PN-ACQ-495

EAPS ENVIRONMENTAL ACTION PROGRAMME SUPPORT PROJECT

RODNIK VODKA COMPANY
POLLUTION-PREVENTION ASSESSMENT REPORT

An In-Plant Environmental Assessment for Low-Cost/No-Cost
Pollution-Prevention and Abatement Measures

Contract No. DHR-0039-C-00-5034-00

Submitted to:
U.S. Agency for International Development

Submitted by:
Chemonics International Inc.

with the cooperation of:
The Russian Engineering Academy, Volga Department
Samara, Russia

May 1999

Environmental Action Programme Support Project
Contract No. DHR-0039-C-00-5034-00

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LIST OF ABBREVIATIONS

BOD	Biochemical oxygen demand
CC	Closed cup method
COD	Chemical oxygen demand
conc.	Concentration
cu. m	Cubic meters
EH&S	Environmental health and safety
est.	Estimated value
g/l	Grams per liter
m^3/day	Cubic meters per day
LD50	Lethal dose 50
m^3/yr	Cubic meters per year
Recom.	Recommendation
RO	Reverse osmosis
ROI	Return on investment
Ru/yr	Rubles per year
STEL	Short-term exposure limit
TER	Technical effectiveness rating
TSS	Total suspended solids
TLV	Threshold limit value

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PREFACE

This report documents the results and recommendations of a pollution-prevention assessment conducted of facilities of the Rodnik Vodka Company, with its cooperation and permission.

The EAPS project is a part of the environmental component of the Samara Regional Investment Initiative, a collaborative effort among U.S. and Russian governments, regional authorities, and private sector entities. The initiative aims to improve the investment environment and overall business climate for sustainable economic growth in selected regions of Russia.

USAID/Russia selected the EAPS project to carry out the initiative's environmental component, which concentrates on activities to promote identification and implementation of no-cost/low-cost measures to improve environmental and economic performance of Samara enterprises. The emphasis is on demonstrating that enterprises can join sound environmental practices with sound business practices and incur little or no financial burden.

ACKNOWLEDGMENTS

Chemonics International Inc., K&M Engineering and Consulting Corporation, and the author wish to acknowledge the technical expertise, advice, and analysis provided by the following individuals and organizations provided in developing the recommendations for pollution-prevention opportunities at the Rodnik Vodka facilities:

- Sergey V. Makarov, chair, Industrial Ecology of Chemical Technology Mendeleev University, Moscow, Russia

- Russian Engineering Academy, Volga Department, Samara, Russia

EXECUTIVE SUMMARY

This report documents the recommendations of a pollution-prevention assessment at the Rodnik Vodka Company. Established in 1905, Rodnik has a main bottling plant and two spirit distilleries. The in-plant assessments were conducted at the bottling plant and one distillery, Novobuyansky Spirit Factory. The assessment aimed to provide a rapid evaluation of the pollution problems in the manufacturing operation, and devise recommendations for no-cost/low-cost measures to improve environmental performance and gain economic benefits. The bottling plant and spirit distillery were selected for the assessment based on Rodnik management's recommendation. Time and budget constraints limited the assessment to only partial identification of environmental issues and analysis of cost-effective recommendations.

The assessment team discussed pollution-abatement recommendations with senior-level management in an exit interview. Although there was general agreement on the environmental priorities and recommendations, the company needs to do further work to refine these recommendations and put them into practice.

This report prioritizes the recommendations in terms of investment requirements (not all recommendations are no-cost) and technical effectiveness (i.e., probability of success in abating a pollution problem or achieving economic benefits). The company should view these recommendations as a starting point for developing an environmental action plan for plant operations. The consultant recommends that Rodnik apply the step-by-step method for pollution-prevention assessments presented in the EAPS guide "In-Plant Environmental Assessment Sourcebook: A Guide to Pollution Prevention Planning."

RODNIK VODKA COMPANY: POLLUTION-PREVENTION ASSESSMENT

A. The In-Plant Assessment

The in-plant assessment consisted of the following steps:

1. *Pre-assessment.* In this step, general information was collected about the operations of the facility, the specific shop areas chosen for the assessment, and the waste issues. The information collected was based on a pre-assessment questionnaire (Annex B) provided to Rodnick at the start of the program, and two meetings with technical experts assigned by the plant to the assessment team.

2. *Walk-through of each operation.* In each walk-through, which took one day or less, the team focused on specific areas of the shops to evaluate waste problems and pollution issues. The team conducted interviews with shop operating personnel and local management.

3. *Exit interview with the plant technical experts.* This interview entailed a review of preliminary findings and recommendations.

4. *Exit interview with senior management.* The assessment team presented its recommendations.

The Rodnik Vodka Company representative who assisted in the in-plant assessment was Mr. Leonid Safronov (head of the Technical Policy Department). The assessment team members assigned by Chemonics International and the Russian Engineering Academy-Volga Department were Nicholas P. Cheremisinoff (team leader), Sergey V. Makarov (technical expert), and Shouvalov Michel Vladimirovich (technical expert).

The team focused on wastewater discharges and indoor air-quality at the Novobuyansky Spirit Factory and on wastewater and water recycling at the main bottling plant. Taking photos were not permitted at the distillery, but were allowed at the bottling plant (for photos, see Annex A).

B. Characteristics of the Operation

B1. Novobuyansky Spirit Factory

The Novobuyansky Spirit Factory, established in 1791, is one of the oldest vodka distilleries in Russia. Over the years, it has undergone various stages of modernization. With the last major renovation, in 1978, its design capacity reached 300 liters per day. The distillery processes the grain of barley, millet and rye and is designed to handle a feedstock capacity of 28,000 tons of grain. It normally operates 11 months per year, but in 1998 operated only 152 days due to the severe economic conditions in Russia.

Spirit production entails the following processes:

- Feedstock material stockpiling and preparation (washing)
- Germination and malt processing
- Grain refining and brewing (digesting)
- Fermentation
- Mash rectification

Grain is carried to the plant by vehicles and then pneumatically transported to bunkers. From storage bunkers, the grain is raised by a bucket elevator to crushers. Next the grain is moved to rolling machine tools, and on to a mixing vessel where fresh water is added. From the mixer, it is pumped through a contact head into a boiling unit (digester) and cooked. The boiled soft mass is mixed with refined malt, cooled, and placed into fermentation tanks, where live yeast is added. After fermentation, the mash is pumped to a mash-rectifying unit, and separated into spirit, ether, aldehyde fractions, fusel oil, and residues.

