Report No. 12238-UA

# Ukraine
# Suggested Priorities for Environmental Protection and Natural Resource Management

(In Two Volumes) Volume I Main Report

**June 15, 1994**

Natural Resource Management Division
Country Department IV
Europe and Central Asia Region

**FOR OFFICIAL USE ONLY**





**Document of the World Bank**

# CURRENCY EQUIVALENTS AND ACRONYMS

Currency unit = Karbovanets, abbrev. krb
US$1 = 47,000 krb (as of June 15, 1994)
Rbl = 7 krb (as of June 6, 1994)

## WEIGHTS AND MEASURES

| | |
|---|---|
| b | Billion |
| bcm | billion $m^3$ |
| Bq | becquerel : decay of one nucleus per second |
| cm | centimeter |
| Ci | curie ($3.7 \times 10^{10}$ Bq) |
| GJ | Gigajoule (0.948 x 106 Btu or 238.8 x 103 kcal) |
| GW | Gigawatt |
| ha | Hectare(s) |
| kcal | Kilocalorie (3.968 Btu) |
| kg | Kilogram (2.2046 lbs) |
| $km^2$ | Square kilometer |
| m | Meter |
| $m^3$ | Cubic meter (35.3147 cubic feet) |
| mg | Milligram |
| MW | Megawatt |
| MWh | Megawatt hour (860 x 103 kcal) |
| ng | Nanogram |
| person-rem | 1 person receiving 1 rem, or 10 people receiving 0.1 rem, or 1,000 people receiving 0 ( 1 rem |
| PM10 | Particulate matter below 10 microns |
| ppm | Part per million |
| rem | Roentgen equivalent man: the amount of ionizing radiation equivalent to biological effect of one roentgen of x or gamma rays 1 rem = 1 mSv |
| Sv | Sievert (mSv = millisivert) : international measure of the biological equivalent of an absorbed dose of radiation. 1 Sv = 100 rem |
| t | Ton (metric) |
| tpa | Tons per annum |
| toe | Ton of oil equivalent (= 10 million kcal = 39.68 million Btu) |
| µg | Microgram |

## CHEMICAL COMPOUNDS AND TECHNICAL TERMS

| | |
|---|---|
| $AlF_3$ | Aluminum fluoride |
| BAP | Benzo-a-pyrene |
| BOD | Biochemical oxygen demand (BOD5 = over a 5 day period) |
| Cd | Cadmium |
| $Ce^{137}$ | Cesium 137 |
| CFCs | Chlorofluorocarbons |
| CO | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| Cu | Copper |
| Hg | Mercury |
| N | Nitrogen |
| $NO_x$ | Nitrogen oxide |
| $O_3$ | Ozone |
| ODS | Ozone Depleting Substances |
| PAH | Polycyclic aromatic hydrocarbons |
| Pb | Lead |
| pH | Logarithmic indicator of acidity or alkalinity |
| $Pu^{139}$ | Plutonium 239 |
| $SO_2$ | Sulfur dioxide |
| $Sr^{90}$ | Strontium 90 |
| TSP | Total Suspended Particles |
| VOCs | Volatile Organic Compounds |
| Zn | Zinc |

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| CAC | Command and Control |
| CEE | Central and Eastern Europe |
| DPRA | Department of Protected and Recreational Areas (MEP) |
| EC | European Community |
| EIA | Environmental Impact Assessments |
| ESP | Electrostatic Precipitators |
| FGD | Flue Gas Desulphurization |
| FSU | Former Soviet Union |
| GDP | Gross Domestic Product |
| GEF | Global Environmental Facility |
| Hydrômet | Hydrometeorological Service |
| IUCN | International Union for Conservation of Nature and Natural Resources |
| MAC | Maximum Acceptable Concentration |
| MAD | Maximum Acceptable Discharge |
| MAE | Maximum Acceptable Emissions |
| MB | Market Based |
| MEP | Ministry for Environmental Protection |
| MFO | Ministry of Forestry |
| MOA | Ministry of Agriculture |
| MOH | Ministry of Health |
| MOI | Ministry of Industry |
| NGO | Non-Governmental Organization |
| SPZ | Sanitary Protection Zone |
| UNCED | UN Conference on Environment and Development |
| WHO | World Health Organization |

# TABLE OF CONTENTS

**MAPS**



**ANNEXES**

## Acknowledgements

This study is a result of the cooperative efforts of Ukrainian and World Bank staff, aided by environmental authorities and technical experts from several countries. The task manager for the Bank was Kathleen Stephenson, and contributors included: Don Theiler, Jack Broadbent and Lars Moseholm (air quality); Erik Borset, Howard Carter, and Eugene Stakhiv (water quality and wastewater treatment); Roman Pyrih and Ray Pilcher (hazardous waste); Al Hubbard (thermal power industry); Nick Korens (chemical industry); Jean Raguin (steel industry); John Pesek (agriculture); Andrew Bond and Steve Berwick (biodiversity protection and nature reserve management); Anil Markandya (environmental economics); Jonathan Lash and Tatiana Zaharchenko (legislative and legal aspects); Tom Kearney, Ian Simm and Seth Rosen (institutional needs); Drs. Dan Hryhorczuk and Barry Levy (epidemiology and occupational health); Dr. Terry Anderson (radiation epidemiology); and Bjorn Larsen and Bilal Rahill (issues concerning international agreements). Messrs. Ron Hoffer and Tom Pace of the US Environmental Protection Agency (USEPA) kindly joined in the study missions and contributed to water and air quality sections of the report. John Palmisano provided information on market-based regulatory approaches. E & E Corporation provided additional comments on steel industry aspects. Anna Skliarenko and Galina Voitsekhovskaya (World Bank Resident Mission) provided crucial support for the team visits.

The study team would like to thank the former and current Ministers for Environmental Protection, Yuri Scherbak and Yuri Kostenko, for their kind cooperation and that of their staff in the Ministry for Environmental Protection (MEP). Special thanks go to those staff who contributed heavily to the study and participated in related site visits: Vera Davydok, Sergei Michailov, Valeriy Osyka, Galina Shimanska, Natalya Simagina, Valeriy Sirenko, and Mikola Stetsenko. Many others at the local MEP branches were extremely helpful. They include the managers and staff of the following branches: Kiev, Dnipropetrovsk, Kamiansk, Kryvyi Rih, Donetsk and surrounding communities, Mariiupil, Luhansk, Zaporizhzhia, Odessa, Lviv, Ivano-Frankivska, and Transcarpathia. Without the contribution of these people, this study would not have been possible. The study team would also like to thank Andriy Demydenko, Director, International Department, and his staff and Vasyl Kostitsky, former Deputy Minister, for their assistance during the study.

Staff of various other agencies also participated and were very helpful: the Ministry of Health (especially Drs. Serdyuk, Antipinko and Prodanczuk); the Ministry of Industry (especially Mr. Rudoy); the State Committee on Geology (especially Messrs. Havrilenko and Yakolev); the State Committee on Water Resources; and the Ministry of Electric Power. The study team also would like to express its appreciation to the managers and staff of numerous industrial plants and municipal Vodokanals, who took time from their busy schedules to cooperate in the study.

The chapter on the impact of Chernobyl was undertaken with the collaboration of MinChernobyl, and special thanks go to Minister Georgy Gotovchits, First Deputy Minister Boris Prister and Alex Stoloroff, International Department.

A conference to discuss the priorities for environmental protection in Ukraine outlined in this report was held in Kiev in November 1993. Andriy Galyapa, Director, Scientific and Technical Department, organized the conference for MEP under the general direction of Yuriy Ruban, First Deputy Minister. Their contribution is also very much appreciated.

## Priorities for Pollution Abatement

### Priority Industrial Cities or Areas with Serious Pollution Problems

| Air Pollution | Industrial Sources |
|---|---|
| Kostiantynivka | Secondary lead/zinc smelter |
| Communities around Donetsk * | Steel, chemical, coal industries |
| Mariiupil | Steel and coking plants |
| Zaporizhzhia | Various industrial plants, including steel plants and an aluminum smelter |
| Kryvyi Rih | Steel and iron ore industries |
| Kamiansk (Dniprodzerzhinsk) | Metallurgical and chemical industries |
| Dnipropetrovsk | Various industrial plants |
| Odessa * | Refining, chemical and port activities |
| Communities in Luhansk oblast * | Coal and chemical industries |

* Indicates scattered household/small industrial coal use

| Water Pollution (Sites of industrial or serious municipal discharges) | Affected Waterbody |
|---|---|
| Zaporizhzhia | Dnieper River |
| Odessa | Black Sea |
| Mariiupil | Azov Sea |
| Dnipropetrovsk | Dnieper River |
| Kamiansk (Dniprodzerzhinsk) | Dnieper River |
| Kryvyi Rih & nearby mining sites | Inhulets River |
| Lysychansk-Siverskodonetsk area | Siverskodonets River |
| Luhansk: coal mining areas | Siverskodonets River |
| Sevastopil | Black Sea |
| Mykolaiv (Nicolayev) | Dnieper River |

### Hazardous Waste Management--Priority Areas

Chernobyl: disposition of sarcophagus; food quality control; low cost remediation

Dnipropetrvosk, Luhansk and Donetsk Oblasts

Other potential sites at scattered military and chemical plants

### Other Sites of Concern (some near areas of natural value or sensitive waterbodies)

High pressure ammonia pipeline across southern Ukraine to Odessa (potential hazard)

Various other cities along Black and Azov Seas (e.g.Yalta) with insufficient wastewater treatment

Various cities in western Ukraine with overloaded wastewater treatment plants, refineries and chemical plants discharging into the northern Buh (tributary of Vistula), Dniester and Prut Rivers, sources of transboundary water pollution.

