ACTIVITY REPORT
No. 29

Summary of Phase II:
Restructuring and Environmental Improvement
Assistance to RAS Kiviter
Kohtla-Järve, Estonia
1994-1996

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EHP TEAM MEMBER DESCRIPTIONS — PHASE II

Activity Manager

Fred Rosensweig is a Vice President and Senior Consultant/Trainer with Training Resources Group, Inc. He has managed numerous large international projects and is experienced in organizing and managing large teams of consultants with varied backgrounds. Mr. Rosensweig is permanently staffed on the Environmental Health Project (EHP) and served as the activity manager for the Estonia activity. He was responsible for managing the overall progress of the effort, including staffing, scope of work, and budget management.

Team Leader

Don Jackson is a Senior Program Manager with Radian International LLC. He has 25 years of management, technical, and environmental experience in the oil refining manufacturing and processing industries and has developed environmental and technical solutions for a broad range of process industry problems. Mr. Jackson was previously associated with a major U.S. developer of oil shale deposits and worked with an engineering firm on the start-up of the largest operating U.S. shale oil facility. As team leader, he was responsible for overall management of the technical work on the Estonia activity.

Technical/Environmental Specialist

Graham Harris is a chemical engineer with Radian International LLC and has over 25 years of experience in process engineering. Mr. Harris concentrates on process analysis, emission measurement, and emission control technology evaluation in his specialty areas of petroleum refining and organic chemicals. He has worked extensively in the international arena and has performed process analysis for various large industrial facilities in Eastern Europe, including the former East Germany and the Czech Republic. Mr. Harris led the technical team of EHP staff and local engineers who worked with the RAS Kiviter process management staff.

Technical/Environmental Specialist

Ed Andrechak is a chemical engineer and project manager with Radian International LLC. Prior to joining Radian, Mr. Andrechak worked as a process and environmental project engineer at one of the largest U.S. refineries. He has led numerous process/design optimization projects for various oil refineries, working directly with plant operators to implement process changes. Mr. Andrechak's areas of technical expertise include air issues/permitting, wastewater evaluations, subsurface investigations and remediations, and hazardous waste site evaluations. He led the EHP team's efforts to locate markets for many of RAS Kiviter's products, identify dephenolization plant improvements, and institute the fuses recycling system at the retorts.

Technical/Environmental Specialist

Frank Castaldi, Ph.D., P.E., is a Principal Engineer and resident expert for wastewater and solid hazardous waste process engineering design with Radian International LLC. Dr. Castaldi holds eight
U.S. and international patents for wastewater and hazardous waste treatment inventions. His responsibilities at Radian International include technical direction and project management in water and wastewater treatment projects, research and development studies in solid and aqueous hazardous waste treatment, and engineering consultation to U.S. and foreign industries on waste treatment practice. His areas of expertise include biological treatment of industrial wastewater and solid hazardous waste, treatment process development, waste management, and process engineering design. Dr. Castaldi was the lead engineer consulting to RAS Kiviter and Estonian Government on the wastewater treatment situation in Kohtla-Järve.

Technical/Environmental Specialist

Daniel Packy is a senior staff chemical engineer and project manager with Radian International LLC. He currently provides technical support to several companies in the chemical and manufacturing industries for compliance with various environmental regulations. Mr. Packy has also designed and supervised the construction of several remediation projects. Prior to joining Radian, he served in engineering management, design engineering, and production supervision roles for a major manufacturer in the chemical process industry. As a member of the EHP team, Mr. Packy performed the dephenolization plant improvement study.

Technical Process Systems Specialist

Frank Mansfield joined the EHP team as an independent consultant in August 1995 to assist with the cogeneration project. Mr. Mansfield has over 20 years of experience in operation, maintenance, inspection, and risk analysis reviews of power generation equipment in the United States and overseas. He was responsible for technical evaluations of the used turbine generator purchased by RAS Kiviter and worked closely with both RAS Kiviter staff and the local Estonian engineers to plan the installation and start-up of the turbine.

Technical Process Systems Specialist

James Brodie was recruited to the team in March 1996 to serve as the lead project engineer on the turbine generator installation and start-up project. Currently an independent consultant, Mr. Brodie has over 40 years of experience in planning, design, specifying, inspection, start-up, testing, and trouble-shooting, as well as overall engineering management of electrical systems for utilities. His experience includes the design of approximately 400 megawatts of power generation. Mr. Brodie has performed these services internationally, in Vietnam, Venezuela, Taiwan, Italy, Germany, Saudi Arabia, and Kuwait, as well as in the United States.

Oil Shale Industry Specialist

Robert Parrish is a chemical engineer with over 22 years of experience in technical program and operations management in the oil shale, petroleum, petrochemical, and mining industries. His areas of expertise include new technology planning and implementation, process development, problem-solving, hazard analysis, and project management. As an independent consultant on the EHP team, Mr. Parrish provided input on several of the RAS Kiviter activity technical tasks.
**Management Specialist**

Edward Salt is a Vice President and Senior Consultant/Trainer with Training Resources Group, Inc. He has more than 20 years of experience in organizational assessment, management improvement, analysis, and consulting. He specializes in institution building, management systems and skills development, strategic planning, training design, presentation and evaluation, and productivity and quality improvement. As management specialist, Mr. Salt worked with RAS Kiviter managers to develop strategies for improving management at the facility.

**Marketing Specialist**

Art Rowley has over 15 years of experience in providing market assessment for the petroleum production industry worldwide. An independent consultant, he is an expert in developing marketing plans and marketing teams to address the demands of the world market for petroleum products. Mr. Rowley worked closely with the EHP technical team to assess market potential for RAS Kiviter's oil shale products on the world market and assisted the RAS Kiviter management team to develop a focused marketing strategy.

**Industrial Hygienist**

Nancy Orr is a Certified Industrial Hygienist and an independent consultant who specializes in comprehensive environmental health and safety hazard assessment and program development. Ms. Orr was previously responsible for ITT Corporation's worldwide environmental protection efforts, industrial hygiene and safety compliance audit program, and for supporting compliance programs for ITT's diverse operations. As industrial hygienist on the EHP team, Ms. Orr was responsible for improving worker health and safety at RAS Kiviter.

**Program Planner**

Leslie Wilkinson is an International Specialist with Radian International LLC and served as a program planner on the EHP team. She has worked on numerous overseas environmental projects, coordinating technical team staffing and facilitating communication between team members and the client. Ms. Wilkinson is also experienced with purchasing and exporting requirements. Her role on the EHP team was to facilitate communication and cohesiveness between the many team members, including the Estonian subcontractors and the RAS Kiviter staff, and to coordinate logistics, compile reports, and procure commodities according to USAID procedures.

**Program Planner**

David Fernandes is an employee of Camp Dresser & McKee International who is permanently staffed to the Environmental Health Project. As Assistant Activity Manager on the EHP team, he was responsible for overall budget monitoring, managing the final production and distribution of all reports, contracting with local consultants in Estonia, purchasing commodities, and organizing all travel arrangements for the team members in conjunction with USAID guidelines.
# ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAP</td>
<td>Environmental Action Program</td>
</tr>
<tr>
<td>EEK</td>
<td>Estonian currency: EEK 11.45 - US $1; EEK 63 million = US $5.5 million</td>
</tr>
<tr>
<td>EHP</td>
<td>Environmental Health Project</td>
</tr>
<tr>
<td>ENI</td>
<td>Bureau for Europe and the New Independent States (USAID)</td>
</tr>
<tr>
<td>FGD</td>
<td>flue gas desulfurization</td>
</tr>
<tr>
<td>LLC</td>
<td>Limited Liability Company</td>
</tr>
<tr>
<td>PPE</td>
<td>personal protective equipment</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
</tr>
<tr>
<td>WWTP</td>
<td>wastewater treatment plant</td>
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</tbody>
</table>
EXECUTIVE SUMMARY

RAS Kiviter, located in Kohtla-Järve (northeast Estonia), is an oil shale retorting and related chemical producing complex that has caused severe environmental impacts and is now struggling to remain viable in the Estonian economy. The United States Agency for International Development (USAID) agreed to assist RAS Kiviter to reduce the environmental impacts of its processes and to improve the plant’s financial, managerial, and technical viability. USAID requested the Environmental Health Project (EHP) to carry out this work. Phase I of the activity was implemented beginning in October 1994 and ending in February 1996. The activity was budgeted at approximately $900,000, of which approximately $220,000 was targeted for commodities. Phase II commenced in October 1995 to consolidate the progress made in Phase I and to firmly establish the recommended process improvements. An additional $900,000 was approved as the budget for Phase II, of which approximately $300,000 was allocated for commodity purchases. Phase II activities ended in December 1996.

The overall objective of this activity was to assist RAS Kiviter to mitigate specific environmental impacts to the Kohtla-Järve region and to help the plant become more financially viable by increasing revenue and decreasing overall production costs.

Objectives were also outlined in the Phase II work plan for each of the seven tasks identified for this activity.

**Task 1**
Identify product application markets for the phenol-based compounds that RAS Kiviter is able to produce. Improve dephenolization plant performance by reducing the plant’s manufacturing costs, and reduce the amount of phenols in the plant’s effluent waters.

**Task 2**
Provide technical and project management assistance to support the installation and start-up of a turbine generator on site at RAS Kiviter. RAS Kiviter will independently produce power, saving millions of dollars in electricity costs from this investment.

**Task 3**
Improve the sulfur removal efficiency of the sulfur recovery unit at RAS Kiviter and examine the optimum retort gas treatment scheme.

**Task 4**
Optimize the fuses recycling operation at RAS Kiviter to maximize the amount of fuse material that can be recycled without impacting retort gas quality or causing unacceptable accumulation of material in the retorts. Implement fuses recycling systems on the three 1,000 ton/day retorts at RAS Kiviter.

**Task 5**
Review the feasibility of technical options to improve the wastewater treatment system in the Kohtla-Järve region and provide technical advice and recommendations to RAS Kiviter management on the most beneficial wastewater treatment scenario for the plant.

**Task 6**
Reduce workers’ exposure to toxic chemicals, reduce accident rates, and increase workers’ awareness of health and safety issues.

**Task 7**
Improve the implementation and acceptance of the management restructuring at RAS Kiviter.

Several major goals were realized in Phases I and II, as detailed below.
Phenol waste reduction through sales contracts. In April 1996, RAS Kiviter and Georgia Pacific signed a US $750,000 contract, under which the U.S. firm agreed to purchase one quarter of RAS Kiviter's yearly production of alkylresorcinol. Once the delivery schedule has been met to its satisfaction, Georgia Pacific may purchase the entire lot of RAS Kiviter's alkylresorcinol production, a potential yearly contract of US $3 million. That company is also considering a joint venture arrangement with RAS Kiviter to purchase and market all of Kiviter's epoxy resins. In addition, two other potential buyers, Plastics Engineering (U.S.) and Deza A.S. (Czech Republic), are currently testing pilot-scale samples. With additional follow-up from RAS Kiviter, it is expected that sales contracts or joint venture agreements will be negotiated in 1997. Such contracts would secure for RAS Kiviter a major customer for each of its three phenol fractions, increasing revenues and eliminating these phenol contaminants from the wastewaters through increased phenols production.

Dephenolization plant improvement. RAS Kiviter will realize an annual savings of approximately US $125,000 from the installation of the new reboiler and the extraction column interface measurement and control systems at the dephenolization plant. The new equipment also affects a reduction in phenols loading in the dephenolized water from 0.3 g/L to 0.2-0.25 g/L. Reduced production costs at the dephenolization plant, as well as improved product quality from the plant improvements, make RAS Kiviter more competitive in foreign market phenols sales.

Upgrading power production. Under EHP guidance, RAS Kiviter purchased a used turbine generator for independent power production at the facility. The EHP team helped RAS Kiviter undertake the major project to install the turbine generator on site. The project was completed in November 1996, and the turbine generator has been operating at full capacity (8 megawatts) since that time. RAS Kiviter is now generating its own power, saving US $1-2 million annually in electricity costs. The cogeneration unit is expected to pay for itself during its second year of operation. Additionally, the Kohtla-Järve region benefits environmentally from decreased emissions at the coal-fired power plants.

Improvement of fuses recycling. In cooperation with a U.S. vendor, the EHP team engineered a fuses recycling pump that could operate under the extreme conditions incurred at RAS Kiviter. Pumps and other recycling system equipment were purchased by EHP, and the fuses recycling systems were installed at all three of the 1,000 ton/day retorts at RAS Kiviter. RAS Kiviter is now able to recycle 100% of its total fuses production back to the retorts, saving nearly $700,000 annually in product recovered. In addition, fuses recycling eliminates the need to dispose of this waste in the "fuses lake," a practice which has occurred for the past 70 years. It is estimated that there are over 63,000 tons of fuses disposed of on the shale piles in this "fuses lake," 30-40% of which is oil product. Seepage potentially contaminates groundwater in the subsurface beneath the lake. The new fuses recycling system has the capacity to recycle in excess of daily fuses production. Thus, fuses from the lake can now be trucked from the shale piles and fed through the system.