Spirit, ether, aldehyde, and fusel oil fractions are sent to appropriate tanks. Solid residues are skimmed off and used as animal feed at collective and state farms. Finally, the spirit product is transported by tankers to the main bottling plant in Samara.

The distillery's water supply comes from eight artesian wells. There is no wastewater treatment plant at the distillery, and wastewater is discharged directly into the Buyanka River.

B2. Samara Bottling Plant

For the most part, the bottling plant in Samara is relatively modern, although some parts are labor-intensive and need modernization. Bottle-washing, product-filling, capping, and labeling operations range from automatic to semi-automatic. The plant has the flexibility to produce 15 different lines of vodka products, each corresponding to different bottle sizes and configurations; however, only two or three product lines were in operation during the site visit. During the team's initial visit to the plant in February, officials indicated it was operating at about 40 percent of its capacity (the plant's nameplate states capacity at about 35,000 bottles per day). However, during the in-plant assessment (March 1999), the operation had been trimmed back to about 15 percent of capacity.

One reason for the reduced operation is that vodka production is strictly regulated, and each distillery has a government-mandated quota each month. This restriction affected the assessment team's ability to observe the bottling plant at a higher rate of production, and also restricted the team from revisiting the distillery operation for a more in-depth review of the operations. (The team's site visit was restricted to less than a half day because plant access to visitors was barred by government officials.)

The plant bottles its products in both recycled and new glass bottles. Trucks carry the bottles to the plant and the bottles are kept in an outer courtyard. Spirits from Rodnik's two distilleries are unloaded from tankers and submitted to a carbon absorption and slow filtration sand-bed system. The spirits are then additionally purified through ultra-filtration, and clean water that has been purified by reverse osmosis is added. For some product lines, herbal and peppered ingredients are added.

The plant's bottling operation consists of the following steps:

- Automatic washing and sterilization of bottles
- Product injection
- Sealing and bottle labeling
- Packaging

Quality-control checks for product and bottles are performed manually. Checks for bottle defects are done visually, with bottles rejected on the basis of physical flaws such as cracks and "bubbles." The team was unable to obtain information on the rejection rate, but a spot observation of the quality-control points in the process indicated rejection rates as high as 25 percent. The rejects are recycled to a local glass factory. Plant management admitted that the quality-control check needed automation and that laser or light-scattering techniques would be the most accurate. A shortage of capital prevents management from investing in such modern methods.

Photographs 1 through 7 in Annex A show various stages of the bottling and packaging steps. As the photographs indicate, the production is in general very clean and well organized.

B3. Walk-through Observations

Plant management strongly recommended an assessment of the Novobuyansky Spirit Factory; however, for reasons described above, the assessment time was very limited. Management generally held the view that there were no environmental issues to be addressed at the bottling plant.

In the limited time spent at the factory, two serious issues were identified. First, the distillery has a problem complying with wastewater discharge requirements. There are no on-site wastewater treatment facilities, and the plant discharges directly to the Buyanka River. The plant is reviewing plans for a major investment (on the order of $10 million) that will provide treatment for suspended solids, biochemical and chemical oxygen demand, and other water parameters. However, an examination of this issue was beyond the scope of this in-plant assessment. The second issue was the application of a disinfectant containing formaldehyde, a hazardous substance (see Table 1) to the process piping and some vessels every three days. This practice (outlined in Section C3 below) causes a serious health risk for workers and contributes to wastewater discharges.

Although the bottling plant is a relatively clean operation, it has a wastewater problem. More than 90 percent of the bottle wash water is discharged after only one use to the municipal wastewater treatment plant. Rodnik is charged for this discharge, and hence there would be significant financial benefit to recycling water in the company's bottle-washing operations.

C. Pollution-Prevention Opportunities

C1. Summary of the Pollution-Prevention and Abatement Measures

Pollution-prevention opportunities identified by the assessment team are presented in Tables 2 and 3. Table 2 prioritizes pollution problems and potential opportunities to prevent air and water pollution. Cost estimates for the recommendations were not possible due to time restrictions.. Rodnik will need to explore the availability and cost options accessible to them in the region to reduce investment costs.

It is important to note that Tables 2 and 3 prioritize pollution-prevention and abatement measures for specific operations, and hence form the basis of an environmental management plan. Although all the steps detailed in the EAPS-prepared guide "In-Plant Environmental Assessment Sourcebook: A Guide to Pollution Prevention Planning" were not followed because of time and budgetary restrictions, the present assessment does provide a first-pass approach to addressing the environmental issues for both operations. The summary approach recommended in Tables 2 and 3 should be followed in other in-plant assessments in other parts of the company. Collectively, these assessments can be used to develop a facility-wide environmental action plan that identifies low-cost/no-cost opportunities.

Summaries of the recommendations along with the environmental, health, safety, and financial benefits are given below.

C2. Novobuyansky Spirit Factory

As noted above, the distillery performs the dangerous and environmentally unsound practice of using an active solution that is by weight 37 percent formaldehyde. The plant uses this solution to disinfect its lines, process vessels, heat exchanges, and stills. Table 1 below describes the characteristics of formaldehyde.