### Significant Non-Point Sources

| Air Pollution | Water Pollution |
|---|---|
| Small boilers or stoves (especially coal fired) | Erosion of soil and water runoff |
| Automobile transportation (reduced now, but a potential future problem) | Chemical/pesticide spills during transport or storage |

# UKRAINE ENVIRONMENTAL STRATEGY STUDY
# EXECUTIVE SUMMARY

## Introduction

1. Ukraine's large industrial and energy base is the source of serious pollution problems in several parts of the country. This is most vividly exemplified by the smoke belching steeltowns of southern and southeastern Ukraine. In the drive to meet production goals in the past, and absent competitive pressures or market signals, resources have been wasted, modernization has been delayed, and very little investment funds have been allocated through the planning system to install or upgrade pollution controls. The heavy industrial pollution in some cities is surely a hazard to the health and productivity of workers and people in surrounding communities. The emphasis of the past on supply, rather than on more efficient use of resources, has also put pressure on agricultural lands and other natural resources. Yet Ukraine remains a country of rolling agricultural landscape, wooded hills and gentle wetlands, still rich agricultural base--and many natural and cultural heritages--should be protected for future generations.

2. Ukraine is now going through a difficult economic transition, suffering high inflation and declines in GDP. Over time, macroeconomic policy changes and economic reform should bring structural changes, accountability at the enterprise level, and opportunities for modernization, which in turn should stimulate economic growth and at the same time ease environmental pressures. But those changes will take time to realize.

3. Major investments in modernization and end-of-pipe pollution control are generally unaffordable right now. Practically speaking, most environmental investments will be funded through enterprises' internal generation of funds or financing capacity and through adequate user fees for energy supply and municipal services; it is likely that there will be very limited public investment in pollution control. Those enterprises offering good prospects for joint ventures (giving them a source of equity) or which are prospering on their own are likely to be the ones that will be able to afford most quickly needed investments in modern processes or "end of pipe" pollution control. Similarly, communities which are able and willing to pay for improved municipal services are more likely to be the ones which will enjoy early investments in better water and wastewater treatment. This argues for policies which encourage private domestic and foreign investment as quickly as possible, in order to stimulate new, profitable economic activities.

4. In view of severe resource constraints in the economy, what steps can be taken in the short to medium term to reduce environmental problems and pressures on natural resources? The following principles are suggested in setting priorities for environmental protection over that time frame:

- As an immediate measure, encourage low cost, short term actions in individual industrial and municipal plants to improve safety, conserve water and energy, and reduce pollution in the workplace caused by sloppy housekeeping and insufficient maintenance. In particular, reductions in air pollution in some plants is critical.

- Build up the institutional capacity and regulatory infrastructure necessary for practical and effective environmental management, in parallel with the economic transition and privatization, as investors will seek a stable, credible regulatory framework. In so

doing, establish reasonable environmental standards and plan a phase-in period to meet environmental targets, rather than trying to achieve all targets at once.

- Focus regulatory efforts (and campaigns to introduce short term action plans) on those industries and cities where occupational health problems are critical or where the health of nearby communities is seriously affected by hazardous pollution.

- Encourage projects which have economic payoffs while also reducing environmental pressures (e.g. energy conservation). Also, encourage more substantial environmental investments over the medium term in areas of high economic or touristic value, where there are opportunities for revenue generation and thus the ability to pay for those investments.

- Protect important natural or agricultural areas that could suffer severe or irreversible damage, if steps are not taken soon, or where preventive measures are especially cost effective.

5. Environmental authorities will need to be practical; inevitably, they will face conflicts between what is "do-able" and what may be a desired goal or priority in terms of the extent of pollution. A balanced, two track strategy is suggested: (i) trying to achieve some pollution reductions in the short to medium term in the most polluting plants, some of which are the weakest in terms of economic outlook; and (ii) moving ahead with accelerated pollution abatement plans in plants or cities which can afford more rapid progress. In many cases, environmental authorities will need to think in terms of promoting small, low cost interventions over the next five years, beginning with pilot programs.

6. **Introduction of Short Term Action Plans.** One of the major themes of this study is that, despite the constraints on resources, much can still be accomplished. Problems of worker safety or pollution in industrial plants are not solely a result of technology. They occur also because of lack of attention to safety, poor housekeeping and maintenance, and general lack of supervision. There are opportunities to take quite inexpensive actions at the plant level now which could improve safety and reduce pollution, particularly in the workplace itself. They include:

- introduction of better safety procedures and equipment to reduce the high level of industrial accidents;

- aggressive cleaning, housekeeping, and attention to materials handling and storage to reduce fugitive emissions and accidental spills;

- repair and maintenance of process and pollution control equipment to reduce leaks;

- attention to operating performance generally, including utilities;

- installation of some minimum instrumentation and controls; and

- attention to utilization of excess energy and conservation of water and other inputs.

7. Such short-term action plans could be included in regulatory permits issued by the Ministry for Environmental Protection (MEP). For the longer term, environmental authorities will need to negotiate realistic compliance schedules which anticipate larger environmental improvements as other capital investments are made.

**Environmental Management at Oblast and Municipal Levels**

8. Many of the most serious pollution problems are centered in urban areas; thus the bulk of responsibility for pollution abatement is likely to fall on municipal and oblast authorities and their respective environmental branches. Particularly in those cities reliant on heavy industry, identifying opportunities for business diversification and area development (including generating recreational or tourism revenue in those areas with such potential) will be essential in building a new economic base, which will eventually generate resources for pollution abatement among other needs. In addition, efforts at the national level to begin to restructure some of the larger state-owned industries would help in clarifying the potential for long term viability. But, as other countries have experienced, this will take considerable time, especially since many communities depend on major industrial plants or operations for much of their employment. In the interim, oblast and municipal authorities, including environmental authorities, should try to introduce programs to identify and implement short term, low cost actions plans in individual plants to reduce pollution in the workplace and immediate community, as described above in para. 6.

9. **Urban Air Pollution.** There are eight cities in Ukraine that merit designation as "priority air pollution areas." Visits to these cities indicate serious ambient pollution--primarily from high particulate concentrations, in association with various hazardous pollutants. A first step would be to introduce short term action plans to reduce pollution and to strengthen emergency response programs (during extreme episodes). Second, air quality management plans should be developed, setting out cost effective strategies to reduce pollution in each of these cities over the medium to long term. In doing so, it will be important to have improved baseline inventories of emissions, a better understanding of ambient conditions and sources (including smaller, dispersed sources) and information on the cost of different abatement options. In this respect, environmental authorities would benefit from exposure to source testing, emission inventory methods, and practical dispersion or receptor modeling techniques used in other countries.

10. It would be worthwhile to start with pilot programs in one or two cities, including installation in those cities of some improved monitoring and testing equipment. Candidates for pilot programs would be: Zaporizhzhia; Mariiupil; the Donetsk area, where various communities are located in a regional airshed; Kryvyi Rih; Dnipropetrovsk and nearby Kamiansk; and Odessa. Many of these same cities are also priorities for better water quality management. A special assessment (including blood lead testing) is recommended at Kostiantynivka because of suspected high lead emissions and soil deposition there.

11. **Longer Term Issues Concerning Transport.** Vehicular emissions are reportedly significant in several cities, especially in Kiev and Kharkiv, although emissions have fallen in recent years because of higher prices and shortages of gasoline. Transport can be a significant source of ambient concentrations of various pollutants (lead, VOCs, SOx and NOx). As traffic levels grow over the longer term, it would be worthwhile to start planning ways to minimize transport emissions, beginning with a program to improve combustion and reduce emissions from the public transport fleet, strengthen inspection programs for other vehicles, and improve management of traffic flows. Full-scale introduction

of unleaded gasoline and requisite changes in cars are an expensive proposition. Such a program should be undertaken over the longer term, but planning for it could start soon, particularly in the context of anticipated refinery restructuring and modernization. Reductions in the sulfur content of oil products would also be a beneficial outcome of refinery rationalization.