Improvement of collection and treatment of spent shale runoff. Spent shale wastewater runoff was addressed initially by development of a runoff collection/treatment system. Once the system design was developed, USAID and EHP approached the Finnish Ministry of Environment about underwriting this task,
based on previous expressions of interest. After a joint site visit to RAS Kiviter, the Finns agreed to implement the EHP-designed runoff collection/treatment system in order to reduce the pollution load on the Gulf of Finland. The system will be implemented by the Finns in 1997. Finnish support of the runoff collection/treatment system is an excellent example of donor coordination, which allowed EHP to redirect scarce USAID resources to other tasks on the project.

- **Improved regional wastewater treatment system.** EHP recommended a technically sound, cost-efficient solution to the wastewater treatment situation in the Kohtla-Järve region, i.e., that granular media filtration of final sedimentation tank effluent be used in conjunction with an upgrade and retrofit of the existing second-stage activated sludge clarifiers. This recommendation was conveyed to RAS Kiviter and the Ministry of Industrial Privatization. In December 1996, the EHP engineer was asked to return to Estonia to review proposals submitted by engineering firms interested in performing the wastewater treatment plant upgrade. Recommendations were communicated to RAS Kiviter management about which design would be most cost-effective for RAS Kiviter.

- **Reduction of workers’ exposure.** Workers’ exposure to pollutants was reduced through the provision of personal protective equipment, intensive worker health and safety training, and the development of a health and safety program “blueprint,” specific to the situation at RAS Kiviter. It is currently being implemented.

- **Advanced management restructuring.** RAS Kiviter staff agreed on key actions to move forward with management restructuring. Interviews with RAS Kiviter management indicated problems in such key areas as the interrelationship between the units and the central operations, communication, money flow, and managers’ rights and obligations, particularly with respect to finance issues. A two-day off-site management seminar for 20 top managers was held in June 1995. It focused on analyzing and discussing a case study and reaching agreement about actions to take to move forward with management restructuring. In September 1996, after another series of management interviews, a second management workshop was held focusing on the challenges of the upcoming privatization.
1 INTRODUCTION

RAS Kiviter, located in Kohtla-Järve (northeast Estonia), is an oil shale retorting and related chemical producing complex that has caused severe environmental impacts and is now struggling to remain viable in the Estonian economy. The U.S. Agency for International Development (USAID) agreed to assist RAS Kiviter to reduce the environmental impacts of its processes and to improve the plant's financial, managerial, and technical viability. USAID requested the Environmental Health Project (EHP) to carry out this work. Phase I of the activity was implemented beginning in October 1994 and ending in February 1996. (A full account of Phase I is given in EHP Activity Report No. 20, Summary of Phase I, Restructuring and Environmental Improvement Assistance to RAS Kiviter, Kohtla-Järve, Estonia, 1994-1995.) The activity was budgeted at approximately $900,000, of which approximately $220,000 was targeted for commodities. Phase II commenced in October 1995 to consolidate the progress made in Phase I and to firmly establish the recommended process improvements. An additional $900,000 was approved as the budget for Phase II, of which approximately $300,000 was allocated for commodity purchases. Phase II activities concluded in December 1996.

1.1 Background

In January 1994, USAID conducted a prefeasibility study of RAS Kiviter as a demonstration project under the Environmental Action Program (EAP), which is designed to help central and Eastern European countries focus their resources and those of donor countries on the most critical environmental health threats. The prefeasibility study took into account previous studies by other donor countries, notably those conducted by Sweden and Finland. The USAID team recommended that the Agency proceed with an assistance program under the EAP framework. A five-person team that included four members of the EHP team and the USAID/Washington project officer traveled to Estonia from November 14 to 22 to develop an overall activity work plan, which was finalized in December 1994.

Since the study in January 1994, a number of changes have taken place at RAS Kiviter. The plant was restructured into cost centers (including the three production departments), with an accountant assigned to each one. A marketing director was appointed and a marketing department with seven full-time staff was established. A planning/economy department was reconstituted, and production planners were assigned to each of the three production departments.

By the time the EHP project had commenced in late 1994, the Benzoic Acid Plant had already been privatized and separated from the rest of the RAS Kiviter plant, in a joint venture with a U.S. company. The NitroFert fertilizer plant that was formerly part of the RAS Kiviter complex was also privatized by the Ministry of Economy, and the nearby RAS Kivioli plant was merged with RAS Kiviter.

In addition, plant operation margins were shrinking due to rising costs. The price of mined shale rose, forcing the plant to squeeze out operational efficiencies and to be more aggressive in selling its products in order to pay the increased cost of raw materials.
During the first phase of this project (1994-1995), the long-range future of the plant appeared to be problematic because of the limited economic viability of the oil shale industry. It was expected that long-term support from the Ministry of Economy would be necessary. In early 1996, the EHP team learned that RAS Kiviter had petitioned the government to allow privatization of the entire plant. RAS Kiviter was officially added to the privatization list in the spring of 1996, and tenders were solicited in August. On November 28, 1996, RAS Kiviter was privatized to Infravest Ltd., a consortium of Estonian business and government leaders. The purchase price was 63 million EEK (approximately US $5.5 million) with a planned investment of 230 million EEK (approximately US $20 million) over three years. Infravest states that it will concentrate on shale oil production.

Negotiations over terms of the privatization are ongoing, primarily over principles of oil shale pricing and environmental obligations, as the investors have stated that they do not want to be held responsible for RAS Kiviter's past environmental problems. It also appears that the offering may come under state scrutiny and could be taken to the courts.

Although it is too early to give firm predictions for RAS Kiviter's future, it appears that the production of oil shale will continue at the plant. As long as the plant remains open, reductions in harmful environmental impacts and improvements that help operating profitability are worthy objectives.

1.2 Description of RAS Kiviter

The RAS Kiviter Oil Shale Chemical Plant is an oil shale retorting and related chemical producing complex with operations in two locations, Kiviter and Kivioli. All of the RAS Kiviter operations are located in Kohtla-Järve. The first oil shale retorting plant began operating in Kohtla-Järve in December 1924, and the same basic thermal processing technology is still used at RAS Kiviter today. However, the 35 ton/day Pintich-type retorts characterized by considerable use of manual labor were upgraded in the 1960s to the 1,000 ton/day gas generators, which utilize the annular heating space with cross hot gas flow for heating. The operations include oil shale processing (retorting and upgrading), using domestic oil shale to produce two grades of oil used in a variety of products, including boiler fuel oil; and production of phenol formaldehyde resins, using phenol extracted from cooling water and formaldehyde produced at Kivioli.

The plant's many different process units are spread over a large area. The physical site of the plant is in poor condition. There are many pollution sources, ranging from substantial air pollution to the large mounds of waste materials. Most of the process equipment at the plant is antiquated, creating high-risk working conditions. Process efficiency is often lost due to equipment failure and/or down time for prolonged maintenance. The poor plant conditions have a negative effect on financial performance.

Despite the company's poor financial performance and deteriorating capital base, the Estonian Ministry of Economy has appeared committed to keeping RAS Kiviter open for socio-political reasons. With support from the Ministry of Economy, in January 1994, the management of RAS Kiviter organized its accounting procedures to measure separate revenues and expenses for the following four profit centers:

- Oil shale processing complex
- Production of aromatic hydrocarbons
- Urea resins and phenol formaldehyde resins
- Production of benzoic acid

1 Zimmerman, Charles; Miller, Craig; and Tarrant, Jim, "Preliminary Assessment of an Environmental Improvement Project for the Estonian Oil
In the oil shale processing complex, the oil shale is processed in three retorts, with a capacity of 1,000 tons per day per retort, and in over 40 other smaller retorts. One hundred percent capacity utilization is estimated to be 6,220 tons per day, 365 days per year. Total production in 1993 was 326,500 metric tons.

This number dropped considerably in 1994 and 1995, as the benzoic acid plant was sold and the production of aromatic hydrocarbons and phenol products ceased. From 1994 through 1996, RAS Kiviter received the bulk of its revenue from the sale of shale oil derived products, used either as end products or intermediates to produce fuel oils and chemicals. Currently, RAS Kiviter has the capability to produce the following marketable products:

- fuel oil, electrode coke, oil for wood impregnation, antiseptic, refined distillate oil, shale road oil, softener for rubber, anticorrosion mastics;
- urcaaldehyde, phenolformaldehyde, styrene-indene resins;
- shale water soluble phenols (total), alkylresorcinol, 5-methyl resorcinol, epoxy resin, plugging compositions; and
- sodium thiosulphate, sulphur (technical grade).

A portion of water soluble phenols is recovered from the shale oil in the condensation system of the retorts on contact with retort liquid. The total phenol water is subjected to solvent extraction and evaporation to recover the total water soluble phenols. Since 1993, when the Russian markets for many of RAS Kiviter's phenolic products were lost, RAS Kiviter management has not been operating the dephenolization plant on a regular schedule to produce the various valuable phenolic streams, which are used mainly for their adhesive properties. As new phenols customers have been located (and as others will be added), this situation will be alleviated during 1997. According to RAS Kiviter management, the production of phenolic compounds could become the facility's most profitable enterprise.

The estimated number of workers at RAS Kiviter in 1993 (including the workers from RAS Kivioli) was 4,640. Approximately 735 of the employees worked in the retorting and chemical processes; the remaining 3,900 people worked in other plant operations. Most of the workers at RAS Kiviter are chemical engineers or skilled operators. Only a very small staff manages the daily operations of the plant and is involved in marketing, accounting, and corporate management. Since 1993, significant internal changes have occurred in the management structure of RAS Kiviter, although these management changes have not always resulted in changes in the way RAS Kiviter works internally.

The senior management of RAS Kiviter essentially includes the general director and the technical director. The general director is in charge of external (mostly government) relations, corporate planning, and financial matters. The technical director is in charge of internal management and achieving production objectives. He supervises managers who are responsible for the various segments of the plant, such as retorting. Although a marketing department, formed in 1994, includes a marketing director and seven staff, the general director and the technical director continue to be the key persons dealing with product sales.

In 1996, a younger, more energetic marketing staff was hired. RAS Kiviter invested in the training of this staff by directly hiring the EHP marketing analyst as a full-

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2 Ibid., p. II-20.

3 Ibid., p. II-11.

time, on-site consultant for three months from August through October 1996. The EHP marketing analyst trained the new marketing department about Western marketing practices in preparation for privatization. As the privatization became imminent in mid-1996, the EHP team directed efforts toward working with the RAS Kiviter management to effect a smooth restructuring transition.

1.3 Activity Objectives

The overall objective of this activity is to assist RAS Kiviter to mitigate specific environmental impacts to the Kohtla-Järve region and to help the plant become more economically viable by increasing revenue and decreasing overall production costs.

The activity is related to the following objectives of USAID’s Bureau for Europe and the New Independent States (ENI).

Strategic Objectives

Strategic Assistance Area 1: Economic Restructuring. Foster the emergence of a competitive, market-oriented economy in which the majority of economic resources are privately owned and managed.

Strategic Assistance Area 3: Quality of Life/Social Sector Restructuring. Strengthen the capacity to manage the human dimension of the transition to democracy and a market economy, and help sustain the neediest sectors of the population during the transition period.

Program Objectives

1.1. Increased transfer of state-owned assets to private sector.

1.5. A more economically sound and environmentally sustainable energy system.

3.1. Reduce environmental risks to public health.

Objectives were also outlined in the Phase II work plan for each of the seven tasks identified for this activity.

Task 1

Identify product application markets for the phenol-based compounds that RAS Kiviter has demonstrated an ability to produce. Improve dephenolization plant performance by reducing the plant’s manufacturing costs, and reduce the amount of phenols in the plant’s effluent waters.

Task 2

Provide technical and project management assistance to support the installation and startup of the turbine generator on site at RAS Kiviter. RAS Kiviter will independently produce power and will save millions of dollars in electricity costs from this investment.

Task 3

Improve the sulfur removal efficiency of the sulfur recovery unit at RAS Kiviter and examine the optimum retort gas treatment scheme.

Task 4

Optimize the fuses recycling operation at RAS Kiviter to maximize the amount of fuse material which can be recycled without impacting retort gas quality or causing unacceptable accumulation of material in the retorts. Implement fuses recycling systems on the three 1,000 ton/day retorts at RAS Kiviter.

