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International Fertilizer Industry Association - Secretariat: 28 rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

PROTECTION OF THE ENVIRONMENT AT LOVOCHEMIE
CLEANING UP A POLLUTED SITE

P. Svarc
Lovochemie a.s., Czech Republic

SUMMARY

Lovochemie, a Czech private joint-stock company, has been a producer of inorganic fertilizer since 1904, but it is only since the 1950's that chemical production has been developed significantly. The owner-state did not seriously concern itself with environmental protection until 1989. Industry was scarcely subject to emission limits or rules for waste deposit areas. After the revolution in 1989, the strict application of laws on the environment was enforced and the state assumed its environmental responsibilities.

There are several major pollution issues in the Lovochemie case:

- *the pollution of soil and underground water in the plant area and the old unauthorized waste deposit at Lukavec near the plant.*
- *air pollution forms a significant portion of the environmental costs, and this will be even a more important issue in future when the Czech Republic joins the European Union.*

The solution for the water pollution problem is oriented towards the minimization of liquid waste rejects in the framework of the project "Transboundary waters environmental protection".

This paper describes the pollution of the soil, the pollutants and their extent, the prospecting methods and the recovery procedures.

The environmental audit, as a part of the privatization project, was prepared in 1993, and covered about 60 indices of polluting elements, such as heavy metals, oil and petrol, radioactive and organic substances. The analytical results confirmed heavy pollution by motor oil, petrol (from NPK manufacturing), PCB, As, Cd, and Zn.

Recovery of soil and underground water in the Lukavec area, which began in 1993 was completed in 1997, at a cost of US$ 8 million. In the plant area the clean-up project, to be completed in 2002, is starting up.

The paper also describes the operational and investment costs for the environmental protection, which rose significantly between 1993 and 1997. The total environmental costs have reached more than 13 USD/t of product. The competitiveness of fertilizer production in the Czech Republic is limited by the high level of environmental costs, which are estimated during the next few years to be of the order of 5 USD/T.

1. INTRODUCTION

The competitiveness of a product on the world market is determined by several factors, Costs related to protection of the environment are an important factor. In the context of the reform of economic systems in countries in the post-communist period, we have to distinguish three types:

- costs needed to eliminate the ecological load related to the past activities of the enterprise
- costs needed to reach a level of environmental pollution due to present activities whereby the production of pollutants corresponds to fixed standards
- costs related to taxes required by the Environmental Protection Fund and corresponding to the authorized production of pollutants. The investment projects in this field are funded from these means.

The investments costs and operational charges continue to limit competitiveness on the markets, and this during a period when neglected modernization and industrial progress require investment in quality, productivity, innovation and research.

The objective of this paper is to describe the present problems of Lovochemie. These problems are divided into:

- Elimination of the old load on the environmental (cleaning up unauthorized discharges and the plant site)
- Attainment of a level of environmental pollution corresponding to fixed limits
- The final situation of the enterprise in the field of environmental protection.

1.1 Lovochemie

Lovochemie S.A. is an enterprise of medium size, specialized in heavy chemicals and producing industrial fertilizers.

1.1.1 Production

At present the main production output is represented by chemical fertilizers, which amount to 700 Kt per year, comprising:

- ammonium nitrate with chalk or dolomite (calcium magnesium ammonium nitrate, CAN 27% N) with an annual production of 420 Kt.
- ammonium nitrate with urea DAM 390 (Urea ammonium nitrate) whose annual production is 110 Kt
- NPK compound fertilizers (15-15-15, 19-19-19, 20-20-0) whose annual production is 110 Kt
- calcium nitrate (15% calcium nitrate) whose annual production is 60 Kt.

At present the company is being restructured in order to concentrate on “core business”, i.e. high volume chemical fertilizers, and increasing the range of compound fertilizers.

The Company has sold the chemical viscose plant, especially velvet silk viscose, used for the manufacture of tyres and for other non-essential plants, which represent only a negligible proportion of the company’s returns, will be sold.

Ammonia and urea are the main raw materials. They are mostly supplied by Chemopetrol which is located 40 km from our plant.

A substantial proportion of our production is destined for export to the German and West European markets. It is of superior quality and comparable to European production.

1.1.2 Geographical location

From a logistics point of view, Lovochemie benefits from an ideal location. It is situated on the navigable rive Elbe which flows out near Hamburg into the Baltic sea and has its own sea transport port. The plant is located where road and rail traffic cross going from Prague to Dresden.

