



**TRIP REPORT #1 PHARMACIA - AD**

**DUPNICA, BULGARIA**

**WASTE MINIMIZATION PROJECT**

**FEBRUARY 5 - 11, 1994**

**WORLD ENVIRONMENT CENTER  
419 PARK AVENUE SOUTH, SUITE 1800  
NEW YORK, NEW YORK 10016**

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James D. Taft, Senior Environmental Specialist, Bureau for Europe and Newly Independent States, United States Agency for International Development

Gerald Zarr, USAID Representative, Sofia, Bulgaria

Patricia A. Swahn, Acquisitions Manager, Document Acquisitions, United States Agency for International Development

Antony G. Marcil

Thomas J. McGrath

Romuald Michalek

Bohdan Aftanas

B. Bhushan Lodh

Carl Schwing

Robert Rowland

Simeon Georgiev, Managing Director, Pharmacia - AD

Raghu Raghavan, Envirometric Systems, Inc.

George Chavdarov, WEC Coordinator, Bulgaria

File

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## **I. INTRODUCTION**

Pursuant to the technical assistance program for Central and Eastern European countries funded by the United States Agency for International Development, the World Environment Center (WEC) team conducted a reconnaissance visit to Pharmacia - AD in Dupnica, Bulgaria on February 5 - 11, 1994.

The purpose of the visit was to establish the feasibility of a Waste Minimization Demonstration Project (WMDP) and to select the subject for such project.

## **II. EXECUTIVE SUMMARY**

WEC's team consisting of Dr. Mariana Strugarova, WEC's in-country coordinator, Mr. Robert Rowland, pro bono specialist, Dr. Bohdan Aftanas, WEC staff, and Mr. Raghu Raghavan, Envirometric Systems, Inc., made a reconnaissance trip to Pharmacia - AD in Dupnica, Bulgaria. The purpose of the visit was to establish the feasibility of a Waste Minimization Demonstration Project and to select process facilities for such project. From February 7 through 9, 1994, WEC's team held a number of meetings with plant management and made a detailed review of the process to explore the opportunities available for conducting a WMDP. Plant management indicated great interest in such project which was reflected, among other things, by their outstanding cooperation with WEC's team.

Following discussions and mutual consultations, it was concluded that the WMDP is feasible. The project will focus on improvement of process control in selected operations for manufacturing Vitamin C with the goal of reducing waste generation and increased production yield. It is anticipated that implementation of the project can yield savings up to \$30,000 per year.

For further details of the WMDP, refer to the enclosed Envirometric Systems, Inc. report.

**III. ENVIROMETRIC SYSTEMS, INC. REPORT**

# Envirometrics Systems, Inc.

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6829 Elm Street, Suite 310  
McLean, Virginia 22101  
Tel: (703) 761-1466 • Fax: (703) 893-2123

## **Interim Report # 1 Waste Minimization Demonstration Project at PHARMACIA - AD, Dupnica, Bulgaria**

### **INTRODUCTION**

The World Environment Center (WEC), under a cooperative agreement with the United States Agency for International Development (USAID) to provide U.S. private sector expertise to transfer technology and skills to the representatives of industry and government in the countries of Central and Eastern Europe, has selected PHARMACIA - AD in Dupnica, Bulgaria (a state-owned manufacturer of pharmaceuticals) as a potential candidate for demonstrating the concepts of waste minimization and pollution prevention. This interim report describes the findings of a reconnaissance visit to this plant, which was made during February 1994, to identify a process line for conducting a Waste Minimization Demonstration Project (WMDP). This report includes a description of the project team which visited PHARMACIA - AD, details of the reconnaissance visit, background information on the plant, an assessment of waste minimization opportunities recognized at the plant, and a proposal for the WMDP to be conducted at the plant.