Table 1. Properties and Characteristics of Formaldehyde

Chemical Designations	
Synonyms:	Formalin, fyde, formalith, methanal, formic aldehyde
Chemical formula:	$HCHO/H_2O/CH_3OH$
Observable Characteristics	
Physical state (as shipped): liquid *Color*: colorless *Odor:* pungent, irritating	
Physical and Chemical Properties	
Physical state at 15°C and 1 atm.: Liquid *Molecular weight:* 18-30 *Specific gravity:* 1.1 at 25°C (liquid)	
Chemical Reactivity	
Reactivity with water: No reaction Reactivity with common materials: No reaction *Stability during transport:* Stable Polymerization: Not pertinent *Neutralizing agents for acids and caustics:* Not pertinent	
Fire Hazards	
Flash point (°F): 182 CC (based on solution of 37% formaldehyde and methanol-free), 122 CC (based on solution with 15% methanol); flammable limits in air (%): 7.0 - 73 *Ignition temperature (°F):* 806 *Fire extinguishing agents*:: Water, dry chemical, carbon dioxide, or alcohol foam *Fire extinguishing agents not to be used:* No data or recommendations found *Special hazards of combustion products:* Toxic vapors form *Behavior in fire:* Not pertinent	
Health Hazards Information	
Recommended personal protective equipment: Self-contained breathing apparatus, chemical goggles, protective clothing, synthetic rubber or plastic gloves *Symptoms following exposure:* Inhalation: Causes coughing, chest pain, nausea, and vomiting Ingestion: Causes nausea, vomiting, abdominal pain, and collapse. Contact with skin and eyes causes severe irritation	

Table 1. Properties and Characteristics of Formaldehyde (cont.)

Health Hazards Information (cont.)

Recommended treatment following exposure:
Inhalation: Remove victim to fresh air, give oxygen if breathing is difficult, call a physician

Ingestion: Induce vomiting at once and repeat until vomit is clear; then give milk or raw egg and call a physician

Skin or eyes: Flush immediately with plenty of water for at least 15 min.; remove contaminated clothing, call a physician

- Toxicity by inhalation (threshold limit value): 2 ppm
- Short-term inhalation limits: 5 ppm for 5 min., 3 ppm for 60 min. (tentative)
- Toxicity by ingestion: Grade 2 formaldehyde solution, LD50 0.5 to 5 g/kg
- Late toxicity: None
- Vapor (gas) irritant characteristics: vapor is moderately irritating such that personnel will not usually tolerate moderate or high concentrations
- Liquid- or solid-irritant characteristics: Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure
- Odor threshold: 0.8 ppm

Source: *Handbook of Industrial Toxicology and Hazardous Materials* (N.P. Cheremisinoff, Marcel Dekker Publishers, New York and Basel, 1999.

The disinfecting material is introduced into a day tank, where it is further diluted/mixed with distilled water and then fed to the process vessels for cleaning and disinfecting. This operation is performed every three days. The vessel (day tank) has several holes in the top for operator viewing. Since this vessel is used in regular production for mash-solution preparation, a visual quality-control check is needed. However, a hatch on the vessel roof that can be used for this purpose, negating the need for these holes. Since this part of the operation is not hermetically sealed, these holes enable formaldehyde vapors to enter into the work area and expose workers. An additional and equally dangerous practice is that the cleaning solution is drained from process lines in open sewer channels along the perimeter of the building. Next, the solution is diluted with fresh water to lower the discharge concentration so that it meets discharge limits required by law. Finally, the solution is discharged directly to the Buyanka River.

The serious environmental, health, and safety problems posed by this operation are summarized below:

- *Workers are exposed to a toxic vapor that has both acute and likely chronic heath effects.* The short-term inhalation limit is only 5 ppm for 5 minutes and 3 ppm for 60 minutes, above the threshold limit value of 2 ppm. Moreover, under current operations, workers are likely exposed to much higher levels for longer periods.

- *A potential fire hazard is created in the work area.* Formaldehyde has a a very broad explosivity range (7 to 73 percent), making it a fire hazard.

- *Wastewater (cleaning solution and water wash) are sent directly to a local river.* The plant adds clean dilution water to meet the legally allowable discharge limits, but this is not a proper solution to the problem. Formaldehyde may not be completely soluble in water, and its solubility is likely to be temperature-dependent. Furthermore, dilution as a practice for pollution discharges is universally recognized as an environmentally unsound.

The pollution-prevention recommendations outlined in Tables 2 and 3 are summarized below:

- The holes in the day tank should be sealed to prevent vapors from entering the work room area. A site gauge, or preferably a high-level detector and alarm, should be installed on the vessel so that the operator/worker has no need to look inside the tank during cleaning operations. For normal operation during mash production, an automatic sampler should be installed and used. An automatic sampler can be installed by the plant for very little money. The sampler may be as simple as a tube and either a self-priming pump or submergible pump, or it may be a manual drum sampler tube. These items can be purchased for hundreds of dollars and their use will greatly reduce worker exposure.

- Open-channel sewers should be covered. A simple sheet-metal hat constructed in straight segments can be placed over the sewer lines to minimize cleaning-solution vapors from entering into the workroom. Furthermore, the additional precaution of chemical cartridge respirators should be used. A full-face respirator with a six-month supply of cartridges costs $165. A respiratory training program should be implemented on the proper use and maintenance of the respirator, and strict enforcement of its use should be imposed by the management.

- The practice of diluting the waste stream containing formaldehyde not only does not eliminate the problem, but continues the practice of pollution. Formaldehyde has a special gravity greater than water (1.1 at 25°C). Without information on its miscibility, there is no assurance that this pollutant is not separating out and concentrating on the river bed. The plant should implement a program to assess a low-cost treatment option. A simple and low-cost treatment may be the use of a strong oxidizing agent (e.g., sodium hypochloride). Formaldehyde readily oxidizes and can be neutralized. This option can be evaluated at the bench-scale by the distillery, and if it works, there is existing storage-tank capacity currently used for wastewater dilution purposes that can be applied on a plant-wide for the oxidation step. This step may serve as an interim approach to managing the environmental problem until a wastewater treatment facility is constructed. As a second option, the plant should attempt to identify a substitute disinfectant that is environmentally friendly and less toxic.

C3. Samara Bottling Plant

The bottling plant uses large amounts of fresh water to wash and sterilize bottles. The operation relies on one recycling stream, in which a cleaning solution is recycled through the washing machines. This cleaning solution must be changed periodically, and there are financial incentives, including reduced expenses for cleaning chemicals and reduced wastewater discharges, for extending the life of the recycling stream. However, extending the recycling stream requires a high-cost solution that would require a modular ultra-filtration unit. This approach offers a reasonable return on investment for a plant operating at close to full capacity. However, for a plant operating at only 15 to 40 percent of capacity, the approach should be to address environmental management issues and manage operating costs to enhance the plant's sustainability. The long-term, higher cost recommendation of ultra-filtration is detailed in Annex C. This material, along with vendor contact information, can be reviewed by the plant and explored as an option when its business operations improve.

