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TRIP REPORT FOR BALTIC REPUBLICS JOINT ENVIRONMENT MISSION

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for
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I. INTRODUCTION AND BACKGROUND

This report summarizes findings on environmental conditions observed during visits to selected industrial sectors in the Baltic Republics of Latvia, Lithuania and Estonia and identifies problems and opportunities for environmental improvement. An additional purpose was to develop priorities for environmental assistance based on an examination of existing environmental conditions and potential solutions. The work was performed under the auspices of The World Bank, the U.S. Agency for International Development, the U.S. Environmental Protection Agency, and the World Environment Center. This study was conducted as part of a broad examination of critical sectors of these countries (environment, energy, housing, transportation, telecommunications) as part of the Baltic countries application for membership in The World Bank.

The examination undertaken was necessarily limited. The time allotted and the size of the industrial sectors in each country required that only a sampling of the whole could be undertaken. Selection of industrial organizations visited was jointly arranged by the environmental and industry departments (ministries) of each host country and members of The World Bank environmental group. In most cases the enterprises selected for examination were well chosen representing both the diversity of manufacturing enterprises each country offers and, in each, the (perceived) largest polluters. In some cases, (in hindsight) serious omissions occurred. For example, the oil refinery at Mazeikiai and the cement plant at Akmene, both in Lithuania, were not visited. Generally, though, the selection was good. Information developed by industrial visits was supplemented by discussions with environmental personnel, available statistical environmental data and environmental reports made available in each country.

Despite the limitation imposed by time restrictions it is felt that the examination permitted valuable environmental information to be developed. These can be found in considerable detail in the environmental portion of *aide memoirs* prepared for each country. The summary presented here represents a small portion of the major findings and addresses only industrial pollution problems.

Following this introduction is a table of enterprises visited in the three Republics, their location, the nature of the operation at each, and some broad, limited observations as to the nature of environmental problems found. Greater detail for each organization visited will be found in attachments to this final report. These attachments are identical to those found at the end of the *aide memoirs* and are included here for completeness in documenting observed industrial conditions.

. As initially conceived, it appeared that it might be appropriate to prepare two sets of recommendations. The first would indicate, for each enterprise visited, recommended activities that would guide those engaged in any follow up activities specific courses of action that might be employed to mitigate existing pollution problems and to ensure good environmental practices in the future. The second would treat the broader problem of industrial pollution in a national context related to existing and developing environmental programs and policies.

During site visits to specific plants it became apparent that individual plant pollution problems could not be addressed except in isolated and obvious cases. Plant visits were too brief, pollution emission data were generally not available and extensive discussions of specific problems with plant personnel were prohibitive. A few specific recommendations were made when possible and these can be found in the attachments describing individual plant visits. Generally, however, this final report is limited to rather broad observations and recommendations based on the sum of individual visits.

Although each of the Baltic Republics are uniquely different they share, to an unusually common degree, similar environment problems. For example, each of the Baltic countries employs a waste charge system as an incentive to industry to reduce pollution. Therefore, the observations and recommendations made here tend to treat these problems without any national distinction. Where environmental problems are distinguished by national differences, these differences are noted.

SUMMARY: ENVIRONMENTAL INSPECTIONS OF INDUSTRIAL PLANTS

SOURCE	LOCATION	PRODUCTION	EFFLUENTS IN AIR	EFFLUENTS IN WATER	PRINCIPAL EMISSIONS
LATVIA					
VALMIERA GLASS FIBER PLANT	VALMEIRA	FIBERGLASS FABRICS, HELMETS	YES	YES	PARTICULATES, SOLVENTS
RIGA VARNISH AND PAINT FACTORY	RIGA	INDUSTRIAL VARNISHES, ENAMELS, PRIMERS	YES	SMALL	SOLVENTS, ODORS
LATBIOFARM PHARMACEUTICALS	OLAINE	CHEMICAL REAGENTS, BIOCHEMICALS	YES	YES	LARGE AMOUNT OF CHEMICALS IN AIR AND WASTEWATER
BIOLAR BIOCHEMICAL CO.	OLAINE	PHARMACEUTICALS, BIOCHEMICALS	YES	YES	LARGE AMOUNT OF CHEMICALS IN AIR AND WASTEWATER
TANNERY WASTES	RIGA	INCINERATION OF TANNERY WASTES	YES	YES	ASH, HEAVY METALS
ELECTRRO-APPARATUS MFG. PLANT	RIGA	ELECTRICAL COMPONENTS, AUTO INSTRUMENT CLUSTERS	YES	YES	PLATING LIQUIDS, SOLVENTS
LAIMA CHOCOLATE FACTORY	RIGA	CHOCOLATES	SMALL	SMALL	ODORS
LITHUANIA					
GRIGISHKES PULP AND PAPER	GRIGISHKES	WALLBOARD, PAPER	YES	YES	SOLVENTS, HEAVY WASTEWATER LOAD
KAUNOS ARTIFICIAL FIBER FACTORY	KAUNOS	CELLULOSE ACETATE	YES	YES	SOLVENTS IN AIR AND WATER
PANAVEZYS STATE SUGAR REFINERY	PANAVEZYS	BEET SUGAR	NO	YES	HEAVY WASTEWATER LOAD
PANAVEZYS SPIRIT AND YEAST PLANT	PANAVEZYS	BAKERS YEAST, ALCOHOL	SMALL	YES	ODORS, WASTEWATER
PANAVEZYS MUNICIPAL WASTEWATER PLANT	PANAVEZYS	WASTEWATER TREATMENT	NO	YES	SLUDGE, HEAVY METALS
JONAVA AZOTAS STATE ENTERPRISE	JONAVA	AMMONIA, AMMONIUM NITRATE, METHANOL	YES	YES	AMMONIA, SOLVENTS, CHEMICALS IN AIR AND WATER
KEDAINIAI CHEMISTRY PLANT	KEDAINIAI	SUPERPHOSPHATE FERTILIZERS, SULFURIC ACID	YES	YES	PHOSPHATE TAILINGS, SO_x, SOLVENTS IN AIR AND WATER
STATE KEDAINIAI BIOCHEMICAL PLANT	KEDAINIAI	ANIMAL FEEDS	YES	YES	PARTICULATES, SOLVENTS

SUMMARY: ENVIRONMENTAL INSPECTIONS OF INDUSTRIAL PLANTS (CONT)

SOURCE	LOCATION	PRODUCTION	EFFLUENTS IN AIR	EFFLUENTS IN WATER	PRINCIPAL EMISSIONS
ESTONIA					
KUNDA CEMENT	KUNDA	CEMENT	YES	YES	PARTICULATES
KEHRA PULP AND PAPER	KEHRA	PAPER	YES	YES	SOx, PARTICULATES, HEAVY WASTEWATER LOAD
OIL SHALE PROCESSING ASSOCIATION	KOHTLA-JARVE	CHEMICALS	YES	YES	OIL SHALE WASTES, PHENOLS, SOLVENTS IN AIR AND WATER
ESTONIAN POWER STATION	NARVA	ELECTRICITY GENERATION	YES	YES	OIL SHALE COMBUSTION WASTES SOLID WASTE LEACHING
BALTIC POWER STATION	NARVA	ELECTRICITY GENERATION	YES	YES	OIL SHALE COMBUSTION WASTES SOLID WASTE LEACHING

II. INDUSTRIAL AIR POLLUTION

Air pollution sources in the Baltic countries essentially result from auto transportation (discussed elsewhere) and fuel burning installations (power generation and heat production) using low quality fuels. In Lithuania and Latvia these fuels are heavy oils, mazout, the equivalent of No. 6 oil. Combustion of this fuel oil is characterized by clearly visible stack plumes of particulates (fly ash), SO_2 and NO_x. Invariably, power plants, district heating plants, and even large industrial boilers burning this fuel have no environmental control equipment. When the occasional boiler is equipped for particulate capture (usually cyclones and electro filters) the equipment is old and maintenance poor leading to low cleaning efficiencies. None are equipped with controls to reduce SO_2 and NO_x emissions. Unfortunately, most fuel burning installations are located close to large population centers and significantly contribute to local pollution. Among the three Baltic states only Latvia burns gas to any significant extent which tends to reduce particulate emissions and SO_2 during combustion.

Power plant and district heating plant combustion emissions in Estonia are particularly troublesome because the fuel of choice is low heating value oil shale which the country has in abundance and has been burning for many years. Oil shale contains about 45% inert material (and about 2% sulfur) which ends up as fly ash and bottom ash. Because of its low heating value and high ash content, oil shale produces about 24 times the amount of solid waste as does the equivalent amount of coal. The largest power plants in Estonia are located along the north east coast adjacent to the Gulf of Finland. Emissions from these power stations produce trans-boundary emissions of particulates, as well as SO_2 and NO_x, that are particularly troublesome to southern Finland. Collected ash, bottom ash and captured fly ash, are usually stored in exposed ash pits (appropriately called "ash mountains") and result in leaching ash contents, which are principally alkaline, into the ground. These leached materials find their way into surface and ground waters and eventually find their way into the Gulf of Finland. Millions of tons of ash are stored in this manner.

In addition, air pollution results from individual manufacturing facilities producing a large variety of products. The largest emitters, in each of the three countries, appear to be pulp and paper mills, cement plants and chemical complexes (fertilizers, biochemicals, pharmaceuticals).

Despite the identification of the largest pollutant emitters, transportation and fuel combustion, and the rather obvious need to reduce emissions to the air from these sources, the effect of pollution from manufacturing operations is not at all clear. This is primarily because air emission data from these sources is poor. It is not at all

apparent that industrial plants meet even minimum requirements for properly monitoring emission sources. Data collection of air emissions are sporadic and analytical instrumentation largely old and inadequate. Measurements are made to satisfy demands by federal and local environmental officials for information so that pollution charges and fees can be set and statistics collected. In too many cases estimates are made when measured data are absent. The relationship between air emissions and local air quality is tenuous. Federal and plant laboratories make air quality measurements in population centers near industrial plants but the presumed relationship between emissions and air quality is estimated on the basis of complex procedures inherited from the Soviet Union. There is no attempt to develop meteorologic models with which to determine the effect of stack emissions on ambient air quality. Nor is there a sound procedure for determining area air quality from multiple stationary sources.

Finally, air quality standards used in the three countries are based on previous all-union regulations for an excessively large number of materials and are so restrictive as to be non-attainable.

Some recommendations for the development of a coherent air pollution program including areas appropriate for technical assistance follow.

1. Air emission sources, both large stationary combustion sources and process emissions from manufacturing operations, require emission measurements to determine the impact on local air quality. Air emission auditing and continuing monitoring programs and procedures should be developed at the federal environmental level and implemented wherever pollution problems are perceived to exist. This information, coupled with air quality measurements will assist in establishing priority pollutants for which air quality standards should be set to assist in establishing safe levels for the protection of health and property.

   System operators of sources emitting air pollutants, as well as federal and local environmental officials, should understand the importance of either auditing or monitoring programs in determining what pollutants must be controlled and the extent of control necessary to achieve health and safety standards. Technical assistance from Western nations that routinely employ auditing and monitoring will probably be extremely helpful.

2. All air emitting pollution sources should conduct inventories of existing control equipment and, through measurements, determine the efficiency and adequacy of such equipment or if upgrading or replacement is necessary. Included here should be stack heights through which air pollutants are emitted to the atmosphere.

Sometimes, something as simple as moderately increasing stack height can be a cost-effective method of reducing local air pollution effects.

3. All air emitting pollution sources should be required to examine current processing techniques, at each level of a manufacturing sequences, to determine whether cost-effective pollutant emission reductions can be achieved by process and/or equipment changes. These include, for example, fuel switching for combustion processes, raw materials substitutions to less volatile or hazardous materials, scheduling and sequencing of operations, purification and recycling of process "wastes", segregation of waste streams, changing processes, using waste materials as combustion fuels, upgrading process equipment. The concept of low cost/no cost process modifications should be developed at the plant level. Technical assistance to develop these concepts should be made available. It is also important to conduct energy audits at these same locations. Very often, increasing process energy efficiency can result in concomitant reductions in environmental pollution.

4. Where existing equipment is unable to adequately control emissions and where process changes are not possible, sufficient emission measurement data should be developed to size and cost engineering control systems for pollution abatement. Technical assistance to acquaint plant operators with the latest cost-effective control systems should be provided.

5. Sampling and analytical protocols should be developed at the federal level and implementation required at industrial plants. Instruments to perform audits and monitoring should be acquired by operators of emission sources. The cost of auditing and monitoring should be borne by the pollution producing enterprise.

6. Federal environmental agencies should undertake the development of meteorological models so that meaningful area-wide air quality levels can be produced with data collected from auditing and monitoring programs.

III. VEHICLE EXHAUST EMISSIONS

Observations and recommendations concerning auto exhaust emissions in each of the three Baltic republics, extracted from the original *aide memoirs*, are gathered as a single group of documents. Latvia and Lithuania judge transport vehicle exhaust emissions to be the most serious single source of air pollutants, 73% of all air emissions in Latvia and 60% in Lithuania. Estonia estimates that less than half, approximately 45%, of all air pollutants are from transport vehicles. In all cases these numbers are estimates based on fuel consumption and emission factors. These estimates could be considerably higher considering the rather large amount of unrecorded black market auto fuel used and the large number of poorly maintained, old vehicles in operation.

Regulations concerning auto pollutant emissions are in place in all three countries, at least in terms of CO, based on previous all-union standards, but are generally not observed. Despite acknowledgement of the seriousness of the problem and existing regulations, no significant planning to control auto emissions is evident and nothing is being currently done to reduce them. Three reasons for the lack of activity are given: (1) the lack of auto fuels suggests that motor traffic is currently minimal and makes the present need for controls problematic, (2) there is a shortage of auto emission measuring equipment, (3) there is a shortage of auto maintenance equipment.

There are significant differences in each countries attitude toward leaded fuels, despite the well known environmental hazard associated with lead. Only unleaded low octane (76 octane) fuel is reportedly used in Lithuania while some unleaded low octane fuel is available in Latvia. Estonia appears not to have any unleaded fuel available. There appears to be no national environmental policy in any of these countries to require the use of unleaded fuels.

It is considered shortsighted to delay making appropriate plans now for auto emission reduction for the given reasons. The problem of auto fuel scarcity is clearly temporary and plans should be formulated now to deal with the auto emission problem when road traffic increases. At the very least, new regulations should be developed and means of reducing them (reformulated fuels, catalytic converters, reduced lead content in fuels, vehicle testing programs) developed. Estimates should be made now of instruments needed to implement such programs, their source and cost. Programs so developed now could be phased in slowly as fuels become more readily available and road traffic increases rather than require a crash effort when auto emissions again become a major source of pollution.

It might be possible to acquire emission testing and auto maintenance equipment by loans made available for this specific purpose.

Loan repayment guarantees could be assured by imposing a schedule of service charges on auto users to recover these costs. But this will first require the development of a coherent national program of emission testing and auto maintenance.

MOTOR VEHICLE EXHAUST EMISSIONS IN LATVIA

Available data indicates that emissions from vehicles is the single greatest air pollution problem in Latvia. The contribution of emissions by vehicles to air pollution in the country is estimated as almost 73% of the total air emissions from all sources, although this conclusion is based on estimates of auto fuel sales, not measured values. An all-union regulation of less then 1.5% CO emissions is enforced for autos during registration and 3% for autos randomly selected on the road for testing. Officials estimate that 30% of all vehicles tested fail the CO test. There is no regulation for hydrocarbon or NO_x emissions. Two cycle engines and older vehicles, both of which contribute significantly to automobile emissions, are not specifically banned. Latvian officials will allow any vehicle to be operated provided it meets the CO emission standard. Lead is used at a level of 0.15 mg/liter in 92 octane fuel but 76 octane fuel is currently available in both leaded and unleaded formulations. The exact quantity of unleaded fuel available is unknown. Current thinking about motor vehicle pollution abatement appears to be centered on catalytic converters. However, until unleaded fuel is available in greater quantity no abatement of motor exhaust emissions is planned.

