AN ABSTRACT FOR PUBLIC REVIEW OF AN ENVIRONMENTAL IMPACT STUDY FOR THE PVC PRODUCTION PLANT AT THE DINA PETROKEMIJA D.D. INDUSTRIAL COMPLEX AT OMIŠALJ

IN ZAGREB, MARCH 2007

EKONERG d.o.o.
Koranska 5, ZAGREB, CROATIA

Client: DINA Petrokemija d.d.
Poje 1, 51513 Omišalj

Contract No.: I-16-461

Title:

AN ABSTRACT FOR PUBLIC REVIEW OF AN ENVIRONMENTAL IMPACT STUDY FOR THE PVC PRODUCTION PLANT AT THE DINA PETROKEMIJA D.D. INDUSTRIAL COMPLEX AT OMIŠALJ

Prepared by: Veronika Tomac, BSc (Chem. Tech.)
Ante Ćurković, BSc (Mech. Eng.)
Niko Malbaša, PhD, BSc (Mech. Eng.)
Gabrijela Kovačić, BSc (Chem. Tech.)
Brigita Štefančić, BSc (Chem. Tech.)
Renata Kos, BSc (Mining Eng.)
Veljko Vorkapić, BSc (Biology)

Director of Environmental Protection Department: Niko Malbaša, PhD, BSc (Mech. Eng.)

Director: Zdravko Mužek, MSc

In Zagreb, March 2007

TABLE OF CONTENTS:

APPENDICES CONTENTS

1. INTRODUCTION

This Environmental Impact Study deals with the construction of the polyvinyl chloride (PVC) plant in the DINA Petrokemija .d.d at Omišalj.

An obligation to have an Environmental Impact Study made for the planned plant arises from Environmental Protection Act (OG 82/94 and 128/99) and the Ordinance on Environmental Assessment (OG Nos. 59/00, 136/04, 85/06). The Study has been prepared according to the content specified in Article 5 of the Ordinance on Environmental Assessment.

On 20 December 2006, the first session of the Commission for the Environmental Assessment of the Project appointed by the Ministry of Environmental Protection, Physical Planning and Construction was held. The Commission found that the Study contains material elements for an assessment of project acceptability to be made. In addition, it found that after amendments to the Study according to comments given by the Commission members are made and the said amendments are approved by the Commission, the Study should be made available for public review. A public review is part of the process of environmental assessment of the planned project.

2. BASIC INFORMATION ABOUT THE DINA INDUSTRIAL COMPLEX AND THE PLANNED PVC PRODUCTION PLANT

DINA industrial complex

The DINA industrial complex is located in northwest part of Krk Island in the area of the Omišalj Municipality (Figure 1). The settlements located the nearest to the DINA industrial complex are Njivice and Omišalj. Omišalj and Njivice are about one km northeast and two km south of the complex limits respectively.

The DINA industrial complex covers the area of 139 ha. Onetime plans were to construct in this area a petrochemical complex with plants for production of vinyl chloride monomers and ethyl chlorides (VCM/EDC), low density polyethylene (LDPE), high density polyethylene (HDPE), ethyl benzene, styrene monomers, and pyrolysis facility. Initial plans have, however, not been realized and only the VCM/EDC[1] and LDPE plants with auxiliary facilities for production of steam, water supply and preparation, waste water treatment, etc. started operation in 1984 (Figure 2). In addition to production and auxiliary facilities, the DINA industrial complex also comprises an industrial port called Sepen through which the bulk of raw materials and energy products/utilities are transported.

Environmental monitoring programme

Soon after the facilities at the petrochemical complex at Omišalj were put in operation, an extensive environmental monitoring programme, i.e. a programme of monitoring the impact of the DINA structures on the environment was introduced[2]. This programme has been implemented for about twenty years. The subject of the environmental monitoring programme is the Institute of Public Health of the Primorje-Gorski Kotar County. The results of this programme and the conclusions made about it are made known annually and regularly presented to the local self-government in the form of a special report after being accepted by an Expert Commission for the assessment of the impacts of the DINA structures on the environment.