WEC will review this report to determine if the objectives of their cooperative agreement with USAID will be met by the proposed WMDP. A Memorandum of Understanding (MOU) will then be prepared between WEC and PHARMACIA - AD to design and implement the WMDP, including training of personnel, which will also assure the commitment of plant management to continue with a specific program of waste minimization. WEC will provide the services of a consultant to work jointly with the management of PHARMACIA - AD to identify and purchase suitable equipment manufactured in the United States to support the WMDP, as well as to design and implement the project. PHARMACIA - AD will form a Waste Minimization Team of plant personnel to implement the project, review its benefits, and disseminate information on waste minimization and its benefits to other companies in the region. PHARMACIA - AD will also develop a long range waste minimization program for the company.

**ESI**

## **PROJECT TEAM**

WEC's project team which visited PHARMACIA - AD during February 1994 included three (3) persons : Dr Bohdan T. Aftanas, J. Robert Rowland and Raghu K. Raghavan.

Dr. Bohdan T. Aftanas, Project Manager, Technical Programs in WEC, was in charge of the reconnaissance team which visited PHARMACIA - AD. He is qualified in Sanitary Engineering and has over 35 years of work experience as an environmental consultant in the United States and abroad. He is also involved in other projects of WEC, including the development of WMDPs in Bulgaria and other countries of Central and Eastern Europe.

Mr. J. Robert Rowland was the pro-bono process specialist in the reconnaissance team which visited PHARMACIA - AD. He is qualified in Mechanical Engineering, and has over 35 years of work experience in the pharmaceutical industry. He worked for Pfizer Inc., a multi-national pharmaceutical manufacturing company from 1946 to 1990 where he was the Director of Environmental Engineering at the corporate headquarters in the United States. He has also been the Director of Engineering Services in the same company responsible for environmental and energy conservation programs and projects. In these positions, he has developed a corporate environmental auditing program and several co-generation projects. Besides travelling to Germany, France, Italy, U.K. and Canada on business for Pfizer Inc., he has assessed pharmaceutical plants in Poland for WEC.

Envirometrics Systems, Inc. (ESI), an environmental consulting firm with which WEC has contracted to assist in demonstrating waste minimization, was represented in the reconnaissance team visiting PHARMACIA - AD by Mr. Raghu K. Raghavan. He is qualified in Chemical and Mechanical Engineering and has over 20 years of experience in industrial manufacturing and environmental consulting. He has completed several projects in the areas of pollution prevention and waste minimization both in the United States and abroad. His work in the United States has included the tracking of waste minimization progress being achieved in specific industrial facilities in New Jersey, New York and Pennsylvania. His work abroad has involved the assessment of environmental projects to control industrial and urban pollution in the countries of Asia, Africa and Eastern Europe. He has also participated in reconnaissance visits to other industrial facilities in Bulgaria which involved the manufacture of soda ash and rayon. He is also currently assisting WEC in designing and implementing a WMDP at the rayon manufacturing plant.

## **RECONNAISSANCE VISIT**

The reconnaissance visit to PHARMACIA - AD was started on Monday, February 7, 1994 by first meeting with the top management of the company to describe the goals of WEC's program, understand the environmental and operational priorities of the company, select a product line for investigating the potential for demonstrating waste minimization, and define the information needs of the WEC's project team during the visit. The first meeting of the visit was attended by :

- Eng. Simeon Georgiev  
Managing Director  
PHARMACIA - AD
- Eng. Boyan Tsanev  
Production Director  
PHARMACIA - AD
- Eng. Stefan Kafedzhiyski  
R&D Director  
PHARMACIA - AD
- Radka Nicolova  
Head of Environmental Department  
PHARMACIA - AD
- WEC's Project Team  
(Dr. Aftanas, Mr. Rowland, and Mr. Raghavan)
- Dr. Mariana Strugarova (WEC Coordinator)