Despite knowledge of the severity of pollution from motor vehicle sources in the country, there appears to be no significant activity to curb them. This situation should not be allowed to continue. This is especially true with respect to lead which is known to cause neurological damage, especially in the very young. It is urged that a comprehensive plan for the reduction of auto emissions be assembled as soon as possible.

AUTO EXHAUST EMISSIONS IN TALLINN, ESTONIA

Tallinn, the largest city in Estonia, has about 177,000 vehicles including:

Benzine Fueled	
automobiles	82,000
buses/light duty vehicles	33,000
Diesel Fueled	
trucks	62,000

All vehicles, are required to have one inspection every two years. Each inspection includes a safety check (tires, lights, brakes) and an emission test for CO. Vehicles with CO emissions exceeding 3% are failed and are required to be reinspected within a 2 month period until the test is passed. Estonian police are empowered to randomly stop moving vehicles and perform a tail-pipe test for CO, with failure again at the 3% level. There are no penalties for repeated failures although in extreme cases drivers licenses can be revoked.

There are laws in Estonia, inherited from Russian standards, specifying hydrocarbon emissions, in addition to the 3% CO test, but are not enforced. The hydrocarbon standards are set for cars with less than 4 cylinders and greater than 4 cylinders in terms of idle and one moving speed, but not with car age. The same standards apply for cars, buses and trucks. In addition, lead levels in 76 octane and 93 octane benzine are specified by Russian standards as 0.17 and 0.37 kg/ton, respectively. No unleaded fuels are available for autos in Estonia. Published statistics on air pollution due to motor vehicles are estimates only using a Finnish model. Ambient air measurements show that lead levels in cities are everywhere below maximum allowable concentrations.

Although environmental officials are aware of auto pollution problems, no effort is currently being made to develop new standards or methods of reducing auto emissions.

The problem is currently not considered sufficiently important to require immediate attention compared with other more serious air pollution problems and no action is recommended at this time.

MOTOR VEHICLE EXHAUST EMISSIONS IN LITHUANIA

Environmental officials in Lithuania believe that emissions from vehicles is the single greatest air pollution problem in Lithuania. The contribution of emissions by vehicles to air pollution in the country is estimated as almost 60% of the total air emissions from all sources, although this conclusion is based on estimates of auto exhausts, not measured values. The basis for this condition is attributed to the low extent of auto maintenance the generally old age of cars in the country.

Auto maintenance is low because of the lack of tools and supplies. Although inspection of all vehicles is required once every two years, it is only rarely done. An all-union regulation of less then 3% CO emissions is required, but there is no way to enforce this rule because of the lack of emission measuring equipment. One bus company and police vehicles can be checked with the few CO monitors available, but nothing else. There is no regulation for hydrocarbon or NO_x emissions. Lead is used at a level of 0.15 mg/liter of fuel in 92 octane fuel but only unleaded 76 octane fuel is currently available in the country. Reformulated auto fuel (MTBE) is to be produced in small amounts in 1992.

Plans are currently being made to reduce the severity of auto exhaust emissions by the following means:

1. Imported vehicles older then 5 years of age will not be allowed into the country.

2. Two cycle engines (as used in the Trabbant, for example) are outlawed because of their high exhaust emissions.

3. Plans are being made to require catalytic converters now that unleaded fuel is available. Catalytic converters are not made in Lithuania, but are made in Latvia and could be readily available.

The removal of lead in auto fuels is a progressive step and removes at least one potential health hazard in the country. This step so early in Lithuania's environmental program is to be congratulated.

The remainder of the program is quite appropriate. Now that lead has been removed the use of catalytic converters, a classical approach to auto exhaust emission control, would be a logical second step. Care must be exercised, though, that the sulfur content of unleaded fuel is very low to prevent sulfuric acid from being produced with catalytic converters.

The aggressive program for reducing vehicle emissions should be greeted with as much support as possible. One method of supporting such policies would be to provide funding for the acquisition of (a) auto exhaust emission measuring equipment and (b) tools and parts needed for auto maintenance in sufficient quantities to enable Lithuanian air pollution authorities to introduce a program of regular vehicle testing. This is especially true with the older cars used in the country. Simultaneous Implementation of plans to reduce auto emissions with catalytic converters along with auto emissions testing could have a vastly significant effect in reducing a major source of air pollution in the country.

Although not specifically discussed with environmental authorities, they should be urged to pass the cost of testing onto auto owners to recover the costs of tools and the cost of emission testing.

IV. INDUSTRIAL/MUNICIPAL WASTEWATER TREATMENT

Most industrial sites visited have their own wastewater cleanup systems but in almost every case observed these are inadequate in terms of the extent of treatment, the technology used or are hampered by a lack of chemicals and replacement equipment. In some cases enterprises simply discharge to local streams with no treatment of any kind. There appears to be no effort made, at the industrial level, to reduce plant water use or to recycle water. Minimally treated industrial wastewaters are often discharged to local municipal facilities which have neither the capacity nor the systems to properly treat such wastes. To make matters worse, some municipal treatment plants are only partially completed due to financial constraints, have inadequate treatment technologies and have no current access to equipment and spare parts.

An associated problem, sludge disposal from wastewater treatment facilities, is at a critical level. Most treatment facilities, industrial and municipal, have inadequate sludge dewatering equipment which translates into large volumes of sludge which cannot be adequately disposed of. Because many industrial facilities do not adequately remove heavy metals from process streams sludges produced must be classified as toxic and are suitable only for landfill rather than being used as fertilizer. Most toxic sludges are disposed of in common municipal landfills which are then subject to leaching and eventual contamination of local ground and surface waters.

In the past, there does not appear to have been a concerted effort that addressed the mutual problems of industrial wastewater and municipal wastewater effluent control. Industrial enterprises, even if they pre-treat their own wastes, minimally clean them to the best of their ability using old and inadequate technology and inefficient equipment. This practice only serves to severely tax municipal wastewater treatment systems. Some recommendations to improve the existing wastewater treatment problems are listed below.

1. Industrial operators must develop in-plant water conservation practices by reducing fresh water intake and recycling of process and treated wastewaters which will reduce the need for expensive effluent treatment systems. These conservation practices will also tend to conserve raw fresh water, a valuable and limited national resource.

2. Current wastewater regulations, which cover too many potential pollutants and are excessively restrictive, should be abandoned in favor of new regulations. Two new sets of discharge standards should be developed, (a) industrial treatment levels that will allow wastewater discharge directly to local receiving waters and

(b) pretreatment levels prior to discharge to local municipal treatment systems at volume flows and at pollutant levels acceptable to the capacity and technology of the local municipal system.

3. Joint treatment systems should be encouraged with user charges to local plants discharging to local municipal facilities which are reflective of actual costs. In some cases, local municipalities have no sewage treatment facilities but are instead dependent upon one or two local plants with industrial wastewater systems. Such arrangements should be encouraged with equitably imposed costs and effluent standards. In those cases where municipal treatment systems are excessively burdened by industrial wastewater discharges, industrial contributors should be disconnected from the municipal system and required to install their own complete treatment systems.

4. Technical assistance should be made available to industry and municipalities to acquaint them with modern wastewater treatment techniques and water usage reduction methods. Technical assistance is also required to review the condition of existing treatment plants to determine how they can be upgraded to meet effluent standards.

5. Assistance to industry and municipalities is required for access to treatment chemicals, replacement equipment and spare parts which can no longer be obtained from Russia.

6. Wastewater pollutant monitoring at most industrial plant sites is done at periodic intervals convenient for reporting to local environmental offices. Most existing industrial wastewater analytical equipment, though, is judged to be inadequate to produce high quality, large quantity data with which to adequately identify problem discharges. Many plants do not have equalization basins and their effluents are often not steady. A greater frequency of sampling and wastewater analysis is necessary under these conditions to adequately determine the nature of the discharge load. Assistance is needed to acquire modern, accurate instrumentation.

7. Technical assistance should be made available to national environmental laboratories to develop wastewater sampling and analytical protocols. Methods developed at the national level should be transferred to plant environmental laboratories. The burden and cost of wastewater monitoring should be borne by those industrial enterprises producing wastewater discharges. Industrial laboratories should be periodically checked to insure that appropriate sampling and analytical procedures are being employed.

8. Auditing programs and procedures examining fresh water usage and wastewater production and disposition should be required of all industrial enterprises. Such data should be for purposes beyond statistical reporting or for determining pollution charges and should be used to examine plant water use and wastewater production in order to reduce consumption and to reduce effluents.

9. Where several plants discharge to a local body of water, methods should be developed to quantify the cumulative effect on downstream water quality and to adjust individual plant and area effluent levels to achieve environmental goals.

INSTITUTIONAL AND NATIONAL POLICIES AFFECTING THE ENVIRONMENT

The governments of the newly established Baltic republic have given high priorities to the development of environmental protection policies and programs almost from the moment of their rebirth. In part this was a reaction to almost 40 years of environmental neglect under Soviet rule which resulted in an all too visible and worsening quality of life. In fact, from the very beginning of newly begun environmental planning, the programs in each country were decentralized probably in reaction to the highly centralized nature of their existence under Soviet rule. The structure of environmental efforts in each of the countries consists of federal level departments or ministries and local or regional environmental groups which are responsible for directly interacting with sources of environmental pollution. These local groups have the authority to monitor pollution emissions, inspect industrial operations and to enforce pollution regulations. Unfortunately, the qualifications of local environmental officials is spotty at best.

Despite the enthusiasm with which environmental protection plans are being developed and implemented, it is important to understand that there are national and institutional problems that mitigate against a concerted effort to solve even the more obvious problems. For example, each of the three Republics has a severe transportation environmental problem. Environmental programs in this sector are stalled pending solution of fuel availability problems. Indeed, environmental ministers bristle when it is suggested that their environmental plans in the transportation area are inadequate. They claim there is no problem that can be addressed until their fuel supply problems can be solved.

Thus, there is the appearance of making progress in solving environmental programs. For example, copious data are produced and reported but is of little value. In most cases, local environmental boards do some monitoring, produce statistics on the nature of the problem, attempt to identify major sources and try to enlist the polluters to reduce emissions. However, success in addressing pollution problems are hampered by institutional and national problems. These problems, briefly discussed below, far outweigh any serious consideration of ameliorating industrial environmental problems. And until they are satisfactorily solved, or at least progress made in their solution, it will be unlikely that long term environmental strategies can be successfully employed.

1. **PRIVATIZATION:** Almost all large industrial organizations in the new Republics continue to be state owned enterprises. Only a single enterprise visited appeared to have developed a partnership with a Western company, but the venture is suspect. Management response to questions concerning privatization were

mixed. Some companies seem eager to consider joint ventures with Western partners, some are aggressively seeking such relationships, while others seem quite content with state ownership and even fearful of privatization. Reasons given for desiring joint ventures were eminently sensible; the need for securing new sources of raw materials, new markets for their products, and acquiring new technology were most often cited. Interestingly, those interested in joint ventures appear to feel that solutions to their environmental problems will be solved only with such joint ventures. They feel that costs to control pollution is prohibitively expensive and that their existing technology and equipment is so old and obsolete that without joint venture partners they will not be able to make satisfactory progress on their own. Management at Kunda Cement (Estonia) was particularly adamant about this. Even more important is managements perception that without joint ventures to bring new raw material sources, new markets and new technology, they will not survive. In that case, environmental problems are just not important enough to be even considered at the present time.

This is a serious problem that must be addressed before any reasonable progress can be made to control pollution problems. An enterprise that considers its existence economically vulnerable sees no need to concern itself with contributing to improvement of the environment. It is imperative that the federal governments of the Baltic Republics assign the highest priority to industrial privatization. In addition to the more traditional benefits of privatization it would appear that environmental goals will be jeopardized unless this is done.

2. **RAW MATERIAL SUPPLY:** Central planning under the previous soviet regime established manufacturing enterprises in the Baltics which were almost totally dependent on raw materials made available by the East and which arranged for industrial output to be returned to the East in the form of finished goods. This dependence still continues. Almost all manufacturing enterprises are currently hampered by restrictions on raw material availability from Russia, which is demanding hard currency prices for materials needed to sustain industrial operations. Almost every enterprise visited claimed to have only raw materials for perhaps 2 - 3 months operation in 1992, after which they would be out of business. Industrial management also complains that some raw materials, currently available from Belarus and Ukraine, are taxed at prohibitive levels. They appear to feel that they are being discriminated against by un-realistic government import policies.

3. **POLLUTION CHARGES AND FEES:** All three Baltic countries have implemented market based incentives to support environmental efforts. Basically, charges are imposed on all pollutant emitters. Actual charges depend on the nature and quantity of each pollutant emitted measured against allowable air and water quality standards. Polluters emitting more than the allowable maximums are required to pay punitive fees which should be large enough to encourage them to develop abatement measures. Pollution charges are generally used to fund environmental cadre and programs, both at the federal and local level, while pollution fees are intended to assist in the development of abatement methods and to acquire instruments and equipment for this purpose. Persistent polluters, those who make no effort to abate serious emission problems are subject to plant or process closings (a so called command and control measure) if the market based incentives fail. There are variations of these market based and command and control strategies in each of the Baltic countries but each is approximately as described.

   Industrial managements are ambivalent about these methods. In some cases they are skeptical about the pollution charge system because they consider these costs little more than a means of funneling money into environmental offices with little benefit returning to them in the form of technical or other assistance to help solve their problems. In other cases, pollution charges and fees are so low that they provide almost no incentive to correct emission problems. They feel that the charges and fees are tantamount to a license to pollute. Management also notes that because almost all enterprises are state owned, pollution charges set by the state are balanced by the state simply increasing their product costs, and pollution fees, which generally come from profits confiscated by the state, are paid by the state to yet another branch of the state, an environmental branch. In other words, there is no economic impact on the enterprise operation whether it pollutes or not. So much for a market based strategy in a state controlled economy.

   It would appear that greater command and control tactics would be more effective in getting corporate managements to address environmental problems as long as the current economic situation abides.

4. **INFLATION:** Inflation in the Baltic countries, although not run-away, is sufficient to make it difficult to set industrial waste charges and fees to encourage pollution reduction that will be appropriate if only for the short term. Industrial managements consider waste charges as almost acceptable because of the

inflationary dilution of these charges which seriously lag behind product, raw material and equipment prices.

5. **MARKETS AND MANUFACTURING QUALITY:** There is a self-assurance, even an arrogance, at some enterprises that appears to have as its origin the fact that markets for their products have previously appeared to have been almost guaranteed. As noted above, under the Soviet system, sole source manufacturing enterprises were created in the Baltic countries. Raw materials were provided and all manufactured goods returned. Some companies firmly believe that their are no substitutes for their products in Russia. Some companies also believe that their products are competitive in quality with the same products available in the West and that potential buyers will beat their doors down to trade with them. They are prepared to abandon their traditional trading partners in the East for some nebulous belief that their goods will find ready acceptance in the West. Attitudes such as these suggest to them that they can expect preferential government treatment because they represent a national treasure. With respect to environmental pollution, this attitude translates into the assumption that they are immune to severe punishment even if they continue to pollute. With market based pollution abatement incentives in a state controlled economy, this may be quite true. It appears quite clear that only by appropriately devised command and control environmental strategies can such companies be made to comply with national environmental requirements.

