations to take place without any damage to the bag and consequent spillage;
- Bags shall have microvents to avoid ballooning and consequent instability in stacking;
- Paper packaging shall not be used;
- IBCs shall comply with the UN Model Regulations for the Transport of Dangerous Goods and shall be of sufficient strength to allow all normal storage, handling and transport operations without damage to the IBC and subsequent spillage;
- All packages shall be clearly labelled and where appropriate show the hazard symbols. Where palletised material is shrink wrapped the warning label shall be visible through the wrapping or an additional label shall be fixed to the outside.

3.2.2. Safety facilities and training

The code gives guidance on fire fighting equipment and training. Some obligatory requirements as examples:

- All stores, outdoors or indoors, shall have the facility to communicate with emergency services either via a telephone permanently connected to the public network or other suitable means within easy access;
- They shall be adequately equipped with fire-fighting equipment, which may include:
 - A water supply, preferably a 64 mm (2.5 inch) water hydrant. The local fire service shall be made aware of the water supply facilities and should approve static water tanks or fire hydrants;
 - A small bore water supply capable of reaching all parts of the storage area, or an adequate supply of water extinguishers for fighting initial outbreaks of fire;
 - Chemical extinguishers for fires on equipment where fertilizers are not directly involved.
- Personnel including subcontractors involved in the handling and storage of nitrate based fertilizers shall be adequately instructed as to the potential hazards of the fertilizers stored;
- A written and documented procedure shall be prepared for guidance of all personnel who may be involved during an emergency situation;
- An evacuation plan shall be prepared for personnel not involved in dealing with the emergency;
- Adequate training shall be provided at least every three years and records of this training shall be kept.

3.2.3. Disposal of contaminated products, off-spec and waste materials

This section gives guidance in handling of off spec materials. The basis is that any stock of nitrate based fertilizer which becomes contaminated shall be treated as suspect and be disposed of in an appropriate manner depending on the nature of the contamination, taking every care to avoid environmental damage.

The following obligatory requests can be picked up:

- Contaminated or broken pallets, ropes or covers, damaged or discarded fertilizer bags shall be disposed of using locally available facilities for waste disposal. The area for storing shall be kept as small as practical, and be separated from fertilizer products, and waste materials;
- Straight ammonium nitrate or class A waste materials shall be separated from other fertilizers and non-compatible materials;
- Off spec Class A products shall be minimised and shall not be stored in quantities exceeding the Seveso 2 limits (lower tier 10 ton);
- The storage facilities for off-specification materials shall be equipped according to their corresponding classification. Untested non-Class A off spec is to be treated as Class B;
- Transport of off-spec material shall follow the rules according to the classification

3.2.4. Recommendations and requirements for storage and store design for types A and B fertilizers

This Section contains rules agreed by EFMA ('Handbook for the Safe Storage of Ammonium Nitrate Based Fertilizer' dated March 1992) and FMA (Code of Practice for Storage, Handling and Transportation of Solid Ammonium Nitrate Based Fertilizers, dated March 2000). In addition to this, some additional rules to be applied by Kemira GrowHow are included, such as:

- An inspection of the store shall be made at least once-per-day when class B or borderline class B material is being stored in bulk. It is recommended that the temperature inside the heaps is monitored and results of inspections recorded;
- It is also recommended that an automatic warning system be installed to detect decomposition gases/temperature rise or that a monitoring system using TV/video cameras is installed;
- Fire-water lines shall be installed which can assure an adequate supply of water to deal with a decomposition outbreak. This shall be provided in each space nominated for the possible storage of Class B and borderline Class B fertilizers. Opening of this water supply shall be from outside the storage building;
- Due consideration shall be given to the containment and disposal of any liquid effluent material arising from any fire-fighting operations. Any national legislation and local authority requirements concerned with liquid effluents shall be met;
- Escape masks or breathing apparatus (BA) Sets (escape type) shall be available in sufficient quantity at strategic locations;
- BA Sets for fighting decomposition shall also be available of a sufficient number and capacity for all individuals who are foreseen as being involved in such an activity.

3.2.5. Recommendations and requirements for storage and store design for types C fertilizers

This section emphasizes that type C fertilizers can contain the same components as those of type A and type B. Generally they have lower ammonium nitrate content than type A and will not exhibit the property of self-sustaining decomposition as do those of type B. Any decomposition caused by an external heat source will cease once that source is removed. However, as with types A and B, if heated or involved in a fire type C fertilizers will release toxic gases and fumes.

In practice, type C fertilizers will often be stored in the same building with types A and/or B, and in these cases the storage and handling requirements for types A and/or B fertilizers must be followed.