---

[1] The VCM/EDC plant temporary stopped operating in 2002 due to economic disturbances in the market. The plant was emptied and brought to a standstill.

[2] The programme of monitoring the impact of the DINA structures on the environment was prepared based on the 1982 Environmental Protection Study made pursuant to urban development requirements for the construction of the DINA complex accepted by the Executive Council of the Krk Municipal Assembly on 6 May 1977. In 1985, Regional Association of Municipalities of Rijeka appointed a Commission for Monitoring the Impact of DINA on the Environment. The Commission consisted of the representatives of professional and scientific institutions, and territorial political communities to enable long-term, all-inclusive and unbiased professional assessment of annual test results. The Expert Commission has prepared a programme for monitoring possible impact of DINA on the environment, which programme has been continuously implemented and updated as for its content and kind of tests since 1986. The Council of Primorje-Gorski Kotar County made in 1993a new Decision on Appointment of an Expert Commission for pursuant to legal provisions of the Republic of Croatia Monitoring the Impact of DINA – Petrokemijska industrija Omišalj on the Environment.

The Environmental monitoring programme, i.e. the monitoring of the impact of the DINA structures on the environment , covers air quality testing[3], water testing[4] (DINA fresh water, see and waste water), an assessment of genotoxic effects of DINA waste water and bio-monitoring *in situ* of exposed maritime organisms. The position of measuring stations for monitoring the impacts of the DINA structures on the environment is presented in Figure 3**.** Parallel with environmental monitoring, chlorinated hydrocarbons in the working atmosphere of DINA have been tested and the health status of the DINA employees controlled.

The test results of testing environmental impacts of DINA over a 20-year period (1986 – 2005) showed that the quality of the environment was not impaired.

PVC production plant

Polyvinyl chloride (PVC) is produced by polymerization of vinyl chloride monomer (VCM). Considering that the DINA industrial complex already includes the plant for production of VCM, a compound only used for PVC production, the investor wishes also to construct a PVC plant there. In this way a production chain from VCM, the basic raw material, to PVC, the final product would be closed in the same location, which is a normal practice in the world.[5] The capacity of the planned plant is 120,000 tonnes of PVC a year.

PVC will be produced by suspension polymerization (S-PVC). Along with VCM, the basic raw material, the list of chemicals used for PVC production includes compounds used initiate the polymerization reaction (Trigonox 423-W50, Trigonox EHP-W60), suspension agents (Methocel 50, polyvinyl alcohol, Alcotex 72,5), suspension inhibitors (acetone thiosemicarbazone – ATCS), additive (Tween 21), puffer (sodium hydrogen carbonate) and an agent used as protective coating to prevent PVC from depositing on the walls of the polymerization reactor (Noxol). As for the utilities required for PVC production (steam, cooling water, demineralised water, air, etc.), the planned plant will fit into the existing

---

[3]Air quality testing programme covers: (1) continuous monitoring of 24-hours concentrations of sulphur dioxide and smoke at the stations of Omišalj and of Jezero /Lake/ near Njivice; (2) continuous measurement of average daily chloride concentrations at the stations of Omišalj and of Jezero near Njivice; (3) testing of quality and composition (pH, total non-soluble portion, ash, combustible, total soluble, sulphates, nitrates, chlorides, ammonia, calcium and low-molecular chlorinated hydrocarbons) of the total sedimentary matter at Omišalj and Jezero near Njivice and the Ponikve reservoir; and (4) testing of acidity and the content of sulphate, nitrate and ammonia in daily precipitation samples at Jezero near Njivice and the Ponikve reservoir.