6. **CURRENCY STABILITY:** Long term, and even short term, planning of any kind is hampered by a currency that is still tied to the Russian rouble. Currency stability in the Baltic Republics is to a large extent reflective of the present economic problems of the new Russian Confederation rather than subject to economic conditions in these new, small, self-governing countries. Expanded industrialization, and the solution of related environmental problems, in the Baltic countries will continue to be hampered until they establish their own stable currencies. The three Baltic republics are working on currency stability but in the short term are hampered by their lack of independence from the Russian rouble. Some short term relief may be forthcoming based on the stabilization of the Russian rouble to a fully convertible currency in terms of tying it to the US $ (at about 80 roubles per US $) which is planned for sometime around the middle of 1992.

APPENDIX 1.

LITHUANIA: PLANT SITE VISITS

ENVIRONMENTAL EFFECTS AT GRIGISHKES PULP AND PAPER

Grigishkes pulp and paper company is described by its management as a Lithuanian-U.S.A. joint venture company owned 29% by the State, 41% privatized and 30% by American interests. The American partner is the Export-Import and Transportation Co. (Seattle, Washington).

Grigishkes makes unbleached paper (tissue and cardboard) from purchased pulp (plus 1% recycled paper) and a specialty coated chip board made from roundwood (with 5-8% recycled paper). Production capacity of pulp and paper is 40,000 tons/a and 17 million sq m of chip board. Pulp is bought from Russia and paper products returned to Russia. About 7 million sq m of chip board was sold to Sweden, Finland, Germany, France and Canada in 1991. Cigarette filter paper was sold to Hungary and Poland. Income from exports to the West in 1991 amounted to US$ 2 million on which taxes of US$ 600,000 were paid.

Production of papers and cardboard is to be severely curtailed in 1992 because pulp is no longer available from Russia and hard currency is not available to buy pulp from the West. Four paper machines and one cardboard machine have been idled. Only two chip board forming machines are working. The normal work force of 2,200 has decreased by 250 and an additional cut of 10% is anticipated.

Chip board is made from whole debarked trees which are chipped and then cooked in hot water to a thick brown pulp. The pulp is then formed on two paper machines, dried and coated on one side to produce wall paneling. The coating process is the only step using chemicals. Solvents from the coating operation are exhausted directly to the atmosphere with no attempt to control them. The amount is not known. Bark removed from trees is sold as an agricultural fertilizer. Paper making involves only re-suspending purchased pulp in water and then forming paper on paper machines. The plant began operating in 1925 and much of its paper making equipment is old and needs upgrading. Estimated cost of replacement is US$ 1.4 million. The chip board line is relatively new, dating from 1969 and appears quite serviceable. During the plant visit activity was low due, according to management, to experimental work on a new coating being developed with an Austrian company.

The usual air and water emissions emitted from pulp and paper making are not present at Grigishkes. No chemical pulping or bleaching is done eliminating two of the principal sources of air

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and water emissions. Air emissions are limited to solvents in the chip board coating operation and combustion gas emissions from steam production using natural gas as boiler fuel. All electricity needs are purchased. Water pollution is the major problem at this plant consisting of high BOD (1200 mg/l), suspended solids (672 mg/l) and a variety of chemicals (phenols, formaldehyde) from the resinous material in the trees pulped in hot water, as well as phosphorus, sulfates and chlorides. Mill process water is mechanically treated only and presently discharges about 15,000 cu m directly to the Neris river. The nearby town (13,000 population) sends its domestic wastewater to the company treatment system and pays 30,000 roubles for the privilege.

The company paid waste charges of 750,000 roubles in 1991. Construction of a lagoon from which to transfer treated waste to the Vilnius municipal wastewater treatment plant is being constructed at a cost to the company of 5 million roubles and will be finished in several months. This system could reduce BOD and suspended solids slightly and will avoid direct discharge to the Neris river. When completed, the company will pay 10 million roubles annually to Vilnius for water sent to the municipal treatment system, far in excess of their current waste charges. (This amount seems to be exaggerated considering that the Vilnius Water Department now collects only 17 million roubles annually from all industrial enterprises currently using the Vilnius wastewater plant.) A biological treatment system planned by the company is no longer being considered.

Solid waste generated by mechanical separators is presently dewatered and sent to a landfill about 20 km from the plant. This solid waste site also accepts solid wastes from the town and part of the solids produced by the Vilnius municipal wastewater treatment system.

One can only wonder about the wisdom of the costly plan connecting the company treatment system to the Vilnius municipal plant. The Vilnius treatment plant is only slightly more efficient than the pulp and paper treatment system, at least until the new biological system is completed. Transporting wastewater from Grigishkes to Vilnius makes no sense at all. A more suitable plan might have been to add a small biological treatment plant to the present wastewater mechanical separators at Grigishkes and then discharge treated water directly to the Neris river. This would relieve the additional burden to the Vilnius system, especially considering the load of contaminants now known to exist in the pulp and paper plant wastewater discharge after mechanical treatment. In fact, it may be necessary to install a biological treatment system in the future to protect the Vilnius system after its

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biological treatment plant is operational.

There is insufficient information to be able to recommend a method for reducing/eliminating solvent emissions from the chip board coating process. If emissions are sufficiently high, a simple condensation system night reduce emissions or a carbon adsorption system could recover valuable solvents for recycle. If concentrations are too low for recovery, or if recovery is not economical, the solvents might be incinerated in the boilers. In any case, the choice of system would depend on the economic value of solvents that could be recovered and the cost of recovery. In general, correcting this problem is rather simple and not very expensive. There is no reason to continue to tolerate it.

The use of waste paper recycle seems very low and could probably be safely increased with a concomitant savings in wood resources. There is also little consideration of possible changes in process water use or recycle which would reduce the wastewater burden on the treatment system.

VILNIUS MUNICIPAL WASTEWATER TREATMENT PLANT

Planning for the Vilnius municipal wastewater treatment plant began in 1961. Construction started in 1971 and was completed in its present form in 1986. City domestic wastes (about 80% of total) and industrial wastewater (about 20%) are both treated in the same facility. There are 19 wastewater pumping stations in the city and treatment currently is by mechanical and chemical means (flocculation with $FeCl_3$) only. The original design included biological treatment but construction of this phase of the project only began in 1988 and was scheduled for completion in 1992. Holding tanks for activated sludge treatment are in place but a completion date is not known because of the difficulty of acquiring equipment. The technical director of the Vilnius wastewater treatment plant is concerned about the operation of the biological system when it is completed. He is not sure it will meet effluent wastewater standards which he believes are each 15mg/l for BOD and suspended solids. He appears to have little information about the design and expected operation of the biological system and this is the cause of his concern.

The treatment plant has a wastewater treating capacity of 420,000 cu m/day but is currently processing 215,000 cu m/day. On the average, mixed wastewater from all sources reaches the treatment plant with 300 mg/liter of BOD and 300 mg/liter of suspended solids with no metal content of any consequence. About 50,000 cu m/day of additional wastewater from industrial sources in Grigishkes (pulp and paper mill), Lentvaris (carpet manufacturing) and Trakai (source unknown) are expected to be connected soon but this should not tax the present system. The plant reduces BOD by about 25-30% and suspended solids by about 55%. Treated water is discharged directly to the Neris river.

There are six vacuum filters for dewatering sludge to about 75% water content. These filters appear extremely old and in poor condition. Plant personnel are attempting to rebuild them. Disposal of about 100 tons/day of collected sludge is a problems. About 30% of the sludge is transported to a landfill near Grigishkes and the balance stored on site at the municipal treatment plant. Additional on site storage is very limited and there are no plans for sludge removal after it is filled. Experiments with sludge incineration were conducted some time ago but abandoned.

The technical director of the municipal wastewater treatment plant indicated that the following were problem areas:

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1. Chemical treatment at the wastewater plant is by coagulation with $FeCl_3$. Much more efficient flocculants such as alum (Al_2O_3) are not available locally. Information on these materials is desired and a supply made available.

2. Pumps are needed for delivery of chemicals.

3. Sludge pumps are needed for emptying large tanks.

4. Only three aerators are available. Spare aerators and spare parts are needed.

5. Equipment for the present treatment system appears satisfactory for possibly another 2 - 3 years. There is some concern about replacements and spare parts after this period.

6. Information on sludge handling is desired, especially filtration methods.

7. Technical training is required, not only for plant managers, but for operating personnel. Feelings of isolation from modern technolofy exists and additional information on wastewater plant management and operation as practiced in the West are very much needed.

8. There are labor problems especially with drinking on the job.

The Vilnius wastewater treatment plant pays a waste charge on the effluent from its system, but the system technical director has no information on how much is paid or how waste charges are calculated. Information on charges was sought from the Department of Water for the City of Vilnius but without much success. The only information obtained was mainly on waste charges assessed by the Water Department for users of the system in 1991.

From industrial users:	16,200,000 roubles	(waste charge)
	2,000,000 roubles	(fines)
From commercial users:	9,600,000 roubles	(waste charges)
From domestic users:	3,000,000 roubles	(waste charges)
	30,800,000 roubles	

The fines shown for industrial users were for wastewater discharges above those discharged in a prior period. The Water Department pays a percentage (about 10%) of waste charges it collects to the State Environmental Board as a tax. In 1991 the Water Board paid

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about 2,600,000 roubles (about 8.4% of income) to the State Environmental Board. No information was available about how the balance of income was spent, including budget for the wastewater treatment plant (labor costs, costs of materials, maintenance, etc.). No information could also be determined on charges assessed against the wastewater plant for effluent discharges.

The single most urgent need is to complete the biological treatment phase of the wastewater plant. This means acquiring and installing needed equipment. Although there appears no need to take any urgent action with respect to operation of the treatment plant in its present configuration, there are medium term objectives that should be planned. Among these are:

1. Suitable new sludge disposal sites must be developed.

2. Examination of existing equipment to determine if continued efficient use is possible.

3. Preparation of spare parts inventory and acquisition of needed parts.

4. Development of a training program for treatment plant managers and operators. Such a training program should not be restricted to Vilnius system personnel but extended throughout the country to municipal and industrial wastewater system workers.

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PLANT VISITS TO ASSESS INDUSTRIAL ENVIRONMENTAL POLLUTION EFFECTS IN KAUNAS (KAUNAS, JONAVA, KEDAINIAI) AND PENEVEZYS

The Kaunas region of Lithuania is reported to be one of the most heavily polluted areas in the country. Within this region lies the city of Kaunas, the second largest in the country, with some 450,000 people, and is the site of several large industrial enterprises including electronics manufacturing, synthetic textile production and construction materials. To the north of the city of Kaunas lie the towns of Jonava and Kedainiai which contain large chemical manufacturing operations. Jonava is the site of the Azotas State Enterprise which produces nitrogen fertilizers while Kedainiai is home to a biochemical plant and a second fertilizer plant. Panevezys, to the north of the Kaunas region is where several large food plants are located producing meat, sugar, and an alcohol and yeast plant as well as other production facilities. This is only a partial list of manufacturing facilities in the region which, in the aggregate, have the potential for imparting a severe environmental impact.

An extended visit to the region was made from February 3-5, 1992 during which 6 manufacturing plants and one municipal wastewater treatment plant (in Panevezys) were visited. Discussions were held with management and operating personnel of each plant to assess their contributions to air, water and solid waste pollution problems in the region.

Some general observations.

1. The Kaunas region is heavily industrialized mainly in the three towns visited, Kaunas, Jonava and Kedainiai. The extent of the regional air pollution problem is difficult to assess because of poor and incomplete emission and air quality test data, but a tentative estimate is that it not believed to be severe in a regional sense. The chemical nature of emissions is of more serious concern, at least locally, where large chemical manufacturing plants (fertilizers and biochemicals) operate. The effect of pollution from even these large plants in the cities of Jonava and Kedainiai is difficult to evaluate because of poor emission and air quality data. Whether these plants are indeed of concern regionally and/or locally awaits further data but they apparently do produce local problems, at least in a nuisance sense. In almost every case, though, there are clear abatement strategies that can be selectively employed to reduce emissions at individual plants. Where possible, these emission reduction methods are indicated in the text which follows.

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Air pollution problems in Panevezys center about a few manufacturing enterprises within the city. Though these plants (glass and cable manufacturing and yeast production) are local problems, it is not believed that they have a regional impact. Outside the city there are no significant industrial operations in the region.

There is, however, one readily identifiable air pollution emission source throughout the region (and the country as well) that must be controlled as soon as possible, fossil fuel burning equipment. The aggregate emissions of particulates, SO_2, and NO_2 emitted by boilers producing power and steam are serious. There appear to be no controls of any kind on such equipment. Fortunately, a considerable amount of natural gas is burned and these boilers will need only NO_2 reduction, but oil burners will need extended controls. This is a costly requirement that will take time to implement but must begin as soon as possible.

2. Wastewater problems in the all the areas visited are quite severe either because of the lack of municipal biological treatment systems or because of the danger of overloading existing treatment facilities with industrial wastewater. In too many cases, individual industrial plant wastewater treatment is woefully inadequate or virtually non-existent. The practice of discharging industrial wastewater into rivers must cease and it should be the responsibility of each plant to provide adequate treatment facilities for its own wastes.

3. Solid waste disposal methods, for both toxic and non-toxic wastes, are inadequate. Little is presently done to separate and treat these wastes differently. Often, what should be non-toxic sludges are contaminated by heavy metals supplied in the wastewaters from industrial operations. The result is sludge that cannot be used elsewhere, for agricultural purposes, for example, and can only be stored. Such sludge waste sites are close to being critically over-filled. Contaminated wastes in landfills are subject to leaching into the aquifer with potentially devastating impact on the drinking water supply. The problem here appears to be poor management and inadequate planning for the disposal of solid wastes.

4. Environmental testing, when it is done, is sporadic and even occasionally irrational. Regional environmental offices make few demands on polluters except for monthly reports which are used to set waste charges and fines. There are no protocols for monitoring methods or for analytical methods and certainly no methods for integrating point source emission data into area wide pollution patterns. Modeling and incorporating meteorological data

with emission and air quality testing is completely absent. It is important to develop pollution audits at the plant level and regional audits at the level of the regional environmental office in order to properly assess the extent of air and wastewater pollution problems. Only with audit results can action plans be developed for pollution abatement.

5. Practices and philosophies of regional environmental control offices are not consistent, one with another. Even worse is that regional offices operate in a manner which is inadequate to constructively solve pollution problems. Some local offices consider themselves monitors and tax assessors (see 4. above) while others understand their function to be pollution control. At least one regional office visited actually works with local enterprises to set environmental goals, develop control strategies, agree to time frames for abatement, monitor progress toward goals and, within their legal framework, punish by taxation and ultimately by plant or process closings. These practices should be routine not the exception. Greater uniformity in regional office functions should be developed at the state level and, if necessary imposed uniformly throughout the country at the regional level.

6. Prior to independence, manufacturing enterprises were created by central planing handed down from Moscow. Those enterprises created under central planning naturally turned to Moscow for advice on operations, particularly technical advice which was not available within the company. Although there are some exceptions, at the present time there is either a reluctance or inability to turn to Russian organizations for technical advice, particularly in terms of environmental problems. Companies must, therefore, be content with using outdated environmental control technology or, in the presence of the need to solve new environmental problems, do not have the technical capability to solve them. Technical expertise must be developed to assist companies in developing solutions to their environmental problems. This expertise should be developed at company level with technical environmental assistance provided by an agency of the federal environmental control board.