1.2 Characteristics of the enterprise

Lovochemie is located in the urban area of Lovosice and not far from the town, in Lotomi oce district. It has its own steam and electricity plant. Rebuilding is under way and the substantial increase in productivity is contributing to a progressive reduction in the number of staff, from 1800 in 1997 to 950 at the end of 1998. The economic results are related to the dramatic fall in fertilizer consumption in the Czech Republic in 1989, up to 30% of its original level, as well as to pan-European problems. Turnover amounts to between 76 and 100 million dollars. The enterprise was privatized in 1996 and since 1997 has been undergoing restructuring and transformation. Among the main shareholders is the Unipetrol group of chemical companies and Agrofert (trade in agricultural products).

1.3 Environmental protection after the second world war

Before the second world war, Czechoslovakia was among the countries which had one of the most developed industries. The change in the political climate after integration of the country in the Soviet communist block for many years and administrative planning of the economy were the causes of a substantial reduction in the industrialization and modernization process of the manufacturing plants. Legislation existed in this field but it was always of marginal interest. Furthermore it was always possible to obtain exceptions due to the direct management of the economy by political organizations and to priorities in other fields. It is only after 1992 that the putting in place of legal standards began and at present these are being harmonized with those of the European Union. After the 1989 revolution, the Ministry of the Environment, as well as other controlling organizations which play a key role in the life of the enterprises, were constituted. The activities of organizations such as Greenpeace also were not without importance.

The main laws are as follows:
- Law No 17/1992 on the protection of the environment
- Law No 282/1992 on the Czech inspection of the environment
- Law No 224/1992 on the assessment of impact on the environment (new constructions)
- Law No 211/1994 on the protection of the atmosphere
- Law No 125/1997 on wastes

1999 is the year during which new limits concerning emissions into the atmosphere (corresponding to those in the European Union) will be fixed for producers of pollutants, as well as corresponding taxes if the authorized quantities are exceeded.

1999 will also see the coming into force of new taxes concerning the discharge of harmful agents into water. During the coming years these taxes will increase progressively.

These legislative measures, the activities of the Ministry of the Environment, the pressure of local organizations and public opinion represent an important motivation for enterprises to invest in this field. In many cases the enterprises must give priority to these costs, well before modernization and development.

2. ECOLOGICAL AUDIT AND ANALYSIS OF THE RISKS OF THE LOVOCHEMIE COMPANY

The law on the transfer of goods (privatization law) takes account of the reparation of the ecological load caused by previous activities of the privatized enterprise. The new owner naturally refused to assume the responsibilities and costs relative to this load. The obligation to carry out an audit and risk analysis in this respect constituted an integral part of the privatization project.

In the Czech Republic, there are some key industrial zones which in the past have been heavily contaminated, especially by the activities of the chemical industry.

This concerns the following enterprises:
- Chemopetrol – crude petrol schlamms discharged into unauthorized discharges
- Diamo – acid underground waters discharged after the chemical treatment of uranium
- Spolchemie- the unauthorized discharge of chemical waste
- Tonaso – the unauthorized discharge of chemical waste, especially chrome
- Ostramo – crude oil schlamms
- Lovochemie – wastes from chemical plants, crude oil schlamms.

In view of the creation of discharges containing dangerous wastes, and this over many years, we can see that this danger is considerable, especially in relation to the future pollution of subterranean waters all over the country.

2.1 Ecological audit

The ecological audit of the Lovochemie plant was carried out in 1994 by the specialist company Aquatest. The objective of the audit was to assess the impact of Lovochemie’s past activities on land, the rock medium and subterranean water. The costs relating to the elimination of this load were given in the chapter devoted to financial questions.

2.1.1 Geomorphology, hydrography

Lovochemie is located geographically on a plain, at an altitude of 149 metres. The river Elbe constitutes the main erosion base. Its flow is relatively stable over the year. Below the enterprise there are 1 to 5 metres of alluvium of different materials. Under these materials are antropozoic river sediments whose gravel and sand bed goes up to 10 to 15 metres under the surface. It is constituted of sandy gravel.

The Cenomian layer is represented by sedimentary rock to 80 m. The mother rock of the country is located 600 m under the surface. Prospection aimed to reach the shallow collector with the free table of underground water, at a depth of about 5 metres from ground level, linked to relatively permeable sandy gravel. The current of underground waters go towards the north and north-west where the river sediments become free to join the river Elbe.