The assessment team focused on the water consumption issue. Photo 8 in Annex A shows a simplified process flow sheet of the water consumption for the main water-bottling train. The train consists of five washing machines although only two full-time machines are operating under current capacity limitations. These machines have four stages of washing, each with a different supply of water from other parts of the plant. Each water stream has slightly different quality, and the water used for the washing machines is not recycled.

Photo 9 in Annex A shows a side-view of one of the bottle-washing machines. The windows along the side of the machine are viewing ports to the four different stages of bottle washing. The bottle-feeding step of this machine is depicted in Photo 3. The water supply is drinking water fed to the plant by a single main header (see Photo 10). After the feedwater enters a bottle-washing machine, it is discharged through machine drains to a floor basin. Each machine has its own floor basin; Photo 11 shows two such drains. From here, the collected water is sent to the municipal sewer, requiring the company to pay pollution charges to the municipality.

Rodnik pays 3.00 Ru/m^3 for fresh water supplied to the plant and 1.56 Ru/m^3 for discharging washing water. Clearly these costs are incentives for the company to recycle water.

The assessment team performed a material balance for water, using the flow scheme provided in Photo 8, and identified six potential reuses (recycling streams) that would result in recycling as much as 18 percent of the water used for current washing-machine demands and a savings of about 236,485 Ru/yr. The largest single source for potential recycling (more than 15 percent of the total water that could be identified) is boiler make-up water feed. Table 4 provides a breakdown of the possible recycling options and the financial incentives.

The specific low-cost recommendation for the plant to assess is the cost and feasibility of collecting water from one or more of the washing-machine drains, and recycling it back to the boiler as feed water. The plant will need to assess the quality and flow rates from this source and possibly one or two other sources for other smaller washing machines. The team recommended a formal assessment program and feasibility study, discussed briefly in the next section.

D. Recommendations

The team held a final meeting with Rodnik management. Although a decision had been made on implementing the low-cost recommendations (Table 3), there was insufficient time in the EAPS program to prepare a formal implementation plan. Table 5 provides a proposed implementation plan for the bottling operation to be presented to Rodnik management for their review and approval. To date, the local management of the distillery has not decided on whether to implement any of the recommendations.

The assessment team recommends that follow-up monitoring of the bottling plant's program be included as a part of the EAPS program.

Table 2. Priority Definition of Environmental Management Issues

Priority Pollution Problems	Environmental Health and Safety Impacts	Potentially Applicable Pollution-Abatement Measures	Environmental, Health, Safety, and Financial Benefits	TER[1]
Novobuyansky Distillery				
Air emissions and exposure to toxic vapors	Excessive formaldehyde vapors discharged to the working zone air in the brewing and cooking departments.	A1. Develop and implement a program to seal equipment treated by formaldehyde solution to minimize fugitive emissions.	• Reduced employee health risks. • Minimized potential for fire.	H
Wastewater discharges to Buyanka River	Direct discharge of formaldehyde-contaminated wastewater to the river. The practice of diluting wastestream is ineffective.	W1. Reduce formaldehyde concentration in disinfecting solution.	• Elimination of an environmentally unsound practice that damages the ecology. • Potential reductions in pollution fines. • Raised image of Rodnik as an environmentally concerned corporation.	M
		W2. Local neutralization of disinfecting solution.		H
		W3. Substitution of formaldehyde with environmentally friendly disinfectant.		M-H
		W4. Construction of wastewater treatment plant.		L

Priority Pollution Problems	Environmental Health and Safety Impacts	Potentially Applicable Pollution-Abatement Measures	Environmental, Health, Safety, and Financial Benefits	TER[1]
Rodnik Bottling Plant				
Wastewater discharges to municipal sewer	Low environmental impact from current practice, but costs Rodnik money because the discharge is a "legal" waste stream.	WB1. Recycle water from washing machines as boiler feed and possibly other uses.	Significant cost saving in pollution fee reductions and in less freshwater feed purchases (see Table 4 for financial incentives).	H
		WB2. Installation of modular ultra-filtration unit.	Same cost savings as WB1 plus incremental chemical cleaning-solution savings. This is a long-term, high-cost option suitable when the plant's production capacity improves. Estimated return on investment based on full capacity is 6.5 years (see Annex C for details and financial incentives).	H

TER = Technical effectiveness rating. H = high; M = medium; L = low.

Table 3. Recommended Environmental Action Plan and Priority Pollution-Prevention Opportunities

Pollution-Prevention Recommendation	Environmental Benefit	Estimated Cost	Estimated Savings or Economic Benefits
Novobuyansky Distillery — No-Cost/Low-Cost Opportunities			
A1. Develop and implement a program to seal equipment treated by formaldehyde solution to minimize fugitive emissions. Refer to Section C2 for details.	• Reduced employee health risks. • Minimized potential for fire.	No cost to very minimal.	Unknown; should be determined.
W1. Reduce formaldehyde concentration in disinfecting solution. Current operation uses disinfection solution with a formaldehyde concentration of 5 g/l or less. Recommend evaluating reducing disinfecting solution by 20 to 30 % and increasing residence time in lines for cleaning effectiveness. Net result will be to reduce wastewater discharge.	• Elimination of an environmentally unsound practice that damages the ecology. • Potential reductions in pollution fines. • Raised image of Rodnik as an environmentally concerned corporation.	No cost.	Unknown; should be determined.
W2. Locally neutralize disinfecting solution. After disinfecting process, which is done every 3 days, 12 - 15 m^3 of waste solution is formed with a formaldehyde concentration of about 2.5 - 3 g/l. Total amount of formaldehyde in the solution is 30 - 35 kg per one operation of disinfection or up to 2.5 t/yr. Dilution of such amount of formaldehyde up to the maximum concentration allowed = 0.1 mg/l is technically impossible (current proposal by Rodnik's external consultant). The total amount of wastewater discharge is 2,000 m^3/day, which means the plant cannot dilute more than 200 g of formaldehyde per day. *Further, dilution is an environmentally unsound practice!* Recommend local treatment by means of oxidation with sodium hypochloride with further removal of the excessive oxidizer as one of the variants. Plant can use on-site compressed air to mix the solution.	• Elimination of an environmentally unsound practice that damages the ecology. • Potential reductions in pollution fines. • Raised image of Rodnik as an environmentally concerned corporation.	Very low cost.	Unknown; should be determined.
W3. Substitute formaldehyde with environmentally friendly disinfectant. Current formulation is based on industry practice. This does not mean that this is best approach. Rodnick should examine other disinfection solution options where products are preferably biodegradable.	• Elimination of an environmentally unsound practice that damages the ecology. • Potential reductions in pollution fines. • Raised image of Rodnik as an environmentally concerned corporation.	Likely very low cost.	Unknown; should be determined.