12. **Municipal Water and Wastewater Treatment.** Municipal utilities for water and sewage treatment are good candidates for economic reform to put them on a commercial basis with operating and financial autonomy, including the ability to set "economic" rates for water and wastewater treatment which reflect the true costs of these operations and create a self-financing capability.

13. A survey of large industrial plants and municipal sewage plants suggests that most have treatment facilities, but that they are overloaded and working above capacity; considerable untreated water is inevitably discharged into rivers. As a result, water is heavily chlorinated at treatment plants to assure a safe drinking water supply. It appears that many industries do not pretreat their chemical and heavy metal wastes before discharging them either directly into rivers or into municipal sewers, in the latter case affecting treatment and disposal of the resulting sludge. Charges for wastewater flowing into municipal sewers should be based not only on volume but also on the nature and strength of pollutants in the wastewater to encourage appropriate pretreatment.

14. Various steps would help improve the effectiveness of water and wastewater treatment facilities and economize in regard to water use and sludge disposal. Introduction of better instrumentation and controls would improve operations and identify areas of concern. Wider and more effective use of anaerobic digestion processes could be introduced, including use of the methane produced from this process for electricity generation to meet plant needs. Mechanical dewatering of sludge could reduce the volume by perhaps 50 percent. Most water treatment plants would benefit from water leakage control programs to bring under control water losses from the distribution system. Relatively low cost measures to improve the efficiency of filtration (increasing the volume of water handled) and reduce backwash effluents should be introduced as soon as possible.

15. **Municipal Waste Management.** Municipal waste management could also be improved at relatively low cost. The bulk of waste disposed off-site goes to sanitary-industrial landfills, where wastes are mixed together. Lack of appropriate equipment, such as bulldozers, dump trucks and compactors, means sanitary practices are not always observed. The wastes are often dumped in unprepared, unconfined areas, which has led to concern about contamination of local surface waters and groundwater. Separation of wastes and improved management of landfills are important first steps. Also, tipping fees should be strengthened. Programs to encourage the recycling of hazardous and solid waste could also be introduced at local levels.

## General Water Quality Issues

16. **The Dnieper River.** About 70 percent of the population depends on the Dnieper for water supplies. Ironically, though it is difficult to obtain an exact picture of the ambient water quality of the Dnieper. Some of the data do not suggest a critical water quality problem in the mainstream of the river, perhaps because of its high volume and assimilative capacity, or perhaps because use of older monitoring and lab equipment is not yielding accurate results. There are reasons for serious concern over water pollution in the southern segments of the river because of the concentration of industrial and municipal

activities and the high volume of wastewater discharges there. The most critical areas appear to be stretches of the river near the cities of Dnipropetrovsk, Kamiansk, and Zaporizhzhia.

17. External donor support should be sought for a baseline survey of water quality in the Dnieper river, using modern monitoring equipment, to provide a picture of the state of the river and to train local experts in modern monitoring and analytical equipment and techniques. Greater coordination is also needed between river management and environmental authorities to integrate the two objectives of meeting water use requirements and preserving water quality.

18. **Other Rivers of Concern.** Among other rivers, two are frequently cited as having severe pollution problems: the Siverskodonets and Inhulets Rivers. The Siverskodonets River is polluted by chemical and mining effluents from Luhansk Oblast. About one million people use the water along it, including people in the Rostov region of Russia. The Inhulets River, which flows into the Dnieper, is reportedly contaminated with heavy metals and salts from the discharges of iron ore mines and metallurgical industries in Kryvyi Rih. Several rivers in western Ukraine also suffer pollution from discharge by chemical plants, refineries and municipal plants and cause transboundary pollution.

19. **Groundwater Pollution.** Groundwater is a source of drinking water for about 15 percent of the population. Again, there are gaps in data about water quality. Reported problems come from major chemical, metallurgical and mining activities. Rural areas also suffer problems as a result of poor sanitary practices and poor waste management related to livestock production.

20. **Problems of the Black and Azov Seas.** There is overwhelming evidence that major parts of the northwest shelf of the Black Sea and the Sea of Azov are critically eutrophic. Both have suffered drastic declines of formerly rich fisheries, especially of high value species. There are several growing problems: heavy nutrient flows and other discharges from the rivers feeding into it, municipal and industrial discharges from coastal cities, pollution from heavy shipping traffic, illegal dumping of hazardous waste, and overfishing. The tourism potential of the region is hurt because of degradation of the water near popular beaches and outbreaks of salmonella and enteric viruses in some coastal cities. Cities along the coast which are priorities for technical assistance and investments to improve wastewater and water treatment and coastal zone management are Odessa, Sevastopil, and Mariiupil. Yalta is also a high ranking candidate because of its recreational and tourism value.

## Issues Concerning Hazardous Waste Management at the National Level

21. At the present time, no agency seems to be inventorying and regulating hazardous waste; in fact, there is not much distinction between hazardous and other solid waste. It is important to begin inventorying and prioritizing sites based on the health impact on workers and the surrounding communities. MEP should take up this responsibility. Solutions should emphasize, as far as possible, low cost mitigation or containment at priority sites. Full clean up of all sites will take a long time and can be very expensive, as experience in other countries demonstrates. Legislation could provide guidance on procedures for prioritization of sites, the extent of clean up, reporting requirements, and rules for storage and transport of hazardous materials and waste.

**Environmental Management and Regulatory Policy**

22. **Ministry for Environmental Protection (MEP).** There is already significant environmental infrastructure in Ukraine, and MEP has many motivated staff at local and central offices. But the Ministry is underfunded and understaffed, both at national and local levels, in relation to its responsibilities and the magnitude of problems. In the past, the owner-regulator conflict within a centrally planned economy and the limited public accountability enjoyed in the FSU hampered the development of a strong environmental regulatory capability. MEP was also isolated from regulatory techniques which have developed in the last 10-15 years in other countries outside the FSU. It will take time and more resources to build up expertise in managerial and technical aspects of regulatory programs. MEP staff would benefit from greater exposure to regulatory approaches in other countries, including: site evaluation and inspection techniques, technologies and cross media issues in specific industries, cost-benefit analysis, public participation techniques, and modern natural resource management approaches.

23. **Environmental Legislation.** A number of new environmental laws have been introduced in the last two years, including a national environmental law, but they tend to be overly declarative, lacking implementation mechanisms. MEP's small legal staff is overwhelmed with the volume of legislative initiatives. They would benefit from the assistance of a group of external advisers, who could periodically review and comment on legislation and offer comparative approaches. It would also be best to take more time and draft fewer, more specific pieces of legislation, rather than rushing to put forward an array of legislation which is overly declarative.

24. **Current Regulatory Programs for Air and Water.** Current regulatory policy in Ukraine is based on an array of ambient standards for air, water and soil. Their number, complexity and, in some cases, strictness reflect an academic rather than practical approach to environmental management. The standards are used to set plant emission or discharge limits, via modeling exercises which try to calculate the contribution to ambient pollution of the individual source. In some cases, the imposition of strict standards pushes plants to consider the most advanced technologies, rather than more practical and affordable investments. Also, available monitoring equipment is unable to measure accurately many of the pollutants or constituent parameters which are regulated. As a whole, this regulatory system is complex to administer and not very cost effective.

25. MEP should reconsider and reorganize some elements of its existing regulatory infrastructure. Suggested steps include:

- revising and limiting the number of standards to those which are most critical and which can be realistically monitored and enforced;

- augmenting the present system by setting technology-based standards for hazardous air pollutants and minimum technology-based standards for water and wastewater treatment plants, but allowing an appropriate phase-in period;

- integrating and strengthening existing monitoring and analytical activities, now scattered among various institutions; then selectively updating monitoring, testing and lab equipment[1];

- improving evaluatory, site characterization, permitting and inspection techniques; and

- establishing better information systems so that data on emissions and discharges and on permits can be accessed and exchanged between the oblasts and the center.

26. **Enforcement.** Enforcement authority has been very weak in the past. MEP needs greater administrative and rulemaking authority to implement legislation. The kind of flexible enforcement authority MEP needs will require a graduated spectrum of enforcement tools that can be tailored to the circumstances of each case. These include: (i) the authority to place conditions on individual permits, violations of which can be sanctioned independently from violation of the permit limits; (ii) authority to negotiate detailed compliance schedules which outline a realistic path to compliance and provide MEP with incremental stages at which to monitor progress and apply sanctions; and (iii) multiple factor penalty calculations which allow fines and other penalties to be adjusted upward or downward in appropriate cases. The combination of these tools avoids saddling MEP with an all-or-nothing decision between ignoring the violation or threatening a high fine or plant closure that will likely be overturned because of economic hardship. MEP's branches will need to work with industry to set goals and compliance schedules, taking into consideration the economic transition and the need to phase in compliance, but with the understanding that substantial penalties will be incurred for non-compliance once a schedule is agreed. Compliance agreements should be open and available to the public, along with later information on any problems of non-compliance.