2.1.2 Methods

2.1.2.1 The location of the wells and forage technology

To establish a map reflecting the contamination of land and underground water, as well of the direction of flow of the latter, we used 9 hydraulic wells and 20 wells for geographical representation (see the map). These wells were installed to serve in future as monitoring wells. The diameter of the wells is 410 mm.

2.1.2.2 Pumping trials

The pumping trials were carried out for chosen wells with a pumping duration of one hour The rising level of the water table was checked until it stabilized.

2.1.2.3 Sampling of land and underground waters

Land

The soil samples were taken at defined depths in the different wells. The following parameters were analyzed:

- The metals, especially Cu, Pb, Cd, Zn, Cr, As, Hg
- The extractable non-polar materials (hydrocarbons from crude oil)
- PCB and chlorinated pesticides
- Phenols and chlorinated phenols
- Aromatic hydrocarbons
- Selected polyaromatic hydrocarbons

The samples were taken at a depth of 0.7 m - the contamination of the subsurface level - surface pollution at 2 metres – contamination of the central layer - and, at the level of underground waters, the contaminating agents transported by the waters.

Waters

Samples of water were taken regularly in all the wells in order to identify the contaminating agents. In addition we carried out water analyses in all five wells of the plant. In the waters, we observed:

- Extractable non-polar materials (crude oil hydrocarbons)
- Phenols and chlorinated phenols
- Chlorinated biphenyls
- Chlorinated hydrocarbons
- Aromatic hydrocarbons
- The metals – especially Cu, Pb, Cd, Zn, Ni, Cr, As, Hg

- The inorganic parameters (pH, conductivity, mineralization, ammonia ions, nitrates, nitrites, chlorides, phosphates, hydrogenated carbonates, sulphates, fluorides, Ca, Mg, Na, K, Fe).

2.1.2.4 Legislative information

There is no law or standard defining the contamination of underground waters and the assessment of its degree. An ecological standard taken from Holland is available in the form of a systematic instruction of the Ministry of the Environment. Contamination is divided into three categories: A, B and C.
A - basic
B - the concentration limits requiring prospection in order to determine the sources of the contamination
C - levels of concentration for which sanctions are prescribed.

The decision to proceed with cleaning up does not have a legal basis in the Czech Republic and it is completely under the authority of the Czech Environment Inspectorate.

2.1.3 Results

2.1.3.1 Land

2.1.3.1.1 Extractable non polar materials (crude oil hydrocarbons)

The C limit has been exceeded in one case, at the location of reservoirs for fuel oil and benzene for coating, located above the soil. The land in this area shows a high level of contamination, but only within the limits of values in category B.

2.1.3.1.2 Polyaromatic hydrocarbons

For all the samples, the contamination did not exceed the levels of values of category B.

2.1.3.1.3 PCB

Limit B was exceeded in surface and central layers near the transformer, which indicates a leakage of oil from the transformer. The PCB exceeded limit B at the edge of land at the plant site. In this case, the contamination could be from a source outside the plant.

2.1.3.1.4 The metals

Limit C was exceeded in the 0.7 m layer for As near to the power plant of the enterprise. It is possible that the source of contamination could be attributed to the “ fraisil ” (cinders from brown coal). Limit B was exceeded for As below the branch for the plant, also for Cd. The other metals exceeded neither limit B nor C.

2.1.3.1.5 Conclusion

The main sources of contamination are as follows:
- the oil and benzene reservoirs used for NPK fertilizer manufacture technology
- the transformer (oil)
- the plant’s power plant (brown coal cinders)
- the branch-piping for the plant.

The cleaning up of land is required in the contaminated areas, polluted by crude oil in the proximity of the oil and benzene store near the NPK plant, and by As below the power plant.

2.1.3.2 Waters

2.1.3.2.1 Non-polar extractable materials (crude oil hydrocarbons)

Substantial pollution was observed around the oil and benzene reservoirs where the C limit was exceeded. The same pollution was observed near the branch-piping the plant.

2.1.3.2.2 The chlorinated hydrocarbons

The B limits were exceed around the degreasing plants where trichlor- and tetrachlorethylene were used, and also around the branch-piping for the plant. Limit C was not exceeded anywhere.