[4]Water testing includes: (1) testing of fresh water from surface reservoirs of Jezero near Njivice and the Ponikve once a month. The parameters of the lake/reservoir water that are determined are the following: temperature, turbidity, pH value, consumption of $KMnO_4$, total organic carbon and easily volatile chlorinated hydrocarbons. (2) Testing of DINA waste water quality; parameters determined are: temperature, appearance, pH value, suspended matter, chlorides, chemical oxygen consumption (COC), 5-day bio-chemical oxygen consumption (BOC_5), total grease, low-molecular chlorinated hydrocarbons and heavy metals (mercury, cadmium and lead). The tests also cover measurement of a change in the temperature of the sea water used in DINA cooling system. (3) Testing of coastal sea that is directly affected by DINA waste water (100 m from plant waste water drainage and in the bay of Sepen) and of that at the reference station Punta Ćuf. The tests are carried out once a month at all three stations. The sea water is tested for temperature, turbidity, pH value, chlorides and low-molecular chlorinated hydrocarbons. The tests also include sediment testing at Knez Cape and at the bay of Sepen. The sediment is tested for heavy metals such as mercury, cadmium and lead.

[5] As a result of this, the produced VCM will not be shipped to its users – PVC production plants by sea as it used to be in previous years. When the PVC plant is constructed, the produced PVC will be used at spot as input raw material in production of PVC, and the end users will be provided with PVC powder.

infrastructure of the DINA industrial complex; thus any expansion of the infrastructure will not be necessary as its capacities suffice for the needs of both existing plants and the planned PVC production plant.

Suspension polymerization (S_PVC) is a discontinuous (batch) process. In this process, first a puffer solution and then liquid VCM and demineralised water (used for heat removal developed during reaction) are introduced into the reactor. After some time, suspension agent and polymerization initiator are added. When a conversion ratio of 80-85% is reached, the inhibitor is injected to stop reaction. The batch is discharged into a suspension vessel from where it is continuously sent to a stripping column in which residual VCM is removed from the suspension with steam. The suspension is then sent to the homogenizing tank providing continuous suspension feeding into the drier. During the drying process, first water from suspension is removed and then the suspension is sent to the drier where a wet powder is dried in a stream of hot air. The finished product, i.e. PVC power, after being dried in control silos, is fluidized and homogenized, and taken to finished product silos. From there, PVC powder is transported by air-conveying system to the bagging line or filled directly into road-tankers.

The residual gases and residual VCM from the production process are sent to the VCM recuperation unit where VCM is separated and sent back to the production process. The inert gases accumulated in the monomer recuperation process are released into the membrane purification system where VCM is further separated and sent back to the VCM recuperation unit and the rest is taken to the system for incineration of waste gases and liquids located in the existing VCM/EDC plant. The design capacity of this system is such that it can receive and treat not only the waste gases and liquids arising from VCM/EDC plant but also the inert gases from PVC plant.
PVC flow diagram is shown in Figure 4.

The planned, i.e. the described technology of PVC production belongs to a category of European Best Available Technique. The concept of Best Available Techniques (BAT) is a key principle in the EU Directive 96/61/EC concerning integrated pollution prevention and control (IPPC).

3. A BRIEF OVERVIEW OF ENVIRONMENTAL IMPACTS

In the analysis of environmental impacts, the impacts of existing facilities at DINA[6] and the planned PVC production plant were considered collectively.

Air

Direct emissions into air from the PVC production process will only include those from the PVC powder drying unit and from storage silos of finished products.

In the PVC powder drying unit, wet powder is dried with hot air. Then, such air passes through a cyclone and wet scrubber where it is purified and drained through a ground-level vent. Air quantity at the vent is 96,000 m^3/h and output air will have up to 13.9 mgVCM/m^3_{air} maximum, or 75.19 mgVCM/kgPVC[7] only at plant start-up and in the event of possible disturbances in the process, in which case the process is stopped.
Under normal working conditions VCM concentrations at the said vent are not expected to exceed 5.5 mgVCM/m^3_{air}. The said emission, converted into the units given in the Ordinance on Emission Limits for Air Pollutants from Stationary Sources, is 28.1 mgVCM/kgPVC; this means that emission value is less than the limit value, i.e. 100 mgVCM/kgPVC, as set out in the Ordinance.