27. In particular, MEP needs to provide more resources and training to inspection teams at oblast and municipal levels, where most enforcement activities will take place. Building a sound regulatory framework and enhancing the skills of regulators, along with encouraging environmental education and public participation, will help to build public and political consensus for stronger enforcement. Improved legal recourse is also important. The judiciary has never played an important role in Ukraine, and the court system is now in crisis; hence, it will take time to build up a competent legal system.

28. **The Pollution Fee System.** Ukraine relies on a pollution fee system as its primary enforcement instrument. It is well to keep in mind, though, that rarely, if ever, have pollution charge systems in themselves motivated enterprises to undertake pollution control. The reason is that fees are generally not set high enough to do so, often out of fear of the economic burden on enterprises. Pollution fee programs in most countries are used to generate revenue for environmental agencies to fund their regulatory activities. This would be a more realistic objective for Ukraine's pollution fee system. It is strongly recommended, therefore, that a larger percentage of the fee revenue from the current pollution fee system be ploughed back into the regulatory activities of MEP, primarily at oblast and municipal levels where most of the regulatory and enforcement activities will take place.

---

1/ For air quality, upgrading of particulate monitors and improving siting is the highest priority; for water quality analysis, it is developing the monitoring and analytical capability to measure important micropollutants for which high concentrations could be expected (e.g. expanding monitoring to include biological indicators);

29. Much of the pollution fee revenue in Ukraine currently goes into local ecology funds, but no specific criteria are set for the use of these resources. These funds will remain small, particularly if more of fee revenue goes into strengthening regulatory activities; the local funds should be targeted to support local abatement actions which are achievable in a short time frame (e.g. supporting short term action plans) rather than being committed, piecemeal, to large projects with long implementation periods.

30. Over time, the pollution fee system could be strengthened. The number of pollutants should be reduced to simplify the program and make it more practical to administer. The level of fees should then be raised on the smaller number of pollutants and adjusted periodically for inflation. Penalties should be more severe to remove the benefit from exceeding limits. There are also many loopholes in the recently enacted system, by which firms are exempted from fees and fines, weakening the program generally. In any case, the pollution fee system will be a more effective instrument as firms and plants become more independent and accountable.

31. **Other Market Based Approaches.** Other market-based approaches beyond pollution fees (e.g. permit trading) might be considered over the longer term after the regulatory infrastructure is strengthened and property rights become clearer. Also, multilateral permit trading or offset programs may offer potential in addressing transboundary or global pollution.

32. **Environmental Impact Assessments (EIA).** The recently proposed legislation on ecological expertise (similar to EIA used in other countries) appears overly ambitious. It calls for environmental assessments on an exhaustive range of projects and activities. Coverage is so broad that it is impossible to enforce. As a comparison, the EIA law in the US requires an assessment only of "major" actions of the national government that "significantly affect the environment." A more practical approach in Ukraine would be to require complete expert assessment of major projects, but only a statement of expected effects for minor projects.

33. **Proposed Ecological Bank.** Caution is suggested in setting up an Ecological Bank, as experience in other countries indicates that banks which are too narrowly directed or which lack staff with experience in credit risk evaluation can end up having serious portfolio problems. Introducing regional or municipal development banks would present broader opportunities for lending and more diversification of risk. In any case, such banks should only lend to commercial entities which can demonstrate a capacity to pay commercial interest rates and repay the loan.

34. **Public Participation.** Environmental NGOs have been active politically ever since public outrage over the Chernobyl accident. Article 9 of the 1991 national environmental law establishes a public right to participate in decisions relating to legislation, program implementation, environmental assessment, and siting. But the law does not specify what participation means or how it is to take place. A more recent information act also promises broad access to environmental data, but the sweep of the law is so broad that it may not be practical. MEP should seek specific authority to develop rules and mechanisms for public information and participation in regulatory processes.

**Privatization and Environmental Considerations**

35. Environmental considerations are a factor in privatization and foreign investment. Investors will want to know what obligations they have in regard to past and future environmental control. Some

clarification of responsibility for past pollution is crucial in order to avoid reduced price offers because of uncertain future liabilities. Yet it is important also not to delay privatization or create too large an administrative burden by requiring extensive environmental reviews for most privatization transactions.

36. In a limited number of industries, where the most hazardous pollution problems may exist, the government might consider partial indemnification of investors (domestic and foreign) for state-mandated clean up of contaminated sites resulting from past pollution and for any third party liability which may arise, based on an application by the investor within a specified time frame. The intent would be to negotiate an arrangement whereby the investor agrees to take relatively low cost measures to contain dangerous contamination on site and to relieve the worker environment, while avoiding being saddled with the cost of an expensive full clean up program. This would balance the interests of the state to address immediate pollution problems having an impact on health and, at the same time, to create certainty for investors and maximize the proceeds from privatization. Baseline surveys through environmental audits would need to be undertaken in such cases, although screening procedures could be used to dictate the extent of the audit necessary.

37. It is recommended that MEP work with the privatization authorities to establish a process for achieving some level of baseline knowledge for sites where health hazards or liabilities may be a major issue or risk in privatization. Some CEE countries are requiring major enterprises to describe their environmental problems and compliance record in their privatization plans; in Poland, a cross-ministerial environmental unit has been established within the Ministry of Privatization. There are screening exercises to narrow down the number of facilities that might require auditing and limit the number of cases where extensive auditing might be necessary. Such a process, if well-designed, might also help the country establish national priorities and an action plan in terms of clean up or remediation. Also helpful might be the establishment of a pooled clean up fund, to which a small percentage of the proceeds from privatization transactions would go, in order to finance mitigation programs at priority sites.

38. In planning and implementing land privatization, regulations should be included to improve siting of activities and general land use planning. Consultations with MEP and its local branches should be encouraged during this process.

39. **Environmental Audits.** Environmental audits are often undertaken in market economies to evaluate environmental problems at plants which are candidates for purchase, and they are used selectively in privatization and foreign investment transactions in Eastern Europe. The introduction of environmental and operational audits in Ukraine would help in establishing baseline information for privatization activities, identifying short term action plans for individual plants, and as part of business evaluations and restructuring analyses. Initially assisted by external companies familiar with such audits, Ukrainian engineers could learn how to conduct these evaluations themselves and build a domestic consulting capability in this area.

**Problems of Key Heavy Industries**

40. **Steel Industry.** This industry is an example of the relationship between older process technology and problems of product quality, overusage of energy, and pollution. About 60 percent of production is by open hearth furnace, an antiquated technology which is costlier to operate, less efficient, and generally more polluting than the more modern basic oxygen furnace (BOF). Use of electric arc

furnaces and scrap iron is very low. Continuous casting, an energy saving technology, represents about 10 percent of steel production, compared to almost 90 percent in the EC. The steel industry is the largest air polluter (in terms of gross emissions), and heavy fugitive emissions are common in the workplace. The industry's 16 merchant coke plants are notable for generally high door leakages (20-40 percent) and emissions which are known to be carcinogenic and a danger to workers. The industry's products are oriented to heavier, non-flat production, rather than lighter, flat products which represent the growth area in world demand although for some time there are likely to be niches in the world market for its relatively cheap, lower quality products. The steel industry is a prime candidate for restructuring and consolidation, in view of changing factor prices and market conditions, paving the way for concentration of scarce resources in modernization of the most competitive plants.

41. **Chemical Industry.** The chemical industry is more diverse, and its process technologies, on average, are not as old as those of the steel industry. Some petrochemical plants, however, are still largely based on coke chemicals, rather than on petroleum-based feedstocks, which is less efficient and more polluting. Products are primarily bulk or intermediate chemicals. The competitiveness of many plants will depend on development of consumer products, where most of demand growth is expected. In those plants visited, much of the energy inefficiency and pollution seemed related to the extensive size of plants (and waste generated), the design and operation of utility systems, and poor housekeeping and maintenance rather than to technologies. For example, problems with liquid hazardous wastes can be traced to disposal practices and to poor housekeeping (e.g. spills and leaks) in chemical plants.

42. Little information was available during this study on the high pressure ammonia pipeline (pressurized at 80 atmospheres) which originates in Russia, crosses the southern half of Ukraine (fed along the way by various ammonia plants), and terminates at Odessa, where much of the ammonia is exported. This pipeline is a potential hazard because the ammonia is at high pressure, and the pipeline crosses areas of uneven terrain, due to land subsidence from mining activities. Leaks in the pipeline could create a life-threatening chemical cloud. It is an early candidate for an operating and safety review.