2.1.3.2.3 PCB

Limit C was not exceeded. As regards limit B, it was exceeded in the zone of location of the oil and benzene reservoirs and near to the branch for the plant.

2.1.3.2.4 The metals

Limit C was exceeded for Pb around the plants power plant. This was probably due to brown coal cinders.

2.1.3.2.5 Inorganic materials

In view of the type of production, a substantial part of the site had a high salt level. At the point of entry of underground waters, the level of salt is 800 mg/l and at the exit exceeds 2000 mg/l. Two thirds of the plant exceeded limit C for NH4 ions. As regards F, the pollution occurs in a substantial part of the old plant used for the manufacture of fluorine silicates. The possible source of this pollution can be attributed to the spillage of fertilizers during handling.

2.1.3.2.6 Conclusion concerning water contamination

Cleaning up the water is required in zones contaminated by crude oil around the oil and benzene reservoirs (NPK fertilizer plant) and around the branch-piping. The spilling of fertilizer on the land, the role of dust and eventual evacuation of dust into subterranean water constitute sources of contamination by inorganic contaminants.

2.1.3.3 Atmogeochemistry

The limit of contamination exceeded category C in the case of crude oil hydrocarbons in the wells near the NPK manufacturing plant and in the eastern part of the plant site.

2.1.4 Risk analysis

The site remains an industrially usable site. Contamination by inorganic salts does not represent a serious risk. Contamination by non polar extractable materials – crude oil hydrocarbons – is a risk. Contamination by chlorinated hydrocarbons, especially PCB, is also a risk.

2.1.5 Recommendations

The recommendations of the audit include cleaning up operations around the oil and benzene reservoirs for coating. In view of the area covered by the operations, it is not possible to evacuate the soil and degrade it biologically. The proposed clean-up method is to vent the soil for six months and to clean it "in situ" by rinsing. The monitoring of the situation is an integral; part. If after six months concentration of oil hydrocarbons does not decline below limit C, another clean up technique will be proposed. The eventual stopping of the use of benzene for coating in the NPK plant represents a condition of the cleanup. The monitoring of the degree of contamination by chlorinated hydrocarbons will be carried out over six months before taking a decision to carry out clean-up work around the plant's branch-piping. The reduction of contamination by As will be achieved by changing the system of storage of brown coal cinders and cleaning up soil in the areas of highest contamination.

2.2 Plan for cleaning up the plant's site

The procedure for calls for offers was launched with the objective of finding the contractor for the work. The company chosen had developed technology for cleaning up operations and presented at the end of 1997 its project for implementing it.

2.2.2 Complementary prospection

It was more than a year since the ecological audit had been carried out. In the middle of 1997, a complementary prospection was carried out to observe the possible change of contamination of recommended areas. It aimed especially at the main contaminants, i.e. the crude oil hydrocarbons. Analyses of the level of chlorinated hydrocarbons, polyaromatic hydrocarbons, PCB and heavy metals were carried out. The samples were taken from existing wells.

The results as regards crude oil hydrocarbon contamination are given in the isoline map. The centre of contamination appears around the NPK production plant where a concentration of 3700 mg/l was measured. In spite of the clear reduction in more of the wells, we noted a substantial increase in one well. It is probably due to propagation in the direction of circulation of subterranean water.

We observed a reduction in the level around the old oil store. This is no doubt due to dilution by water coming from the bed of the Elbe. There was little change in the case of the other contaminants.

2.2.3 Realization technology

The cleaning up technology consists of pumping-out underground waters, cleaning them and returning them into the contaminated area with a biodegradable product added. In view of the subsequent contamination in the direction of circulation of subterranean waters, 4 other cleaning up wells will again be constructed in the area of the NPK production plant. The dimensions of the contaminated land are approximately 75 x 75 metres.

The cleaning-up pumping from existing wells will begin in the eastern part of the plant's site. The level in the underground waters around the old oil store has fallen, but the soil are still has concentrations of 3 to 5 g/m3. For this reason the venting method will be used.

2.2.4 It is prohibited to saturate land with noxious agents coming from the NPK manufacturing plant.

The avoidance of the possible saturation of land with benzene for coating coming from the NPK plant is an essential condition for the effectiveness of the cleaning up operation . In year 2000, Lovochemie envisages the implementation of direct elimination by freezing with the help of indirect freezing of benzene for coating (Uhde technology). A coating-benzene balance has been prepared to ensure the sealing of the whole system, but has demonstrated the leakage of this material into the soil. The entire piping system and storage sites have been checked regularly as regards sealing. Where sealing has been damaged, the installation has been repaired.