Ground-level VCM concentrations in the environment are not set out in legislative regulations; these regulations only specify 5 mg/m^3 [8]as maximal allowable value of VCM concentration in working rooms and spaces. Considering that a normally applied criterion for open spaces (the environment) is one-tenth the maximal value specified for working spaces, the maximal allowable value of VCM concentration in the environment could be considered to be 0.5 mg/m^3. Since air emission during plant operation will not exceed 13.9 mgVCM/m^3 even in extreme conditions, it is necessary to provide for diluting this concentration in the

---

[6] Existing sources of air pollutants include: discharges from utility facilities to which steam boilers and diesel motor are connected; three discharges from three ethylene dichloride cracking furnaces of the VCM/EDC plant; and joint discharge of thermal incinerator and flame tubular boiler on which waste liquids and gases generated during VCM/EDC production are incinerated. The total number of discharges of air pollutants in the DINA complex is five. After being pre-treated at the production facilities, all waste water is sent to the central waste water treatment plant to be additionally treated before being finally discharged into the sea. In the DINA complex there is one waste water discharge into the sea.

[7] According to the Ordinance on Emission Limits for Air Pollutants from Stationary Sources (NG Nos.140/97, 105/02, 108/03, 100/04, 98/05) Article 49, LEV for vinyl chloride in mono-polymer suspension in the places of transition from the closed system to the open system (treatment and drying) is 100 mgVCM/kgPVC. A maximum VCM emission from the drying unit is 13.9 mgVCM/$^3_{air}$. Thus this emission, converted into the units given in the Ordinance, totals 75,19mgVCM/kgPVC, or it is less than the limit value of 100 mgVCM/kgPVC set out in the Ordinance.

[8] According to the Rules on maximal allowable concentrations of harmful substances in the atmosphere of working rooms and spaces and on biological limit values (OG 92/93). A maximal allowable concentration (MAC) of harmful substances is that high limit of the concentrations of harmful gases, fumes and aerosols at a temperature of 20 ^oC and pressure of 1013 mbar in the air of working rooms and spaces which, based on current knowledge, does not negatively affect health over the course of a day-to-day 8 hour work shift (under normal micro-climatic conditions and moderate physical exercise). It is expressed in ml/m^3 (ppm) and in mg/m^3 or in the number of fibres/cm^3. The MAC for vinyl chloride is 2 ppm or 5mg/m^3.

environment by 28 times; this can be achieved, irrespective of meteorological parameters, at distances of a few hundreds of meters from the source of emission. Thus, all concentrations higher than0.5 mg/m^3, if any, will be localized within the fence of the industrial complex.

It is expected that particle emission at the vent of the PVC powder drying unit will be 10 mg/m^3. According to the Ordinance on Emission Limits for Air Pollutants from Stationary Sources, Article 17, the limit value of particle emissions for the expected air stream is 150 mg/m^3.

There will be also emissions into air from the finished product silos in which air is used for PVC powder fluidization and homogenization. The silos will be provided with high-performance bag-like filters and thus PVC particle emission into air will be negligible.

Some parts of the PVC plant are to be connected to existing systems in the DINA complex. Thus, steam for PVC production will be supplied from the existing system and the inert gases from the VCM recuperation unit will be sent, after they have passed the membrane unit, to the system, existing within VCM/EDC plant, for incineration of waste liquids and gases. All emission measurement to date on the systems mentioned above and on all the existing sources of pollutant emissions into air in the DINA complex was made by a certified laboratory. Based on the said measurement, a conclusion was drawn that all measuring parameters comply with the values set out by the law. In view of the fact that any expansion of the existing systems will not be necessary since their capacities meet the requirements/needs of the planned PVC production plant, it is not expected that the limit values of pollutant emissions into air from the existing units to which PVC production will be connected will be exceeded because of the operation of the new plant.