43. **Coal and Other Mining Industries.** Underground coal mining is the worst industry in terms of occupational health, with high death rates due to in-mine accidents, the result of hazardous methods of mining in some of the mines and lack of sound safety procedures. Steps to improve safety practices should be initiated immediately. Mining in general has contributed to other serious environmental problems as well: (a) vast areas of perhaps fertile land covered with waste rock and tailings dumps; (b) surface and ground water pollution from salts and, in the iron ore region, heavy metals as well; and (c) waste of large quantities of groundwater from mine dewatering (a necessity as mines go deeper). Both the iron ore and coal produced in Ukraine have problems with quality, reflecting various factors: the lower quality reserves now being exploited, the type of equipment employed, and insufficient beneficiation or blending practices employed. Rationalization of these industries--to concentrate on the most economic reserves and to improve product quality through better beneficiation--would be expected to lead to both efficiency gains in operations and reductions in pollution.

## Specific Issues in the Electric Power Industry

44. **Pollution from Thermal Power Stations.** Thermal power plants are the second largest source of gross air emissions, after metallurgy. However, stack heights are generally very high. This suggests that emissions from power plants may not be the primary source of local ambient air pollution, although

better monitoring and site characterization would provide a clearer picture at individual sites. In general, installed particulate control equipment is performing below world standards; training and better operating and maintenance procedures would offer some improvements. Fuel quality tends to be very poor: the coal supplied is often a washer waste with high ash and sulfur; high sulfur heavy fuel oil is also used. Plant managers should become more aggressive in fuel acquisition to assure they receive a blend of coals which meet the requirements of boilers and pollution control equipment. The economics of washing more steam coal should also be evaluated. Introduction of monitors to aid better furnace operation (e.g. combustion analyzers) is strongly recommended. A desirable system-wide measure would be improved system planning to reduce the extensive diurnal plant cycling which is hard on boilers and disturbs the combustion process, releasing hazardous emissions associated with incomplete combustion.

45. Electric power authorities are planning a major rehabilitation of existing thermal plants over the next 10 years. An important strategic question is the extent to which they should put scarce resources into expensive $SO_2$ and NOx control. Increasingly strict $SO_2$ and NOx controls are being mandated in the EC, Japan and US, but these are countries which have already substantially reduced particulate and hazardous emissions and generally can afford to move now to more rigorous control of other pollutants. In an economy where resources are very limited, investments in costly $SO_2$ scrubbers are not likely to be a priority. Other opportunities for lower cost $SO_2$ reductions through other sectors (e.g. reduction of sulfur levels in oil products) and energy conservation should be explored first. Also, lower cost technologies for SOx and NOx reductions warrant further investigation; for example, some plants already have low NOx burners, but they require technical assistance to improve them

46. **Nuclear Safety.** Retirement of remaining units at Chernobyl by the end of 1993 will remove all RBMK units, considered unsafe in design, from Ukraine's power system. A joint IEA-Bank study undertook power demand estimates and concluded that closing the remaining units at Chernobyl poses no threat of capacity shortages within the next seven years under most reasonable scenarios. Closing those units will be an important step for nuclear safety. The remaining nuclear units, based on later designs, still have safety deficiencies, particularly in fire prevention and protection and in operational procedures and the general safety culture among operating personnel. One of the most important elements in determining any future expansion of nuclear power in Ukraine (e.g. completing construction of three unfinished units) will be a demonstrated improvement in the safety culture at existing plants. Steps to improve safety are being taken with the support of bilateral aid and CEC assistance. However, safety upgrading will also involve significant investment costs over the next 10 years.

47. Building a credible nuclear regulatory capability is also critical. More resources should go to the State Committee of Ukraine for Nuclear and Radiation Safety (SCUNRS) to enable it to take up full responsibility for regulation. MEP has a division concerned with nuclear safety, but it is unclear how its role will be differentiated from that of SCUNRS.

**Priorities Concerning the Chernobyl Accident**

48. The high amount of radioactive debris in or near the destroyed unit 4 will remain a burden and a hazard for a long time. The priority now is to understand better the reported problems with the enclosure around unit 4, in order to address any potential hazards as cost effectively as possible. Any full clean up of the 30 km zone would be so prohibitively expensive that it is not practical. Proper containment of waste, inside and outside the 30 km zone, is the most cost effective approach at this time.

49. Showing up six to seven years after this tragic accident is an increase in thyroid cancer in children who were exposed to high doses of radioactive iodine in the first few days or week after the accident. Increased incidence of other cancers related to radiation exposure will probably not be significant enough to detect or isolate from the average incidence of cancer in the population, the one exception being leukemia in children who received whole body doses of radiation in the range of 50 rem. The background health problems in Ukraine, indicated by reduced life spans relative to people in many other industrialized countries, are more threatening to the vast majority of the population. Nonetheless, Chernobyl is cited as the cause of a variety of health disorders in the population, and those reports cause considerable emotional and psychological stress among the population.

50. The public needs greater information about background radiation, radon levels in the country (a major source of background radiation), and established health risks from radiation exposure. Introduction of several controlled studies to evaluate the health impacts from Chernobyl, in collaboration with external health experts familiar with modern epidemiological techniques, would help to clarify the situation and provide feedback to local health experts. Such studies could pave the way for better information to the public and to policymakers struggling to allocate scarce funds. The budgetary burden attributable to Chernobyl is large and raises questions of affordability in view of the current economic situation. Benefits for victims of Chernobyl have not been bestowed according to health criteria, and some benefit categories could increase over time as more claims of health impacts are made.

51. Most important in reducing any further health impact is to maintain good controls on food production to avoid any uptake through the food chain. Quality assurance procedures in food control should be checked regularly, perhaps with external assistance periodically.

**Environmental Pressures in Agriculture and Forestry**

52. Ukraine has good arable land and generally rich soils. The principal environmental concern in agriculture is soil erosion which causes runoff of nutrients and pesticides into surface waters and is a common non-point source of water pollution. Introduction of minimum tillage practices, along with lighter, more specialized equipment, would help to reduce erosion. Contrary to some reports, unit fertilizer use is not high in Ukraine relative to many European countries. Pesticide use is not excessive either, but there are problems with applicator equipment and applications may be uneven in some areas. Also, better management of transport and storage would reduce accidental spills, which may be the biggest concern in regard to pesticide use. Naturally, farmers are generally conservative about adopting new practices. To promote change, good agricultural extension services and demonstrations are essential.

53. Livestock management, both large-scale and informal, are point sources of water pollution. Assuming private or individual agricultural activities expand as reforms are introduced, the pressures could become worse if livestock management techniques are not improved. A public information campaign to improve sanitary practices and waste disposal and storage in rural areas, along with the authorization of stronger fines, should help to prevent or reduce groundwater pollution.

54. While the survey of forestry operations in this study was limited, there is evidence that the sector suffers from poor planning and siting of harvest operations which may be damaging the growing stock and soil. Harvest operations witnessed during the study did not avoid watercourses and tended to compact the soil; they suffered from the disadvantage of using "whole log" extraction equipment designed for low ground pressure, ruling out the ability to cut logs near harvest sites. Still, with careful planning

it should be possible to avoid soil disruption. US and Australia, for example, have strict controls on when (and under what weather conditions) harvesting can take place.

**Protected Areas and Biodiversity**

55. Protected reserves and parks in Ukraine currently represent less than 3 percent of the land area, but include some unique places: the Carpathians (unique beech forests), Ascanya-Nova (steppe region), and the Danube Delta and other wetlands of the Black Sea. MEP has oversight responsibilities for the reserves, but day-to-day management and funding lies with six other Ministries and three agencies, which have varying interests and operations. Responsibility for protected areas should be consolidated under MEP, along with claims to more of the existing budgetary support, in order to focus on conservation and introduce modern reserve/park management techniques. Developing ecotourism and other sources of revenue (visitor fees and concessions) will help in supplementing the limited available funding.

56. The network of protected areas is limited and, alone, cannot maintain the range and extent of habitats required for the continuation of free-living populations of flora and fauna. Cooperative activities in forestry and agriculture are essential to maintain wildlife habitats. Ukrainian wildlife biologists and forestry professionals are aware of multiple use planning and conservation biology, but have not yet incorporated them into training or practice. Foresters are the largest managers of natural resources; therefore, conservation measures to protect habitats for plants and wildlife must be practiced on managed as well as protected areas. Another recommended area of emphasis is to assist communities near reserves to make the land that they use as productive as possible, avoiding pressures on the reserves themselves.