2.2.5 Costs

The cleaning up operation has not for the moment been implemented. The signature of the contract with the supplier is envisaged for the month of September 1998, the completion date being foreseen in 2001. The anticipated cost is 1 M dollars.

3. THE LUKAVEC DISCHARGE

The discharge area is located near the southern edge of the Elbe valley in a deserted quarry where chalk has been extracted in the past. The discharge covers an area of about 105 000 m^2 500 m from the commune of Lukavec. After the end of chalk mining, for more than 30 years the waste from chemical production was stored there. It concerned in particular the following materials:

- cleaning effluent from neutralizing schlamms
- waste from fertilizer manufacture
- brown coal cinders and slags
- gravel and construction wastes
- soil and filters contaminated by crude oil hydrocarbons
- waste from the production of viscose fibres

- packaging materials and PVC containers with the remains of contaminating agents
- solid waste from the paint manufacturing plant.

The waste was stored in the open air without being protected against water leakage into the underlying layer. In 1993 storage was stopped. The area around the discharge is at present being farmed.

The underground water table is located at a level of 4.5 m. This collector is very vulnerable since it is constituted for the most part of permeable sandy gravel. The underground water flow goes toward the river Elbe. Following leakage of polluting agents from the discharge into underground water, the northern zone of these waters has a high concentration of Na, NH_4, Cl, NO_2 and NO_3 ions.

3.1 Risk Analysis

The extent and the level of contamination of the discharge area and the underlying layer were examined by prospection as from 1990 and then in 1992. The objective of this work was to analyze the stored material, the contamination of underground water and the model of the circulation of underground waters. The monitoring of the quality of the underground waters in defined wells began in November 1994 and has continued to date.

The risk analysis was brought up-to-date in 1997, taking account of the monitoring of the effectiveness of cleaning up work and after the elimination of the primary sources of contamination. The situation as regards pollution of underground water in and around the discharge area was the main object of the risk analysis and especially of its up-dating. In the stored soil samples and water extracts the level of fluorides seemed high, exceeding the limit in the C values and this 14 times (57 mg/l). The content of crude oil hydrocarbons was situated in values B and C. We observed that the limits of certain metals such as As (230 µg/l), Cu, Ni, Hg were exceeded.

The quality of the underground water under the storage area was checked only once in the context of prospection work preceding the cleaning up of the discharge. The underground water contained quantities of chlorides (up to 432 mg/l), NH_4 (336 mg/l, NO_2 (18 mg/l), NO_3 (1925 mg/l), F (6 mg/l) exceeding the limit. As regards metals, it is Zn with 6 mg/l, Ni and Al which exceeded the limited. Chlorinated hydrocarbons also exceeded the C limit (dichorethane 133 µg/L). The degree of contamination with PCB was situated in the B value limits. Cyanides were observed to be at about 0.17 mg/l. The hydrological prospection and underground water prospection showed flow towards the river Elbe. This was confirmed by analysis of contamination in the wells.

The overall mineralization of underground water - the reference value outside the discharge area - is high and is about 1300 mg/l. Nearer the discharge, it increases to 6000 mg/l. The underground waters are saturated especially in Na and Cl ions, which is due especially to the storage of salt for the salting of roads near the discharge. The NH_4 and NO_2 ions exceed by up to 10 times the C limit in the area below the discharge. Their concentration diminishes as they rejoin the river.

3.2 Cleaning up

3.2.1 Principles

The old discharge area is composed of six (S1-S5) storage lagoons where contaminated material was disposed of. The schlamms and contaminated soils were successively removed from each zone and transferred to the S6 lagoon area, already authorized. Part of the soil with a lower degree of contamination was degraded using biodegradable products. The area freed in lagoons S1-S6 was authorized and part of the soil transferred to its place of origin. The area was put back into cultivation in order to be able, in due course, to use the land for agricultural purposes.

Lagoon S6 is a new safe discharge comprising a free space for eventual protected storage. The other zones have been finally closed and authorized.