In the analysis of an impact on the quality of air in the areas surrounding DINA, a Gaussian dispersion model SCREEN 3 recommended by the US Environmental Protection Agency (US EPA) was employed. A conservative, "screening" method, namely dispersion calculation with a set of meteorological data that provide the highest hour-by-hour concentrations of pollutants found around the source was used. Input data for the model are pollutant emission parameters and points at provisional distances from the source at which above ground concentrations of pollutants are calculated. The results of the calculation show that the operation of both the existing facilities at DINA and that of the planned PVC plant, taking also into account current pollutions, will not result in an impaired air quality that is now of the Category I.

Water

WASTE WATER

On site of PVC plant the following kinds of waste water will be produced: storm water from the plant working area, sanitary waste water and plant (industrial) waste water.

Storm water from the plant working areas will be collected and sent to a waste water pre-treatment facility within the PVC plant. In waste water pre-treatment process, particles and possible oils and grease will be separated and clarified water free of oils and grease will be than taken to the DINA central waste water treatment plant.

Sanitary waste water will be evacuated through a special drainage system to the DINA central waste water treatment system.

In PVC production several waste water streams are produced; they can be categorized as: water that has been in contact with VCM; water that has not been in contact with; and water separated from PVC suspension by centrifuging. The waste water streams from the production process will be, depending on the kind of load, partially treated at the plant and then sent to the DINA central waste water treatment plant for further treatment.

The DINA central waste water treatment plant was designed to meet the needs of all the production plants that were planned to be constructed in the petrochemical complex. Of the planned plants only VCM/EDC and LDPE plants have been constructed and thus the plant operates at reduced capacity relative to the designed one. Consequently, the plant has spare capacity to receive additional quantities of waste water produced at the PVC plant.

Previous experience of the DINA central waste water treatment plant suggests that the plant shows good results in purifying input waste water streams over a number of years; this is confirmed by the results of monitoring waste water composition at the plant outlet. Therefore, it is expected that such good results will be also achieved when the PVC plant starts operation.

Output concentrations of pollutants from the central waste water treatment plant will not exceed limit values set down in regulations in force and therefore will be in compliance with requirements for waste water discharge into natural receiving water body /recipient/ of Category II.

COOLING WATER

For the production process, certain quantities of cooling water have to be provided. Necessary quantities of cooling water will be provided from the existing DINA central cooling system (CCS) that provides cooling water in a closed-loop system. Sea water circulates in the primary loop of the CCS, takes heat, in the heat exchangers, from the used cooling water and is then discharged into the sea. The existing central cooling system will be able to meet extra demand for cooling sea water once the PVC plant is constructed without its capacity being expanded. In addition, a current average difference between water temperatures at the input and output will not change.

WATER SUPPLY

The capacity of an existing industrial water supply system suffices for the needs of both DINA's existing facilities and the PVC plant planned.

Waste

During PVC plant operation and its regular maintenance certain quantities of hazardous waste will be produced. Such waste will include: waste oils and oily waste; waste from oil and grease separator; and non-hazardous waste from plant maintenance, i.e. mostly metal waste. In plant operation, certain quantities of sludge (mostly PVC particles) will be present in the device for pre-treatment of process waste water that has not been in contact with VCM. Being classified as non-hazardous waste, it will be sent back into the production process. In the central waste water treatment plant, i.e. in its portion for biological treatment (BIOX) sludge from biological treatment of waste water will be collected. Such sludge will be densified/thicken and pressed in the very central waste water treatment plant. Biological sludge will be disposed outside DINA, i.e. a contract for its disposal will be made with a legal person holding a licence for such an activity.