This group met again on the last day of the the reconnaissance visit - Wednesday, February 9, 1994 - to discuss WEC's proposal for conducting a WMDP based on improved control of selected manufacturing operations in PHARMACIA - AD. Before submitting its proposal, WEC's Project Team completed a detailed review of the plant and process lines for manufacturing Vitamin-C, including meetings and discussions with various plant personnel to explore the opportunities which were available for conducting a WMDP. These personnel included : Mr. Vladimir Radev, Production Manager; Ms. Trendafila Dimitrova, Deputy Production Manager; Mr. Zeliasko Zeliaskov, Manager of Process Controls; and Mr. Vladimir Michaltchev, Manager of the Control and Metering Department for the entire plant. Preliminary discussions were also held during these meetings to identify process control equipment to support the WMDP.

## **BACKGROUND INFORMATION**

PHARMACIA - AD, one of the three state-owned manufacturers of pharmaceuticals in Bulgaria, is located in the City of Dupnica which is approximately 70 kilometers to the southwest of Sofia. This plant has been in operation from 1954 and manufactures numerous medical and a few health-care products with an employment of over 2,500. Manufacturing activities at the plant include both the chemical synthesis of active ingredients and the formulation of medicines. The largest manufacturing operation in PHARMACIA - AD is the chemical synthesis and formulation of Vitamin-C (medical-grade ascorbic acid) which was started in 1971. The technologies used for manufacturing most of the products in PHARMACIA - AD need to be upgraded, with adequate increase in manufacturing capacity, for the company to compete in the global market. At present, however, the products of PHARMACIA - AD are being targeted for use only in Bulgaria. The company also has access to manufacturing specialists in Bulgaria's research institutes.

The top management of PHARMACIA - AD has been making their best efforts to improve manufacturing operations within the available funds. For example, a major improvement of steam use was recently achieved in PHARMACIA - AD by replacing all steam traps at the plant with a more efficient model at a total cost of approximately \$ 0.25 million. The company expects to recover this investment in less than a year from savings in energy consumption at the plant. Out of the three steam boilers in operation at the plant now, only one is expected to be necessary by the next summer. It is also reported that the manufacturing capacity of Vitamin-C has recently been increased approximately from 200 to 270 metric tons per year by modifying the technology for the process in-house.

The manufacturing operations in PHARMACIA - AD result in the generation of approximately 0.5 million gallons of wastewater per day, which is pretreated on-site and discharged to the sewer system in Dupnica for additional treatment by the municipality. The municipality charges PHARMACIA - AD approximately \$200,000 per year for this treatment. Approximately 50% of the wastewater generated in PHARMACIA - AD is reportedly from the manufacture of Vitamin-C, which includes several steps generating aqueous by-products and / or off-spec products with high concentrations of dissolved solids and some presence of organic pollutants. In addition, the manufacture of Vitamin-C generates solid wastes including spent catalysts (which are usually recycled and reused in another process step) and polymerized materials from reactors (which are being separated from the product and stored onsite for possible disposal by incineration in the future).

The manufacture of Vitamin-C involves the following six (6) major process steps :

- Step 1 - Hydrogenation of Dextrose to produce Sorbitol
- Step 2 - Fermentation of Sorbitol to produce Sorbose
- Step 3 - Acetonation of Sorbose to produce Diacetone Sorbose
- Step 4 - Oxidation of Diacetone Sorbose to produce Diacetone  
2-keto Gulonic Acid (DKGA)
- Step 5 - Hydrolysis of DKGA to produce Technical-Grade Ascorbic Acid
- Step 6 - Purification of Technical-Grade Ascorbic Acid to produce  
Medical-Grade Ascorbic Acid which is formulated as Vitamin-C

Each of the process steps listed above involve different unit operations and raw materials. Many of the unit operations applied by the process are energy intensive, such as autoclaving, evaporation, crystallization and drying. The basic raw material used in the process, Dextrose, is imported as it must meet stringent purity requirements. Other raw materials used in the process in relatively large quantities are purchased locally, including sodium hydroxide and sulfuric acid / oleum (Steps 3 and 4), hydrochloric acid (Step 5), and acetone or dichloroethane (Steps 3 and 6). One of the major raw materials used in Step 1 of the process, hydrogen, is produced by electrolysis of water onsite. This step also uses expensive nickel catalysts which are typically recycled and reused. The solvents used in the process, acetone and dichloroethane, must also be regenerated on-site.