Pollution-Prevention Recommendation	Environmental Benefit	Estimated Cost	Estimated Savings or Economic Benefits
Novobuyansky Distillery — Longer Range Pollution-Prevention Opportunities			
W4. Construct wastewater treatment plant. This is a very long-term, high investment aimed at addressing all wastewater discharges. At least 2 years will be needed before this option is realized; hence it does not address the immediate discharge issue. The current design (conceptual) includes dilution vessel, primary settlers, disc biological filters, secondary settlers, 1st and 2nd stage filtration, and ozonation. Total design capacity is 700 m^3/day.	• Addresses long-term legal and environmental management remedy.	Likely in excess of $10 million	Unknown. Rodnik should carefully assess this option both from a design and cost standpoint. Conceptual design seems excessive and further, large capital investments should be competitive bid.
Rodnik Bottling Plant — No-Cost/Low-Cost Opportunities			
WB1. Recycle water from washing machines as boiler feed and possibly other uses. Refer to Section C3 of the report for detailed recommendations.	Significant cost saving in pollution fee reductions and in less freshwater feed purchases. See Table 4 for financial incentives.	Needs definition. Refer to program in Table 5.	Needs definition. Refer to program in Table 5.
Rodnik Bottling Plant — Longer Range Pollution-Prevention Opportunities			
WB2. Install modular ultra-filtration unit. Refer to Annex C for detailed recommendations.	Same cost saving as WB1 plus incremental chemical cleaning-solution savings. This is a long-term, high-cost option appropriate when the plant's production capacity improves. Estimated return on investment based on full-plant capacity is 6.5 years. See Annex C for details and financial incentives.	Refer to Annex C.	Refer to Annex C.

Table 4. Potential Water Savings at the Rodnik Bottling Plant

Possible Recycling Applications	Analysis Based On Plant Design Capacity				Analysis Based On Current Capacity Requirements				
	Consumpt. (cu. m/yr)	Fresh feed purchase, (Ru/yr[1])	Waste-water disch. cost (Ru/yr[2])	Cumm. savngs (Ru/yr[3])	Consumpt. (cu. m)	Fresh feed purchase (Ru/yr)	Waste-water disch. cost (Ru/yr)	Cumm. savngs (Ru/yr)	Percent use (recycle capacity)
Apply once-thru water for washing yards	600	1,800	936	2,736	600	1,800	936	2,736	0.20
Apply once-thru water for cleaning solution make-up in day tank	576	1,728	898	2,626	173	518	270	788	0.06
Apply once-thru water for hot and warm water wash tank make-up	960	2,880	1,497	4,378	288	864	449	1,313	0.10
Apply once-thru water for compressor cooling	1,8020	5,4060	2,8111	82,171	5,300	15,900	8,268	24,168	1.81
Apply once-thru water as boiler feed	45,500[4]	136,500	70,980	207,480	45,500	136,500	70,980	207,480	15.53
Recycle water discharge from reverse osmosis to boiler feed or reuse for washing stage	0	0	0	0	0	0	0	0	0
Total Savings	65,656	196,968	102,423	299,391	51,861	155,582	80,903	236,485	17.70

[1] The freshwater feed purchase price used was 3 Ru/cu. m, as quoted by the Rodnik Bottling Plant.

[2] The cost to discharge wastewater to the municipal sewer is 1.56 Ru/cu. m, according to the plant.

[3] Cumulative savings are calculated on the basis of the sum of the savings from reduced freshwater feed purchases and reductions in pollution fees from wastewater discharges to the municipal sewer. No attempt to account for losses, holdup, or direct consumption usage has been made.

[4] No reliable data were available on the water requirements for 100 percent design capacity. It was therefore assumed that the boiler requirements are 40 percent higher than current consumption requirements. This seems reasonable based on discussions with the boiler plant manager on current production demands.

Table 5. Recommended Implementation Plan for the Bottling Plant Operations

Step	Task Description	Target Completion Date (1999)
1	*Sampling program.* There are three possible points of water discharge on a single washing machine where water may be acceptable for the boiler. The water quality and flow rates are different at each station. A one-day test is needed to establish the discharge rates at each of the three discharge points. In addition, three water samples should be taken evenly throughout the day (morning, mid-day, afternoon), or a total of 9 water quality samples.	Late April
2	*Analysis of water.* The nine water samples should be analyzed for quality. In particular: pH and alkalinity, calcium, magnesium, chemical oxygen demand, total suspended solids.	Mid - late May
3	*Analysis of data.* Based on the water-quality analysis and flow rates of the three discharge points of a single machine, and the average demands of the boiler, determine the point(s) of collection for the water recycle stream to the boiler. Consultation with a boiler expert may be needed.	Late May
4	*Phase I — engineering and cost estimate.* This is a feasibility study aimed at developing an "approximate" flow scheme (piping layout) and itemized list of components (valves, length of pipe, flow meter, approximate number of elbows and unions for a pressure drop estimate and to size a pump and shut-off valve). From this conceptual layout, a cost estimate should be prepared so that a return on investment calculation can be made based on savings and cost for installation and approximate costs for electrical consumption for recycling. If the calculation is acceptable, then go to Phase II.	Mid June
5	*Phase II — detailed engineering and cost estimate.* Prepare a detailed design specification and cost estimate good to within 5 percent.	Late June
6	*Development of detailed project schedule for construction.* To be reviewed with the EAPS assessment team.	Mid July

ANNEX A

Photos of Rodnik's Samara Bottling Plant

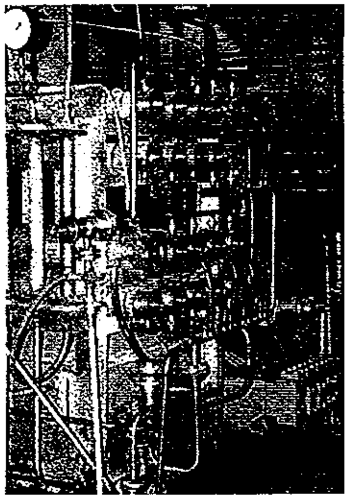


Photo 1. Reverse osmosis unit for dilution water purification.