Task 5

Review the feasibility of technical options to improve the wastewater treatment system in the Kohtla-Järve region and provide technical advice and recommendations to RAS Kiviter management on the most beneficial regional wastewater treatment scenario for the plant.
Task 6
Reduce worker exposure to toxic chemicals, reduce worker accident rates, and increase worker awareness of health and safety issues.

Task 7
Improve the implementation and acceptance of the management restructuring at RAS Kiviter.

1.4 Purpose and Organization of the Report

The purpose of this report is to summarize Phase II of the activity, explain how the various tasks have evolved, discuss the progress made toward achieving the indicators set out in the work plan, and provide recommendations for sustainability.

The report is organized into five chapters. Chapter 1 is an introductory chapter that provides an explanation of the background to this activity, its objectives, and a description of RAS Kiviter. Chapter 2 provides a comprehensive overview of the activity and includes a discussion of how it was originally scoped and planned, the implementation approach taken by the EHP team, including staffing both in the United States and Estonia, and a description of each task. Chapter 3 discusses the results of the activity, which are based on their impact on environmental problems at the site, on RAS Kiviter's financial viability, and on the plant's management effectiveness. Chapter 4 outlines recommendations for additional work to be undertaken by RAS Kiviter itself or other donors to ensure sustainability of the progress made under this program. The final chapter of the report discusses the lessons learned during this activity, specifically, how the EHP team has worked with the Kiviter staff, the activity design, the team's technical approach to the work, and collaboration with other donors.
OVERVIEW OF THE ACTIVITY

2.1 Initial Assessment and Planning

A five-person team traveled to Estonia from November 14 to 22, 1994, to develop the Phase I work plan for this activity. The team consisted of four members of the Environmental Health Project activity team and the USAID project officer in Washington.

The team divided its work between Tallinn, the capital of Estonia, and Kohtla-Järve. Discussions in Tallinn focused on the perspective of central ministries and the USAID Mission. The team met with representatives of the Chemical Holding Group at the Ministry of Economy and with staff of the Ministry of Environment. The team also spent time identifying local Estonian firms with which EHP could work to implement this project.

At RAS Kiviter, the team members met with managers from various departments within the plant: oil shale processing, chemicals production, environmental protection, health, accounting, finance, and marketing. They interviewed approximately 25 people and met with the managing director, technical director, marketing director, and deputies of the accounting and economy departments.

After discussions at RAS Kiviter, the team returned to Tallinn to meet with additional local firms and to put together a draft work plan, then returned to Kohtla-Järve to present the draft plan and related schedule to senior staff at RAS Kiviter. RAS Kiviter management agreed without exception and made a commitment to provide active staff participation. The deputy director of the technology department was assigned as the primary RAS Kiviter coordinator for the activity.

Overall Approach

The overall approach to the Phase I work plan was based on the following assertions:

- The technical activities directly contributed to reducing environmental impacts.
- The technical activities tried to integrate financial, marketing, and managerial aspects.
- All commodities directly contributed to the eight tasks selected.
- The activities were results-oriented and directly aimed at fostering change within the plant.
- The activities served to demonstrate environmentally sound industrial restructuring to other Estonian industries.
- The plan of activities was flexible since it was anticipated that during the course of the year circumstances would require some modification to the work plan.
- The plan of activities was based on funding for only one phase (through December 1995), with no assurances of funding for a second phase.
- To enhance sustainability, the tasks made extensive use of local consultant resources, working in cooperation with U.S. experts and RAS Kiviter staff.

The team used two primary criteria to select the eight tasks listed in the work plan: first, to improve the operations of the plant; second, to reduce environmental impacts. The highest priority activities were those that met both of these criteria.
The work plan contained eight tasks:

1. Phenol Products Market Development
2. Cogeneration of Electrical Power from Steam Pressure Reduction and Excess Gas Combustion
3. Optimization of Sulfur Recovery System
4. Optimize Recycling of Fuses to Retort
5. Spent Shale Runoff Treatment
6. Worker Health and Safety Improvement
7. Cost Accounting Practices
8. Management Structuring Review

In October 1995, it became evident that funding for the implementation of Phase II activities would be available. In general, it was decided that Phase II would continue the work begun under Phase I, and that the budget allocation under Phase II would allow the EHP team to make necessary process improvements that would lead to the successful implementation of the various tasks.

The EHP team held a meeting in Washington, D.C., in October 1995 to scope the Phase II activities. A draft work plan was developed and presented to the RAS Kiviter management in November 1995, which met with approval. The final Phase II work plan included seven tasks:

1. Phenols Product Market Development and Dephenolization Plant Improvement
2. Turbine Generator Installation and Startup
3. Retort Gas Treatment Upgrade Feasibility Study
4. Optimizing Recycling of Fuses to Retorts
5. Wastewater Treatment Feasibility Study
6. Worker Health and Safety Improvement
7. Management Restructuring Review

One task was completely dropped from Phase I: the financial accounting task, as it was determined in Phase I that EHP assistance was no longer necessary. In addition, with the acceptance by the Finnish Ministry of Environment to fund the stormwater runoff and collection system, that task was deemed concluded in Phase I. A new task, to review the wastewater treatment system in Kohtla-Järve and provide recommendations to an expert committee and RAS Kiviter about technically appropriate options for wastewater treatment in the region, was chosen as an appropriate follow-on to the stormwater runoff and collection task. The other tasks were all follow-on activities from Phase I.

2.2 Implementation Approach

2.2.1 Technical Assistance Team

Formation of the project team was an ongoing process throughout the project, as the emphasis on various tasks and the technical work involved shifted, based on the priorities of RAS Kiviter. As a result of the varied nature of the tasks, the EHP team drew upon the expertise of consultants with diverse professional strengths. The Phase II team included experts in the areas of oil shale processing, oil refining process engineering, industrial health and safety, management training, environmental engineering, wastewater engineering, marketing, and project management. All of the consultants are experienced in performing work in developing countries, and many of them have worked in Eastern Europe.

A brief description of the team members and their qualifications is provided at the front of this report.

2.2.2 Local Consultants

During the initial planning trip in November 1994, the EHP team identified a small engineering company, EnPro Engineers, located in Tallinn, to work as the main local subcontractor on this activity. EnPro took the lead by assisting the EHP team in communications with the RAS Kiviter staff. When necessary, letters were translated into Estonian or Russian before they were sent to RAS Kiviter. EnPro coordinated all of the trips...
to Estonia by the EHP consultants, arranged for interpreters, and set up meetings with key RAS Kiviter contacts. EnPro engineers also located and contracted with other local consultants as needed, i.e., staff from the Oil Shale Research Institute, professors from the University of Tartu to work on the wastewater treatment task, and other private consultants.

During Phase II, EnPro Engineers became more involved with the turbine generator installation and startup task. As that project progressed, it became necessary to use local technical assistance from several different firms, all of which were contracted through EnPro Engineers.

The EHP team also worked closely with a private translator, who provided excellent translations and also acted as a liaison for the EHP team, providing updated information on the progress of tasks, and sending information taken from the local papers about Kiviter or the political climate in Estonia. In addition, the translator was instrumental in organizing the presentation, site tour, and reception provided for key officials from USAID, Estonian government officials, and members of the Estonian industry in September 1996.

### 2.2.3 RAS Kiviter Team

When the EHP team first began working with RAS Kiviter, appropriate key contacts for each of the tasks were assigned to work with the various team members, under the direction of RAS Kiviter Deputy Technical Director, Dr. Juri Zhirjakov. In the early months, it was difficult to obtain full commitment from the RAS Kiviter staff to work closely with the EHP team. However, as the activity developed, and as it began to deliver commodities and valuable technical assistance, RAS Kiviter General Director, Dr. Yuri Soone, and Technical Director, Mr. Ivar Rooks, became more committed to the project. As a result of this increased senior management attention to the activity, other technical staff at RAS Kiviter became more willing to actively participate.

On Task 1, the phenols marketing task, the EHP team initially expected to work with Mrs. Bolhovotina, the marketing director. However, it became apparent when Dr. Soone, Dr. Zhirjakov, and Mrs. Bolhovotina visited the United States in June 1995 to discuss product sales that Dr. Soone would be responsible for negotiating sales contracts. Since then, Dr. Soone has been very involved in the phenols marketing task. As General Director at RAS Kiviter, Dr. Soone has also been the key contact for Task 7, the management review task. In addition, he has been directly involved in the turbine generator installation project under Task 2 since summer 1995, when his assistance was needed to expedite the purchase of the used turbine. Dr. Soone made a commitment to move the project forward quickly and to meet the deadline of December 1996 for completion of Phase II. The main technical contact on the turbine installation project has been the Director of Electricity Generation at RAS Kiviter, Mr. Yuri Utt.

Ms. Pallady has been the main contact person at Kiviter for both the sulfur recovery and fuses recycling tasks. Mr. Rein Rahe has been the key contact on both the spent shale runoff task and the wastewater treatment feasibility study.

A list of all key Estonian contacts is provided as an appendix.

### 2.3 Task Descriptions

The seven tasks identified in the Phase II work plan are described on the following pages. Each is organized into four sections: Task Description, Objectives, Progress Made, and Results Compared to Indicators. In the last section, the indicators are written as outlined in the original work plan, and the degree of success in meeting them is discussed.

Each of the seven tasks is essentially a continuation of work performed in Phase I. For example, under Phase I, Task 1 was titled
"Phenol Products Market Development," and the objective of the task was to locate customers for RAS Kiviter's phenols products. Many of the negotiations initiated during Phase I were continued in Phase II. In addition, Phase II included a new emphasis to improve the performance of the dephenolization plant. Regarding cogeneration at RAS Kiviter, the emphasis of this task under Phase I was to determine whether or not cogeneration at RAS Kiviter was feasible, and if so, to specify a turbine generator. This task was taken beyond the scope during Phase I as a turbine generator was located and purchased by RAS Kiviter. The purchase of the equipment necessitated the continuance of this task under Phase II to provide project management, technical assistance, and procurement assistance to the turbine installation and startup project. Task 3, the sulfur recovery task was initiated in Phase I with the purchase and installation of the sulfur filter. However, testing the filter and full-scale implementation of the improvements were scheduled as part of Phase II.

A similar situation occurred with Task 4. A fuses recycling system was designed and pilot equipment engineered and installed during Phase I, but the final testing and full-scale implementation of the system did not occur until Phase II.

Task 5 is a bit different. Under Phase I, this task was entitled "Stormwater Runoff Collection and Treatment System." EHP designed a stormwater treatment system for implementation at RAS Kiviter. Donor support from the Finland Ministry of Environment was solicited and received for the implementation of the design. Thus, this project was deemed completed under Phase I. A follow-on project was initiated as Task 5 under Phase II: to perform a feasibility study of wastewater treatment options in the Kohtla-Järve region. These activities are related in that they both address pollutant emissions to the Gulf of Finland.

Worker health and safety was addressed as Task 6 under both Phases I and II. Phase II was a continuation of the effort under Phase I to provide additional personal protective equipment (PPE) and training to the workers at RAS Kiviter. Under Phase II, a "blueprint" of a comprehensive worker health and safety program, tailored to RAS Kiviter, was developed.

Task 7 under Phase I, entitled "Cost Accounting Practices," was cut short as it became apparent that RAS Kiviter did not require much assistance in this area. There was no follow-on activity in Phase II.

Management restructuring advice was provided as Task 8 under Phase I and as Task 7 under Phase II. Phase II work was a continuance of the work begun under Phase I.

Detailed descriptions of Tasks 1-7 in Phase II are provided on the following pages.
Task 1
Phenol Products Marketing Development
And Dephenolization Plant Improvement

Task Description

The first task, recovering for sale the phenol compounds contained in the retort quench waters and improving the dephenolization plant performance, was identified because of its potential to yield both financial and environmental improvements. Following the shale retorting process at RAS Kiviter, quench waters cool the retort overhead gas. Phenol-based compounds are absorbed in this quench water stream. These phenol compounds are then extracted using a mixture of butyl acetate and isopropyl ether. Historically, this extraction step has been followed by a series of distillations to separate various useful phenol product streams. Products from the distillation section are used as intermediates for the production of various epoxy and phenoxy resins.

Since 1992, the distillation section of the plant has not been operated on a regular schedule due to the lack of markets for these compounds. Previously, the phenols were produced solely for downstream uses in the former Soviet Union. With the dissolution of the Soviet Union and emergence of Estonian independence, these markets were lost. By developing new markets for these previously manufactured products, RAS Kiviter benefits financially from their sale. Furthermore, the shale oil processed at RAS Kiviter is high in "resorcinol," which in some cases may warrant a premium price due to its desirable characteristics in adhesives and resin applications. At the same time, successful implementation of dephenolization plant improvements will decrease phenols production costs and reduce the phenols concentration in the plant effluent waters.