7. Technical expertise in environmental control methods is sorely lacking at the level of the environmental regional offices. There are exceptions where technically trained individuals are hired for industrial inspection purposes, but this is generally not the rule. Inadequately trained personnel cannot judge the appropriateness of industrial abatement plans or even what technology is available for solving pollution problems. Adequately trained personnel must be found or training given to those responsible for assisting in industrial pollution abatement.

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8. Company managements are more concerned with maintaining production than with environmental problems and generally do not appear dismayed with waste charges or even fines. Of major concern to them is raw material and equipment availability and prices. There is little if any attempt to institute process changes which might reduce costs, increase efficiency or reduce emissions. This is understandable given the current economic condition in the country. However, management emphasis must change to include environmental concerns as part of the job of running a business.

The balance of this report consists of descriptions of industrial enterprises visited and their environmental problems.

JONAVA AZOTAS STATE ENTERPRISE

"Azotas" is one of two large fertilizer manufacturers located in the Kaunas region. Main products produced and 1991 production levels are listed below.

Liquid ammonia	615,000 tons/a
Ammonium nitrate	430,000
Urea	240,000
Methanol	100,000
Urea formaldehyde resins	78,000
Polyvinyl acetate resin	9,000

Ammonia is made from natural gas using standard technology for this important basic material leading to a variety of nitrogen fertilizers. Some of the synthesis gas used to produce ammonia is diverted to methanol production but most is catalytically oxidized to NO_2 and then absorbed in water to produce dilute nitric acid. Ammonia and nitric acid are combined to produce ammonium nitrate, the single most important inorganic nitrogen based fertilizer. Urea is produced from ammonia and carbon dioxide and is valued as a fertilizer and in the manufacture of resins and adhesives. The large scale, complex sequence of chemical steps in this plant leads to a wide variety of emissions including gases (NH_3, NO_2, CO, and SO_2) as well as dust from ammonium nitrate and urea granulation, transportation and storage. The plant is a sprawling complex of process areas with old equipment and with many potential emission sources.

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NO_2 emissions from nitric acid production is particularly serious in basic fertilizer plants and one of its principal sources is the absorption tower to produce nitric acid. The simplest control method is additional scrubbing in a tail gas tower to reduce NO_2 to acceptable limits and is the method used at Azotas. Very often this procedure is inadequate and additional treatment is necessary to chemically convert NO_2 to innocuous nitrogen. The plant technical director says he is particularly sensitive to the yellow plume occasionally emitted from nitric acid production which is an indicator of NO_2 emissions. Claims are made that all plant process emissions are adequately controlled. Scrubbers on ammonium nitrate production facilities are described as 95% efficient. It is not clear whether actual emissions are monitored or only ambient air quality concentrations measured near the plant site and in Jonava by company environmental staff and local environmental office inspectors. Emphasis on air quality was stressed as demonstrating that emission are maintained below maximum allowable concentrations of pollutants. It is suspected that measurements are principally air quality concentrations not emission measurements. Ground level pollutant concentrations are made 3 times each week only at points in the direction of the wind; if winds are static no measurements are made! Apparently there are suspicions that plant emissions are serious but this is based on the nature of the processes, not on measured values. For the last 6 months of 1991, the plant would have paid 470,000 roubles in waste charges if emissions were at standard levels. Actual waste charges were only 390,000 roubles because they were considered below standard levels.

An explosion and fire occurred at this plant in March 1989 due to a break in an old liquid ammonia tank. The fire burned itself out in two days apparently with considerable damage to nearby facilities. Seven deaths occurred. The diminished production capacity caused by the incident was not reconstructed. The company claims to have reduced emissions by some 50% in the last 3 years but some of this amount could be due to reduced production of ammonia caused by the 1989 accident.

The company owns 8-50 ton/hour steam boilers and burns natural gas and heavy oil. Oil burning capacity is 60,000 tons/a but only 10,000 tons were burned in 1991. There are no fuel combustion emission control systems installed. The company consumed 1,170 million cu m of gas in 1991 and paid 1,050 roubles/thousand cu m. Electricity usage is about 1,000 mWh/month for which it paid 45 kopeks/kW. Platinum for nitric acid production is purchased from Russia at 800,000 roubles/24 kg and 240 kg were used in 1991.

The plant wastewater system is in two parts, one for "clean"

water and another for wastewater containing chemicals. The clean water is mechanically treated and mostly recycled to the plant except for a purge sent to a 100,000 cu m lagoon and then to the Neris River. Total wastewater discharged is 50,000 cu m/day of which 10-15,000 cu m/day is sent to the municipal biological treatment system. The municipal plant has a capacity of 70,000 cu m/day and also treats domestic wastewater for the town which has a population of 35-40,000. Two other enterprises, a furniture manufacturer and a fish processor also discharge to the municipal system. A typical wastewater analysis is shown below (all concentrations in mg/liter).

	EXITING THE PLANT	SENT TO THE RIVER
BOD	10.14	6.
Oil	0.73	0.73
Suspended solids	30.37	21.7
Ammonium salts	1.3	0.36
Nitrates	2.23	0.11
Nitrites	0.112	0.02
Total N	--	--
Total phosphorus	0.148	0.073
Sulfates	73.02	22.65
Chlorides	129.12	25.14
Methanol	--	--
Urea	--	--

The company is building its own wastewater treatment system but is being hampered by equipment procurement problems.

One or two truck loads of non-toxic solid waste are transported daily to a 10 ha waste site about 2 km from town.

Management suggests it is actively pursuing several programs for pollution reduction:

1. Wastewater treatment facility.

2. Increase conversion of urea production; problem is being examined by a Canadian firm.

3. Plans for CO reduction from the nitric acid plant and ammonia from the urea plant are being developed with the Dzerzhinsky Institute in Novogorod.

4. Working with Scandanavian countries through the Nordic Bank to acquire monitoring equipment at 50% of cost.

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5. Plans to attend a Danish equipment exhibition in Vilnius on February 16-18, 1992.

6. A total of 23 million roubles (10% of profits) were spent in 1991 on emission treatment problems.

THE STATE KEDAINIAI BIOCHEMICAL PLANT

This company produces mainly animal feed additives (vitamins, minerals, amino acids, antibiotics) for breeding and stimulating growth. Plant capacity for these additives is 72,000 tons/a although only 66,000 tons were produced in 1991 due to a lack of raw materials. Yeast for animal fodder is produced by hydrolyzing wood wastes from lumber mills and other wood product sources. Production of yeast in 1991 was 5,000 tons, about 50% of capacity, because of environmental problems. Other products include Trichlordermin, a plant root rot disease preventive, and Dimethylphosphonum, an organic phosphide used in the treatment of diabetes. Operations started with feed additives in 1970. Animal feed additives and yeast are mixed with pulverized wheat bran and sold primarily to feed lots in the Baltic countries and Russia.

The plant has two-50 ton/h steam boilers which burn heavy fuel oil and the dry residue after saccharification of wood wastes. The wood wastes are blown into furnaces together with fuel oil and accounts for 35% of fuel needs which is an excellent energy conservation strategy. The company claims to have the only boiler burning mixed fuels in the country.

The plant has air and wastewater emissions problems. Air emissions consist of the usual combustion emissions which probably contain somewhat more dust than usual due to the wood waste fuel. Total emissions from combustion are about 640 tons/a and 1,320 tons/a from processes. Process air wastes consist of dust from grinding and drying operations, such as yeast, bran, antibiotics, plus volatile organic compounds, such as furfural, methanol, acetone, and organic acids. There are no control devices on combustion equipment but the company claims that NO_x emissions are low, only 280-350 mg/cu m, because of the lower flame temperature for mixed wood/oil combustion, 1200 ^{0}C, than for fuel oil combustion alone, 1500 ^{0}C. There are dust control systems on processes vessels, transportation lines and packaging.

The biochemical company claims to discharge about 33,000 cu m/day of wastewater, which is exceedingly large, through its own treatment plant and then to the Nevezys River. Wastewater composition data offered are as follows (all numbers are mg/liter):

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	AVERAGE DISCHARGE	STANDARD
Ph	5.5-8.3	--
Suspended solids	50.5	60
COD	129	--
BOD	47	21
NH_4	52.6	--
Total N	94.5	120
Total P	11.3	30
Cu	0.0015	0.0017
Zn	0.011	0.012
Cr	0.0045	0.045
Fluorides	0.86	0.372
Sulfates	27	27.2
Chlorides	74.7	76.2
Fats	--	1.35
Oils	1	1
Detergents	0.44	0.59

Many of the effluents are at, or near, permissible emission standards. Emission charges for the last six months of 1991 were 500,000 roubles.

Plant solid wastes consist of sludge from the treatment plant, 97% of which is stored in tanks on site and 3% sold as forest fertilizer. Hazardous wastes such as lamps, tires, some oils and herbicides are stored in an off-site waste landfill.

KAUNOS ARTIFICIAL FIBRE FACTORY

This company makes cellulose di- and tri-acetate yarns from purchased cellulose acetate. Raw materials are purchased from Russia and all except about 10% of production is returned to Russia. The 10% exported to the West went to Switzerland, South Korea, Japan and Yugoslavia. Processing is rather simple. Cellulose flakes are dissolved in either a methylene chloride/ethyl alcohol solution (to produce triacetate) or in acetone (to produce diacetate) and then drawn into yarn from the liquid through spinerettes. Mono-filaments emerging from the drawing tanks are wet with solvent and are dried by blowing warm air over them. The solvent laden warm air is passed to activated carbon adsorbers where the solvent are recovered.

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The company uses 13 parallel adsobers for methylene chloride recovery and 19 parallel carbon adsorbers for acetone recovery. Inlet to the adsorbers average 25 g/cu m, for either solvent, and the maximum outlet concentration from the adsorbers is 200 mg/cu m. A gas chromatograph is used to monitor solvent concentration at the bed exit and when the maximum allowable concentration is reached, the inlet solvent is manually switched to a fresh bed. An operator samples the exhaust stream every five minutes. The old carbon bed is then heated with steam to release the adsorbed solvent, cooled and placed back into service. Steam for processing and solvent recovery is purchased as is power. Each time this cycle, adsorbing solvent, steam heating and cooling down, occurs the carbon bed decreases in solvent adsorption capacity. After many cycles, the bed is considered exhausted, that is it can no longer pick up solvent efficiently, and is discarded. This is done by bringing the carbon to the local waste dump site. Good quality activated carbon used to cost 1 rouble/kg but now costs 3 roubles/kg and could perform for 10 years before becoming exhausted. Only poorer quality carbon is now available and lasts for only 2 years The company buys about 50-60 tons of carbon annually, up from 40 tons/year when high quality carbon was available. High quality activated carbon can be bought from the West but the cost is too high. Management believes that high quality carbon when made available from Russia is bought at a high price and then sold to them at a reduced price.

The solvents recovered by steaming the carbon bed are purified by distillation and returned to process. Each ton of triacetate produced uses about 4,200 kg of solvent and about 348 kg of methylene chloride and 45 kg of ethyl alcohol are lost to the atmosphere. Diacetate production emits about 360 kg of acetone. Only some of the losses are solvents passing through the carbon adsorption system come from fiber drawing, the balance comes from tanks in which mixing and dissolving occur. Solvent concentrations on the plant floor are maintained at 38 mg/cu m against a standard of 58 mg/cu m but concentrations as high as 1,000 mg/cu m occur when filters are changed. The company pays 12,000 roubles/a for waste charges on 5,000 tons/a total solvents emitted and considers them absurdly low. These charges are most likely estimated based on annual solvent purchases not measured emissions. Emissions will vary with time, especially through the carbon bed, and would have to be mathematically integrated from chromatographic data to directly determine the amounts of solvents lost. Water condensed from the steaming operations and separated from the solvents (by decantation and distillation for methylene chloride and by distillation only for acetone) are sewered. The company claims that there is no methylene chloride in sewered water and only about 0.02% of acetone. Only 1-2% of the carbon mass discarded as solid

waste is believed to be solvents.

When switching carbon beds it is quite likely that emissions greater than 200 mg/cu m occur. When asked if scavenger carbon beds were used to avoid these emissions, the practice appeared to be unknown.

Measurements are made by the company within the plant and by the environmental board in the city for solvents but have never found any concentrations above standard values. Methylene chloride, ethyl alcohol and acetone are not hazardous materials and air quality standards for them are probably fairly high. However they do have distinctive odors which can be a nuisance if persistent. Solvent odors are clearly present inside the front door of the plant. Arguably though, methylene chloride can accumulate in the liver after long exposure and is of concern as a contributing agent to global warming. When asked if alternative emission control methods were, or would be, considered, the answer was no. The only concern was for high quality carbon for their adsorbers and filters for removing suspended solids from drawing solutions. Clearly, there is little concern or incentive for reducing emissions. Management appears quite ready to pay reasonable emission charges and is content to operate their present control system provided materials (filters, carbon) to continue operation are available. The control of solvent emissions is a well understood process and several alternatives exist, the choice depending on the value of the solvents being recovered and the level to which emissions must be controlled. A proper economic study of alternatives would provide a least-cost emission control system but apparently this is not understood here. Maintenance of the current system is the only route being considered.

KEDAINIAI CHEMISTRY PLANT

This company produces phosphate based fertilizers (monoammonium phosphate, MAP, and superphosphate, SP) as its primary products. SP (about 280,000 ton/a in 1991) is made from phosphate rock and sulfuric acid. About 500,000 tons/a of phosphate rock are purchased from Russia. Sulfuric acid is made in the Kedainiai plant, using sulfur which is mainly purchased as the mineral from the Ukraine (170,000 tons/a) and partly from sulfur recovered at the Mazeikiai refinery (35,000 ton/a). Total sulfuric acid production is 500,000 tons/a which is also used to produce phosphoric acid from phosphate rock in addition to SP. The phosphoric acid, plus ammonia purchased from Azotas in Jonava, are reacted to make MAP. Some small amount of sulfuric acid (18,000 ton/a) is sold. Aluminum fluoride (technical grade) is made from

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hydrogen fluoride recovered in the SP and phosphoric acid processes. Process steam is produced in the companies own boilers, fueled with heavy oil, and by heat recovery in its sulfuric acid process (about 30% of total demand). About 20% of the plants electricity requirements are produced with its own steam turbine and the balance purchased.

The company has major problems with air, water and solid waste emissions. Total emissions from the plant are estimated as 2,500 tons/a of which 1,000 tons/a are from power production. SO_2/SO_3 and sulfuric acid emissions from sulfuric acid production are estimated as 400 and 18 tons/a, respectively. Appropriate gas and fume emission control equipment is claimed to be installed on all process equipment such as sulfuric acid mist tail gas scrubbers from SO_3 absorption and fluoride scrubbers for MAP, SP and phosphoric acid production. There are no control devices for emissions of any kind on boilers. The company conducts its own emission and air quality monitoring program. Emission monitoring is conducted at 32 points every 10 days. Air quality measurements are made at points on three concentric rings located 1.52, 3.4 and 5.6 km from the plant. These air quality measurements are made at three adjacent points on each circle but only in the direction the wind is blowing. Measurements are made of HF, H_2SO_4, SO_2, NH_3 and NO_2. Particulates and HF are apparently not measured. Concentrations of measured materials in 1991 have never exceeded maximum allowable concentrations except once for NH_3 which was only 1.25% over the standard. Environmental officials conduct air quality measurements in the town. The company paid a half-yearly waste charge in 1991 of 300,000 roubles which they appear to be comfortable with. However they claim to be deathly afraid of fines which would be imposed if maximum allowable concentrations are ever exceeded. They claim the fines are so large they could bankrupt them.