In addition to the procurement of raw materials at the lowest cost, recycling of catalysts and regeneration of solvents, the economics of manufacturing Vitamin-C will depend critically upon the installation of adequate manufacturing capacity and the achievement of a high production yield in each step of the process. The achievement of a high production yield requires the use of the most advanced technology available and the best control of process operations in order to prevent the production of off-spec products. In most chemical manufacturing processes, the off-spec products represent the most "expensive" waste streams being generated. In general, production yields for manufacture of Vitamin-C have been lower than international standards at PHARMACIA - AD. The top management recognizes this fact and has contacted U.S. firms and consultants in the past to recommend technology changes to improve upon the production yields of specific operations at the plant. However, technology changes have been too expensive for implementation.

## **WASTE MINIMIZATION OPPORTUNITIES**

WEC's project team examined the data provided by PHARMACIA - AD on the standard and actual consumption of raw materials, as well as data on the quantities and characteristics of waste streams typically generated during the manufacture of Vitamin-C. However, it was noted that these data were not presented in adequate detail to identify specific cases of increased material and energy consumption, as well as increased waste generation, during actual operation of individual process steps in the manufacture of Vitamin-C at PHARMACIA - AD. For example, PHARMACIA - AD does not regularly monitor the quantities and characteristics of individual waste streams generated at the plant.

The project team also found during detailed discussions with the management of PHARMACIA - AD that several options had already been considered for changing the manufacturing technology of specific operations at the plant to increase their yields. Some of these technology changes could also be seen as opportunities for reducing individual waste streams at the plant. While most of these options were too expensive to be considered as a candidate for the WMDP, discussions with plant personnel identified three (3) unit operations which can be improved by better process control :

- Regeneration of acetone with higher moisture content in Step 3 of process.
- Degradation of Diacetone Sorbos at high temperature and low pH in Step 3.
- Polymerization of reactor contents during hydrolysis of DKGA in Step 5.

The project team and the plant management have further assessed these opportunities for achieving waste minimization and increasing production yields. First, the regeneration of acetone takes place in two rectification columns with no instrumentation which indicates the moisture content of the acetone produced by the operation. Use of acetone with high moisture content is known to decrease the yield of Diacetone Sorbos during the step of acetonation where it is used. A densitometer may be considered for installation in the piping from rectification columns to measure the moisture content of the product. Second, acetonation occurs at a low pH and temperature, and is followed by neutralization which is highly exothermic. A closer monitoring of temperature and pH during neutralization and rapid response to any fluctuation of either parameter could prevent degradation of Diacetone Sorbos. Lastly, the hydrolysis of DKGA takes place in a manually controlled batch reaction which lasts for 30 hours. Improved temperature control during this operation is expected to reduce polymerization of materials in the reactor, which will increase production yield of Ascorbic Acid while reducing the generation of waste.

## **WASTE MINIMIZATION DEMONSTRATION PROJECT**

WEC's project team has proposed to develop and implement a Waste Minimization Demonstration Project (WMDP) to demonstrate that improved process control in selected operations for manufacturing Vitamin-C can reduce waste generation and increase production yield. In order to finalize the selection of operation(s) for the WMDP, PHARMACIA - AD will first develop more information on the process operating conditions in which the control instruments will be used and provide more accurate estimates of the cost benefits which are expected from each process improvement. It is also possible that non-availability of adequate funds may make it necessary for WEC to supply the instrumentation for only one unit in each selected operation(s) for the project. It is also necessary to follow suitable procedures during the project for measuring the waste minimization and production yield increase achieved by the final process improvement(s).