Objectives

1. Identify product application markets for the phenol-based compounds that RAS Kiviter has demonstrated an ability to produce.
2. Improve dephenolization plant performance by reducing the plant’s manufacturing costs; and
3. Reduce the amount of phenols in the plant’s effluent waters.

Progress Made

The original Phase I scope of work identified this task as a two-step process. Step 1 was to locate viable phenols customers. Step 2 was to optimize the performance of the dephenolization plant. It was evident from the start of the project that upgrade of the dephenolization plant would be useless unless an adequate customer base existed to warrant plant operation.

Thus, during Phase I, the EHP team concentrated on locating new phenols customers. Four potential natural phenols customers were identified after screening more than 30 companies worldwide. The four companies are:

- Coalite - United Kingdom
- Deza A.S. - Czech Republic
- Georgia Pacific Resins - U.S.
- Plastics Engineering - U.S.

A formal agreement between Georgia Pacific Resins and RAS Kiviter was officially signed in Atlanta in April 1996. The agreement, for the sale of the alkylresorcinol fraction, represents an increase to RAS Kiviter’s revenue of approximately US $3
million over a three-year period. The agreement also includes the potential future sale of RAS Kiviter’s epoxy resin fraction.

Deza A.S. (Czech Republic) and Plastics Engineering (U.S.) both have received phenols samples to determine their initial interest in the product. They have also received a subsequent set of pilot-scale samples. Deza is primarily interested in the monohydric phenols fraction (295° - 340°C). RAS Kiviter’s General Manager, Dr. Soone visited Plastics Engineering headquarters in Sheboygan, Wisconsin, and met with the company’s officers in April 1996. RAS Kiviter’s technical and marketing manager has had regular communication with Deza throughout 1996. With additional follow-up by RAS Kiviter in 1997, it is expected that both companies will complete their product evaluation testing and enter into sales agreements with RAS Kiviter.

Coalite’s interest is in the processing of the raw, undistilled total phenols stream. After additional bench-testing of total phenols samples in the first quarter of 1996, Coalite has declined to proceed with further testing and/or a sales agreement due to impurities found in the total phenols stream.

In summary, if sales agreements can be reached in 1997 with Deza and Plastics Engineering, RAS Kiviter will have secured a major customer for each of its three phenolic fractions.

As it became evident in late 1995 that customers for RAS Kiviter’s phenols products would be located, the EHP team decided to undertake a fast-track dephenolization plant improvement study in October 1995, at the beginning of Phase II of the program. The objective of the study was to determine what process and design changes could be implemented to improve the economic performance of the plant through higher phenol product yields and lower operating costs, and to reduce phenol loading in the wastewater effluent sent to RAS Kiviter’s wastewater treatment plant.

As a result of the study, two capital improvements were recommended:

- To replace existing reboilers for the two solvent regeneration columns with new, energy-efficient, thin-film design reboilers; and
- To install new interface level indicators and controls for five extraction columns.

USAID funded the procurement of one vertical, falling-film heat exchanger to replace the existing reboiler T-4. It was ordered in May 1996 and delivered to Kiviter in August. EHP engineers assisted RAS Kiviter with the installation of the new reboiler in October 1996. Final startup and testing of the new exchanger took place in December 1996.

The level controllers, sensors, and associated control loop elements for five extraction columns were purchased in August 1996 and delivered to RAS Kiviter in October. Installation of this equipment was facilitated by an EHP engineer in mid-December 1996.

It is estimated that RAS Kiviter will realize a savings of approximately US $100,000/year in steam costs and will improve its yield of phenols by 20,000 kg/year, for an additional savings of about US $25,000/year. Further savings of makeup butyl acetate should also be achieved. Environmental benefits will be achieved as the additional phenols yield will reduce the loading to the RAS Kiviter wastewater treatment plant by an equal amount, to below 0.3 g/L total phenols in the plant’s effluent. Initial startup test data collected in December 1996 indicate that these plant improvement targets will be met. These cost savings result in a lower cost of phenols production, which will allow RAS Kiviter to sell its phenols at a more competitive price to a wider variety of customers and maximize profits.

Finally, Dr. Leevi Molder of the University in Tallinn performed a process improvement study, evaluating additional process improvement beyond the process and
mechanical improvements implemented by the EHP team. The study was completed in September 1996 and provides RAS Kiviter with recommendations and a "blueprint" for additional future improvements at the dephenolization plant.

Commodities purchased under Task 1 include a specialized distillation column for the production of currently manufactured and new phenols sample materials to support the market development process, as well as subscriptions to various electronic marketing information services, and an exhibition display booth. In support of the dephenolization plant improvement, one vertical, falling-film heat exchanger was purchased, as well as level controllers, sensors, and associated control loop elements for five extraction columns.

Results Compared to Indicators

Listed below are the task indicators as described in the work plan and an update on the team's progress toward meeting these indicators.

1. **Develop phenols sales or joint venture agreements for four key customers to increase Kiviter's revenues.** A US $3 million agreement has been signed between Georgia Pacific Resins and RAS Kiviter, for the sale of alkylresorcinol. Pilot-scale phenols sample testing was performed by both Deza and Plastics Engineering in 1996 to qualify further the technical performance of RAS Kiviter's phenols toward potential sales agreements.

2. **Identify up to three new epoxy resin sales or joint venture resin phenol customers to justify operation of the dephenolization plant.** Two potential epoxy resins customers were identified: Georgia Pacific Resins and Plastics Engineering. Georgia Pacific Resins has an option to purchase the epoxy resin fraction in its agreement with RAS Kiviter, although there has been no action. Plastics Engineering is performing additional qualification testing of RAS Kiviter's epoxy resin fraction.

3. **Empower Kiviter marketing staff with new marketing methods and an international network to increase revenues and sustain the progress in marketing.** In the spring of 1996, RAS Kiviter hired a new, younger, and more energetic marketing staff. In addition, RAS Kiviter directly hired the EHP Marketing Analyst for a three-month on-site position to train the new staff on Western marketing practices, in preparation for privatization. These actions demonstrate RAS Kiviter's commitment to the sustainability of the marketing program initiated through the EHP activity. The EHP activity has funded the purchase of electronic subscriptions to marketing resources and an exhibition display booth, in support of RAS Kiviter's marketing department.

4. **Lower phenols in the dephenolized water from 0.3 g/L to 0.2-0.25 g/L through installation of improved interface controllers for the extraction columns in the dephenolization plant.** This reduction has been achieved through the installation of interface controllers in December 1996.

5. **Reduce dephenolization costs by as much as $300,000 per year so RAS Kiviter can reduce operating costs of the dephenolization plant.** It is estimated that RAS Kiviter will realize approximately US $100,000/year in steam cost savings and will improve its yield of phenols by 20,000 kg/year, for an additional savings of about US $25,000/year, as a result of installation of the new reboiler and the level interface controllers. Additional savings of makeup butyl acetate should also be achieved.
Task 2
Turbine Generator Installation and Start-Up

Task Description

This task has resulted in significant financial improvements at RAS Kiviter and could potentially bring about environmental improvements in the Kohtla-Järve region as well. Currently, the steam created by the operating boilers is dropped in pressure to lower usable levels by using pressure reducing valves. The pressure differentials are sufficient to drive moderate-scale cogeneration equipment. In addition, there is a surplus of fuel gas to fire the boilers and excess capacity in the boiler system to utilize this fuel to create more steam for useful purposes (e.g., cogeneration). The price of power from the state utility (Eesti Energia) is expected to increase by a factor of four in the next few years, a strong incentive for the RAS Kiviter facility to become electrically independent and perhaps even to sell electrical power.

The environmental benefits of cogeneration would stem from the controlled combustion of the surplus fuel gas in the boilers and the reduced emissions from the state utility power plants because of the lessened demand.

Objectives

To provide project management, technical, and procurement assistance to RAS Kiviter to complete the installation and startup of the turbine generator system.

Progress Made

The objective of the Phase I activity was to determine whether or not cogeneration at RAS Kiviter was technically and economically feasible, and if so, to assist RAS Kiviter to locate cogeneration equipment and an investor to fund the installation project. By April 1995, the EHP team had determined that cogeneration at RAS Kiviter was feasible. In June 1995, the EHP team completed the specifications for an appropriate turbine generator system and wrote an investment grade proposal for funding of the cogeneration project at RAS Kiviter. The team had begun to approach European investors when a used turbine generator, located in Germany, was offered for sale. At the recommendation of EHP, RAS Kiviter purchased the turbine generator at a very low price. The equipment was dismantled during the summer of 1995, and shipped to Estonia in September.

At this point, it became evident that EHP support should continue in Phase II to assure an expedited installation and startup schedule. RAS Kiviter had never undertaken this type of large capital construction project. In October 1995, the EHP team provided project management and technical support to RAS Kiviter to assist in developing a master plan and schedule for the turbine installation, purchased project management software for RAS Kiviter, and spent several days in Estonia with the plant staff and local subcontractors developing a master schedule.

From October 1995 through November 1996, the EHP team provided continuous project management support to this task, monitoring its progress and assisting with management decisions. Conference calls with the Kiviter management and the consultant engineering firm in Tallinn, EnPro Engineers, were held on a periodic basis to review the team's progress on the installation of the turbine in relation to the schedule.

The EHP team also provided ongoing technical assistance to the RAS Kiviter staff. The team was instrumental in reviewing RAS Kiviter's electrical design engineering work.
Specifically, a U.S. electrical engineer worked with RAS Kiviter and the electrical design engineering firm in Tallinn to perform a review of the electrical plans for the activity and a detailed fault analysis. A report entitled “Cogeneration Design Basis” was prepared for RAS Kiviter following the electrical engineer’s site visit in February 1996 to answer many of the questions RAS Kiviter had regarding proper electrical system design, and to address several issues that the electrical engineer thought needed to be considered in the design. This technical assistance led to the proper specification and procurement of electrical cable and utility switchgear.

In April 1996, the EHP team recruited an expert in power generation to assist RAS Kiviter with management of the final installation and start-up in the critical months, May to November 1996. This project engineer was located on-site for over 40 days during the seven-month timeframe to help RAS Kiviter make critical decisions and provide site management, with the ultimate goal of keeping the overall project on schedule and within budget.

As a third major effort on this task, the EHP team provided procurement assistance to RAS Kiviter. There was a significant amount of equipment that needed to be purchased in support of this activity. Although most of the equipment was purchased directly by RAS Kiviter, the EHP team provided expertise to assure that the specifications of the equipment were correctly engineered and that RAS Kiviter received the best price and availability. As stated earlier, an EHP electrical engineer reviewed the engineering specifications for both the distribution cable and the cogeneration switchgear in detail. He performed a detailed review of the electrical system design and helped RAS Kiviter to correctly specify both the electrical cable and the switchgear. In March 1996, EHP ordered the electrical distribution cable from a U.S. vendor. The electrical switchgear was purchased directly by RAS Kiviter from a manufacturer in Finland.

**Results Compared to Indicators**

Listed below are the task indicators as described in the work plan, followed by a brief description of the team’s progress toward meeting these indicators.

1. A turbine generator set, fully owned by RAS Kiviter, will be installed on the plant site and will be initially operating, which will result in cost savings and lower energy demand. The turbine generator was started during the third week of November 1996. After a few small modifications, the turbine was brought up to full capacity of 8 megawatts during the fourth week of November. Annual cost savings are estimated at US $1-2 million.

2. Kiviter management will be able to manage large systems design and construction projects. Although the EHP team provided technical support and advice throughout the life of this task, it was essentially managed and performed by RAS Kiviter staff. RAS Kiviter is now able to develop a project schedule, estimate a project budget, and manage discreet tasks on a project to meet overall project goals.
Task 3
Sulfur Recovery Optimization

Task Description

This task had the potential to provide significant environmental benefits, but it could not directly improve RAS Kiviter’s financial situation. The existing retort gas treating system at RAS Kiviter is an archaic process called Thylox. The Thylox process uses sodium arsenate as the working fluid in a liquid redox type of reduced sulfur recovery system. This process was abandoned in the West by the 1950s because of the toxicity of the arsenic waste materials and the greater efficiency of processes using vanadium and iron. The sulfur recovery unit at RAS Kiviter also suffers from many years of poor maintenance. Its operation suffers from too much oil in the feed gas, too low a pressure drop to allow for good contacting, and frequent plugging of the spray nozzles.

The identification of a self-cleaning filter that could reduce plugging of the spray nozzles would result in a small improvement in the sulfur removal efficiency and reduce sulfur dioxide emissions.

Objectives

Improve the sulfur removal efficiency of the sulfur recovery unit at RAS Kiviter and examine the optimum retort gas treatment scheme.