Solid wastes mainly concern solid materials from wet-process phosphoric acid manufacture. These wastes consist mainly of $CaSO_4$ (23.4% as CaO), SO_2 (33%)and P_2O_5 (1.05%). Heavy metals include Pb, Cd, Ni and Cr. The largest heavy metal concentration is Pb at 14 ppm. A rather lengthy, and apparently complete, analysis of this material by the Central Research Laboratory is available. The above-ground storage pile can be seen from the road passing the plant and contains some 8 million tons of waste. Annual additions to the waste pile amount to 600,000 tons/a and 100,000 tons/a of this material are sold to the Akmene cement plant. The waste pile is apparently surrounded by a dike to contain leachate which is pumped back to process because of its P_2O_5 content.

The wastewater situation at the plant is divided into three

parts, cooling water, process water and rainwater runoff. The claim was made that all process wastewater is completely recycled and that none is discharged to the nearby Neveszis River. Two other water sources, however, are discharged to the river. One is from a closed-loop cooling water system which is purged to avoid the buildup of salts. The source of fresh makeup water for cooling is also the river. There are cooling towers in the system, and the tower output is lagooned, most of which is recycled for cooling purposes except for the purge sent to the Nevezis.

The largest discharge to the river is from rain water runoff from a 10 km square area catchement. Rain water is collected and stored in a lagoon which serves as an equalization tank. About 4 million cu m/a of water is discharged to the Neveszis River of which 1.2 million is rainwater. Rainwater collection is uneven, most of it occurring in early spring and fall with the heaviest rainfall, at which time the overflow can be 50 cu m/hour. A typical analysis of water discharged untreated to the river is shown below (all numbers are mg/liter):

	RIVER WATER COMPOSITION UPSTREAM OF DISCHARGE POINT	COMPOSITION OF DISCHARGE WATER	WATER STANDARDS
BOD	2.8	4.5	66
Suspended solids	7.2	17.6	15
Fluorides	0.36	2.45	3
Total nitrogen	8.8	18.21	12
Total phosphorus	0.25	8.5	30
Sulfates	57.	123.	200
Chlorides	32.	103.	300
Oils	0.22	0.32	1

The standards supplied by the company seem extraordinarily high. The composition of the discharged plant water also appear to be extremely high especially considering that it is supposed to be composed of rainfall. The company explanation is vague and unconvincing. At first it was suggested that spills to the ground from product loading operations onto trucks and railroad cars was responsible. This could hardly explain the high fluorides in the discharge water, however. Also, the company claims that only covered trucks and rail cars are used. Then an explanation was offered that rainwater picks up materials from the ground due to stack emissions but they also claim to have efficient process cleaning equipment. It would appear that no one really knows where the rainwater contaminants come from and no planned program to determine the source has been designed.

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PANEVEZYS STATE SUGAR REFINERY

Refined sugar is produced at this plant from sugar beets (15-16,000 tons/a) from local farms and sugar cane (10,000 tons/a) from Cuba and Brazil. Production of sugar from cane accounted for 3 months of total production and 4 months production with beets in 1991. The remaining 5 months were used for plant maintenance. At the moment sugar cane is no longer available from Cuba. The raw material supply has reduced employment at the plant from 500 to 400 with additional layoffs anticipated. Processing is based on standard technology with old equipment and poorly automated. The plant is 100 years old.

There are no air emissions from plant processes except for steam production in their boiler plant which fires heavy oil but has no emission controls. Solids produced at the plant consist of mud from processing. This material is given away free to local collective farms.

Wastewater is the current major pollution problem. Water input to the plant for both cooling and processes comes from two sources, the Nevezis River and from the drinking water supply. At full operating capacity the plant would use about 750,000 cu m of water annually, which is approximately 4,200 cu m/ton of beet sugar produced and 2,300 cu m/ton of cane sugar. Management claims new plants in the West use about 1/4 this amount, but this figure seems low. The plant used about 25,000 cu m of water daily in 1991 divided into 7,000 cu m/day for cooling and 18,000 cu m/day for processing. Cooling water is recycled after passing through cooling towers. Process water is mechanically cleaned and returned to process with about 1,000 cu m/day sent to the local municipal wastewater treatment system. The discharged wastewater contains about 1,750 mg/liter of BOD and 500 mg/liter of suspended solids. Municipal wastewater authorities want this load reduced and the company plans to comply by reducing the volume discharged by 1/2 and then treating the lowered volume discharged in holding tanks before delivery to the treatment plant. They believe they can reduce BOD to 750 mg/liter which is a 57% reduction based on concentration alone. The local environmental board inspector agrees with this plan. It was suggested to management that oxidation with air would enhance the BOD reduction significantly over that possible by just holding the discharge, but this suggestion met with little response.

Waste charges in late 1991 were 2.7 roubles/cu m of wastewater discharge prorated on the actual amount of water received by the

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municipal treatment plant.

PANEVEZYS SPIRIT AND YEAST PLANT

This company is located in the center of town which grew around the plant since its inception 100 years ago. The immediate area around the plant is a typical downtown location containing business, residences and rather crowded with pedestrians and motor traffic. The plant facade is attractive (as indeed is much of Panevezys) belying the manufacturing operation it houses. There were no noticeable odors in the brief walk to the entrance although there have been complaints of odors in the area. Inside the building there was the clear typical odor of yeast fermentation.

Molasses purchased from 4 local sugar plants is used to produce 42,000 tons/a of bakers yeast and 500,000 decaliters of 96.2% ethyl alcohol by fermentation. The bakers yeast produced is for large establishments and is also packaged in small amounts for home use. Ethyl alcohol is sold for medical purposes and for spirits. Fermentation processing produces CO_2 which is recovered, compressed and dissolved in water for sale to soft drink producers.

The company buys its electricity and steam, the latter from a neighboring plant. There are no fuel burning systems producing combustion emissions. There are odorous emissions from washing fermentation tanks and from the storage of slops (from the residue of alcohol purification). Slops are generally dewatered (to 60% solids) and sold as cattle feed but dewatering capacity is limited and 20% of slops are sent to a special pit at the local waste land fill after being stored on site. Air measurements (local air quality/emissions?) show that CO and ethyl alcohol exceed standards. Air emission charges have not as yet been set.

Wastewater is the company's most serious problem. About 2,400 cu m/day of wastewater is discharge to the municipal treatment system which has complained repeatedly about the load to its system. Connection to the municipal system was made in 1960 and only 6 years ago an equalization system was installed. Current wastewater charges are 7.20 roubles/cu m. Repeated warnings about wastewater led to a two day closing of the plant in 1991. The company is having wastewater system cleaning designs prepared at the Moscow Engineering Institute and The Vilnius Technological University and plans to install its own cleaning plant.

Considering its location, the air emission problem could be much more serious than it appears to be. It is difficult to assess

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Equipment needs include vacuum filters for sludge dewatering and pipe for aerators. Coagulating materials for metal removal are also needed.

The wastewater system control room is automated for continuous measurement of, for example, water volumes received and biological system tank temperatures. It would appear that the system could achieve effluent standards if excessively high burdens from industrial users could be removed or required, at the very least, to pre-treat their wastewaters. Joint domestic/industrial wastewater is always a good idea unless industrial users abuse the system. In that case it is essential that individual industrial plants build their own complete wastewater treatment systems and disconnect from the municipal system or develop partial treatment processes for their own wastes.

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the air emission problem without a more detailed examination of emission and air quality data but at this time it is judged not to be critical. Air emission controls should be considered but wastewater is currently the more serious problem.

Wastewater composition from yeast fermentation can be quite high in BOD, COD, sulfates and phosphates. That the municipal treatment plant cannot cope with these wastes (in volume and strength) is quite clear, although this plant is just one of many contributors to this problem. That the company is considering its own wastewater cleaning plant is good but the local environment board should establish effluent standards and the time frame for implementation. If possible, the company should consider a complete treatment system with discharge directly to the river rather than to the municipal plant after partial treatment.

Solid waste disposal of slops to landfill could be avoided by adding additional dewatering equipment. However, it is doubtful that the marginal value of the slops recovered for sale could recover processing costs.

PANEVEZYS MUNICIPAL WASTEWATER TREATMENT SYSTEM

The city of Panevezys has a population of about 130,000 people and has one of the few biological wastewater treatment plants in the country. The plant was built in 1978 with a capacity of 70,000 cu m/day and is currently treating 60,000 cu m/day. The present volume received is too close to capacity and appears to be due to the large volume of industrial wastewater treated, about 40% of the total, along with 60% domestic wastewater. In addition to the high volume of industrial wastewater treated, the plant is burdened by high loads of BOD and heavy metals from these industrial users.

The BOD standard for wastewater discharge is 15 mg/liter and cannot generally be met. High BOD contributors are from the sugar refiner, spirit and yeast plant (especially in October, November and December), meat, beer and ale plants and a linen manufacturer. There are 9 industrial users contributing high metal content wastewaters (cable and TV plants, electronic equipment and calculator production plants, an auto compressor plant and small metal parts for furniture manufacturing, and a nearby military airport which will close some time in the future). These high metal content wastewaters produce a sludge from biological treatment too high in metals to be of value as an agricultural fertilizer. Dewatered sludge is now produced at the rate of 100 cu m/day and is stored in a nearby solid waste field which is rapidly filling. New waste fields must be found in the near future.

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APPENDIX 2.

LATVIA: PLANT SITE VISITS

ENVIRONMENTAL EFFECTS AT RIGA VARNISH AND PAINT FACTORY

This factory is located on 14 hectares in central Riga and produces a modest variety of industrial coatings: alkyd paints, polyurethane varnishes and enamels. Much of this production, about 50,000 tons/a, is for anti-corrosive primers (auto and ship bodies) and wood and metal protective coatings. About 50% of production is exported to Russia, 30% to Byelorussia and the Ukraine with about 20% used in Latvia. Raw materials are mainly from Russia but supply problems are expected to reduce production by 50% in 1992. The company hopes to pursue higher added value products in the future by licensing processes to make modern, higher quality, anti-corrosive surface coatings.

Pollution problems embrace air, water and solids. Some volatile organic materials such as esters, acetates and aromatics used in production formulas are mixed with pigments and vehicles in batch vessels. Although solvents are delivered to tankage by pipe and mixed in closed vessels, it is inevitable that some solvents escape into the plant work place. Exhaust blowers pull air through the plant to maintain a safe working environment. Some 70 points are monitored by chromatography for combustible solvents in work areas principally, it would appear, to avoid explosive mixtures when welding pipe and tank connections. Management claims that interior air quality standards are generally satisfied with only occasional exceptions.

In one work area, exhaust gases are incinerated with natural gas and then vented. When installed, the equipment manufacturer assured no emissions provided the incinerator temperature was controlled at 800-900 ^{0}C. Emissions from the incinerator are not monitored. Allowable air emissions are reported to be 70 kg/ton of product distributed as 30% pigments, 30% binder and 40% plasticizer and solvents. The company claims to discharge only 0.15-0.2 kg/ton product, a figure estimated from material balances. Air emission standards are based on work performed at the Scientific Research Institute of the Lacquer and Paint Institute (now called SPEKTR) and are used in the absence of any other source of standard emissions from these processes. Some lead based pigments are used but only in relatively small amounts. The company is surrounded by a park and other industrial operations (beer and glass production) and only one small residential area. Nuisance odor complaints by area residents were really not traceable to company operations. Complaints ceased when residents were moved to new locations. A description of catalytic incineration and solvent recovery systems met with no positive response.

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A natural gas fired boiler raises steam for plant use. Only 17% of steam produced is used for process heating and the balance sold to the municipality. All electrical needs are purchased.

Wastewater is composed of rain water runoff, sanitary water and process water discharges. These mixed streams are mechanically treated and then discharged to the municipal treatment plant. Cooling water is presently not recycled. The company has plans to segregate waste water sources and to (a) recycle cooling water and (b) recover and recycle materials from resin synthesis. This would reduce waste water discharge from the current 2,000 cu m/day. The plant waste water treatment system needs spare parts and filters. Filters presently bought from Russia are unsatisfactory.

Solid wastes, mostly paper, cardboard, cans and some sludge from mechanical wastewater treatment (not dewatered) are discarded at the local landfill. Waste charges paid for the last three months was 70,000 roubles which the company considers modest. It is believed that waste charges will drastically increase in the near future and it is this that is driving the company to make plans for an improved treatment system.

Monitoring of emissions is done once/week and reported to the regional environmental committee every three months. The national environmental pollution committee makes measurements once/month.

The company's plans for improving their waste treatment system are generally sound but there appear to be no time frame for making changes. Changes are apparently dependent on financial improvement in the company's future and the availability of funding and equipment. There appear to be no plans to improve monitoring, conduct plant-wide pollution audits or examine the suitability of the present air emission control system, all of which are considered satisfactory by management.

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ENVIRONMENTAL EFFECTS AT VALMIERA GLASS FIBRE PLANT

The city of Valmiera is about 80 km north east of Riga almost to the Estonian border. The fiberglass plant is the only large factory in the area and produces textile yarn and finished fiberglass products from basic raw materials using standard, old technology. Raw materials include sand (specially selected and washed), dolomite and $CaCO_3$, alumina, boric acid and zirconium oxide, among others. All these materials are imported mostly from Russia with some from Lithuania, Estonia, Byelorussia and the Ukraine, except for dolomite which is locally produced. High value metals, platinum and rhodium for spinneretes, come from Russia.

Products consist mainly of fiberglass for electrical insulation materials, boat hulls and yarn and consumer goods such as motor bike helmets and printed sheeting. Plant production in 1991 was close to capacity, 10,000 ton/a. Products are shipped mainly to Russia with 12% remaining in Latvia and 1% to the West. Sufficient materials were stock piled last year to continue production until March. After that no raw materials will be available.

Management is anxious to receive technical assistance from the West and are especially interested in a joint venture. They have a close relationship with Schuller in Germany and are hoping to produce fiberglass for roof insulation. They have been in contact with the John Manville Company and would very much like a contact with Owens-Corning.

Air pollution is the main problem at the plant. Emissions consist largely of dust from material preparation (grinding, mixing, transport), glass dust from melting (a two furnace sequence), drawing fiber and coating (with an oil emulsion containing only about 5% oil in water). During a walk through the plant considerable dust was observed on equipment and floors in the raw material preparation area but was not excessive for this kind of operation. The floors around the glass melting tanks producing drawn fibers was very slippery and the air was heavy with odors of the oil emulsion used. About 40% of the oil emulsion coating is burned off woven fiberglass sheets directly in contact with flames in low temperature furnaces and produces oily vapors. Except for the glass melting furnaces, which use an extremely low sulfur content imported oil, heavy oil is used to fire other furnaces and boilers. Only about 30% of steam raised in company boilers is used on site, the balance sold to the city. The only air pollution control equipment installed is in the material preparation area where mechanical filters (baghouses) are used to return captured

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particulates to process. Air emissions are sampled manually once every month and analyzed in the company laboratory. Instruments are generally not available and most methods use wet chemical procedures.

Air emission data provided by the company are listed below:

Dust	1,170 ton/a
SO_2	620
CO	170
NO_x	143
B_2O_3	180
Fluorides	35
As_2O_3	6
V_2O_5	0.83
Styrene	5
Toluene	1.5
Butylacetate	1.8

These numbers would appear to be a mixture of measured and calculated estimates. It is interesting to see As_2O_3 listed as a rather large emission but not even listed as a raw material. The company claims to be examining the possibility of producing a transparent fiberglass yarn which would require larger amounts of arsenic than is currently used.