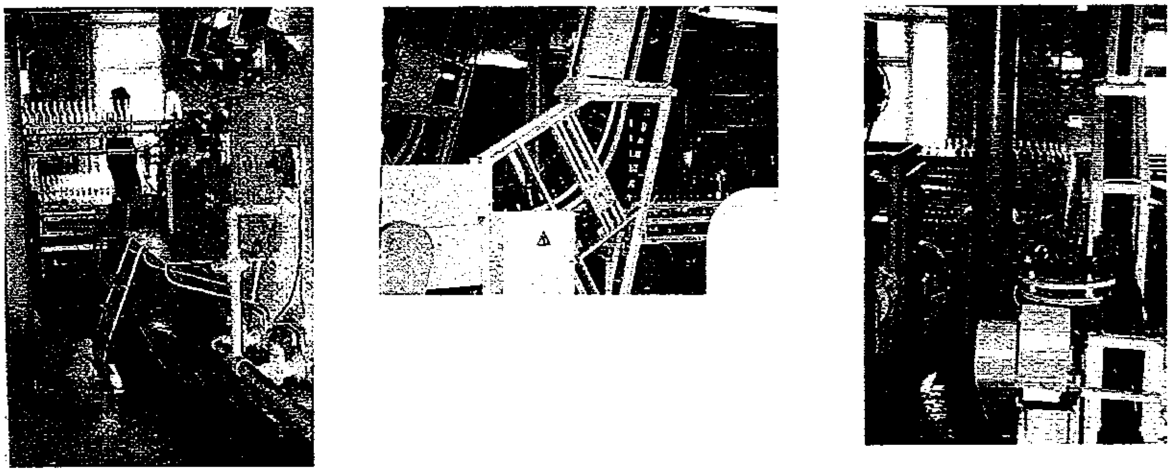


Photo 2. Bottles on train feeding into automatic bottle-washing machines.

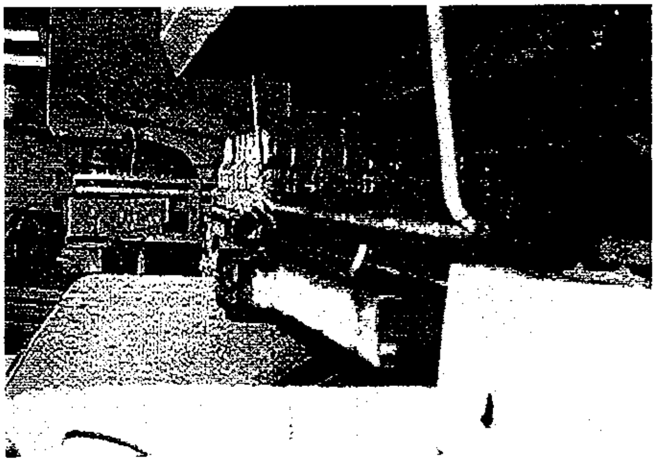


Photo 3a. Bottles feeding into a large, automatic bottle-washing machine.

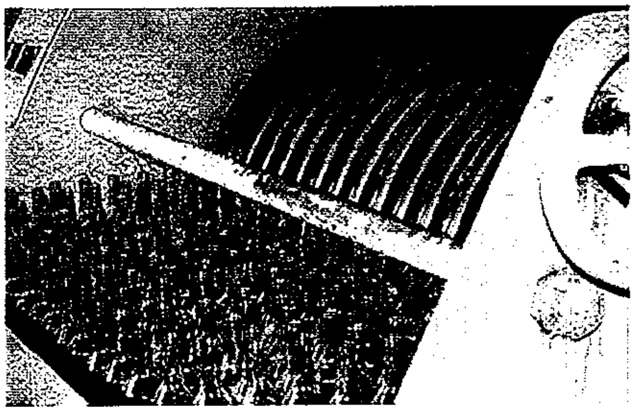
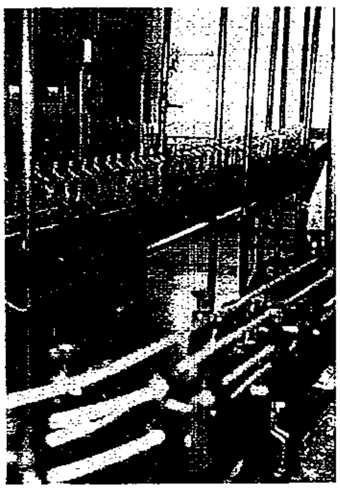


Photo 3b. Bottles about to be washed and sterilized in the automatic washing machine.



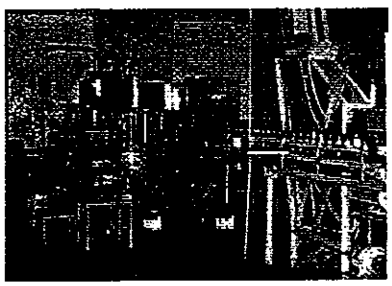


Photo 4. Clean bottles transferring to automatic product-filling stations.

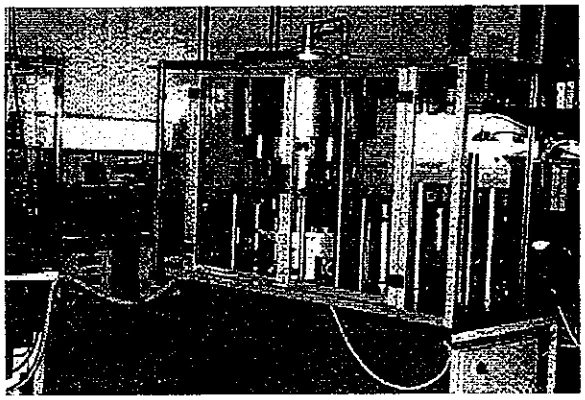


Photo 5. An automated filling station for small bottled products.