**Business Opportunities in the Environmental Sector**

57. More attention to energy or water conservation and environmental activities could in fact stimulate new businesses, for example, in manufacturing energy efficient equipment or controls, equipment to improve water conservation and treatment, pollution control equipment in a variety of industries, and lighter, specialized farm and forestry equipment. Such opportunities should be explored aggressively. Attracting licensing arrangements or joint ventures with other industrialized countries would be important to create access to modern designs and technologies.

**Responsibility for International Agreements**

58. Ukraine is a signatory to various international environmental conventions. With so many domestic priorities, MEP has few resources or staff to devote to implementation of these agreements. As far as possible, it needs to identify "win-win" strategies where cost effective actions to address domestic priorities also contribute to international obligations. The international community should support such strategies also.

**Recommended Actions Over the Short to Medium Term**

59. Recommendations for the short to medium term are presented in Chapter X. Some key priorities are mentioned here:

- **Short Term Action Plans**. The most important recommendations for achieving reductions in pollution over the short to medium term are those which focus on short term, low cost actions which can be taken at the municipal level or at individual state enterprises to address safety hazards, air and water pollution and waste management problems. Introduction of such plans could begin with pilot programs in a few key cities. Use of operational/environmental audits to identify short term action plans at individual plants is an important tool. Securing foreign technical assistance to help develop a domestic capability to conduct audits is a recommended approach. Local ecology funds could also be used to provide incentives and support for short term action plans.

- **Air Quality Management**. Through the short term action plans, oblast and municipal authorities, along with environmental authorities, need to address the very serious urban air pollution problems in a number of industrial cities, including worker exposures, where the impacts on human health appear greatest. Luckily, there are low cost measures which will make a start in reducing fugitive emissions and improving the performance of existing equipment. Also, encouraging improved particulate control (which also reduces some hazardous pollutants) is an inexpensive strategy over the medium term relative to other air pollution control or, indeed, water pollution control investments.

Because of the health impact, attention should go to known sources of hazardous emissions: lead and aluminum smelters, coke ovens, some chemical plants, and various workshops in steel plants emitting heavy metals or trace hydrocarbons. These plants are priority candidates for agreement on short term action plans. They are also candidates for early review of their business prospects and attractiveness compared to other plants in the same industry. If a plant is likely to continue for many years, despite its lack of economic viability, more significant investments to reduce hazardous emissions may need to be considered in order to reduce health risks further (e.g. installation of improved dust filters). If the number of such plants is large, however, then the question of affordability will become a major issue.

- **Water Quality Management.** Water quality in the Dnieper is an emotional national issue, and it is a priority to have a baseline survey of water quality in this river. Municipal "hot spots", particularly along the southern reaches of the river, should be among the municipal areas designated for the pilot programs mentioned above.

Beyond short term action plans, an important step in improving water quality management is encouraging utility reform more generally across the country and creating autonomous water utilities responsible for their own self-financing, enabling them to improve operations and expand as necessary. This is a sector where the goal, over time and as resources permit, should be to try to reach minimum standards of treatment over a broad number of communities rather than reaching the most advanced forms of treatment for only a few cities.

- **Waste Management.** Improving the categorization of hazardous wastes and developing regulations for management and transport are steps which are needed over the medium term. The emphasis should be on prioritizing sites based on health impact and undertaking low cost mitigation and containment efforts wherever possible. At the municipal level, authorities should look for low cost solutions to solid and hazardous waste management, including emphasizing waste minimization at plants and considering opportunities for introducing recycling programs. Rules and procedures in regard to the environmental liability incurred in respect of existing contaminated sites during privatization or foreign investment should be clarified, considering other country experience.

- **Management of Other Hazards.** The coal industry can be singled out as an industry which should be able to reduce safety hazards over the short to medium term by implementing improved safety programs and establishing stronger regulatory requirements in this regard. Also warranted is an assessment of operating and safety procedures for the high pressure ammonia pipeline crossing the southern part of the country.

- **Regulatory Improvements**. The pilot programs mentioned above should include efforts to begin improving the regulatory infrastructure and regulatory tools available to environmental authorities. Exposure to regulatory programs and techniques and associated analytical tools (e.g. cost-benefit analysis) used in other countries would begin this process; foreign assistance to support equipment upgrading and staff training, in parallel with regulatory improvements, is also needed. Greater funding for regulatory programs should come from the pollution fee system.

- **Chernobyl Follow up.** Concerning Chernobyl, both domestic and international communities look forward to the closing of remaining units at the site. Another priority is to take cost effective mitigation measures to address outstanding problems at unit 4. Establishing improved safety procedures at remaining nuclear power units and making associated investments are also clearly priorities. A series of steps are recommended to improve the cost effectiveness of ongoing Chernobyl-related domestic programs. The first priority is to undertake the control studies necessary to understand clearly what the health impacts and risks are. Such studies should provide the impetus for a re-examination of the current statutory dose limit and existing mitigation and compensation programs. Greater public information is also essential.

- **Natural Resource Management and Protected Areas**. In regard to natural resource management, a sensible way to introduce changes is, again, to focus on a few pilot programs in agricultural and forestry operations to introduce soil conservation and other techniques which could reduce environmental pressures as well as offering economic benefits. Forestry personnel should be trained along with wildlife biologists and other natural resource professionals because of the importance of the areas they manage to conservation of habitats. MEP needs to have greater authority over the protected area network in order to assure conservation objectives are met. An assessment of emergency needs in protected areas and wetlands is also warranted to identify priorities for technical assistance, again through pilot programs.

**Funding Mechanisms for Technical Assistance and Environmental Investments**

60. External assistance, whether through bilateral or multilateral grants and loans, is likely to play only a small part in achieving environmental improvements in Ukraine, but some early assistance could be instrumental in supporting the start up of pilot programs and modest investments. Annex 1 and also Annex 5 (the latter for thermal power plants) suggest some priorities for technical assistance and small scale investments. Local ecology funds could also direct resources to support pilot programs and low cost, short term action plans over the medium term. As mentioned earlier, the bulk of resources for major environmental improvements will inevitably come from domestic sources, starting with plants and municipal utilities which generate sufficient cash flow to afford them, or which can assume financing at commercial terms from local or external banks and funding agencies.

# I. INTRODUCTION AND BACKGROUND ON UKRAINE



## A. Background

1.0 Ukraine declared its independence from the former Soviet Union (FSU) on August 24, 1991, a proclamation which was overwhelmingly ratified by referendum on December 1, 1991. It is a country of 52 million people with a land mass of over 600,000 km$^2$. Ethnic Ukrainians constitute about 73 percent of the national population, with Russians being the largest minority, comprising 22 percent. The country has a rich historical and cultural tradition, having been the center of the first Slavic state of Kievan Rus, later the site of a brief Cossack state, and birthplace of prominent writers and poets. Kiev, its capital, is culturally wealthy and enjoys some beautiful examples of architecture from Byzantine Christianity and Russian Orthodoxy.

1.1 Today, an estimated 67 percent of the population is urban, and Ukraine has five cities with a population over one million, Kiev being the largest with 2.6 million people.[1] The country is divided into twenty four oblasts and one autonomous region (Crimea) with two cities, Kiev and Sevastopil, having special administrative status.[2] Population density averages 86 people/km$^2$, which is not as dense as various other European countries; density varies considerably across the country, however. Donetsk Oblast, in the southeast, is the most densely populated region with 202 people/km$^2$, followed by Dnipropetrovsk Oblast, in the central-south region, with 123 people/km$^2$. Both of these regions are major industrial centers and critical areas in respect of industrial pollution.

1.2 The territory of Ukraine is divided into three natural physiographic zones: a forested zone in the north, wooded steppe in the center, and the traditional steppe of the south. The south-central region's rich black soils (chernozems) give it some of the best arable land in Europe. Several north to south drainage systems flow into the Black and Azov Seas, which form Ukraine's southern border; the largest river basin is that of the well-known Dnieper River. The Carpathian mountains and their foothills to the west and the Crimean mountains along the southern coast of the Crimea are the only two mountainous areas of the country, both very beautiful regions. Several wetland areas are hosts to wildlife along the Black and Azov Seas and the Dnieper Delta--the most famous area being the Danube Delta, which Romania and Ukraine share.

---

1/ The five largest cities are: Kiev, Kharkiv, Dnipropetrovsk, Donetsk and Odessa.

2/ The oblasts, in turn, are divided administratively into 481 raions (districts), in which there are 436 cities. See also Annex 2, Table 1.

1.3 Ukraine's neighbors include Poland, the Czech Republic and Slovakia to the west, Hungary, Moldova and Romania to the southwest, Russia to the east and northeast, sharing over 1,000 km of border, and Belarus to the north. Various rivers in western Ukraine flow into the Danube. Another river system, the Buh River, flows north, ultimately draining into the Baltic. Ukraine shares the Carpathian mountains with Poland, Slovakia, Hungary and Romania. And it shares the coast of the Black Sea with five other littoral states. Through these many geographical links, Ukraine truly belongs to Central Europe, and its activities have environmental consequences for its neighbors and vice versa.