In addition to measurements in the plant, the company measures air quality at ground level 3 km from the plant. The Environmetal Protection Committee and a consulting company in Valmiera also make emission measurements which apparently agree with the company data. The company claims to be in violation of air emission limits but claims that this is known based upon materials found in soil samples. The fact that particulates from the plant have been falling in the area since 1936 and that it would be rather difficult to relate present emissions with materials found in soils was not appreciated. There have been reported cases of asthma and cancer at the plant but work place concentrations of process emissions were not available.

Company water supply is from its own underground wells. Cooling water is treated in cooling towers and recycled. Waste water effluents, 1,570 cu m/day of which 50% is sanitary waste, are monitored once every three weeks with the following gross results:

	AVERAGE CONCENTRATION	ANNUAL TOTAL
Oil	3.3 mg/l	1,900 kg
Detergents	2.6	1,400
BOD	11.6	9,860
Suspended solids	18.7	1,300

The plant treats its waste water mechanically and biologically, the output then flowing into a small stream which passes to the Gauja River. The concentrations shown were not identified as input or output. Metal components in wastewater are either not measured or not available. On an average basis, the waste water effluents meet emission standards; what is required are more detailed data to determine maximum and minimum effluent concentration and their frequency. Only in this way can the efficiency of the treatment system be estimated and appropriate remediation methods developed.

Solid wastes consist of sludge from wastewater treatment (not dewatered), fiberglass that cannot be recycled, resins, and packaging materials. About 15 cu m/day (460 tons/a) of waste solids are deposited in an old municipal landfill.

Fiberglass manufacturing is a well known and usually bothersome source of pollution. The fact that there are no installed control systems except for raw material processing suggests that the plant could well be in violation of current emission regulations. However, the extent of environmental pollution at the plant are really difficult to assess. The data available are not sufficient, or appropriate, to make any judgement. What is particularly interesting is management's feeling of guilt and their feeling that they are indeed serious polluters. They feel the 370,000 roubles in waste charges and fines are fair. If maximum allowable concentrations are satisfied the total paid would drop to about 340,000 roubles, a differential hardly likely to encourage pollution reduction.

A proper emission audit is really necessary at this location to determine the actual extent of the problem. Also needed is an achievable set of realistic emission standards. Until these are available, waste charges and fines are essentially devices to raise money, not to encourage pollution reduction.

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INCINERATION OF TANNERY WASTES IN JELGAVA

One of the more serious environmental problems in Latvia is the disposal of solid wastes, particularly wastes identified as containing toxic and hazardous materials. Much of these materials are sludges from waste water treatment systems, municipal and industrial, containing high metals content. There are large storage piles of these materials while new solid wastes are added daily. Exposed sludge storage piles are subject to leaching with the potential danger of contaminating ground water or passing directly to nearby surface waters. There is a need for methods to reduce the volume of these sludges and to find safe storage sites where ground and surface water contamination will not occur.

Typical of this problem is the sludge produced at the Jelgava Tannery which contains chromium and possibly small amounts of other metals (nickel, zinc) . One method of reducing sludge volume is to dewater it and then to incinerate the semi-dry residue. To explore the effectiveness of this procedure, the city of Jelgava has selected 40 tons of residual sludge from the local tannery for an extended incineration test.

With the assistance of an American company, EcoLatvia (New York), experts at the Latvian Ministry of Industry and the Environmental Protection Committee selected an incineration system developed by the WasteAll Corporation (Peapack, New Jersey) for the test. Prior to purchase, West European environmental companies (in Sweden and Germany) were consulted concerning similar equipment but were not able to meet the price of the American system. The WasteAll incinerator was purchased for USD 130,000 including dismantling, transportation to Latvia and technical assistance for installation with local labor. The low price reflects the fact that the equipment is not new having been used in the U.S.A to prove its capability to destroy explosives contaminated soils [1]. Technical assistance will also be provided for startup in Latvia. Prior to purchase a small sample of the tannery waste was sent to WasteAll for evaluation. If specifications for the incinerator was submitted or If a report of the WasteAll test was produced neither is available. However, the company apparently felt that its

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[1]. The WasteAll incinerator design was subjected to tests by Roy F. Weston, Inc., West Chester, Pa. for the U.S. Army Toxic and Hazardous Materials Agency. A report of these tests was issued April 1984, "Installation Restoration General Environmental Technology Development. Task 2. Incineration Test of Explosives Contaminated Soils at Savanna Army Depot Activity, Savannah, Illinois", Report No. DRXTH-TE-CR-84277.

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equipment was capable of satisfactorily treating the tannery waste solids. It offered a guarantee that requires it to add additional sections to a high efficiency mechanical filter if it does not meet standards in its present configuration.

The incinerator has two combustion sections. The first consists of a rotary inclined, refractory-lined kiln in which the solid waste feed is burned with a gaseous fuel. Kiln temperatures can be maintained between 430-1,000 ^{0}C and residence time can be controlled by th kiln rotation rate. Ash and combustion gases are removed from the same end of the kiln (unusual in kiln design). The combustion gas is then further burned in a secondary chamber where incompletely burned gases exiting the kiln are combusted at temperatures up to 1,650 ^{0}C. Combustion gases exiting the secondary firing chamber are passed to a waste heat boiler producing low pressure steam and reducing flue gas temperature to 150-175 ^{0}C. Cooled exhaust gases from the waste heat recovery boiler are discharged to the atmosphere through a Micro Pulse fabric filter containing 64 glass and teflon bags coated with $CaCO_3$. The filter is jet-pulse cleaned and is designed to capture particulates at 99% efficiency down to 0.5 micrometers.

During soil incineration tests for the U.S. Army 19 tests were performed during which solid feed rates were varied from 135-181 kg/hour, kiln temperatures from 430-870 ^{0}C and the secondary combustion chamber temperatures from 760-1,100 ^{0}C. Test results reported are summarized in the test report [1]. Some highlights of the test findings are reported below.

1. Ash recovered (bottom and fly ash) averaged about 60% of the solid waste incinerated, on a mass basis. Thus, solid waste mass reduction averaged 40%. Volume compaction of incinerated soils averaged about 15%. These are not very significant reductions although results with other solid wastes may vary considerably depending on the amount of combustibles, water and ash in the waste.

2. Fabric filter control efficiency varied from 99.1-99.9% comparing inlet and outlet particulate quantities. These efficiencies are quite typical of good fabric filters.

3. The table below shows how metals in the test soil incinerated are redistributed in the bottom ash (from the kiln) and fly ash (captured in fabric filter and released to the air). The metals in the ash samples are expressed as mg/l of ash leachate and, therefore, are not comparable with the original metal content of the soils, expressed as g of metal/g soil. However, it is important to note that there is a tendency to concentrate heavy metals in the fly ash at the expense of bottom ash. This means

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that fly ash penetrating the fabric filter will be richer in some metals than the bottom ash. The total quantity emitted and the concentrations related to maximum allowable concentration standards are not known. It will be important to measure the metal quantity emitted, both concentration and total quantity, to ensure incinerator emissions will not be hazardous to human health over the long term. However, the findings in the U.S Army tests showing that the U.S. Environmental Protection Agency toxicity limits are not exceeded.

	SOILS CONTENT (ppm)	BOTTOM ASH (mg/l)	FLY ASH (mg/l)	USEPA TOXICITY LIMITS (mg/l)
Barium	17-19	0.04	0.23	100
Cadmium	ND (a)	0.10	0.10	1
Chromium	ND-13	ND	ND	5
Copper	ND-30	--	--	--
Lead	16-100	ND	ND	5
Zinc	32-160	--	--	--
Arsenic	ND	0.02	0.04	5
Selenium	ND	ND	0.02	1
Mercury	ND	0.004	0.004	0.2

(a) ND - Not Detected

4. Incineration of solid wastes will produce gaseous emissions from combustibles in the waste and from the burned fuel. Soil incineration tests used propane gas and produced gaseous emissions reported below.

	MEASURED EMISSIONS (mg/cu m)	LATVIAN STANDARDS (mean/day, mg/cu m)
HCl	2.5	0.2
SO_2	13	0.05
NO_x (as NO_2)	570	0.04
HC (as CH_4)	ND	--
CO	ND	3.0

Because Latvia has no emission standards, only ambient level air quality standards (AAQS), the measured values should be converted to AAQS using appropriate equations. The data shown are specific to the American tests and really academic for applications in Latvia. Gaseous emissions will, of course, significantly depend on

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the chemical composition of the solid waste to be incinerated and the composition of the fuel used. Estimates of expected emissions should be made after chemical analysis of the solid wastes to be tested and then emissions should be measured for confirmation.

5. A carefully designed experimental program should be prepared to determine the suitability of incineration in general, and the WasteAll incinerator in particular, to safely reduce tannery sludge wastes. Chromium content of waste to be burned should be compared with chromium recovered in incinerator bottom and fly ash. (Initial tests performed in Latvia show that tannery wastes contain 3.3-6.6 g of chromium/kg of tannery waste and is not homogeneously distributed, which could be troublesome.

6. Other variables which should be examined are waste feed rate, combustion temperature in the kiln and secondary combustion chamber, kiln rotation speed, fuel excess air, filter efficiency, fuel firing rate and fuel type. The test design is for the purpose of maximizing performance which means (a) minimizing fuel used per kg of waste solid incineration, (b) minimizing the fly ash containing heavy metals reaching the atmosphere, (c) minimizing the quantities of polluting gases (SO_2, NO_x, CO, hydrocarbons, and other possible materials) to the atmosphere. Gaseous emissions may strongly depend on the type of fuel used and preference should be given to natural gas as the combustion fuel.

7. Among the findings in the U.S. Army tests was the observation that the second combustion chamber was not needed provided the kiln temperature was not less than 760 ^{0}C. This observation should be checked so that minimum fuel is used for incineration.

8. The incinerator test scheduled in Latvia is for 40 tons of tannery wastes. At the minimum burning rate of 160 kg/hour, a continuous burn will take 250 hours. Actual test time will be shorter if higher burn rates are used. Nevertheless, it would appear that the quantity of tannery wastes should be sufficient to produce an initial evaluation of the incineration concept. However, it is urged that the incinerator continue to be used as a test bed with other sources of solid waste material in order to fully test incineration as a suitable method for reducing solid wastes.

9. It has been reported that some toxic and hazardous solid wastes have been used to produce bricks and concrete blocks. This is a bad idea. Incinerated wastes (ash) should be disposed of safely in secure land fills and not used.

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10. It is felt that the incineration project being developed is sound and is being properly executed. Success in these tests could possibly provide Latvia with a powerful solid waste disposal method.

PHARMACEUTICAL AND BIOLOGICAL PRODUCTION
LATBIOFARM AND BIOLAR IN OLAINE

Two large adjacent chemical plants, Latbiofarm and Biolar, are located on the outskirts of Olaine, population about 18,000, some 20 km from Riga. Both plants produce mainly pharmaceuticals (Latbiofarm) or precursors to pharmaceuticals (Biolar). Pharmaceuticals produced by Latbiofarm include cardiovascular, antiviral, neuroleptics, vasodilators and cancer drugs. Among the larger quantities of intermediates produced by Biolar are itaconic acid, aminophenyl acetic acid, and lecithin. Some of Biolar's production of intermediates is sold to Latbiofarm for pharmaceutical production. Biolar would like to sell some of its synthesized intermediates to Western markets but would have to compete against large, strong companies such as Sigma and Aldrich, two specific American specialty chemical companies mentioned. At the moment both companies are having typical problems with raw material supplies. Latbiofarm is working at 25% of capacity and has material for possibly one more month of production.

Both plants together consume almost 19,000 tons of raw materials annually (essentially mixed organic and inorganic chemicals) when operating at or near full capacity. Of the two companies Latbiofarm is the larger consuming almost 13,000 ton/a of almost 300 different chemicals. The consumption of large amounts of chemical raw materials coupled with often small production runs of specialty products can lead to many sources of pollution. In addition, the high purity demanded of the materials produced requires many purification steps (extraction, distillation, etc) and adds to the emissions burden. Also, Latbiofarm claims that they must purify raw chemical materials they receive because they are of low quality. Both companies have problems with air and waste water discharges and are the largest emitters in the area although there are other three small plants in the area; a plastics converter, gelatin factory, and a peat producer.

Some atmospheric emissions from both plants are tabulated listed below [1].

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1. Emission data were not available from either Latbiofarm or Biolar, or the Environmental Protection Committee. Both air and water data were taken from "Environmental Situation and Project Identification in Latvia", Nordic Project Fund, Helsinki, May 1991, Appendix 3.4 and 3.5.

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	FROM LATBIOFARM	FROM BIOLAR
Toluene	17.5 tons/a	0.3
Isopropyl alcohol	47.9	6.4
Hydrochloric acid	11.3	
Ammonia	13.2	5.4
Acetic acid	5.7	
Benzol	10.2	
Bromine benzol	4.6	
Bromine	1.6	
Ether	5.1	0.2
Acetone		5.5
Ethanol		43.0
Formalin		2.2
Benzaldehyde		2.9
Methyl chloroformate		1.3
Nitromethane		0.24
Chloroform		0.02
NO_x	0.7	0.9
SO_2	0.5	

Latbiofarm claims to have 300 stacks or emission points at which measurements are made or estimated. Apparently, agreements have been made with the regional environmental pollution committee as to the quantity of materials emitted and on which the company pays waste charges and fines. Latbiofarm has major air problems with isopropyl alcohol, ammonia and hydrochloric acid leaks from storage. Large amounts of emissions are shown in the table above. Triglyceride processing creates dust problems. The company claims to have high energy wet scrubbers for many of its process emissions.

Biolar also claims to have high air emissions, about 47 ton/a total, of which ethyl alcohol is the largest. They claim that many processes employed are obsolete and plant and equipment are old, giving rise to one reason for high air emissions. There are 160 known emission points in the plant of which 50 serve as monitoring points. Air measurements are made once/week and ammonia is monitored continuously.

Latbiofarm operates the only major waste water treatment plant in the area. It also supplies drinking and process water for itself, Biolar and the town; it's source is the local river which it purifies and then distributes. Biolar in addition has three artesian wells for its own water supply. The waste water plant has biological treatment and dewaters sludge in vacuum filters to about 80% water content. Treated waste water is discharged to the local

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Misa River, which flows to the Iecava River, to the Lielupe and then to the Baltic. About 8-10 tons/day of sludge are produced. Biolar has its own waste water plant, through biological treatment, and then sends its treated waste to the Latbiofarm treatment system.

Latbiofarm pays waste charges of 3 million roubles/a and 140,000 roubles in fines in 1991. Biolar pays 30,000 roubles/a in waste charges and 400,000 roubles/a to Latbiofarm to process its waste waters. Biolar is concerned that if it cannot clean its own waste waters to meet effluent standards then Latbiofarm will increase charges to Biolar cover its waste charges and fines. Waste water discharge parameters from both plants are tabulated below (all data in mg/liter, except as indicated)..

	LATBIOFARM		BIOLAR	
	INFLLUENT	EFFLUENT	INFLUENT	EFFLUENT
Flow (cu m/day)	5,600		6,800	
Suspended solids	23	--	146	277
COD	265	--	1,653	527
BOD	33	--	1,240	280
Total N	82	--	78.4	44.7
Total P	0.36	--	3.8	2.5
Volatile organics	220	--	251	244
Surface active substances	0.28	--	0.83	0.64
Oil	1	--	0.57	0.31
Pyridine		--	0.60	0.31
Phenols	0.018	--	0.03	0.007
Sulfates	248	--	--	--

Some liquid and solid toxic and hazardous wastes from both plants have, in the past, ~~been~~ deposited in lagoons in a swampy area some distance from production areas or have been burned in an incinerator in the same area. These practices have been discontinued and the lagoons emptied into deep well about q,300 meters deep.