Photo 6. Automated bottling machines and operators at work.

Photo 7. Packaging and warehousing operations.

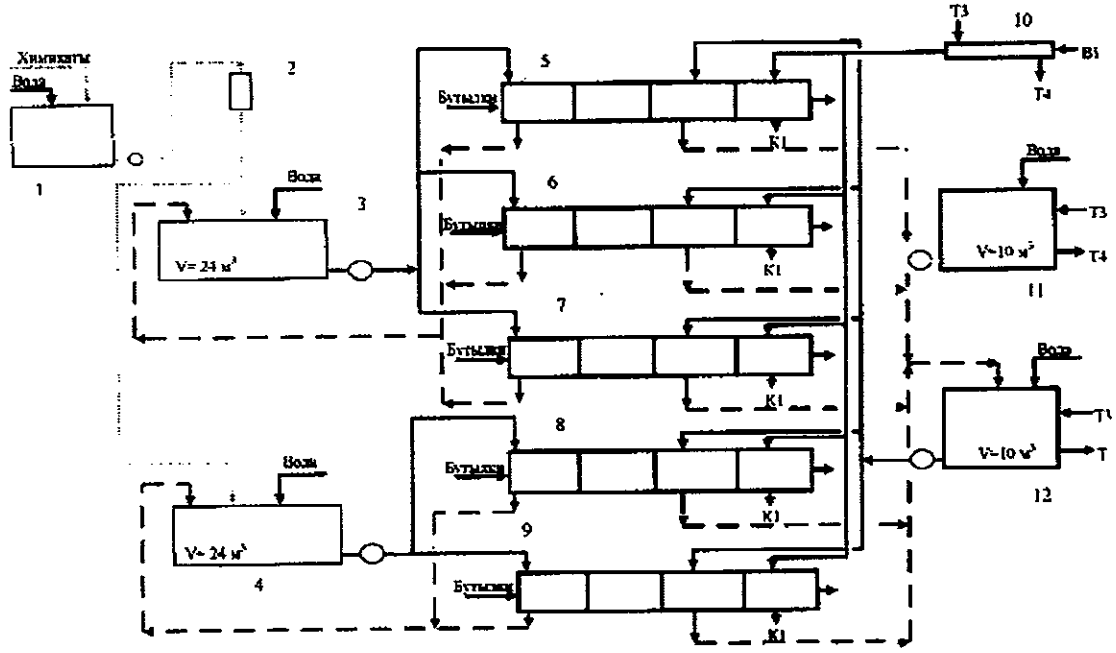


Рисунок 1. Схема материального баланса по моющему раствору бутыломоечных машин водочного цеха комбината «Родник»

1-растворный бак; 2-мерник концентрата, 3-циркуляционный бак моющего раствора № 1; 4-то же, № 2, 5-бутыломоечная машина № 1; 6- то же, № 2, 7-то же. № 3; 8- то же, № 4, 9-то же, № 5, 10-водонагреватель, 11-циркуляционный бак горячей воды (t=60°C); 12- циркуляционный бак теплой воды (t=45°C)

Photo 8. Scheme of the water-flow balance for the main bottle-washing line: 1 - solution tank; 2 - measuring device; 3 - circulation tank for the No. 1 washing solution; 4 - the same as No. 2; 5 - bottle washing machine No. 1 ; 6 - the same as No. 2; 7 - the same No. 3; 8 - the same No. 4; 9 - the same No. 5; 10 - water heater; 11 - circulation tank for hot water (60 C) ; 12 - circulation tank for warm water (45 C).

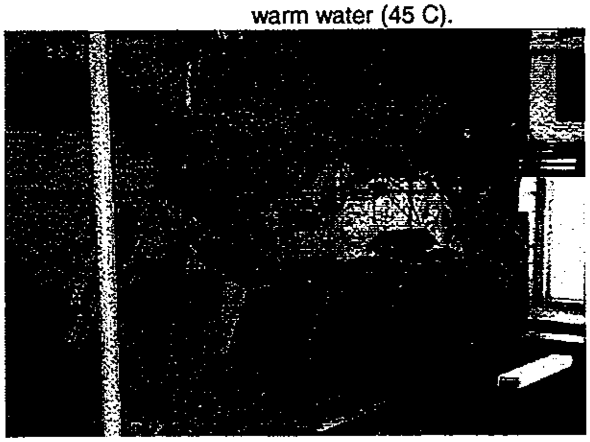


Photo 9. Side-view of a main bottle-washing machine.

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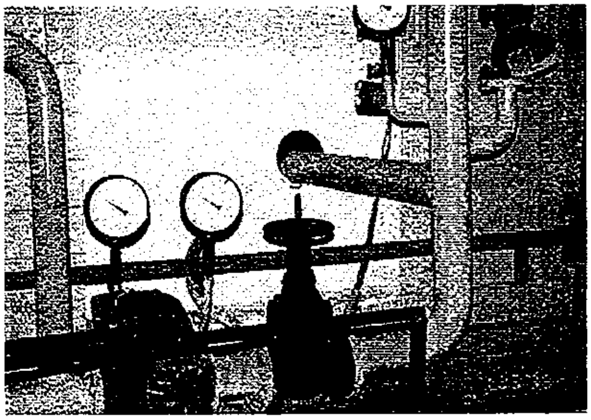

Photo 10. Main freshwater feed to plant.

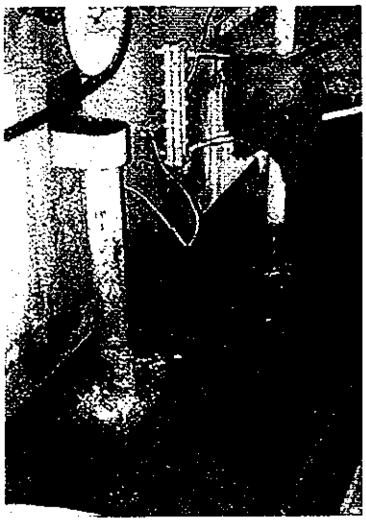

Photo 11. Bottle-washing machine drains water to the floor trough.