Progress Made

Under Phase I, it was determined that self-cleaning filters installed at the sulfur recovery unit could potentially reduce plugging of the spray nozzles and improve sulfur removal efficiency. A pilot-scale filter system was purchased by EHP and installed at the plant in late 1995. In Phase II, the effectiveness of this filter was evaluated and a decision was made not to continue with full-scale implementation of the filtering system. An explanation of this decision is provided below.

The Thylox sulfur removal plant at RAS Kiviter is an obsolete process with many problems. Poor contacting between gas and scrubbing liquid is the main problem, but it is caused by a number of other factors. There is very little pressure drop to work with on either the gas or liquid sides of the scrubber. It is difficult to obtain good contact/mixing without some pressure drop. On the liquid side, one of the manifestations of the problem is spray nozzle plugging. The pilot test of the automatic filter was designed to try to reduce nozzle plugging and perhaps allow the substitution of a more efficient nozzle type.

The automatic filter was installed in late 1995. There were problems with installation of the timer that back flushes the filter after a preset interval. The filter was started up with the timer out of service, and an operator was stationed at the filter to manually actuate the back flush. The actual time between back flushing during that first test is not known. The filter clogged up after less than a day of operation and was removed from service.

Inspection of the filter element showed a heavy buildup of a grayish clay-like material, which hardened like concrete after removal. The PVC backing and the filter element were damaged by either the pressure against the plugged filter or by attempts to chip away some of the hardened deposit.

EHP still believes that the automatic filter concept could work in this application. A larger mesh size in the filter element, along with a functioning timer in the back flush system, should allow for stable filter operation. The damage to the filter element, however, makes the proposed test using only the PVC
backing (because of its larger mesh size) suspect. It would have cost several thousand dollars and taken several more weeks to get new filter elements and a pressure-actuated back flush system to Kiviter to do a meaningful test. By the time that test would have been completed, there would not have been sufficient time to assess the effects on nozzle plugging (which would require at least two months) and then implement a full-scale filter system by the end of the EHP activity. In addition, the staff of the sulfur removal plant are highly skeptical of the viability of the automatic cleaning filter. The EHP team would have had to have forced the issue of more testing, which seemed counterproductive. Accordingly, EHP decided to terminate the filter task in April 1996 and transfer the unused funds to other tasks where they could be used more beneficially.

The EHP team did complete the evaluation of long-term retort gas treating options as discussed in the Phase II work plan. RAS Kiviter has the option to build a new sulfur recovery unit or to burn sour gas and install a flue gas desulfurization (FGD) unit on the boiler stacks. There are also many options as to the kind of sulfur recovery or FGD unit that might be employed. RAS Kiviter contracted with Thermisco Processor of Sweden to conduct a similar options analysis and the EHP team reviewed this report in May 1996 and provided technical comments to RAS Kiviter.

No commodities were purchased under Phase II of this task. The self-cleaning pilot filter was purchased by EHP under the Phase I budget.

**Results Compared to Indicators**

Listed below are the task indicators as described in the work plan and a description of the team’s progress toward meeting these indicators.

1. **Increase sulfur removal efficiency from an average of about 10 tons per day to about 10.8 tons per day to reduce sulfur dioxide emissions.** This target will not be met now that the commercial-scale sulfur filter system will not be installed at the sulfur recovery unit.

2. **RAS Kiviter will gain a better understanding of the gas treating options available and will prioritize the order of their attractiveness so they can continue to optimize the sulfur recovery process.** This target was met in June 1996 with the delivery of the EHP team’s comments on the Thermisco report.
Task 4
Recycling of Fuses to Retorts

Task Description

This task has yielded both environmental and financial improvements. Recycling the fuses to the retorts eliminates them as a waste product. An average of 1.125% fuses are produced from the average plant rate of 5,480 tons/day. Historically, the fuses have been disposed in a nearby waste shale pile, runoff from which has potentially contaminated the groundwater in the subsurface beneath the pile as well as other water collection systems. The financial benefits of recycling the fuses are increased product yields resulting from a greater utilization of the shale material.

Objectives

Optimize the fuses recycling operation to maximize the amount of fuse material that can be recycled without impacting retort gas quality and/or causing unacceptable accumulation of material in the retorts.

Progress Made under Phase I

Early in the Phase I activity, EHP determined that new fuses recycling pumps were needed at each of the three 1,000-ton/day retorts to more efficiently recycle the fuses back to the retorts. A test pump was purchased and installed by June 1995 and the EHP team determined that the pump design was sufficiently sized to handle the entire daily production of fuses to be recycled to the retorts.

As a result, four additional pumps were purchased, two for installation at the other two 1,000-ton/day retorts, and two extra pumps as spares, in lieu of purchasing key replacement parts for the other pumps. Also, as a result of the Phase I pump installation and validation, RAS Kiviter determined that the installation of a mixer ahead of these pumps would enable the re-introduction of historically produced and stockpiled fuses back into the system, thus eliminating the continual contamination source.

The EHP team was also tasked with putting together a more focused test plan to validate RAS Kiviter's ability to increase its fuses recycle rate and to determine what percentage of the total feed stock can be recycled as fuses. This was originally scheduled to take place in the third quarter of 1995, but was postponed until February 1996, due to the unforeseen prolonged shutdown of the 1,000-ton retort where the fuses pump was installed in June 1995. The EHP team oil shale industry process expert conducted the test with RAS Kiviter staff after the retort was back on line in February 1996, demonstrating that this pump was capable of pumping the fuses back up to the retort feed system.

During the fourth quarter of 1995, it was also determined that technical assistance and commodities assistance to help RAS Kiviter upgrade the other two 1,000-ton retorts would allow it to move forward quickly to install the recycle pumps. The EHP team purchased eight screw conveyor drive systems and eight hydraulic cylinders (four per retort) for the fuses injection system. The screw conveyors are used to transport the fuses from a surge hopper at the top of the retort to a plunger mechanism where the hydraulic cylinders are the driving mechanisms to “spray” the fuses back into the retort. The hydraulic cylinder depresses a plunger that is filled with the fuses, which are then spread across the top of the bed in the retort.

Phase II efforts concentrated on installation of the upgrades to the fuses injection systems and pumps at all three of the 1,000-ton/day retorts. Currently, all three of these retorts are
equipped with the mixer/pump systems to recycle fuses back into the retort systems. The new pumps have provided a nearly 15-fold greater operating life than the pumps used previously at RAS Kiviter. Ongoing discussions between RAS Kiviter and the pump manufacturer are expected to further increase the life of the pumps.

RAS Kiviter is now able to recycle 100% of its total fuses production back to the retorts, saving nearly $700,000 annually in products recovered. In addition, fuses recycling eliminates the need to dispose of this waste in the “fuses lake,” a practice which has occurred for the past 70 years. It is estimated that there are over 63,000 tons of fuses disposed of on the shale piles in this “fuses lake,” 30-40% of which is oil product. Seepage from the lake potentially contaminates groundwater in the subsurface beneath the lake. The new fuses recycling system has the capacity to recycle in excess of daily fuses production. Thus, fuses from the lake can now be trucked from the shale piles and fed through the system.

Results Compared to Indicators

Listed below are the task indicators as described in the work plan and a brief report on the team’s progress toward meeting these indicators.

1. **Achieve recycling of fuses to a substantial extent.** With the installation of the fuses recycling system on all three of the 1,000-ton/day retorts, RAS Kiviter is now recycling 100% of its fuses production. Fuses have been eliminated as a waste product at RAS Kiviter.

2. **Determine maximum recycle with regard to product.** It has been determined that the total recycle of all generated fuses is possible with no discernible degradation of retort products. This testing has included the addition of historically generated fuses that were previously disposed to the environment.
Task Description

This task has the potential for significant environmental improvement, and it could directly improve the financial situation for RAS Kiviter through reduced investment costs for the wastewater treatment plant upgrades and possibly through the reduction in emission fees to account for more efficient destruction of pollutants before discharge.

The existing wastewater treatment plant (WWTP) at the RAS Kiviter facility is a large two-stage biological treatment system. It treats not only the industrial wastewater from RAS Kiviter, but also from other nearby industries and municipalities. This mixture of industrial and sanitary wastes makes the treatment more difficult. The facility uses a fine bubble aeration system, in which many large air blowers/compressors are used to force air through a network of small holes in ceramic tiles that line the bottom of the treating system. Many of these tiles have been broken or dislodged, and current air distribution is poor. There are some areas with little bubbling evident and other areas where the surface is violently turbulent. The clarification capacity for the system appears to be inadequate. The biological colony does not appear to be at optimum levels. The net effect is that the treatment efficiency is not good, and the utility costs for the blowers are high.

This task is designed to review the feasibility of options to improve the wastewater treatment system in the Kohtla-Järve region.

Objectives

1. Review the feasibility of technical options to improve the wastewater treatment system in the Kohtla-Järve region.

2. Provide technical advice and recommendations to RAS Kiviter management on the most beneficial regional wastewater treatment scenario for the plant.

Progress Made

As part of the scope of work outlined in the Phase II work plan, an EHP environmental engineer was assigned to participate on an Expert Panel selected by the Estonia Ministry of Environment to review the feasibility of options to improve the wastewater treatment system in the Kohtla-Järve region. In December 1995, the EHP environmental engineer traveled to Estonia and joined a site visit by the Expert Panel to RAS Kiviter to inspect the wastewater treatment plant. The panel of experts carried out its subsequent analyses of the wastewater treatment situation individually.

The EHP environmental engineer prepared a report, “Feasibility of Wastewater Treatment Options for the Kohtla-Järve Region,” which was submitted to the Expert Panel and RAS Kiviter in February 1996. The report recommended a cost-efficient solution to the wastewater treatment situation in the region: that granular media filtration of final sedimentation tank effluent be used in conjunction with an upgrade and retrofit of the existing second-stage activated sludge clarifiers.

A subsequent trip was made to Estonia by the EHP environmental engineer in March 1996 to present the findings of the Expert Panel to the Ministries of Environment and Economy. During this visit the environmental engineer had a chance to review and comment on the Estonia Ministry of the Environment report, “Expert Opinion on the Environmental, Technical, and Economic Aspects of Improvement of the Kohtla-Järve Wastewater
Treatment System," which presented the Ministry’s approach for future expansion of the WWTP.

The “Expert Opinion” rejected the EHP team’s recommendation that granular media filtration of final sedimentation tank effluent be used in conjunction with an upgrade and retrofit of the existing second-stage activated sludge clarifiers. The preference of the “Expert Opinion” is to install new treatment equipment and process technology at Kohtla-Järve rather than repair and retrofit existing equipment and processes. The “Expert Opinion” recommends the use of the four-stage Bardenpho™ process as the biological treatment process to meet the future carbon, nitrogen, and phosphorus discharge limitations specified by the “Helcom Recommendations.”

The EHP environmental engineer held meetings in Tallinn and Kohtla-Järve with the Estonia Ministry of the Environment panel of experts and representatives of both RAS Kiviter and Velsicol Eesti, AS. These meetings resulted in the identification of a number of concerns relative to the practicability of the “Expert Opinion” on how the Kohtla-Järve WWTP should be improved to meet future effluent requirements. These concerns resulted in the following discussion items:

- Technical issues with regard to the stringency of the effluent discharge requirements
- Technical issues with regard to the selection of the biological treatment process
- Technical issues with regard to probable industrial wastewater pretreatment requirements and their impact on RAS Kiviter

The “Expert Opinion” indicated that the treated effluent quality requirements for wastewater treatment facility discharges to surface waters and the sea, specifically for the content of oils and oil products in biologically treated effluents, have been made more stringent than those originally proposed by the “Helcom Recommendations.” Given the severity of the wastewater discharge limitations for phenolics, oils, and nutrients present in the Kohtla-Järve WWTP treated effluents, it is doubtful that the biological treatment process proposed in the “Expert Opinion” can meet these requirements. Nevertheless, it is the position of the panel of experts that these discharge quality limits will be met through source control by the industrial contributors. Simply stated, each industry will be required to pretreat its wastewater to the discharge standard for any pollutant that causes discharge noncompliances at the regional wastewater treatment plant. This position presents a problem for RAS Kiviter, primarily with regard to phenolics and oils in its wastewaters. Nutrient removal is not at issue because the “Expert Opinion” has elected to design the biological treatment process to achieve nitrogen removal (to the extent practicable), a position that tends to favor the municipalities. This is further complicated by the fact that the Bardenpho™ process promoted by the “Expert Opinion” probably will not be effective for removal of the organic constituents in the RAS Kiviter wastewater.