The section lists typical housekeeping rules, stating f. eg. that:

- Contaminated materials shall be disposed of safely;
- Broken pallets and rubbish shall be cleaned up and disposed of safely and not allowed to accumulate in the store;
- Organic substances such as sawdust shall not be used as an aid to cleaning floors but inorganic absorbents can be used.

The Code mentions also details about storing class C fertilizers with other products:

- Fertilizers shall not be stored adjacent to flammable or readily combustible materials such as gasoline, oil, sulphur, hay, straw, organic substances, and reactive chemicals such as acids, or oxidising agents which can contaminate or affect the fertilizer even in a fire. A minimum separation distance of 5 metres or a fire resistant wall should be adequate for this purpose.

3.3. Code of practice for the safe manufacture and storage of nitric acid

The Code for the safe manufacture and storage of nitric acid was published in 2002.

The Code of Practice covers the safe manufacture and handling of nitric acid with a concentration of less than 68%. The Code sets out constraints for the selection and operation of equipment. It covers the process and engineering design of mechanical and electrical equipment and instrumentation used in or directly associated with the manufacture and handling of nitric acid within Kemira GrowHow.

The Code is intended to guide all personnel concerned in the safe and practicable design, construction, operation and maintenance of plant and equipment used in the manufacture and handling of nitric acid. The Code of Practice is in accordance with the best generally accepted practice and conforms to relevant national and international regulations and statutory instruments.

The Code consists of the following sections:

3.3.1. General

This section describes the properties of nitric acid, risks related to nitric acid production process, materials of construction and ammonia oxidation catalyst and catchment systems used in nitric acid processes.

One risk related to the production of nitric acid is the contaminants in the raw materials. The Code advises that:

- To minimise the content of impurities (oil and rust) in the ammonia gas, ammonia evaporators shall be purged on regular basis;
- Atmospheric air shall be properly filtered to remove iron, sulphur, sand, chlorides and other solid or liquid contaminants in the air;
- Absorption water can be either demineralised water or condensate from other units, e.g. condensate from ammonium nitrate solution units. The condensates used shall be clean, e.g. to avoid deposits of ammonium nitrate/nitrite in downstream equipment. If condensates are used they shall respect the following requirements :
 - They shall not contain any free ammonia (pH < 3);
 - They shall not contain other impurities to such a degree that HNO₃ sales specs to outside customers or delivery specs to the neighbouring AN plants cannot be met;
 - By the recycle all necessary precautions shall be taken to avoid deposits of ammonium nitrate/nitrate in down stream process equipment.

About the ammonia/air mixture the Code gives the following obligatory requirements:

- The nitric acid plant shall be equipped with a trip function for high ammonia/air ratio and shall be equipped with a trip for high gauze temperatures indicating high ammonia content in the mixed gas;
- Trip function for low temperature downstream the ammonia superheater shall be installed.

Obligatory guidance given by the Code related to ammonium nitrite/nitrate salts:

- Weak acid shall be circulated to the cooler-condenser inlet during start-up to ensure low pH and prevent formation of ammonium nitrite. The ammonium nitrate concentration shall be checked from the weak condensate acid during start-up.

The Code pays attention to the selection of the materials of construction, and advices in selecting proper gasket materials, but these are not given as obligatory but rather as examples.

3.3.2. Nitric acid production

The scope of this section is to provide guidance as to good practice/safety considerations of the major process stages within the nitric acid process, such as:

- Ammonia evaporation:
 - The ammonia vapour to be used in the burner shall be superheated to reduce the risk of liquid carry-over;
 - Liquid carry-over shall be protected against by means of:
 - High level trip in the evaporator
 - Low temperature trip downstream of the superheater
 - The action of these trips is to shut down the plant via the ammonia trip group;
 - A facility for the blow-down of oil and/or water from the evaporator (and stripper, if included) shall be provided.
- Ammonia/air mixing and measurement:
 - The ammonia flow shall be independently measured for control and trip purposes. Two sets of tappings from the same orifice plate can be used, provided all downstream instrumentation is independent;
 - The flow rate of ammonia for trip purposes shall be temperature and pressure compensated to give an accurate ammonia/air ratio.
- Air and ammonia gas filtration:
 - An air filter shall be installed in the atmospheric air inlet. This filter shall protect the air compressor against damage due to erosion and fouling and remove most of the solid particles contaminating the gauzes;
 - The compressed air and ammonia gas streams shall be filtered prior to the catalytic gauze to remove remaining impurities.