1.4 Ukraine's large industrial and energy base, sheltered from competitive pressures or price incentives and in some cases starved of the capital necessary to modernize, is the source of serious pollution problems, most vividly exemplified by the smoke belching steeltowns of southern and southeastern Ukraine. Places such as Kryvyi Rih, Mariiupil, and Makiivka are reminiscent of the steeltowns in the EC and US some 20 to 30 years ago with similar pollution problems. The emphasis of the past on production targets, rather than on efficient use of resources, has also put pressure on agricultural lands and other natural resources. Nevertheless, Ukraine remains a country of rolling agricultural landscape, wooded hills and gentle wetlands. Its still rich agricultural base and its remaining natural and cultural heritages should be protected for future generations.

## B. The Difficult Economic Transition[3]

1.5 Ukraine's economy was highly integrated with the economy of the FSU. The recent collapse in trade with other countries of the FSU, therefore, has had a very disruptive effect on its economy, resulting in loss of markets and domestic shortages of many essential inputs and commodities. The country is suffering deteriorating economic circumstances and political uncertainty about how to proceed on a course which will bring both economic stabilization and growth for the future. Especially difficult is the task of dismantling the structures of production and trade which were created during 70 years of central planning.

1.6 The Ukrainian economy registered a poor performance in 1992, and with a further deterioration in 1993, has now reached a critical point. Despite a better agricultural harvest, real GDP contracted by about 18 percent in 1993, bringing the cumulative fall in output since 1989 to 40 percent. The collapse of output accelerated in the first months of 1994; industrial production is estimated to have fallen by almost 40 percent during January-March 1994. The rate of inflation, which averaged 1,445 percent in 1992, increased to about 5,000 percent in 1993. However, the monthly inflation rate has come down sharply since the beginning of 1994, reaching 5.7 percent in March. This is attributable in particular to a significant tightening of monetary policy in recent months and a marked decline in real wages. Living standards for most of the population have fallen steeply, and the real wage is estimated to have declined by more than 50 percent between December 1992 and December 1993. Large external imbalances have emerged because of a substantial trade deficit with the FSU, mainly Russia, partly reflecting a deterioration in Ukraine's terms of trade as the prices of energy imports move toward world levels. The value of the karbovanets plummeted from krb 749 per US$ at end-1992 to more than krb 40,000 per US$ in early 1994.

3/ This section draws from a more extensive discussion of the economic crisis in "Ukraine: Country Economic Memorandum," World Bank Report No. 10029-UA, June 2, 1993, and updates thereto.

1.7 An emphasis on administrative interventions through planning and controls has shielded enterprises from the need to adjust to the decline in demand for their products and higher production costs. The state budget deficit narrowed from 16.5 percent of GDP in 1992 to 5.4 percent of GDP in 1993 from 16.5 percent of GDP in 1992, largely by squeezing enterprises for more income taxes and cutting public investment; at the same time, extensive directed credits were channeled to the agriculture and coal sectors.

1.8 The situation in Ukraine requires that a program of stabilization and structural reform be put in place without delay. A stabilization program would hinge on a sustainable reduction in the budget deficit; in turn, this calls for improvements in revenue performance, and especially, a restructuring and cuts in expenditure. In support of such fiscal measures, a tight rein would have to be maintained on domestic credit, notably to loss-making state enterprises. Together with demand management policies that would harden the budget constraint of state enterprises, the Government would also have to liberalize prices further so that they can provide appropriate signals for the allocation of resources that is needed in Ukraine. The role of prices would be enhanced by the break up of large monopolies, including those that dominate the distribution system. In addition, trade policy must be reoriented through the elimination of the fixed exchange rate applied to the foreign exchange surrender and the removal of export controls

1.9 Sectoral reform has proceeded at a slow pace so far, but is critical to efforts to generate growth and employment opportunities over the longer-run and to protect the most vulnerable groups of society during the transition period. Special attention needs to be paid to the following issues: (a) creation of a targeted social safety net; (b) restructuring the economy through the privatization of state enterprises and improved management of enterprises that would remain in the public sector in the medium-term; (c) development of the private sector through free entry and exit among economic activities, promotion of a real estate market and stable leasing arrangements, and the sale of assets by state enterprises; (d) generating a supply response in agriculture by restructuring the kolkhoz/sovkhoz system and establishing the basis for a private agriculture; and (e) reform of the financial sector.

**Current Share of Heavy Industry and Expected Structural Changes**

1.10 Ukraine's share of heavy industry is very high. Measured as a percentage of gross domestic product (GDP), it is 61 percent; this compares to a range of 49-61 percent overall in the Central and Eastern European countries and an average of 34 percent for the European Community.[4] With movement toward economic prices and toward a greater "market" orientation, the structure of the economy will gradually change--away from heavy industry towards lighter industries (including production of more consumer goods) and service industries. The transition to a healthy competitive private sector should create more accountable and responsive enterprises and more opportunities in the future for investment in more modern process technologies. All of these changes would help to reduce environmental pressures. However, the process of reform will take a long time, perhaps 10 to 20 years, especially for older plants in heavy industry. Some industries--metallurgy and coal industries, for instance--will require restructuring and consolidation. Various western countries have undergone similar restructuring of their heavy industries, while at the same time coming under increasing pressure to reduce pollution. It has taken them 20 years to achieve the level of pollution control they now enjoy. Such a time frame is, therefore, likely in anticipating changes in Ukraine.

---

4/ The second largest sector in Ukraine's economy is agriculture, representing 20 percent.

**Resource Pricing**

1.11 Low energy, water and raw materials prices--and a lack of accountability among enterprises--have encouraged excessive resource use and sustained energy inefficient industrial activities. They have also impeded technology changes to more efficient processes. The consequent pressure *to supply more* has steadily exacerbated environmental pressures.

1.12 **Energy Intensity and Energy Prices.** Table 1.1 shows the energy intensities of several countries which were part of the FSU; they are among the highest in the world. Interestingly, energy intensities (koe/$ of GDP) vary substantially across the states of the FSU, with the lowest energy intensities in the Baltics and the highest in Ukraine. Rough estimates suggest that the energy intensity of Ukraine's economy is roughly nine times higher than the average for OECD countries and almost 4 times higher than in upper middle income countries.[5]

**Table 1.1: Energy Intensity, Selected Countries of the FSU**

| Country | Pop. (mill) | Total Energy Consumption (ktoe) | Energy Intensity (koe/$ of GDP) |
|---|---|---|---|
| Lithuania | 3.7 | 13,493 | 1.03 |
| Belarus | 10.3 | 39,960 | 1.67 |
| Azerbaijan | 7.1 | 14,237 | 1.91 |
| Russia | 148.5 | 838,160 | 2.23 |
| Kazakhstan | 16.9 | 70,160 | 2.29 |
| Turkmenistan | 3.8 | 15,209 | 2.45 |
| Uzbekistan | 21.3 | 47,919 | 2.55 |
| ***UKRAINE*** | ***51.7*** | ***230,025*** | ***2.63*** |
| **Comparative Data:** | | | |
| OECD | | | 0.27 |
| China | | | 1.69 |
| Upper middle-income countries | | | 0.60 |

Note: For assumptions, see Table 2 of Annex 2.

1.13 A top priority in Ukraine, therefore, should be to develop an incentive structure that induces energy efficiency and conservation across the economy. In view of concern over the availability and security of energy supplies, this should be a domestic priority in any case. Energy price liberalization in 1992 did not go far enough to correct past distortions, and relative prices of fuels remained badly

5/ An international comparison requires conversion of GDP to a common currency, which is a difficult task with respect to the FSU given the uncertainty of an appropriate exchange rate; the results in Table 1.1 should, therefore, be considered indicative.

distorted.[6] The Russian Federation is now raising the price of energy exports to world levels, and this is forcing further price adjustments in Ukraine, since it imports over 50 percent of primary energy requirements, primarily oil and gas. Energy prices have moved further upwards in 1993 and 1994, although controls remain in some sectors, e.g. households and agriculture. The continuing subsidization of some industries and controls on output prices, however, may be impeding adjustments which could result in greater operating efficiency and conservation of energy.

1.14 There are also constraints on the availability of energy efficient appliances and equipment; there is very little domestic manufacturing capability in this area at the present time and limited access to imported equipment because of trade restrictions and insufficient foreign exchange. Relaxing those constraints would also increase the effectiveness of higher energy prices by speeding up the response to price changes.