The implementation of pretreatments for improved removal of oils and phenolics from the RAS Kiviter wastewaters would add substantial cost to existing wastewater treatment operations at Kohtla-Järve. Moreover, given the stringent character of the treated effluent discharge limitations proposed for the future WWTP, it is unlikely that RAS Kiviter can guarantee compliance under all treatment conditions. To employ this level of pretreatment for both oils and phenolics in the RAS Kiviter wastewaters would require that substantial amounts of other organics also be removed during wastewater treatment. The degree to which other organic pollutants are removed by pretreatments designed for recovery of oils and phenolics, would determine whether RAS Kiviter gains any advantage in treating its wastewaters in the
regional WWTP at Kohtla-Järve. Under the conditions imposed by the “Expert Opinion” for discharge to the regional WWTP, RAS Kiviter may be severely penalized because of the chemistry of its wastewaters.

During the summer of 1996, it became evident that the WWTP would become part of RAS Kiviter’s privatization package. Thus, it would be up to the new owner of RAS Kiviter to decide how to proceed. This being the case, the EHP environmental engineer visited Estonia in November 1996 and met with representatives from RAS Kiviter and the Ministry of Industrial Privatization. The meetings were to provide information on a cost-effective solution to the wastewater treatment situation proposed in the March 1996 report published by EHP (Activity Report No. 20). They also provided an opportunity for exchange of information and discussion on the issues. The EHP environmental engineer also made a presentation on these issues at the Estonian seminar on Kohtla-Järve wastewater problems held in Lohusalu from November 21-22, 1996. The EHP environmental engineer prepared a paper which detailed the technical issues of his presentation for submittal to the Journal “Oil Shale,” which is publishing a special issue on the Lohusalu Seminar.

In December, the EHP environmental engineer returned to Estonia to meet with representatives of several engineering firms who are making submittals for the Kohtla-Järve WWTP upgrade. He reviewed the submittals and made recommendations to RAS Kiviter’s management on the selection of a design firm for the upgrade project.

Results Compared to Indicators

Listed below are the task indicators as described in the work plan and a brief report on the team’s progress toward meeting these indicators.

1. RAS Kiviter personnel will gain a better understanding of wastewater treatment options and develop a ranking in terms of attractiveness to RAS Kiviter so that they can make cost-effective decisions that will reduce pollution in the Gulf of Finland. This target was met with the submittal and subsequent communication with RAS Kiviter staff of the EHP report and Expert Panel’s recommendations. RAS Kiviter staff understand the options they have for wastewater treatment and the most cost-effective solution to reducing pollution in the Gulf of Finland.
Task 6
Worker Health and Safety Improvements

Task Description

This task was designed to improve the health and safety of RAS Kiviter's workers by reducing exposure to toxic chemicals, lowering accident rates, and increasing workers' awareness of health and safety issues. From previous visits to the facility, it was evident to the EHP team that hazards exist in virtually all aspects of worker activities. The challenge in this task was to identify which hazards posed the greatest risks and determine how these hazards could be addressed through the purchase of personal protective equipment (PPE), the management and worker health and safety training, and worker health and safety program development.

Objectives

Reduce workers' exposure to toxic chemicals, lower accident rates, and increase workers' awareness of health and safety issues.

Progress Made

A hazards assessment of the RAS Kiviter plant was completed in June 1995 during Phase I. It included an overview of the RAS Kiviter Safety Department and a walk-through survey by the EHP industrial hygienist. The industrial hygienist visited most functional units to observe workers performing their tasks, and she interviewed technical directors of units and workers to learn more about the type and frequency of their tasks. The consultant visited the infirmary to examine the accident and injury log and discuss injury trends. She collected a limited number of point-in-time (grab) air samples using colorimetric detector tubes.

The remainder of the first visit was spent understanding the existing health and safety programs and procedures and discussing the current inventory of health and safety equipment.

In September 1995, the EHP team developed a list of appropriate personal protective equipment for purchase and supply to RAS Kiviter workers that included respirators, gloves, goggles, face shields, fall protection harnesses, hearing protectors, splash aprons, and jackets.

Worker health and safety training was conducted at RAS Kiviter during the first week of December 1995 to address the care of personal protective equipment and safe work practices. Key workers, supervisors, and unit heads were identified for participation in the training. Twenty-five staff members attended the workshop, most of them managers representing various areas of the facility. The intent was to extend the benefits to a wider audience by training supervisors. Topics covered included:

1. A review of the hazard assessment results
2. A review of the types of hazards identified
3. A discussion of the role of work practices, engineering, and administrative controls
4. A discussion of the role of PPE
5. A review of the selection, care, maintenance, useful life, and disposal of PPE

Although EHP was initially told that workers would be reluctant to use PPE, this proved not to be the case. RAS Kiviter workers found the U.S. equipment to be comfortable and of high quality and were very willing to use it. The cooperation of RAS Kiviter's Safety Department has also led to encouragement of workers to use the PPE.
Under Phase II, the EHP industrial hygienist visited RAS Kiviter in February 1996 and met with the key department supervisors to discuss the strengths and limitations of all of the PPE that had been delivered in December 1995. She also assessed the need for additional PPE orders. (In May 1996, more PPE was procured.)

It was agreed that a blueprint of an appropriate health and safety program tailored to RAS Kiviter's needs would be the most effective use of this technical assistance. The blueprint was developed and distributed to RAS Kiviter staff during the industrial hygienist's last visit to Estonia in July 1996. The blueprint (translated) describes the major components of an effective occupation health and safety program and discusses what portions already exist, at least in part, within RAS Kiviter. Examples were used from the National Safety Council and the International Loss Control Institute to highlight the indirect costs associated with occupational injuries and illnesses, which are frequently not calculated or considered. The numerical relationship between “first aid” and serious injuries were illustrated in an effort to emphasize that the serious, reported injuries are only a small part of the injury picture at RAS Kiviter. It was determined that some areas require more attention, such as hazard control, recordkeeping, and management leadership. Translated inspection forms were distributed that contained a “feedback” loop that can be used to monitor improvement in safety conditions within a particular unit. Much time was also spent discussing the changing relationship between RAS Kiviter's Safety Department and the facility's upper management.

The industrial hygienist also met with the manager of the RAS Kiviter clinic, to develop a better understanding of how injury and illness statistics are collected and managed at the plant. Since the reorganization at RAS Kiviter in 1991, responsibility for tracking illnesses and injuries has been split between the on-site clinic and the town's "poly-clinic." Workers sent to the poly-clinic for treatment of occupational diseases or medical treatment for injuries (other than first aid) frequently receive at least three days leave from work. Unfortunately, there is currently no follow-up performed by RAS Kiviter on these workers, thereby making calculation of the severity rate at the facility impossible. The industrial hygienist analyzed what data were available and demonstrated how the injury and illness frequency rate can be used to measure the facility's performance in reducing this rate.

The industrial hygienist met again with the Safety Department to demonstrate how to calculate the incidence rate. This rate takes into consideration the number of man-hours worked, therefore not penalizing a large facility such as RAS Kiviter.

Based on the data available, the incidence rate was calculated at approximately 58.9. This rate was compared to rates calculated by the National Safety Council in "equivalent" industries, deemed to be roughly a combination of surface coal mining and petroleum refining, as there is no true equivalent to oil shale processing. The incidence rates for these industries are, respectively, 4.5 and 5.1 (1992 data). As can be seen, RAS Kiviter's rate is higher by a factor of at least 10.

The industrial hygienist discussed the significance of these calculations with the Safety Department and explained that the rates should be viewed as a goal for improving performance. They discussed how the rates could be used to inform and educate management concerning the size of the task still before them.

Meetings were also held with supervisors in the phenol, retort, coke, aromatics and maintenance departments concerning their role in increasing and maintaining employee awareness of health and safety issues and program elements. It should be noted that several individual department heads have undertaken significant clean-up campaigns in
their areas, resulting in a marked improvement in housekeeping at the facility.

Results Compared to Indicators

Listed below are the task indicators as described in the work plan and a brief report on progress toward meeting these indicators.

1. Reduce worker pollution exposures by providing personal respirators to all the styrene plant workers, aromatic control room operators, and retort maintenance workers. This target was met in June 1996 when the equipment was delivered to Estonia and distributed to the workers.

2. Reduce worker heat stress and contact with hot coke by providing heat proximity suits to all of the coke oven entry workers. This target was met in June 1996 when the equipment was delivered to Estonia and distributed to the workers.

3. Develop a strategic plan for worker health and safety at RAS Kiviter to reduce exposure to toxic chemicals. A blueprint for a comprehensive health and safety program, based on internationally-recognized parameters, was developed and presented to RAS Kiviter in July 1996. The effectiveness of this program and the level of implementation will be difficult to assess as a result of the changes in health and safety management at RAS Kiviter.
Task 7
Management Restructuring Review

Task Description

The seventh task focused on assessing the status and progress of the major reorganization that is taking place at RAS Kiviter, and addressing the issues that arose in 1996 in light of the coming privatization. New organizational, functional, and operational concepts have been introduced and need to be embraced, continued, and supported. This task reviewed what occurred in the restructuring process and identified a number of problems. Workshops were held to begin to address those problems.

Objectives

Improve the implementation and acceptance of the management restructuring at RAS Kiviter.

Progress Made

In January 1995, the EHP team interviewed key management staff at RAS Kiviter. The interviews explored the staff members’ perspectives on the purpose of the restructuring, asked for their views on its impact on various units, and examined problems that were hindering effective implementation of the restructuring process. The interviews identified a number of problem areas, including lack of clarity about intradepartment money flow and the need to develop better relationships between production units and centralized functions. Six months later, another series of interviews were conducted. Data from the interviews indicated that most managers had seen significant progress in restructuring, but that problems continued in such key areas as the relationships between the units and central operations, communication, money flow, and managers’ rights and obligations, particularly regarding finance issues.

Based on the data from both rounds of interviews, a two-day off-site management seminar for 20 top RAS Kiviter managers was held in June 1995. The seminar focused on analyzing and discussing a case study and making agreements about actions that should be taken to move forward with management restructuring. The case study was based on a Hungarian petrochemical plant that had been through a major restructuring, and was written by a Hungarian consultant who participated in the seminar. Following the workshop, a number of recommendations were discussed regarding how the EHP activity could continue to assist RAS Kiviter in management restructuring.

In October 1995, the General Director of RAS Kiviter said that the management seminar had made an important contribution to restructuring the facility and requested a second seminar as part of Phase II. After RAS Kiviter was added to the privatization list, Dr. Soone asked that the seminar be held in September 1996 to provide support to management staff of RAS Kiviter as they faced the privatization, and to prepare them to manage the changes associated with the privatization more effectively.

In preparation for the seminar, 13 interviews were conducted with a representative sample of RAS Kiviter management staff. Staff shared perspectives on changes that had taken place in RAS Kiviter’s management structure over the past year, and described their views on the potential impact of privatization.

The seminar was held at Uuskula, a holiday center about 50 kilometers from Kohtla-Järve. Twenty-one managers attended
the workshop, which was designed to help managers at RAS Kiviter:

- Gain a broader sense of the role of a manager, particularly as it relates to managing change
- Discuss important issues related to privatization
- Discuss actions to be taken following the seminar

The seminar provided a framework to help participants conceptualize the process of organizational change, and focused on specific actions that managers can take to help staff move toward commitment to doing things in a new way. There were two primary themes of the seminar:

- Managers need to take extraordinary actions during times of change and should not expect that someone at a higher level will have sole responsibility for change management.
- Managing change requires much two-way communication between staff and management.

The preseminar interviews identified a number of critical issues that managers at RAS Kiviter are facing. Three of these issues were chosen as topics of discussion in a small group problem-solving exercise: unneeded labor, marketing and sales, and information about privatization. As a concluding activity, the small groups were asked to look at 15 managerial actions for each of the three topics and to identify the two actions that they felt were most important for them to implement with their own staff.

**Results Compared to Indicators**

RAS Kiviter will develop a plan for future implementation to address management restructuring concerns. As a result of the management workshop held in September 1996, RAS Kiviter management brainstormed ideas about actions they could take to alleviate problems in the three areas of unneeded labor, marketing and sales, and information about privatization.
3 RESULTS

3.1 Summary of Key Results

Several major goals were realized as a result of this activity, as detailed below.

- **Phenol waste reduction through sales contracts.** In April 1996, RAS Kiviter and Georgia Pacific signed a US $750,000 contract, under which the U.S. firm agreed to purchase one quarter of RAS Kiviter's yearly production of alkylresorcinol. Once the delivery schedule has been met to its satisfaction, Georgia Pacific may purchase the entire lot of RAS Kiviter's alkylresorcinol production, a potential yearly contract of US $3 million. This company is also considering a joint venture arrangement with RAS Kiviter to purchase and market all of Kiviter's epoxy resins. In addition, two other potential buyers, Plastics Engineering (U.S.) and Deza A.S. (Czech Republic), are currently testing pilot-scale samples. With additional follow-up from RAS Kiviter, it is expected that sales contracts or joint venture agreements will be negotiated in 1997. This will allow RAS Kiviter to secure a major customer for each of its three phenol fractions, increasing revenues and eliminating these phenol contaminants from the wastewaters through increased phenols production.