Both plants appear to be seriously concerned about environmental affairs but seem to somewhat overwhelmed by the problem. Clearly, monitoring of both air and water is not sufficiently comprehensive to either establish the exact nature of the problem nor precise enough to suggest process alterations to reduce emissions or to indicate engineering control schemes. Part of the problem, of course is the size of the problem. From a

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pollution point of view, there are too many small batch processes producing too many different materials. Such an arrangement can be a nightmare of emission problems. Both companies are proud of their production flexibility but give no indication that this flexibility may be the major source of their environmental problem. Pollution reduction at both plants can be a never ending battle unless they find secure markets for just a few major products that can be synthesized in fixed processes.

APPENDIX 3.

ESTONIA: PLANT SITE VISITS

INDUSTRIAL AUDITS IN ESTONIA

Although air quality measurements are currently routinely conducted in three major cities, Tallinn, Kohtla-Jarve and Narva, there is very little monitoring of air pollution sources. Submission of source emission data to local Environmental Boards are required from all industrial pollution sources on a monthly basis but is mainly concentrated in the wastewater treatment area. Air pollution emission data are mostly calculated using emission factors which, at best, can only approximate actual source levels. An urgent need exists to develop the expertise required to conduct plant- and industry- wide environmental audits.

Such a program would have multiple benefits. Environmental standards, as they now exist in Estonia, are a direct and complete adoption of pre-existing all-union Russian standards. There has apparently been insufficient time or perceived need to promulgate a new set of standards for the country in a hurried fashion. These existing standards are currently being used for multiple purposes: (i) to set charges and fees for industrial air and waterpollutants, (ii) to define pollution problems believed to exist in the country and (iii) to give the Ministry of the Environment and local Environmental Boards time to develop an operating framework within which they can attack environmental problems. Industrial emission audits are intended to assist in these tasks.

An audit program can assist in emission charges which truly reflect actual, not perceived, conditions. Also, some presumed environmental problems may be more or less important when based on actual not estimated emission levels. Emission audits can assist in rationally setting priorities or revising present priorities using measured data.

Unlike wastewater monitoring, which is generally based on intermittent samples taken from the source, air source sampling is best undertaken by continuous monitoring. Processes, even those assumed to operate under steady conditions are subject to variations and a true picture of emissions is generally achievable only by integrating data over long time periods. Unfortunately, instruments required for air source emissions monitoring are generally not available. In addition trained personnel to undertake air source monitoring are generally not available at industrial sites.

Grants and loans are needed to purchase appropriate monitoring instruments and technical assistance is required to train industrial environmental personnel in the monitoring process and how to conduct industrial audits.

ENVIRONMENTAL EFFECTS AT KEHRA PULP AND PAPER MILL

The Kehra pulp and paper mill is the larger of two pulp and paper mills now operating in Estonia. Pulp is made from local trees (largely pine) and the whole tree is pulped, bark included. Some 500 tons/a of recycle paper from Byelorussia and recycle from mechanical process water cleaners are also used. The integrated mill produces 40,000 tons/a of Kraft pulp from which 38,500 tons/a of Kraft paper (jumbo rolls) and 7 million large paper sacks are produced. The plant was built in 1938 and rebuilt after the war. About 92% of the paper produced is exported to Russia, the balance used in Estonia. About 1 million paper bags are exported to Finland annually for potato sacking.

The mill produces power and steam in its own boiler house burning 40,000 tons/a of heavy fuel oil (mazout) and from a black liquor recovery furnace. When needed, 3,700 tons/a of oil-shale can be burned in a standby boiler. About 50% of electric power is purchased. The plant expects to convert from oil to gas when a local transmission line is completed. The mill has no lime kiln but purchases CaO locally. Chemicals from the recovery furnace are recycled to process.

The recovery furnace has an electrostatic precipitator. Furnace and control system were both installed by Mitsubishi in 1965. There are no emission controls of any kind on evaporators or on fuel boiler exhausts. The power plant stack constantly emits a visible black plume, clearly observed during the visit. Emissions from the Kehra plant are reported to be of some concern in southern Finland [1]. One wonders, however, how sulfur emissions from the pulp and paper plant can be distinguished from the more severe emissions from power generation to the north and closer to the coast along the Gulf of Finland.

Mill wastewater is treated by mechanical and activated sludge processes in its own plant built in 1977. Domestic wastes from the nearby town is treated in the mill wastewater plant and adds only about 2-3% additional burden but the treatment system is not efficient. Combined treatment plant effluents are sent to a local

[1] See also "Reduction of the Environmental Effects of Kehra and Tallinn Pulp and Paper Mills", Pre-feasibiity Study No. 16, Environmental Priority Action Programme for Leningrad, Leningrad Region, Karella and Estonia, Ministry of Environment of Finland, September 1991.

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river and then to the Gulf of Finland. An expansion of the wastewater treatment plant was begun last year but is currently on hold due to contractor difficulties.

Solid wastes are stored in a 30 hectare site some 1.5 km from the plant. According to mill personnel there is no measurable ground water contamination from dump site run-off. The town draws water from 3 underground wells which show no sign of contamination.

The mill paid 800,000 roubles for discharges in 1991 (about 1% of income) and was granted a rebate of 40,000 roubles because of wastewater expansion plans. Plans to reduce air emissions are coupled with plant reconstruction or capacity increase.

The company has an environmental group headed by a chemist-engineer and 40 laboratory staff superintended by two managers. All new employees are given on-the-job environmental training. Little confidence is placed in the local environmental board which has 15-20 members but with no technical skills to be of any assistance. Although the company believes the waste charge system is proper, they feel that inflation dilutes its ability to provide incentives for action.

The recovery furnace is in very bad condition. It has no functioning instrumentation at present and its continued operation depends upon skilled operators. The lack of instrumentation probably means very low energy and material recovery efficiencies. Also of concern are odorous sulfur emissions from recovery furnace concentrators. Mill management hopes to upgrade these units at a cost of US$ 50,000. Losing the recovery furnace will close the mill. Present contracts with Finland for paper bags, and an expected expansion of this niche opportunity, are expected to provide funds for the upgrade which they believe will produce an additional 4-5 years of life for the recovery furnace. If needed, management believes plant pulp capacity could be increased to 55-60,000 tons/a. A second-stage project involving either a new plant of the same capacity, costing US$ 20 million, or an increased capacity to 200,000 tons/a involving new technology and bleached paper production, would cost about US$ 400 million, are being discussed with Canadian and Swedish firms.

Company plans are ambitious and may be feasible in the long term. However, any capacity increase will severely increase environmental burdens in the area. Their present position is precarious because of equipment obsolescence, need for a secure fuel supply and environmental concerns. Present emphasis is on staying in business and looking for increased export opportunities

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with which to finance new equipment and increased capacity. There are no plans to do any pollution abatement without expansion or reconstruction of major units of the mill, except for wastewater. It would appear that there is no great pressure to clean air emissions by the local environmental board because of the economic value of the plant to the community. The mill employs 800 people in a town of some 4,000 residents.

There does not appear to be any dramatic need to unrelentingly pursue a program of air pollution abatement. The uncertain fuel supply and equipment upgrade problems must be resolved before proper control strategies are developed. Leaching from the waste dump clearly needs closer examination to determine if a problem exits. Recommendations include considering partly fueling their processes with tree bark. The marginal value of pulping bark would be offset by a secure source of fuel, as small as it might be. Additional electric energy would be needed for barking as well as bark boiler emission control equipment, but the trade-off might be economical. Also, it is not clear that the mill sufficiently recycles its own as well as locally available waste papers rather than importing recycle stock.

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ENVIRONMENTAL EFFECTS AT KUNDA CEMENT

Kunda Cement, the only cement plant in Estonia, is 30 years old with an operating capacity of 1 million tons annually compared with a 1.2 million ton design capacity. Main products are portland cements along with some aggregates and roofing materials. All materials are made to Russian standards except for a portland cement made with oil-shale fly ash. About 120,000 tons of annual production is sent to Russia, 120,000 tons exported to the west and the balance, 760,000 tons, used internally. About 30,000 tons/a of collected flyash is sold as agricultural fertilizer and 15,000 tons have been sold to make a special cement for a radio tower being built in Tallinn.

Raw materials are from local sources with gypsum for production purchased in Latvia. Added to this are some 100,000 tons/a of oil-shale flyash purchased from the Baltic Power Station along with some flyash recycled from their own power plant. The Baltic Power flyash comes directly from boiler cyclones and is used because it does not need grinding. It can be mixed with clinker and sent directly to the kilns. Oil-shale is exclusively used to fire 4 kilns (about 560,000 tons/a) and for power production (about 40,000 tons/a).

During a visit to the plant, heavy dust emissions were clearly visible from the two-80 meter stacks on the kilns and from adjacent 30-meter stacks on the oil-shale grinding operations. Additional dust emissions are produced at the raw clinker grinding operation but are some distance away and were not observed. The plant estimates, and pays emission charges, on some 60,000 tons/a of dust, but estimates as high as 100,000 tons/a of dust emissions have been made.

Dust emission control equipment consists of cyclones and electrostatic precipitators (ESPs) on the kilns and cyclones and shaker type mechanical filters (baghouses) on the grinding operation. The mechanical filters were installed two years ago. Management claims emission problems are based on two causes: the ash transport system for the ESPs (Russian design) located on the kilns are under-sized. The ESPs can be operated only for about 2 hours and then must be turned off because dust backs up into the precipitator body. When all cleaning systems are working, management claims dust emissions are only 10-15,000 tons/a, but even this level exceeds emission standards for this operation. Also, the stacks on the oil-shale rinding operation are judged too

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short causing dust to fall in the nearby town.

Clearly, though, the problems are more severe than suggested. People in the neighboring town of Kunda have been complaining for years about ash fallout but nothing has been done. The local board cannot cope with the problem and no longer visits the plant or even discusses the problem with management. In any event, raising the height of the grinding operation stacks will not reduce emissions but simply divert them further from the source. Further, the mechanical filters on the grinding operation either are not working or are working poorly. There should be virtually no dust emission if theses filters are operating properly.

Other air pollution problems associated with using oil-shale as a fuel involve the usual SO_2 and NO_2 emissions. No engineering controls to reduce these emissions are installed.

Beginning September, 1991 joint agreement discussions were begun by Kunda Cement and a consortium of western companies (Partek and Lohja, Finland, Atlas, USA, Euroc, Sweden, Halderbank, Switzerland) to either construct a new cement plant at a new site some 6 km away, or reconstruct the existing facility. A decision is to be made at the end of 1992. If the new plant is to be built it will take 4 years to construct and in the interim the consortium would rebuild the emission system at the present plant beginning March/April 1992. If a new plant is built it will be 51% owned by Estonian interests, 49% by the consortium. Size of the new plant will be either 3 million tons/a or 1.5-2 million tons/a. A reconstructed plant will be 65% Estonian, 35% others.

In general, environmental problems at the cement plant must be considered severe. In addition to the air emissions of dust, SO_2 and NO_2 there is the problem of ash storage. If the consortium agreement goes through the dust emission problem, and other air emissions, could be solved in short order. Any additional problems, such as local ash storage and wastewater discharge would also be addressed.

If the agreement falls through it might be possible to obtain some relief from dust emissions in a reasonable time frame by increasing the height of the oil-shale grinding mill stacks and by increasing the kiln dust transport system capacity. The company is apparently doing nothing at present to relieve these problems.

EXAMINATION OF OIL-SHALE COMBUSTION EMISSIONS FOR TOXIC AND HAZARDOUS EMISSIONS

Oil-shale is the predominant fuel used in Estonia for the production of electricity, for under-firing industrial boilers for power and steam and in industrial plant operations. More than 23 million tons of oil-shale were used for these purposes in 1988. Concern with the use of oil-shale includes environmental damage to land, water and air. Land pollution results from mining oil-shale and from the storing of ash in open, exposed landfills. Water damage is caused by the leaching of toxic substances from these landfills into drinking water and the sea. Air pollution damage has been generally limited to the emissions of dust, SOx, NOx and trace metals, the latter found in all solid fuels, and carried into the atmosphere with flyash.

Detailed examinations of combustion emissions (from boilers and incinerators) have discovered a variety of potentially toxic substances in combustion products such as formaldehyde, pyrene, anthracene, phenanthrene, benz(a)anthracene and benz(e)pyrene, among others. Many such substances are present in trace amounts but are effectively carcinogenic or mutagenic over long exposure periods. Many of these materials are not present in the original fuel but rather are formed during the combustion process. The kind and quantity of toxic polynuclear organics emitted depends on a host of variables such as the fuel composition, the method of firing and the combustion temperature. Because oil-shale has been intensively used only in limited situations, not much is known about minor constituents in its combustion products. The composition of oil-shale is a complex mixture of minerals and organic substances which suggests that emissions from oil-shale combustion may include unsuspected toxic substances, possibly of completely unknown types.

It is recommended that an extensive examination be conducted of the air emission constituents formed during oil-shale combustion. Such a project could possibly be conducted at one of the technical universities in Estonia. The technical assistance of Western experts experienced in the analysis and identification of trace substances formed during combustion could be made available. In addition, this work could be extended to potentially toxic materials formed in the leachate of fly ash and black ash, the latter produced by the pyrolysis of oil-shale to produce liquid and gaseous fuels. The assistance of technical experts from the Oil Shale Processing Association could be of considerable value.

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ENVIRONMENTAL EFFECTS AT KHOTLA-JARVE CHEMICAL COMPLEX

The chemical complex in Kohtla-Jarve, as its name Oil Shale Processing Association implies, is largely based on converting chemical values in oil-shale into industrial chemicals, petrochemicals and fuels. The nearby Kivioli Oil Shale Chemical Plant engages in similar activities but is considerably smaller.

In addition to oil-shale as a raw material, the Khotla-Jarve chemical complex uses some natural gas and imports some (pyrolytic) oils from Russia to produce about 50 different chemical substances. Some indication of the size of the operation is suggested in the list below:

sulfuric acid	450,000 tons/a
ammonia	300,000
urea	200,000
wood preservatives	150,000
electrode coke	50,000
benzene, toluene	40,000
phenols/benzoic acid	50,000
fuel oils	50,000

About half the sulfuric acid produced is used in the local phosphate industry and the balance exported to Russia, Latvia and Finland. The fuel oil produced is highly valued containing less than 1% sulfur, has low viscosity and no waxes. The company makes a variety of resins and monomers for plastics and detergents. Sulfur for sulfuric acid is imported from Russia. Ammonia, made from natural gas and air is used for urea and other nitrogen bearing compounds.

Company operations began in the early 1920's, was partly destroyed during the war and rebuilt. Production until 1960 involved only oil and gas production from oil-shale consuming some 35 million tons/a. Manufacture of chemicals from oil-shale began In the late 1960's. The process of recovering chemical values in oil-shale begins with pyrolysis, which is the heating of shale in the absence of air. The vapors driven off are cooled, some condensing to oil and part remaining gaseous. Chemical extraction and purification follows to provide raw materials for sale and chemical manufacture. Carbon for electrode manufacture probably comes from pitch in the recovered oil refining operation. The oil-shale used as the principal source of recovered oil and gas is at least 45% of the mined shale. It has a different appearance than the ash produced by burning oil-shale but most likely contains a good amount of un-recovered organic constituents. The residue after oil-shale pyrolyzing is called "black ash" and is stored on

company property near the recovery unit. Environment '90 estimates the existing black ash field as containing 70 million tons of waste with new wastes being added at the rate of 1.5 million tons annually.