Emergencies

Some raw materials used for PVC production are categorized as highly inflammable substances (VCM) and as toxic substances (VCM, acetone thiosemicarbazone – ATCS, Trigonox EHP-W60). In order to reduce the possibility that an emergency situation arise during the plant operation and to minimize the effect of a possible emergency situation, vessels and the pieces of equipment in which substances harmful to people and the environment will be stored, used and otherwise handled will be installed in compliance with legislation, Croatian standards and good engineering practice. In addition, an existing operational plan of interventions in environmental protection and an operational plan in the event of sudden pollution of the coastal sea will be supplemented with data on hazardous substances used at the PVC production plant; also new plans and the existing plans and procedures directly related to environmental disaster and its consequences will be made and supplemented respectively as governed by the Safety at Work Act (OG 56/96, 114/03); Fire-Fighting Act (OG 58/93; 33/05), Safety and Rescue Act (NG 174/04) and Chemicals Act (NG 150/05).

Noise

In view of the location of the whole DINA complex relative to the surrounding settlements, i.e. Omišalj and Njivice that are situated about one km and two km respectively of the complex limits, it can be concluded that the noise created during the operation of both the existing facilities and the planned PVC plant will not affect the surrounding communities.

4. PROPOSED ENVIRONMENTAL PROTECTION MEASURES TO BE TAKEN DURING CONSTRUCTION AND PVC PLANT OPERATION, INCLUDING PROPOSED MEASURES FOR PREVENTION AND ALLEVIATION OF THE CONSEQUENCES OF POSSIBLE EMERGENCIES

Environmental protection measures to be taken during PVC plant construction

SOIL AND WATER:

- Manage site operations so as to avoid unnecessary ground stamping by machinery, backfilling with construction material and waste, and pollution with fuels and lubricants.
- Maintain regularly machinery and equipment.
- Provide for a mobile sanitary chemical unit for sanitary waste water, and empty and clean/maintain it regularly
- Where fuel tanks for machines and the plant are located at site, ensure that they have two linings and that they are placed in a catch basin Make available on site suitable absorbing agents for cleaning up polluted soil in the event of fuel or lubricant leakage from the plant and machines.

AIR:

- Where necessary, spray water in the zone of machinery movements in order to reduce rising of dust.

WASTE:

- Collect and select by types waste generated during construction.
- Organize waste carting and disposal depending on project construction schedule.
- Provide for the carting to an appropriate waste disposal site of construction waste, generated during construction (concrete, stone, excavation soil), which can be used in plant construction and location renovation/clean-up.
- Use metal waste generated during construction as secondary raw materials.
- Dispose hazardous waste generated during construction through an approved hazardous waste collector

NOISE:

- During construction, use sound-proof equipment and construction machinery causing less noise pollution.

Environmental protection measures to be taken during PVC plant operation

AIR:

- Filter the air used for drying PVC powder through a purification system consisting of a cyclone and an air scrubber.
- PVC emissions from the drying unit during normal operation shall not exceed 100 mgVCM/kgPVC. Any deviations may be only tolerated during plant start-up.
- Measure concentrations of VCM and particles at the outlet of a drying unit.
- Install particle filters on PVC bins/vessels and silos.
- Send gases from a VCM recuperation unit to a membrane unit.
- Send gaseous VCM separated in the membrane unit to the recuperation unit. Send the VCM-purified gases from the membrane unit to a waste gas incineration system within the VCM/EDC plant.

WASTE WATER:

- Send storm water from working areas to pre-treatment consisting of a retention basin and oil separator and then to the central waste water treatment plant.
- Send process (industrial) water that has not been in contact with VCM (1) water used for washing reactors and (2) water used for washing pieces of process equipment that has not been in contact with VCM for pre-treatment to retention basin and oil separator and then to the existing central waste water treatment plant.
- Send sanitary waste water to the existing central waste water treatment plant.
- Send the water that has been in contact with VCM to stripping columns. Send purified water to the central waste water treatment plant.
- Use water separated from suspension by centrifuging for flushing process equipment or send it to the central waste water treatment plant.
- Send scrubber water used for air washing back to homogenization vessel.
- Maintain systems for drainage of waste water streams regularly.