- **Upgrading power production.** Under EHP guidance, RAS Kiviter purchased a used turbine generator for independent power production at the facility. The EHP team helped RAS Kiviter undertake the major project to install the turbine generator on site. The project was completed in November 1996, and the turbine generator has been operating at full capacity (8 megawatts) since that time. RAS Kiviter is now generating its own power, saving US $1-2 million annually in electricity costs. The cogeneration unit is expected to pay for itself during its second year of operation. Additionally, the Kohtla-Järve region benefits environmentally from decreased emissions at the coal-fired power plants.

- **Cost savings achieved through improvement of fuses recycling.** In cooperation with the U.S. vendor, the EHP team engineered a fuses recycling pump that can operate under the extreme conditions incurred at RAS Kiviter. The pumps and other recycling system equipment were purchased by EHP, and the fuses recycling systems were installed at all three of the 1,000 ton/day retorts at RAS Kiviter. RAS Kiviter is now able to recycle 100% of its total fuses production back to the retorts, saving nearly $700,000 annually in product recovered. In addition, fuses recycling eliminates the need to
dispose of this waste in the "fuses lake," a practice which has occurred for the past 70 years. It is estimated that there are over 63,000 tons of fuses disposed on the shale piles in this "fuses lake," 30-40% of which is oil product. Seepage from the lake potentially contaminates groundwater in the subsurface beneath the lake. The new fuses recycling system has the capacity to recycle in excess of daily fuses production. Thus, fuses from the lake can now be trucked from the shale piles and fed through the system.

- **Improvement of collection and treatment of spent shale runoff.** Spent shale wastewater runoff was addressed initially by development of a runoff collection/treatment system. Once the system design was developed, USAID and EHP approached the Finnish Ministry of Environment about its interest in this task, based on interest expressed earlier. After a joint site visit to RAS Kiviter, the Finns agreed to implement the EHP-designed runoff collection/treatment system in order to reduce the pollution load on the Gulf of Finland. The system will be implemented by the Finns in 1997. Finnish support of the runoff collection/treatment system is an excellent example of donor coordination; it allowed EHP to redirect scarce USAID resources to other tasks on the project.

- **Improved regional wastewater treatment system.** EHP recommended to RAS Kiviter and the Ministry of Industrial Privatization a technically sound, cost-efficient solution to the wastewater treatment situation in the Kohtla-Järve region, i.e., that granular media filtration of final sedimentation tank effluent be used in conjunction with an upgrade and retrofit of the existing second-stage activated sludge clarifiers. In December 1996, the EHP engineer was asked to return to Estonia to review the proposals submitted by engineering firms interested in performing the wastewater treatment plant upgrade. Recommendations were given to RAS Kiviter management about which design would be most cost-effective.

- **Reduction of worker exposure.** Worker exposure to pollutants was reduced through the provision of personal protective equipment (PPE), intensive worker health and safety training, and the development of a health and safety program “blueprint,” specific to the situation at RAS Kiviter. It is currently being implemented.

- **Advanced management restructuring.** RAS Kiviter staff agreed on key actions to move forward with management restructuring. Interviews with management indicated problems in such key areas as the interrelationship between the units and the central operations, communication, money flow, and managers’ rights and obligations, particularly with respect to finance issues. A two-day off-site management seminar for 20 top managers, held in June 1995, focused on analyzing and discussing a case study and reaching agreements about actions to move forward with the restructuring. In September 1996, after another series of management interviews, a second management workshop was held focusing on the challenges of the upcoming privatization.

These results can be grouped into three categories: 1) impact on environmental problems; 2) impact on financial viability; and 3) impact on management effectiveness. A discussion of how the activities’ accomplishments have met these criteria is provided below. The relationship is also presented in Table 3-1.

### 3.2 Impact on Environmental Problems

Three of the tasks identified under this activity were implemented primarily for their
environmental benefits. The feasibility study undertaken to assess wastewater treatment options for the Kohtla-Järve region will have a significant impact on the water quality in the region once upgrades to the plant are implemented in 1997.

The task to optimize recycling of fuses to the retorts is another task with significant environmental benefits. By recycling the fuses to the retorts, they are eliminated as a waste product. For the past 70 years, the fuses have been disposed in a nearby waste shale pile. Runoff from this pile has potentially contaminated the groundwater in the subsurface beneath the pile as well as other water collection systems. RAS Kiviter is now able to recycle 100% of its total fuses production back to the retorts. The new fuses recycling system has the capacity to recycle in excess of daily fuses production. This allows fuses from the lake to be trucked from the shale piles and fed through the system.

The recycling will solve the problem of additional fuses being added to the spent shale pile, but does not address the problem of treating rainwater runoff from the existing shale pile that is contaminated with phenols. This issue was addressed under the spent shale runoff treatment task under Phase I of the program. The EHP team intended to design a collection and treatment system and to implement the first phases of this design by purchasing curtain walls and pumping stations. However, the budget under Phase I was reallocated to increase assistance with installation of the turbine generator. The EHP team prepared a project proposal for the shale pile runoff system and presented it to several donors, including the Finnish Ministry of Environment, which decided to undertake the project. The Finns have an interest in completing this task because the resultant pollution eventually empties into the Gulf of Finland and the Baltic Sea and creates a major environmental problem for the region. This accomplishment is an excellent example of donor coordination.

Other tasks also result in environmental improvements. The development of a market for RAS Kiviter's phenols products has provided the justification for upgrading and running the dephenolization unit, which extracts the phenol compounds from the quench water stream. The installation of the turbine generator provides environmental benefits that stem from the controlled combustion of the surplus fuel gas in the boilers and reduction of emissions from the state utility, as demand from its shale-fired power plants is diminished.

### 3.3 Impact on RAS Kiviter’s Financial Viability

The other overall objective of the RAS Kiviter activity was to improve the financial status of the facility. Three of the tasks directly related to this objective: (1) turbine generator installation and startup, (2) phenol products marketing development and dephenolization plant improvement, and (3) fuses recycling at the retorts. RAS Kiviter's purchase of the steam turbine generator shows management's commitment to RAS Kiviter's long-term economic viability. The up-front costs for the purchase, refurbishment, installation, and startup of the used turbine are minor compared to the long-term savings RAS Kiviter will achieve by not having to purchase power from the grid. It is estimated that the system will pay for itself within one year, saving RAS Kiviter US $1-2 million of dollars in annual electricity costs.

The phenols market development task also affects RAS Kiviter's financial viability over the long term. The EHP team identified four potential customers of RAS Kiviter's phenolic compound streams, and RAS Kiviter continues to nurture these relationships to complete other sales agreements in 1997. The agreement with a U.S. resins manufacturer to purchase US $750,000 worth of RAS Kiviter's alkylresorcinol, with an option to purchase the entire production lot, worth about US $3
million annually, will benefit the company financially.

Improvements made at the dephenolization plant, via installation of the new reboiler and interface control systems on the extraction columns, reduce plant operation costs by US $125,000/year. This cost savings allows RAS Kiviter to be more competitive in foreign markets and will potentially increase sales.

Recycling the fuses back to the retorts increases product yields by more completely utilizing the shale material. The financial impact of the new recycling system is US $700,000 in annual cost savings.

Other tasks also have the potential to produce financial gains. The worker health and safety improvements should lead to decreased accident rates, with the financial benefit of more efficient workers and fewer days lost to illness and injury. The management restructuring technical assistance should also result in financial gain as management becomes better organized and motivated toward making RAS Kiviter a profitable business.

3.4 Impact on RAS Kiviter’s Management Effectiveness

The most obvious task that contributes to RAS Kiviter’s management effectiveness is the management training provided under Task 7. It was determined early in the activity that many senior managers resisted the restructuring. The first management training program provided a venue for managers to express their opinions about how restructuring should be organized. Teams were organized to address various issues, and a plan was developed that the managers could follow to ease the restructuring transition. In Phase II, another management workshop was held specifically to address the issues of the imminent privatization. Recommendations were provided to RAS Kiviter management on actions to take in the coming months to ease the transition to privatization.

Task 1, the phenols marketing task, also contributed to management effectiveness. The EHP team worked with RAS Kiviter to empower its marketing staff with new methods and an international network. Through negotiations with real clients, RAS Kiviter’s management is learning how to sell the products on the Western market.

The turbine installation activity was a major undertaking. RAS Kiviter management had never taken on this type of large project without the support of the Russians and without being subject to Russian central planning to implement the project. The EHP team provided on-the-job training to RAS Kiviter’s management, from the planning phases through final start-up. This assistance provided technology transfer in the areas of project scheduling, budgeting, contracting with outside sources, and purchasing of commodities. Since the schedule on this project was very tight, the Estonians learned how to implement a project quickly and how all tasks on a project schedule are interdependent for completing a project on time. This type of “Western” project management training was invaluable. It will serve the RAS Kiviter management well on other projects in the future.
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<th>Financial Impact</th>
<th>Managerial Impact</th>
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<td>Lower phenols concentrations in dephenolized water from 0.3 g/L to 2.0-2.5 g/L.</td>
<td>Develop phenols sales or joint venture agreements.</td>
<td>Empower RAS Kiviter marketing staff with new methods and an international network.</td>
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<td>Turbine Generator Installation and Startup</td>
<td>Control combustion of the surplus fuel gas in the boilers.</td>
<td>Save RAS Kiviter US $1-2 million in annual electricity costs.</td>
<td>RAS Kiviter management learns to manage large systems design and construction projects.</td>
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<td>Wastewater Treatment Feasibility Study</td>
<td>Reduce effluent loading to the Gulf of Finland and the Baltic Sea from the Kohtla-Järve region.</td>
<td>Reduce potential pretreatment costs.</td>
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<tr>
<td>Optimize Recycling of Fuses to Retorts</td>
<td>Increase the recycling rate of fuses back to the retorts to 100%. Fuses are no longer a waste product at RAS Kiviter.</td>
<td>An annual cost savings of US $700,000 due to increased product yields as a result of more complete utilization of the shale material.</td>
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<td>Spent Shale Runoff Treatment</td>
<td>Reduce phenol contamination in Estonian waterways.</td>
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4 RECOMMENDATIONS

4.1 Ensuring Sustainability

Long-term success of any donor-supported activity is measured through sustainability of the progress made once outside support ceases. This specific activity at RAS Kiviter has achieved significant results in a relatively short timeframe, and the biggest challenge facing the EHP team is how to ensure sustainability. With privatization of RAS Kiviter now a reality, it is likely that it will be a very different place one year from now. There will likely be changes in the dynamic management with whom the EHP team has worked closely to achieve results. There will be staff reductions, process changes and improvements, and new strategies developed with the marketing department.

Throughout the activity, the EHP team has taken steps to ensure sustainability after 1996. Training provided under each task will contribute to sustainability, especially evident in management restructuring (Task 7) and work health and safety improvement (Task 6), for which formal training seminars were conducted. On-the-job training was provided on all of the technical tasks. In fact, most of the actual new equipment installation and maintenance was performed by the RAS Kiviter staff, e.g., the self-cleaning filter installed in the sulfur recovery unit and the recycling pumps installed at the retorts. The EHP team provided a peer review function after the systems were installed to assure their performance, but it was RAS Kiviter staff who invested the most time.

The turbine purchase, refurbishment, and installation effort truly was a “RAS Kiviter project.” Sustainability of this project is assured since RAS Kiviter has overseen the entire program, with technical and management assistance provided by EHP.

The use of local consultants, such as EnPro Engineers, the Oil Shale Research Institute, and Tartu University, will also contribute to sustainability. Many of these consultants were working with RAS Kiviter management prior to EHP’s arrival, and they will continue to work with them after the EHP activity is completed. Their intimate involvement in the various tasks enhances their ability to encourage the RAS Kiviter staff to continue along the same path. Additionally, the EHP team’s relationship with RAS Kiviter management on both the corporate and the operations side has grown substantially over the past two years. The results delivered under this activity have promoted trust and encouraged RAS Kiviter’s direct participation in all of the tasks.

4.2 Recommendations for the Future

The EHP team has also discussed with RAS Kiviter management actions to take in the future to promote sustainability. These action items have been conveyed in writing and are summarized below:

Phenol Waste Reduction

- Continue to keep up communications with Georgia Pacific, Plastics Engineering, and Deza A.S. in relation to current and potential contracts for phenol products. It is important that RAS Kiviter pay close
attention to its relationship with Georgia Pacific in order to build trust that will lead to a long-term commitment. Plastics Engineering and Deza A.S. are interested in RAS Kiviter's products as well. They are, however, smaller companies than Georgia Pacific, and they move slowly. RAS Kiviter needs to prod them along in order to close a deal.