The company admits to a variety of environmental problems including air, water and land pollution. Waste charges imposed by the local environment boards mounted to 5.5 million roubles in 1991. The Hydrometeorology Institute conducts continuous monitoring of air emissions in towns in the area and the company itself has three monitoring stations. Reports on environmental measurements and estimates are submitted to the local board monthly with the Environmental Ministry receiving only annual reports. Major air emissions include NOx from ammonia production, SOx from sulfuric acid manufacture and a large variety of hydrocarbons and solvents, in addition to the usual combustion emissions and total some 16,000 tons/a. The plant is in two sections, one new part containing some modern processing units but the bulk of the plant is quite old. There do not appear to be any emission control devices on any process equipment except those that increase process efficiency. One example is a fume recovery unit on sulfuric acid absorbers where the recovered fumes are recycled to process. The company has its own environmental department.

The chemical complex discharges wastewater in three principal streams. The largest flow is 6 million cu m from the chemical plant and is directed to an area biological treatment system in Khotla-Jarve. This plant also receives an additional 9 million cu m of wastewaters from the city and from the nearby towns of Ahtme and Johvi and small local industries. The biological treatment plant discharges 15 million cu m of treated water to the Gulf of Finland. A second stream from the chemical plant is mechanically treated in its own treatment plant, joins the output from the biological treatment plant and the combined waters flow directly to the Gulf of Finland. The third stream from the chemical plant is diverted to a nearby ash mound with re-circulation back to the plant for ash handling. Some overflow from the mound is joined by other sources and a total of 3 million cu m are then sent directly to the Khotla river which joins the Purtse river and then flows directly to the Gulf [1].

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[1] Additional information concerning wastewater discharge in this complex can be found in "Reduction of the Environmental Effects in Khotla-jarve District and Eesti Tsement", Pre-Feasiblity Study No. 15, Environmental Programme for Leningrad, Leningrad Region, Karelia and Estonia, Ministry of the Environment of Finland, September 1991.

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The area biological treatment plant appears reasonably effective. However, sludge from the biological plant is partly sent to the ash mounds and partly with treated water to the Gulf. The biological plant has no thickening or dewatering capability. Also, as mentioned above, after treated water is discharged from the biological treatment facility it is joined with mechanically treated wastewater from acid and fertilizer production wastes from the chemical plant. The joint stream contains high quantities of phenols and sulfate. The untreated wastewater load to the Khotla river is extremely high in BOD, COD, phenols, sulphate and suspended solids.

One of the chemical companies latest projects involves removing an additional 300 tons/a of untreated phenolic materials from its wastewater. When this is done the company expects waste charges to drop to 2 million rubles.

The chemical company is just one component of the pollution problem, though perhaps the largest, in the Khotla-Jarve area. The entire region is heavily industrialized containing other manufacturing operations generating wastes such as a tire retreading plant and a wood working plant. In addition there are large amounts of domestic wastes from the local population in the area towns. The environmental consequences of these activities are severe.

Although some reduction of pollution can be achieved by attacking emissions process-by-process, the achievements attained this way can be terribly slow and lead to only marginal improvements. Much of the chemical plant is obsolete and remediation of current air emissions may not even be achievable without extensive process and equipment upgrading. What is distressing is the lack of a coordinated plan within the company. There is no coherent strategy for pollution reduction in all its many facets, air, water and solid wastes. A plant-wide emissions audit is required followed by an analysis which defines priorities to emission sources most able to quickly improve the air in the region. Even worse is the lack of a regional plan to improve inadequate wastewater treatment facilities and to develop regional sold waste disposal methods. There are too many sources to attack the problems one at a time. And certainly the emission problems are too technical and immense for a district environmental board to solve.

It is believed that the problems found in Kholta-Jarve demand a regional waste management approach in addition to individual plant attention to specific process emissions. Technical assistance is required to help define regional environmental problems, arrange for appropriate regional environmental audits and

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to develop regional plans for adequate wastewater and solid waste disposal facilities. Required also is assistance to the regional environmental board to set up a management structure to deal with these matters in the future.

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OIL-SHALE COMBUSTION WASTES

The disposal of solid wastes, particularly from industrial sources, represents a particularly severe hazardous condition in Estonia. This is largely due to 30-odd years of using oil-shale for power boilers and district heating plants as well as in many industrial operations. Oil-shale contains about 45% solids which means that almost half the oil-shale burned has to be disposed of as a solid waste. Compared with coal, which has on average 7% ash, oil-shale produces about 8 times more solid waste to be disposed. In addition, oil-shale heating value is about one-third the value of coal leading to a total of 24 times the solid wastes from oil-shale burning than coal producing the same energy.

Almost exclusively, oil-shale ash has been disposed of in landfills close to the ash source. Generally, water is used to sluice the ash from the boilers to the ash field. The water is then recycled to carry off more ash. The accompanying table shows the ash produced from 4 power plants in 1989. In one year some 10 million tons of oil-shale ash, bottom ash and captured flyash are sent to land fills. Assuming wet ash has a density of about 500 kg/cu m, about 20 million cu m of ash-water mixtures are being added to currently overflowing ash pits.

The hazard, of course, is the potential for leaching toxic materials from the highly alkaline ash into the earth which can infiltrate underground pure water sources, flow to rivers and streams, and then on to the Baltic Sea and the Gulf of Finland affecting the marine environment and closing coastal swimming beaches. Of particular importance is the contamination of ground water used for drinking. All of these effects have been observed. Many rivers and streams in Estonia are already biologically dead and the effect will only accelerate with time if nothing is done to prevent ash field leaching.

Means must be found, not only to stop adding to currently existing ashfields, but to also empty those that are presently scattered around the countryside. There is no simple solution to this problem and, worse, the environmental boards in Estonia do not appear to be addressing the problem. Even worse is the insistence that all such ash fields are located over geologically sound regions through which leaaching cannot occur.

It is recommended that technical assistance be provided Estonian environment officials in the task of developing strategies

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for reducing and eventually ending these practices. These problems, though on a lesser scale, are receiving increasing attention among western nations and the expertise developed should either be transferred to Estonia or new solutions developed for the unique situation encountered there. In any event, the problem is too massive to leave to local environmental boards, which do not have the needed technical capability to address the problem, nor to the companies producing these wastes. Action in this case should be centered at the national level where plans for the country as a whole can be formulated and executed.

CURRICULUM VITAE OF AUTHOR

ROBERT S. KAPNER

PRESENT POSITION

Principal Consultant, RCG/Hagler, Bailly, Inc., Washington, D.C., 1985-.

AREAS OF QUALIFICATION

- Process design for petroleum refining, pulp and paper, steel, and electric power industries
- Energy conservation in the commercial and industrial sectors
- Environmental research and development
- Environmental pollution control for process industries

PREVIOUS POSITIONS

- Professor of Chemical Engineering, The Cooper Union School of Engineering, New York, New York, 1968-1990
- Research Director and Member, Board of Directors, Diamond West Energy Corporation, Salt Lake City, Utah, 1982-1985
- Head, Department of Chemical Engineering, The Cooper Union School of Engineering and Science, New York, New York, 1968-1974
- Vice President, Teller Environmental Systems, New York, New York, 1970-1972
- Advanced Chemical Development Operation, Chemical and Metallurgical Division, General Electric Corporation, Pittsfield, Massachusetts, 1963-1964
- Associate Professor of Chemical Engineering, Rensselaer Polytechnic Institute, Troy, New York, 1963-1968; Assistant Professor, 1959-1963
- Research and Development, General Aniline Film Corporation, Linden, New Jersey, 1953-1955
- General Foods Corporation, Central Research Laboratories, Hoboken, New Jersey, 1952-1953

EDUCATION

- The Johns Hopkins University, Baltimore, Maryland, DEng, Chemical Engineering, 1959
- University of Cincinnati, Cincinnati, Ohio, MSc, Chemical Engineering, 1952
- Polytechnic Institute of Brooklyn, Brooklyn, New York, BChE, 1950

PROFESSIONAL EXPERIENCE

Dr. Kapner has nearly 40 years of experience in engineering environmental solutions to problems for industries, including research and development, process design, energy conservation, and environmental control. In the area of pollution control, he has assessed power generation reliability based on regulations and control systems (e.g., scrubbers, SO2 and NOx abatement, bag houses, cyclones), conducted impact assessments on the control of lead emissions, assessed waste solvents and the control of toxic emissions, evaluated fume abatement, developed a wastewater treatment system for the disposal of toxic metal discharges, and conducted environmental studies of particulate emissions. He holds a patent on the desulfurization of delayed petroleum coke. His experience includes work in the petroleum refining, pulp and paper, steel, and electric power industries. Selected examples of his work assignments are given below.

1991 **Energy Conservation Studies, Hungary**
For: U.S. Agency for International Development

As senior consultant to RCG/Hagler, Bailly on this A.I.D.-funded project, Dr. Kapner carried out energy conservation studies in selected manufacturing operations (alumina, basic copper, refractories, yeast, and alcohol) in Budapest, Hungary. His work on this assignment included process studies in plant energy conservation equipment.

1990 **Energy Conservation and Efficiency Training, Jordan**
For: U.S. Agency for International Development

Under subcontract to RCG/Hagler, Bailly, Dr. Kapner directed a course on industrial energy efficiency and energy conservation in Amman Jordan, in which he lectured on appropriate equipment types, energy conservation, and pollution control.

1989 **Energy Conservation and Efficiency Project, Egypt**
For: U.S. Agency for International Development, Egypt

As senior consultant to RCG/Hagler, Bailly on this assignment, Dr. Kapner was responsible for the conceptual development of air pollution control requirements for the Arab Republic of Egypt. He visited plants, conducted energy audits, and studied the interaction between energy conservation and pollution control.

Other Consulting Assignments

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- For Crouse-Irving Memorial Hospital, Dr. Kapner conducted energy audits, developed conservation strategies, and conducted studies of the feasibility of cogeneration.

- For the Electric Power Research Institute, Dr. Kapner assessed regional power generation reliability based on federal emission control regulations and state-of-the-art control systems (e.g., wet scrubbers, SO2 and NOx abatement, bag houses, particulate removal scrubbers, venturi scrubbers, cyclones) for fossil fuel-burning installations.

- For Vernitron Corporation's Piezoelectric Division in Bedford Ohio, Dr. Kapner conducted an impact assessment analysis on the control of lead emissions from piezoelectric device manufacturing. This included an evaluation of workplace and engineering control equipment.

- For Wheelabrator-Frye, Dr. Kapner conducted a new technology assessment for high-performance electrostatic precipitators and fabric filters for fossil fuel-burning electricity generation and cement manufacture.

- For IBM in Fishkill, New York and Burlington, Vermont, Dr. Kapner managed an assessment of waste solvents and the control of toxic emissions, and evaluated state and federal emission control regulations. His work for IBM included workplace engineering control for volatile organic compound (VOC) abatement.

- For Watervliet Arsenal in Watervliet, New York, Dr. Kapner evaluated fume abatement in heavy ordnance manufacture, including engineering controls.

- For Diamond West Energy Corporation in Salt Lake City, Utah, Dr. Kapner was responsible for research and development on petroleum coke desulfurization for the aluminum refining industry, environmental impact assessment of sulfur emissions, and studies of the economic feasibility of sulfur removal and pilot plant processes.

- For the U.S. Department of Energy, Dr. Kapner has completed several assignments. For the petroleum refining industry, he evaluated energy conservation targets, performed cost analyses, assessed control technology, and performed environmental impact assessments of air and water emissions. For the pulp and paper industry, he performed cost analyses, developed control strategies for air and water emissions, and predicted energy usage for paper and paper board manufacture from virgin and recycled sources. He also provided organizational and technical support for the U.S. delegation to the NATO Committee on Challenges in Modern Society, CCMS, on the

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U.S./Western Europe steel industry, and on energy conservation, pollution control, and technology transfer.

- For E.R. Squibb, Dr. Kapner provided consulting expertise on the incineration of pharmaceutical wastes, including vapor incinerator equipment information.

- For the U.S. Environmental Protection Agency, Office of Solid Waste Management, Dr. Kapner conducted environmental impact assessments, evaluated the cost and control of emissions from virgin and recycled pulp and paper manufacture, and assessed equipment for particulate and SOX abatement.

- For Kingsport Press, Kingsport, Tennessee, Dr. Kapner developed a wastewater treatment system for the disposal of toxic metal discharges from printing operations.

- For Gustave Getter Associates, Architects/Engineers, New Rochelle, New York, Dr. Kapner conducted environmental studies of particulate emissions, conducted impact assessments, developed control strategies for fume abatement from manufacturing source emissions, and developed strategies for the control of jet fuel emissions from a catastrophic aircraft test facility at Wright-Patterson Air Force Base.

- For General Motors Corporation's Fuels and Lubricants Department, Warren, Michigan, Dr. Kapner conducted research on catalytic methods for the control of automobile exhaust emissions.

SELECTED PUBLICATIONS

"Economics of Conventional Steam Turbine and Fuel Cell Cogeneration Systems for Segments of the Pulp and Paper Industry: A Case Study," with King Y. Look. Accepted for publication in *Energy, The International Journal.*

"The Dependence of Axial Dispersion on Non-Uniform Flows in Beds of Uniform Packing," with G. Johnson. *Chemical Engineering Science*, Pergamon Press, Ltd., Oxford, England. Volume 45, 1990.

"Computerized Fixed Bed/Fluidized Bed Laboratory Experiment," with J. Day. Presented at the 1987 ASEE Annual Conference, Reno, Nevada, June 21-25, 1987. Published in *Journal of Applied Engineering Education*, vol. 5, 1989.

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"Microcomputer Applications in the Traditional Unit Operations Laboratory," with R. O'Brien. Presented at the 1986 ASEE Annual Conference, Cincinnati, Ohio, June 22-26, 1986. Published in the *ConEd Journal*, vol. 7, no. 3, July-September, 1987.

"Petroleum Coke Desulfurization: Improved Thermal-Chemical Process," with H.H. Brant. Chapter 14 in A.C.S. Symposium Series 303, *Petroleum-Derived Carbons*, John D. Bacha, John W. Newman, and J.L. White, eds. Washington, D.C.: American Chemical Society, 1986.

"Teaching Engineering Subjects Using Electronic Flowsheets." Presented at the 1985 ASEE Annual Conference, Atlanta, Georgia, June 16-20, 1985.

"Desulfurization of Petroleum Coke," with H.H. Brandt. Presented before the Petroleum Derived Carbons Symposium, 188th National American Chemical Society Meeting, April 8-13, 1984, St. Louis, Missouri.

"Desulfurization of Petroleum Coke," with H.H. Brandt. Presented at the TMS-AIME Annual Meeting, February 26-March 1, 1984, Los Angeles, California.

"A Thermochemical Process for the Production of Low Sulfur Anode Grade Petroleum Coke." Presented at the 16th Biennial Conference on Carbon, July 18-22, 1983, San Diego, California.

"Thermodynamic Analysis of Energy Efficiency in Catalytic Reforming," with Arvo Lannus. Presented at the Second Law of Thermodynamics Workshop, George Washington University, August 1982. Published in *Energy*, vol. 5, 1982.

PROFESSIONAL SOCIETY MEMBERSHIPS

- American Chemical Society
- American Institute of Chemical Engineers
- American Society of Engineering Education
- Air and Waste Management Association
- American Association for the Advancement of Science
- New York Academy of Science

PATENT

- U.S. Patent # 4,406,872, Desulfurization of Delayed Petroleum Coke, September 1983