ANNEX B

Pre-Assessment Pollution-Prevention Questionnaire

ANNEX B

Pre-Assessment Pollution-Prevention Questionnaire

Item	Information Required	Date
I. Process Operating Characteristics and Productivity Levels		
I.1	What is the length of time of a typical operating shift (e.g., 8 hours, 16 hours, 24 hours per day, other)?	
I.2	How many operators are required per shift?	
I.3	How many hours throughout the year represent production?	
I.4	How many hours throughout the year is downtime for maintenance reasons?	
I.5	How many hours throughout the year is downtime due to seasonal business restrictions?	
I.6	What is the nameplate deign capacity of the operation (i.e., how many bottles of product is the process designed for or in terms of liters of bottled product)?	
I.7	What are total production capacities for the last 3 years (i.e., number of bottled finished product or liters product for 1998, 1997, 1996)? Give outlook production (projections) for 1999.	
I.8	List reasons for shift (production) interruption and downtimes.	
I.9	Does loss of product occur, typically how much per week or as a percentage of yearly production capacity, and what are the reasons for these losses?	
I.10	What are the raw material costs (provide an itemized list with average unit prices – e.g., for bottles, labels, stoppers, other)?	
II. Process and Product Quality Control and Assurance Characteristics		
II.1	What are typical maintenance and equipment parts replacement costs throughout a year?	
II.2	What product quality control tests are conducted and what are the frequency of these tests?	
II.3	How much off-spec product is produced in a year and why?	
II.4	Is any control charting done for product quality control parameters? If so, provide typical charts.	
II.5	Is any control charting done for process control parameters? If so, provide typical charts	
II.6	What are the parameters controlled in a production shift?	
II.7	How much operator attention is required to control the process (e.g., continuous, intermittent – provide typical percentage or fraction of shift time devoted to control)?	

III. Energy Efficiency Characteristics		
III.1	Are there pumps used in the operation? How many pumps are used and for what purposes? What type of pumps are used (e.g., centrifugal, positive displacement, metering, other)?	
III.2	List all sources of energy consumption required to run the process. For examples: Electricity consumption for bottling machines, pumps, for lighting, for ventilation of work room environment	
III.3	If pumps are used, how are flow rates metered and controlled?	
III.4	If pumps are used, what types of drives are used (variable speed or constant)?	
III.5	If pumps are used, what are the capacities of these units?	
III.6	What is the unit cost for electricity and heating?	
III.7	What energy measuring devices (if any) are used, how often and has an energy audit ever been performed?	
III.8	Are the walls of the shop area insulated? Give characteristics of construction (e.g., brick walls, stucco walls, other, and the approximate thickness of the room).	
III.9	What type of ventilation is provided in the shop area (natural, forced draft, other)?	
III.10	What are the approximate dimensions or total volume of the shop area?	
III.11	How many times in an hour is the volume of air displaced in the shop area?	
III.12	Is the air temperature of the shop area measured and is it regulated?	
IV. Environmental Management Characteristics		
IV.1	Are there any hydraulic equipment used in the operation (if so, list them)?	
IV.2	Is oil used for heating purposes? If so, what is typical consumption for a yearly production?	
IV.3	What environmental permits are there for the shop operation?	
IV.4	List all waste categories and classes of wastes. Organize the list into 3 categories: Water Discharges, Solid Waste, Air Emissions.	
IV.5	Provide waste reporting forms or a summary of the amounts of each type of waste produced per year. Provide this data for 1998, 1997, and projections for 1999.	
IV.6	Describe how wastewater is handled? Is it treated on site; is it sent to an off-site treatment facility; is it discharged directly to sewer or surface body of water?	
IV.7	Describe how solid wastes are disposed of. Are they stockpiled and staged on site? Are wastes removed to a disposal or recycling facility?	
IV.8	Is there any form of recycling in the shop operation? Describe what is done and give an estimate of the amounts of materials recycled during a year.	
IV.9	Are there any air pollution control devices used in the shop operation? What are they and are they functioning?	
IV.10	Is oil used for machine lubricating or heating purposes in the shop area?	

IV.11	Are there oil losses in the shop operation? Describe them.	
IV.12	If oil is used, how is inventory maintained? Are there above ground or underground storage tanks, or is oil stored in barrels? What are typical inventories maintained throughout a year?	
IV.13	Are there any fugitive emissions that you are aware of (for example – lost of spilled product allowed to evaporate into the work shop area)? Describe these losses and frequency of occurrence.	
IV.14	How often is the facility inspected by the oblást environmental inspectorate? When was the last inspection, and were there any citations, fines, or corrective actions?	
IV.15	Have there been any major fires or spills in the shop area within the last three years? If so, describe what happened.	

ANNEX C

Vendor Quote and Recommended Specifications for Ultra-Filtration Unit

ANNEX C

Vendor Quote and Recommended Specifications for Ultra-Filtration Unit

ZAO Membrane of Samara (telephone and fax: 0922-23-45-65) has proposed an ultra-filtration (skid-mounted modular unit) to extend the recycling efficiency of the used washing solutions discharged by the main washing machines. This solution contains mechanical impurities and oils that can be passed through a pre-filter that removes 50-micron size particles and larger. The filtered solution can be recycled through the system. The proposed unit separates the used washing solution into two flows: an ultra-filtered portion with an oil content of up to 20 mg/l that is sent from the membrane module to a consumer, and a concentrate saturated with oil products and solid particulate matter that is returned to a collection tank. The membrane elements must be periodically backflushed. The specifications and costs for the proposed unit are as follows:

Vendor Quote and Specification

Installation Model	YM-3T
Capacity (m^3/hr)	0.15
Filtration capacity (% removal of particles 50 microns and above)	99.9
Removal efficiency of oils (%)	95
Inlet pressure (bar)	3.7 - 4.5
Maximum temperature rating (°C)	50
Yearly energy requirements (kW)	3.3
Replacement of filtration elements (years)	up to 3
System warranty	1
Floorspace requirements (m^2)	8
Weight of unit (tons)	1.9
Installation costs (including value-added tax) (1,000 rubles)	96.0
Delivery time (months)	3