- Combustion/reactor design:
 - The primary hazard associated with the burner is the formation of explosive gas mixtures in the combustion section i.e. the ammonia/air ratio being too great. The lower explosion limit is dependent on the temperature and pressure. A high ratio event can result in equipment/catalyst damage due to overheating and possibly lead to the explosive limit being reached. At least two independent means of protection shall be provided. As a minimum, these shall be high ratio trip and high gauze temperature trip;
 - The primary device shall be the high ratio trip, which responds rapidly to an increase in ammonia vapour flow or a decrease in air flow;
 - The ratio trip system (part of the Emergency Shut Down System) shall be independent of the ratio control system;
 - The secondary protection device shall be the high gauze temperature trip;
 - A low ammonia/air ratio trip shall be provided;
 - A low gauze temperature trip shall be provided.

- Steam systems:
 - The minimum temperature of the NO_x gas shall not be within 30°C above its dew point within the boiler/economiser sections. This is to protect against re- evaporative corrosion.

- NO gas cooling:
 - The NO gas shall not be allowed to cool below its dew point where not intended for weak acid condensation.

- Primary and secondary cooling water system:
 - In an open circulation cooling water system where an aerosol could be formed (including direct- contacting cooling towers), then a policy and procedure for the monitoring and control of Legionella shall be prepared;
 - If seawater is used for cooling, the secondary cooling water loop shall be regularly checked for chlorides;
 - A circulation cooling water loop shall be regularly checked for pH.

- NO_x Abatement Systems (NSCR - Non-Selective Catalytic Reduction):
 - High temperature trips shall be provided at the outlet of each catalyst bed (if more than one bed);
 - The operation of the DeNO_x reactor shall be such that temperature limitations of the vessel are not exceeded.

3.3.3. Rotary equipment

This section of the Code covers the design, operation and maintenance of high-speed rotating equipment in a nitric acid plant. The Code applies only to in-line compressor sets - bullgear compressor sets are excluded from this Code. The whole in-line unit, including air compressor, intercooler, tail gas expander and possibly NO_x compressor, gearing, steam turbine, motor/ generator (including motor cooler and its related lubrication and control system) is called the 'machine train'. Detailed instructions are given for the machine train instrumentation, steam turbines, compressors, tail gas expanders and lube oil and control oil systems.

3.3.4. Steam systems

This section of the Code covers the operation and maintenance of a steam system, recovering heat from the NO_x gases of a nitric acid plant. Waste heat boilers in nitric acid plants are characterised by elevated pressure and high temperature on the combustion gas side. This Code covers steam systems which may include boiler feed water pumps, economiser, steam drum, natural circulation or forced circulation boiler and superheater. Steam condensate conditioning and auxiliary boilers are not covered by this section. The steam is often used to drive a steam turbine.

There shall be independent high and low level trips on the steam drum. The high level shall trip the BFW supply, the low level shall trip the process.

There shall be a low flow trip on forced circulation boilers, resulting in the starting of the stand-by pump. There shall be a very low flow trip that shall trip the process. Consideration of a short delay may be appropriate. (There is a risk of tube failure on loss of circulation).

Corrosion is prevented by the formation of a magnetite layer. The magnetite layer shall be maintained by pH control and oxygen level control.

The boiler drum water and the boiler feed water shall be sampled at least once per day to ensure that chemical protection is maintained.

3.3.5. Equipment testing

This section covers the testing of equipment like pressure vessels, plant's emergency shutdown system, control and electrical systems, and storage tanks.

3.3.6. Nitric acid storage and handling facilities

This section of the Code covers the storage of nitric acid, the loading and unloading of ships, road tankers, rail tankers and containers with less than 68 % nitric acid.

The materials of construction for the road and rail tankers, the tanker barrel, piping, hoses and fittings shall be suitable for nitric acid. In particular, copper or any of its alloys such as brass or bronze, shall be excluded from contact with nitric acid. Tanks to contain nitric acid below 68% concentration shall be made of special steel that is resistant to nitric acid.

There shall be a procedure to ensure that the tank has been cleaned or that the previous product was identical and the tank is free of contamination.

To protect long piping against over-pressurisation and failure due to thermal expansion, the nitric acid shall not be blocked in between two shut-off valves or the volume between two shut-off valves shall be limited and a pressure relief valve should be installed in the pipeline. Attention on right and safe start-up of the acid pumps shall be provided to avoid pressure shocks to pipeline.

3.4. Code of practice for the use of Personal Protective Equipment (PPE)

In late 1990s Kemira GrowHow started a systematic work to reduce the number of Lost Time Accidents. The Loss Control process was introduced, and tools to monitor and manage safety were introduced throughout the company.