- Purchase the second reboiler for installation at T-5 in the dephenolization plant. An additional annual cost savings of US $75,000 can be achieved with the installation of this piece of equipment.
- Implement the process improvements at the dephenolization plant as outlined in Leevi Molder's study.

**Fuses Recycling**
- The life of the stators from the pumps installed in the fuses recycling systems is reduced by their severe service beyond what was expected. A sample pump stator was returned to the manufacturer for analysis and recommendation of how to increase the expected life. Communication with the vendor needs to continue to further reduce the cost of the recycling operation and to maintain the ability to recycle fuses (to the extent that the historically produced fuses are eventually consumed).
- Recycling of the historically produced fuses from the waste pile introduces large rocks and debris into the mixing/pumping system. The design of the mixer includes mechanisms for trapping these "contaminants." However, this process should be watched closely to determine if these mechanisms are capable of preventing potentially serious equipment failures.

**Wastewater Treatment**
- Develop a technical justification for the establishment of achievable treated effluent discharge limitations for the Kohtla-Järve wastewater treatment plant. This activity would take the form of discharge permit application development, and make the case for less stringent effluent quality criteria while suggesting a reasonable discharge compliance schedule to meet the original "Helcom Recommendations" or as modified by the Estonian Government. This step would also include representing RAS Kiviter before the Ministry of the Environment concerning issues of wastewater pretreatment.
- Develop a test protocol for assessing the viability of a biological nutrient removal process as applied to the treatment of Kohtla-Järve region wastewaters. Evaluate the data generated from this test program and make recommendations for alternative approaches to treatment, should this be necessary.
- Conduct an engineering evaluation of alternative aeration system designs utilizing data for gas transfer efficiency, oxygenation capacity, energy requirements, and cost to select the most appropriate system for the "future" Kohtla-Järve wastewater treatment plant.

**Worker Health and Safety**
- Develop a system for identifying worker health and safety hazards. This system would include frequent and routine physical inspections of all work areas, recording the findings of inspectors and maintaining records, creating work orders for the maintenance unit based on inspection reports, and examining the injury and illness records for workers by unit to help identify hazards specific to the work area.
- Develop procedures for the reduction and elimination of workplace hazards. Implement a system to correct hazards quickly once identified.
- Institute incident investigation and analysis procedures to determine the root cause of an incident and to prevent its recurrence.
- Develop and maintain a health and safety recordkeeping and reporting system. Identify records that measure gains in health and safety, such as reduction in injury and illness rates, reduction in accident trends within a unit, reduced elapsed time to complete maintenance work for a safety hazard, increased frequency of worker health and safety training, reduction in airborne levels of hazardous materials (sampling results), and the like. Report progress on meeting health and safety goals on a regular basis to top management.

**Management**

- Develop a plan to give staff information about coming changes and make clear what their role is in the process. This will prepare staff for changing requirements and motivate them to let go of old ways.
- Train the RAS Kiviter workers who remain after reductions in force in order to support better work quality and to allow workers to be ready to switch from one profession to another inside RAS Kiviter.

- Develop brochures and questionnaires and solicit responses from potential clients about quality expectations from RAS Kiviter as a supplier.

- Assemble a marketing group composed of economists, technologists, marketing and production staff to analyze possibilities for selling more products based on improvements in technology, increased product quality, and reduced cost. The marketing group should regularly discuss what is on the market and how RAS Kiviter should respond to marketing requirements.

- Organize and conduct a follow-up management seminar in January 1997 and utilize Anna Tammerik as the trainer. The seminar could review the framework and skills discussed at the September 1996 seminar, discuss what steps have been taken since then, and examine new issues raised by the privatization process. Management "workshops" should be held on a quarterly basis.
5
LESSONS LEARNED

5.1 Working with RAS Kiviter

Over the past two years, the EHP team has learned much about working with the RAS Kiviter staff. In the early months of the project, EHP consultants faced the doubts of the RAS Kiviter management. Foreign consultants were not new to RAS Kiviter, and most of the RAS Kiviter management believed that the money spent to fund outside consultants was a waste. In the past, consultants would arrive, develop relationships with the RAS Kiviter staff, promise further assistance to RAS Kiviter, then leave and never return. RAS Kiviter management were skeptical about what the EHP program would deliver, and they were wary about investing much time with the EHP consultant team.

This attitude changed gradually in the first few months, as the EHP team members continued to visit RAS Kiviter and made progress with their various tasks. By summer 1995, the recycle pump for the fuses recycling at the retort had been delivered and installed, the used turbine generator had been located and purchased by RAS Kiviter, and a seminar had been held with all of the RAS Kiviter management staff. With these examples of the EHP team’s determination to meet commitments and “stay the course,” RAS Kiviter’s managers became more optimistic about a successful outcome to the project and began to deal with the U.S. team members directly, as opposed to relying on EnPro.

It has also been important for the EHP consultants to remember that the institutional barriers and preconceived notions of areas of responsibility are still very much in place at RAS Kiviter. The EHP team has had to consider this as a major factor in implementing any task that crosses departmental lines or goes outside RAS Kiviter. Although the Estonians are anxious to “Westernize,” the concepts of empowerment, information, entrepreneurship, and marketing are still relatively new to RAS Kiviter. This has been particularly evident in the phenols marketing task, where the consultants received resistance when asking for pricing information. It has been important to be persistent in asking for drawings/technical information; however, it has also been important to be sensitive to what RAS Kiviter considers “confidential.”

The EHP team learned that RAS Kiviter General Manager Juri Soone clearly possesses strong leadership skills. Dr. Soone emerged as a decision-maker on this activity during the critical period of pursuing the steam turbine purchase. Quick decisions and actions were necessary at that time, and Dr. Soone provided the leadership required.

5.2 Design of the Activity

After the EHP team made its first trip to RAS Kiviter, it became apparent that the activity had to concentrate on tasks that would have immediate and profound effects on RAS Kiviter’s economic and environmental performance. A decision was made to undertake only those tasks that would have the most significant impact and that could be accomplished within the timeframe of the EHP assistance. It was also decided that if a new task emerged that would be more successful than another, changes would be made to
accommodate the new task. Conversely, if a task proved ineffective at making a significant change, it would be cut short and the resources reallocated.

The most significant lesson learned about this activity is that flexibility in staffing, budgeting, scopes of work, levels of effort, and commodities purchases has been vital. The level of effort of certain individuals on the team has shifted; scopes of work have been amended to fit the goals of the tasks. As commodities were identified and exact costs obtained, commodities budgets were traded between tasks to get the most out of the total budget allocation. Some tasks—such as the finance task, the sulphur recovery task, and the spent shale runoff task—were cut short to make room for other tasks that would provide more significant change, such as the turbine generator installation. Staffing changes were also made as needs shifted on various tasks and new skill areas became necessary. As a result of this flexibility and careful attention to the overall budget, USAID and RAS Kiviter are getting maximum assistance from limited resources.

The EHP team has also learned the fundamental importance of commodities purchases as a supplement to the technical assistance on this activity. During one of the first meetings with RAS Kiviter staff, one of the senior managers mentioned that consultants had been wasting valuable money trying to “fix” RAS Kiviter for several years, and that he wished donor agencies would just give him the money so that RAS Kiviter could buy the plant improvements necessary to make significant changes. It became apparent that the RAS Kiviter staff viewed the commodities purchases as the most valuable aspect of the program. The EHP team has made it apparent, however, that in order to purchase the most appropriate, cost-effective equipment, it is necessary to combine engineering/technical assistance with commodities purchases. Without a budget to purchase equipment, programs and systems to improve RAS Kiviter’s economic viability and environmental performance could have been designed and engineered, but little would have been done to implement them. The money spent on the activity has in most cases been leveraged with RAS Kiviter’s own funds to purchase systems that RAS Kiviter is convinced will be beneficial. This is especially true in the case of the turbine installation task, where EHP and RAS Kiviter basically split the cost of purchasing circuit breakers and electrical cabling for the system under Phase II. The same applied to the spent fuses recycling program. EHP purchased pumps and cylinders to upgrade and facilitate recycling at the retorts; RAS Kiviter bought some of the equipment and designed other equipment to outfit the retorts for the recycling system.

5.3 Technical Assistance Approach

The technical assistance approach used in this activity was instituted early on. Identification of qualified U.S. consultants to staff this program was the first hurdle. It was necessary to assemble a fairly large team of experts in the technical areas of oil shale processing, cogeneration, industrial health and safety, and environmental engineering, as well as experts in marketing, management training, and finance. The diversity and experience of these team members have been vital to the success of the entire activity.

An assumption was made that local experts outside of the RAS Kiviter staff should be involved in the activity. The EHP team learned in the first few months that there were Estonian consultants who had been working with RAS Kiviter for quite some time and who understood the situation at the plant. These consultants have been instrumental in assisting the EHP team to move quickly along the learning curve. The EHP team learned that many studies done by various countries had been implemented at the site with little positive effect. The team also gained
knowledge from learning about previous work accomplished at RAS Kiviter.

RAS Kiviter has very capable personnel who, under proper guidance, can further the progress of the various tasks themselves after USAID assistance has ended. In most cases, RAS Kiviter staff have been responsible for the installation of all the equipment provided under USAID funds.

5.4 Collaborating with Other Donors

The EHP team made every attempt to leverage the resources provided under this activity. There have been two instances where donor support has been solicited. A grant funding proposal for the spent shale runoff collection and treatment systems design was developed and presented to the Finnish Ministry of Environment in August 1995, followed by a meeting in October 1995, when the Finns conducted a site inspection at the Kiviter site. The Finnish Ministry of Environment subsequently decided to fund the project and to purchase US $220,000 of the required curtain walls and pumping systems for the collection basins.

Early in the activity, cogeneration at the site was deemed feasible. At that time, the EHP team began researching used turbine equipment that RAS Kiviter could purchase on its own. Concurrently, the team developed an investment-grade proposal to fund the purchase of a new turbine system. This investment proposal was presented to several potential investors, many of whom were interested. Fortunately, the EHP team was able to locate a used steam turbine in Germany that could be purchased by RAS Kiviter for a sum of about US $75,000, making an investor unnecessary.
APPENDIX

List of Key Contacts

Detailed below is a list of the key Estonian contacts, both outside consultants and RAS Kiviter staff. They are listed based on their affiliations with the eight key tasks.

Task 1: Phenols Marketing

Dr. Yuri Soone, Managing Director, RAS Kiviter
Dr. Yurij Zhirjakov, Deputy Technical Director, RAS Kiviter
Mrs. Bolhovotina, Marketing Director, RAS Kiviter
Mr. Tiit Purre, Head of Laboratory of Shale Oil Refining, Oil Shale Research Institute

Task 2: Cogeneration

Dr. Yuri Soone, Managing Director, RAS Kiviter
Mr. Ivar Rooks, Technical Director, RAS Kiviter
Mr. Yuri Utt, Head of Electricity Generation, RAS Kiviter
Mr. Vallandi, Engineer, RAS Kiviter
Mr. Heinar Nurste, President, EnPro Engineers

Task 3: Sulfur Recovery

Ms. Pallady, RAS Kiviter
Mr. Nikolai Petrovitsh, Principal of Oil Shale Complex, RAS Kiviter

Task 4: Fuses Recycling

Mr. Ivar Rooks, Technical Director, RAS Kiviter
Ms. Pallady, RAS Kiviter
Dr. Victor Yefimov, Doctor of Technical Sciences, Oil Shale Research Institute

Phase I Task 5: Spent Shale Runoff

Mr. Rein Rahe, RAS Kiviter
Dr. Toomas Tenno, Professor, University of Tartu
Dr. Aleksander Maastik, Professor, Estonian Agricultural University, Institute of Water Management
Mr. Enno Kirt, President, AS ENNO PROJEKT

Phase II Task 5: Wastewater Treatment Feasibility Study

Mr. Rein Rahe, RAS Kiviter
Dr. Toomas Tenno, Professor, University of Tartu
Task 6: Worker Health & Safety

Ms. Ludmilla Korkorina, Acting Deputy Chief, Safety Department, RAS Kiviter

Phase I Task 7: Finance

Mrs. Kiivima, Director of Economic Planning, RAS Kiviter
Mrs. Kaiscnova, Chief Accountant, RAS Kiviter
Mr. Kainjukov, Deputy in Economic Planning
Mr. Ivo Sillaste, Independent Consultant

Task 8: Management Review

Dr. Yuri Soone, Managing Director, RAS Kiviter
Ms. Anna Tammerik, Independent Consultant

Overall Assistance

Mr. Heinar Nurste, President, EnPro Engineers
Ms. Riina Reinholm, Interpreter