In response to WEC's proposal, the top management of PHARMACIA - AD has shown their interest in the WMDP by indicating the possibility of contributing their own funds to the project if the initial results are promising. It is therefore important to design the WMDP for early results and accelerate the project schedule as much as possible. Accordingly, PHARMACIA - AD has agreed to provide the additional information required by WEC to enable finalization of the project's scope of work by end of March 1994. A memorandum of understanding (MOU) is then expected to be signed by WEC and PHARMACIA - AD. Installation of the new instruments is expected to be completed during the annual shutdown of the plant for maintenance during this summer. At the same time, a final protocol will be implemented for tracking waste generation and production yields for selected operations. The economic benefits of process improvement will then be reported by PHARMACIA - AD, to be followed by development of a long term waste minimization program. It is expected that the WMDP will be completed by the end of September 1994.

Although good estimates are not available at present on the cost benefits of the proposed WMDP, it is reasonable to expect that the demonstration project itself will result in reduction of costs in the annual production of Vitamin-C at PHARMACIA - AD (approximately \$ 3 million per year) by at least 1% or \$30,000. Additional potential for cost savings exists with an expansion of the WMDP to other units within the same plant. By improving the production yields, the WMDP is also expected to reduce the concentration of dissolved solids and organics in the plant's wastewater by at least 5%.

**IV. BUSINESS CARDS OF CONTACTS**



Stefan KAFEDZHYSKI  
R&D DIRECTOR

BULGARIA  
2600 Dupnica  
3, Samokovsko Chaussee

Tel: (+359701) 2 67 21  
Fax: (+359701) 2 23 65  
2 81 62  
Telex: 27433



eng. SIMEON GEORGIEV  
MANAGING DIRECTOR

BULGARIA  
2600 Dupnica  
3, Samokovsko chaussee

Tel: (0) 701 2 67 62  
2 81 63  
Fax (0) 701 2 23 65  
Тlx. 27 433



2-90-21/29 Ext. 177  
/ ANELIA KOSTADINOVA

Telephone translator  
Exchange

2600 Dupnica  
3, Samokovsko chaussee  
tel./0701/ 2 42 80(1,2)  
2 57 70(1,2)Ext. ~~555~~ 177

2600 Dupnica  
8, St. Kl. Ohridsky STR.  
tel./0701/ 2 80 28



Инж. БОЯН ЦАНЕВ  
ЗАМ. ДИРЕКТОР  
ПРОИЗВОДСТВЕНИ  
И ТЕХНИЧЕСКИ ВЪПРОСИ

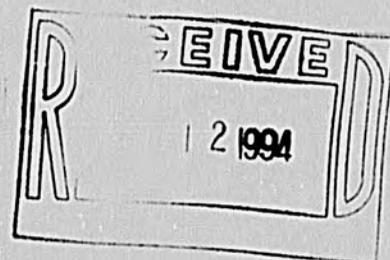
БЪЛГАРИЯ  
2600 Ст. Димитров  
3, Самоковско шосе

тел. (0701) 2 28 16  
телекс 27433  
факс (0701) 2 23 65

J. Robert Rowland  
Environmental Consultant

12 Merry Lane  
Weston, CT 06883 USA

(203) 226-6432



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May 3, 1994

Ms. Patricia A. Swahn  
Acquisitions Manager  
Document Acquisitions  
POL/CDIE/DI  
Room 303, SA-18  
United States Agency for International Development  
Washington, D.C. 20523-1803

Dear Ms. Swahn:

Enclosed is a copy of the WEC Trip Report to Pharmacia - AD in Dupnica, Bulgaria.

Should you have any questions or comments, please let me know.

Sincerely,

Bohdan Aftanas, Ph.D., P.E.  
Project Manager

BA:mg  
Enclosure

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