3.2.2 Closure technology for lagoon S6

- the underlying layer of S6 has been shaped and thickened according to Czech standards concerning the closure of dangerous discharges.
- the mineral joint whose thickness is 1 m has been placed in 5 thick layers on the underlying layer
- the 2 mm film which represents the primary barrier, has been posed on the adapted surface
- to protect of this film against rupture a geotextile whose load is 800 g/m has been posed on it
- the geotextile is double under the piping
- over the geotextile is a drainage and protection layer of 0.3 m.
- on the drainage layer we have placed a transitory layer of contaminated brown coal cinders of 0.2m.

The work carried out has been followed by an organization designated by state bodies especially as regards the placing of insulating layers and the correct realization of the pose in general. As regard the seal, pressure tests as well as the checking of the welds have been carried out.

3.2.3 The drainage system

The drainage system is designed as a horizontal network collector linked to a grouped conduit. The principal collectors are composed of pipes with a diameter of 300 mm. This pipework ends in a check point outside the discharge where is it possible to monitor the gases and rinse the drainage system. The drainage system is linked to the pumping station which evacuates the water into the scrubbing system of Lovochimie. A rain water collection gutter with an evacuation pipe has been constructed in the drainage system.

3.2.4 Costs

The costs of the clean-up reached 8 M dollars between 1994 and 1998.

3.3 Present situation

The clean-up began after the calls for tender and the drafting of the project for realization in September 1994, and ended in May 1997. During the clean-up operations 350 000 m^3 of contaminated soils were evacuated and 370 000 m^3 were handled in total. A capacity of 195 000 m^3 was established in lagoon S6 with, as its objective, the eventual storage of dangerous waste in the years to come.

3.3.1 Underground waters – Present situation

To be able to assess the present situation concerning the contamination of underground waters (in 1998), we used all the data assembled during the prospections and monitoring during the clean-up. In the context of the monitoring operation, the quality of underground waters was followed at a three monthly intervals in 6 basic wells and 4 reference wells. The degree of water contamination of the discharge was checked at the exit point of the drainage system into the control point. Monitoring was carried out from November 1994 to date and it will continue.

3.3.1.1 The crude oil hydrocarbons

The level of contamination is very low, the values exceeding the limits have been observed only exceptionally (7000 µg/l). In other cases the values were at the natural background level.

3.3.1.2 PCB

Values between the B and C limits were observed only in certain wells, the other concentrations being at the background level.

3.3.1.3 Volatile organic matter

Contamination has not been observed.

3.3.1.4 Metals

The C limit value is exceeded for Al. The Ni content is at the base level. The Zn values have not reached the B limit.

3.3.1.5 Inorganic ions

The fluorides level had fallen below the B limit in all the wells, As regards the NH_4, NO_2, NO_3 and Cl ions, the level has fallen substantially. NH_4 has fallen to 260 mg/l, NO_2 to 3 mg/l and NO_3 to 750 mg/l. This fall is proof of the effective elimination of the source of contamination. According to the mathematical model, the eventual removal of the remaining contents by water is very possible in the coming years.

3.3.2 Risk evaluation

The analysis demonstrated a health danger for people in the event of the use of underground water for drinking purposes. This risk is eliminated if the NO_3 levels fall below 58 mg/l. The NO_3 limit fixed for drinking water is 50 mg/l. The underground waters are not used in the area as drinking water, since the communes are linked to the drinking water distribution system from good quality sources. Having said this, it is not realistic to reach this level.

The use of underground water for irrigation is unlikely, but reaching the chloride limit of 400 mg/l is also unrealistic.

3.3.3 Recommendations

It is recommended that the present network of wells should be kept and the contamination of underground waters monitored at six monthly intervals. In view of the low level of volatile organic matter, it is possible to exclude these from the analyses.

3.3.4 Conclusion

- It has been proved - supported by the modern solution for the transport of contaminating agents – that the water quality of the Elbe will no longer be threatened by the migration of pollutants contained in underground waters after cleaning-up.
- The underground waters should not be used, neither as drinking water nor for irrigation (in view of the nitrate and chloride contents)
- From the point of view of using the site, it is not necessary to plan for the cleaning up of the underground waters.