As one element to fulfil the new Health and Safety strategy, a Code of Practice for the use of PPE in Kemira GrowHow sites was first introduced in 1998.

The Code states that the use of PPE should be based on risk analysis, task analysis, accident/incident analysis and local experiences, regulations, codes and standards.

The minimum requirement for the use of PPE is as follows (applicable to the Manufacturing Area including Materials Handling and Despatch):

- Hard hat:
 - Each employee, contractor and visitor shall wear a hard hat.
- Eye protection:
 - Minimal eye protection is strongly recommended for all personnel (employees, contractors and visitors) entering the plant area (the site has to define the specification for eye protection);
 - Everyone who is making a break into line operation, or loading or unloading liquid chemicals, shall wear a goggle or a face shield.
- Hand protection:
 - In case of break into line or loading and unloading liquid chemicals chemical resistant gloves shall be worn.
- Foot protection:
 - All site employees and contractors shall wear safety shoes, except for working in and visiting offices, in control rooms, in the canteen, laboratories and in trucks, at start of work while going to the working place and going home leaving the working place and walking on the road ways.
- Ear protection:
 - Suitable ear protection shall be worn by employees, contractors and visitors in areas where the noise level exceeds the level set by local site management.
- Working clothes:
 - All employees and contractors shall wear proper clothing. It is the duty of site management to define proper working clothes for the different activities on the site.
- Breathing protection:
 - The use of breathing protection is area and job specific and shall be analysed per site.

3.5. Code of practice for work permits

Safe systems of work including the use of work permits are a fundamental requirement for the safe maintenance, construction or modification of the manufacturing plants.

The Code does not intend to standardise on the design of individual permits at Kemira GrowHow's manufacturing sites but the Code gives guidance on which permits should be used, on the authorisation of permits and on the minimum information to be contained within the permits. Guidance is also given on training and auditing.

The overall purpose of a work permit is to ensure that a job has been prepared safely for maintenance, construction or modification and that clear communication takes place with those doing the maintenance work regarding the precautions already taken, any hazards remaining and the safety precautions that need to be taken to carry out the work. The use of work permits also ensures that equipment is not returned to operation until the maintenance is completely and safely finished.

Some obligatory requirements:

- Each location shall be required to define the areas of responsibility (Work areas) and to assess the hazards and hazardous areas in which various types of permits to work are required to carry out tasks such as maintenance, construction or modification.
- Each Kemira GrowHow location shall be required to define which personnel are authorised to sign the respective permits to work. A register of these persons shall be maintained and should be readily available for reference purposes;
- Each Kemira GrowHow location shall be required to operate a written work order system for any maintenance, construction or modification work that is to be carried out in the defined work areas;
- Each location shall maintain a list of the different types of permits that may be required for maintenance, construction or modification tasks in the defined areas;
- Each location shall define the types of work that require permits and work that may be undertaken without a permit;
- Each location or department shall maintain a list of the level of responsible persons who may sign these permits;
- Each set of Permits shall have unique sequential numbers;
- The minimum set of work permits are:
 - General work permit
 - Hot work permit
 - Confined space entry permit
- The minimum content requirements for work permits are given as mandatory requirements.
- Each site shall maintain training records which should show the type and date of all permit to work training received by all personnel.

4. Experiences

The implementation of the common Codes of Practice has had many benefits.

The support of management is of essence, especially when the implementation of the Codes means investments or changes in the existing working procedures.

Clear rules on what is an obligatory requirement and what is a recommendation has made the implementation phase easier, especially when prioritising the changes at the beginning of the implementation.

The awareness of safety related matters has increased remarkably. Even though many of the items mentioned in the Codes can be found in the guideline books of the industries, the fact that they are company rules, and there is clear guidance on what is applicable, has crystallized the message.

The Codes are a powerful tool to communicate the safety practices of the company in case of acquisitions.

The internal auditing procedure of the Codes has not been clearly stated in the Codes. When more experience has been gathered, the need for some state of systematic Corporate level auditing procedure could be beneficial.

During the first implementation and training session the need for continuous training must be emphasized. The training of the Codes should be part of the normal induction programme.

The implementation of the Codes naturally has a cost. Therefore it is of great importance that the Codes have a full support of the management. By approving the Codes the management shows the commitment to a safety level provided by the Codes.

Due to the systematic work on safety, the number of LTAs has decreased steadily in Kemira GrowHow, dropping from 11,9 (1998) to 2,1 (2005).

APPENDIX 1. Classification scheme used in Kemira GrowHow.