WASTE:

- Provide for separate collection of waste by the type of waste.
- Collect hazardous waste in special containers designed so as to prevent spills, leakage, and evaporation of hazardous waste. Mark/label the containers as required by regulations and store in water-proof, roofed area.
- Hazardous waste must not be mixed with other types of waste.
- After the start of the production in the PVC plant, find out, based on analyses made, if biological sludge is hazardous or non-hazardous waste.
- Contract for waste removal by particular waste types with legal persons holding a licence for collection, recovery and/or disposal of these waste types.

NOISE:

- Take following operational measures at noise sources:
  - Maintain devices and pieces of equipment regularly
  - Meet plant standards/rules and follow instructions for the operation of particular devices and equipment (keeping the doors and other openings on the buildings during plant operation open, the run/operation of devices and machines in the designed mode of operation, etc.)

Environmental protection measures to be taken after the PVC plant has ceased operating

It is not planned that the PVC plant will cease to operate. However, when it comes to that, the environmental impacts and environmental protection measures relative to assessed impacts will be set down in a special study/report as part of preparatory activities for winding up and/or removing the plant.

Emergencies

- Install vessels and the pieces of equipment in which substances harmful to people and the environment are stored, used and otherwise handled in compliance with legislation, Croatian standards and good engineering practice.
- Before an inspection certificate is obtained, supplement the existing operational plan of interventions in environmental protection with data on the new PVC production plant and submit it to competent authorities.
- Before an inspection certificate is obtained, supplement and revise existing plans and procedures directly related to environmental disaster and its consequences as governed by the Safety at Work Act (OG 56/96, 114/03); Fire-Fighting Act (OG 58/93; 33/05), Safety and Rescue Act (NG 174/04) and Chemicals Act (NG 150/05).

5. ENVIRONMENTAL MONITORING PROGRAMME

The following can be seen as continuation of the existing environmental monitoring programme that includes as following:

- Air quality testing:
- Continuous monitoring of 24-hours concentrations of sulphur dioxide and smoke at the stations of Omišalj and of Jezero near Njivice;
- Continuous measurement of average daily chloride concentrations at the stations of Omišalj and of Jezero near Njivice;
- Testing of quality and composition of the total sedimentary matter at Omišalj and Jezero near Njivice and the Ponikve reservoir; and
- Testing of acidity and the content of sulphate, nitrate and ammonia in daily precipitation samples at Jezero near Njivice and the Ponikve reservoir.

- Water testing (fresh water, sea water and DINA waste water):
- Testing of fresh water from surface fresh water reservoirs: Jezero near Njivice and the Ponikve once a month. The parameters of the lake/reservoir water that are determined are the following: temperature, turbidity, pH value, consumption of $KMnO_4$, total organic carbon and easily volatile chlorinated hydrocarbons;
- Testing of DINA waste water quality according to requirements given in water authority's permit; and
- Testing of coastal sea in the area of DINA waste water discharge, i.e. in the area of the bay of Sepen and at the reference point Punta Ćuf. The sea water is tested for temperature, turbidity, pH value, chlorides and low-molecular chlorinated hydrocarbons. The tests also include sediment testing at Knez Cape and at the bay of Sepen. The sediment is tested for heavy metals such as mercury, cadmium and lead.

- *In situ* bio-monitoring of the sea organisms exposed.

- The assessment of geo-toxic effects of the DINA waste water.

APPENDICES

Figure 1: DINA Petrokemija d.d. industrial complex and the immediate area

A) VCM/EDC production unit
B) LDPE production unit
C) Utility plants
D) Auxiliary facilities
G) Administrative buildings
I) Su-contractors' buildings
L) Production of technical gases
M) Central warehouse
P) Environmental protection department
R) Product trade/sales department/security
S) Main entrance
T) The Sepen industrial port

Figure 2: DINA industrial complex

- Air quality testing
- Subsurface fresh water testing
- Sea water testing
- Sediment testing

Figure 3: Position of measuring stations for monitoring DINA's impact on the environment

Figure 4: Flow diagram of PVC production process