4. OTHER ECOLOGICAL LOADS DUE TO LOVOCHEMIE ACTIVITIES

In the context of a responsible approach to the protection of the environment, Lovochemie A.S. has had to attain - in the form of the policy for the protection of the environment adopted by the company - the following objectives:

- Reduce by year 2000 the negative influence on all the component parts of the environment, conforming to EU limits and conforming subsequently with the trend towards increasingly strict regulations.
- Resolve for year 2002 the whole of the problem linked to the elimination of the old ecological load resulting from the period before privatization
- Carry out a programme of the successive modernization of technologies used and to make them more ecological, with the objective of reducing the negative impact on the environment and at the same time providing the best possible conditions for production
- Carry out our own training programme for all employees with the aim making them feel responsible for the objectives of the company in the context of environmental protection.

In 1998, Lovochemie requested that its environmental protection programme should be reviewed and attributed the Responsible Care logo, according to CEFIC rules. As from 1996, the programme was an integral part of the quality certification system RZ TUV ISO 9002.

4.1 The waters

As regards water protection, the strategic objective for 2002 consists of limiting the volume of residual waters evacuated into the Elbe by 10%. In order to do this, the following means will be used:

- optimization of the technological process in fertilizer manufacture
- the reconstruction of the NPK production plant using new indirect freezing and cleaning of the gases
- the constructions of chemical canalization conduits which were damaged
- the reconstruction of the cleaning station for residual waters.

In all cases, our activities will be oriented towards research and the elimination of primary source of contamination. Lovochemie wishes to participate actively in the programme called "The protection of the frontier waters of the Elbe river" under the management of the UN and the international committee for the protection of the Elbe.

4.1.1 Actions carried out to protect waters

- Degasification of residual waters
- The scrubbing of the schlamms press
- Monitoring of residual waters
- Adaptation of distribution conduits
- Reconstruction of sewers
- Reconstruction of the oil management system
- Circulation of refrigerating waters
- Scrubbing of gases coming from the NPK plant.

The evacuation of undissolved materials has fallen compared with 1990 by 310 t/year to 208 t/year. The quantity of phosphates has fallen from 300 t/year in 1990 to 90 t/year.

4.2 Air

The strategic objective consists of achieving stricter limits for the emissions of SO_2, NH_3, HF, which will be in force as from 1999. To reach these limits, we have carried out the following actions:

- the reconstruction of scrubbing stations of the NPK plant allowing the limits of 50 Mg/m^3 to be achieved for NH_3 and 10(5) mg/m^3 for HF
- the reduction of SO_2 emissions and solid parts from the generator of the plant to reach for SO_2, the limit of 2500 mg/m^3 and for solids 150 mg/m^3.

Action to protect the air

- the reconstruction of coal boilers, the installation of gas boilers
- the installation of a selective reduction valve in order to reduce NO_x emissions during production of HNO_3
- the construction of the dedusting unit
- the reconstruction of NPK scrubbing stations
- the reconstruction of the NPK neutralization equipment

Between 1990 and 1997, emissions have fallen significantly as shown in the following table:

	1990	1997	97/90 %
SO_2 (t/year)	6500	2100	32
Solids	3800	54	1
NO_X	3000	1000	33
HF(t/year)	33	3	9
NH_3 (t/year)	800	220	28
Fertilizer production (kt/year)	590	650	110

In order to be able to follow the load of the region, the concentrations of the main harmful agents especially NH_3, HF, SO_2 and NO_x are measured every day at 8 measuring points installed around the Lovochemie pant. These data are evaluated and the State bodies are kept informed about the situation. As regards emissions within the enterprise, the situation is also checked regularly to maintain and improve the standard of work-place hygiene.

4.3 Waste

As regards waste, at present our strategic objective is aimed at the efficient management of the new Lukavec discharge, the commercial management of its capacity and the minimization of waste production as such, possibly their secondary utilization.

The production of waste is tending to decline

	1990	1997	97/90 %
Total production (kt/year)	88	40	45
Dangerous waste (t/year)	3000	400	13

5. COST OF ENVIRONMENTAL PROTECTION

Since 1992 the costs of environmental protection have been increasing and will stabilize when the limits fixed have been reached. In future the trend will be rather for them to fall. This shows the curve of costs for the years 1990-1997 and after 1998. The breakdown of Lovochemie costs into investment costs and operating costs are given in the annexed table.

ANNEXES

Figure 1. Isoline map of underground waters - Lovochemie site

Figure 2. Isoline map of the concentration of crude oil hydrocarbons in underground waters - Lovochemie site

Figure 3. Maps of the wells - Lukavec discharge

Figure 4. Development of NO_3 going into the Elbe from the Lukavec discharge

Graphs illustrating the loads

Table and graphs of the costs.

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