1.15 **Water Pricing**. The undervaluation of water resources is another problem. Ukraine is a water-short country; per capita water supply was said to be one-tenth the average of the FSU. Yet, water consumption in both industry and agriculture appear to be very high. Water diversion schemes have been undertaken extensively to assure sufficient supplies for urban areas, industry use, energy development (hydro) and irrigation. Water charges, a means of encouraging conservation, have been insignificant, however. Water and wastewater charges have been raised generally over the past year, although they still are low in real terms. Municipal utilities now have greater discretion over water and wastewater charges, although charges to the general population are still controlled by the central government.[7] Charges to profitable industrial firms have been increased substantially over the past two years, in order to cross-subsidize other industries and sectors.

## C. Background on Health

1.16 The fact that the average life span of Ukrainian males is six years less than that of males in the United States (a three year difference exists for women) is medically significant, especially since infant mortality rates are similar for both countries. A number of factors are likely to be at work--smoking habits, diet, occupational hazards and environmental influences. Ironically, there appears to be little attention given to the effects of heavy smoking (a known carcinogen) among the adult population. It is against this backdrop that environmental effects on health are considered.

1.17 While a considerable effort has been made to generate data on health status and environmental factors in Ukraine, analyses of these data have not been structured according to modern epidemiological techniques. Basic approaches, such as age and sex standardization of disease rates, have rarely been done. Their absence makes it very difficult to compare rates of morbidity or mortality between different populations adequately. In addition, controlled studies and risk assessment techniques are almost never used. Some of the Ukrainian studies show interesting data, though--for the cities of Mariiupil,

---

6/ Electricity prices rose by less than the general increase in prices. At end-1992, the price of crude oil and natural gas had risen by 8 and 6 times their respective levels, while coal prices had increased by 59 times. Considering exchange rate changes, though, domestic prices were still well below world prices.

7/ In Odessa Oblast, for instance, water charges to industry in mid-1993 were reported to be 1480 krb/m$^3$, while household charges were only 10 krb/m$^3$. In Zaporizhzhia, water and wastewater charges for industry were 627 and 575 krb/m$^3$ respectively; household charges were 10 and 6 krb/m$^3$ respectively.

Zaporizhzhia and Kryvyi Rih, for example--and should be followed up by introduction of controlled studies. Over the medium term, opportunities for Ukrainian health officials to work with or receive feedback from external scientific and public health colleagues will be very important in sharpening control procedures and analytical techniques

1.18 Based on visits to a series of plants in Ukraine, workers appear to be the group most at risk. Occupational health hazards in mining, coke and chemical, and metallurgical industries are very serious. Visits to plants show that workers often do not wear protective gear (a compliance problem in many countries); although they have medical check ups, testing appears to be inadequate. Occupational health problems were probably underreported in the past, although a substantial increase in reporting has occurred in the last three years

## D. Practical Principles to Consider in Setting Environmental Policy

1.19 Given the difficult economic circumstances cited above, what is achievable in reducing environmental pressures? And where will the resources come from? Most environmental investments will have to be made using domestic resources--enterprises' internal generation of funds, user fees for municipal services, and very limited public investment. International and bilateral funding will provide some help, albeit limited compared to the sizeable needs.

1.20 Those enterprises offering good prospects for joint ventures (giving them a source of equity) or which are prospering on their own are likely to be the ones that will be able to afford most quickly the investments in modern process technology or "end of pipe" pollution control which are needed. Similarly, communities which are able and willing to pay for improved municipal services are more likely to be the ones which will enjoy early investments in better water and wastewater treatment. This argues for policies which encourage domestic privatization and foreign investment as quickly as possible, in order to stimulate new, profitable economic activities and generate funds which can be used, in part, to improve the environmental situation. Clearly, as new plant investments are made, that is the time to assure installation of good pollution control equipment.

1.21 In view of severe resource constraints in the economy, the following five principles are suggested in setting priorities for environmental protection over the short to medium term, particularly in considering expenditures of public resources:

- As an immediate measure, encourage low cost short term actions in individual industrial and municipal plants to improve safety, conserve water and energy, and reduce pollution in the workplace caused by sloppy housekeeping and insufficient maintenance.

- Build up the institutional capacity and regulatory infrastructure necessary for practical and effective environmental management, in parallel with the economic transition and privatization, as investors need a stable, credible regulatory framework. In so doing, establish reasonable environmental standards and anticipate a phase-in period to meet environmental targets, rather than trying to achieve all targets at once.

- Focus regulatory efforts (and campaigns to introduce short term action plans) on those industries and cities where occupational health problems are critical or where the health of nearby communities is affected by hazardous pollution.

- Encourage projects which have economic payoffs while also reducing environmental pressures (e.g. energy conservation). Also, encourage early, affordable environmental investments in areas of high economic or touristic value, where there are opportunities for revenue generation and thus the ability to pay for those investments.

- Protect important natural or agricultural areas that could suffer severe or irreversible damage, if steps are not taken soon, or where preventive measures are especially cost effective.

These principles run through the chapters of this report The emphasis is on practicality--what can be achieved under difficult circumstances.

## E. Overview of Subsequent Chapters

1.22 Chapter II offers an overview of pollution problems across media and suggests some priorities. Chapter III describes the substantial existing institutional base for environmental management in Ukraine and suggests ways to strengthen the institutional and regulatory framework, while Chapter IV goes into more depth about air and water regulatory programs. Chapter V focuses on environmental issues related to industry, with emphasis on environmental questions raised during privatization and the interrelationship of structural and pollution problems in metallurgical and chemical industries. Chapter VI discusses issues concerning the electric power industry, with lesser attention to other energy industries, while Chapter VII specifically discusses the legacy of Chernobyl. Chapter VIII reviews concerns in regard to agriculture, forestry, habitats for biodiversity and the protected areas network. Chapter IX discusses ways to balance domestic needs and international commitments, specifically covering obligations under the European Protocols on Transboundary Pollution, the Montreal Protocol, and the Framework Convention on Climate Change. Representing a summary of earlier recommendations in the other chapters, Chapter X sets out a short to medium term action plan. Annex 1 provides ideas for technical assistance, and other annexes provide more detailed information, for example summaries from extensive plant visits and descriptions of the parks, nature reserves and wetlands of Ukraine.

# II. BACKGROUND ON POLLUTION PROBLEMS



## A. Urban Air Pollution

2.0 Urban air pollution is one of the most serious environmental problems in Ukraine. Existing air quality data indicate there are a limited number of industrial cities which are extremely polluted, *much of the most serious pollution coming from large industrial plants, particularly metallurgical plants, coke ovens and chemical plants*. Many industrial plants have both poorly operating pollution control equipment and high fugitive emissions. In most cases, the pollution is limited to a relatively small area within a few kilometers of the plant, but within these areas the conditions are very bad. Moreover, these plants are often close to residential areas. Theoretically, there are "sanitary protection zones" (SPZs) around them, where people are not supposed to live, allowing dispersion of air pollutants. In reality, though, people do live in these zones. Pollution problems may be further exacerbated by smaller, dispersed sources, particularly in areas using coal or high sulfur fuel oil in small boilers. The most affected cities are located in the Donetsk, Dnipropetrovsk, and Zaporizhzhia Oblasts in the industrial south and southeast of the country. Other areas of particular concern are in Luhansk Oblast and the city of Odessa. Measurements of air pollution in these areas show that particulates[1] are the most pervasive problem, probably in combination with hazardous pollutants (heavy metals, benzo-a-pyrene, and other organics) and, in some cases, sulfur dioxide.

2.1 More broadly, there are individual plants in numerous cities causing some air pollution problems, particularly in industrial districts, and a few cities which experience pollution from automobile traffic. Production and use of asbestos (a known carcinogen) may also be a problem, but how extensively is unknown. There are also *many cases* throughout the country where *air quality conditions within plants represent a serious hazard to the health of workers*. Much of the pollution inside plants is caused by fugitive emissions, not pouring out of industrial stacks, but accumulating in the work place because of poor housekeeping and maintenance. Occupational health should be considered among the country's environmental priorities, and hazardous conditions ought to be addressed urgently.

**Hazardous Emissions**

2.2 Health research in other industrialized countries indicates that especially hazardous emissions come from non-ferrous smelters, coke ovens, parts of metallurgical plants and some chemical plants. The non-ferrous industries in Ukraine are actually very few: principally, a zinc/secondary lead smelter in Kostiantynivka and an aluminum smelter in Zaporizhzhia. The country's large merchant coke ovens (16

1/ Known also as dust or TSP, total suspended particles.

in all) are emitters of known carcinogens (e.g. benzo-a-pyrene); their emissions are very localized but serious. Visits to several coke ovens showed generally high coke oven door leakages (20-40 percent) and insufficient attention to other emissions in the process. Those plants using or producing heavy metals, such as mercury, lead or cadmium, and toxic organics are also of special concern. The suspected health effects of selected hazardous emissions are described in Annex 2, Box 2.

**Common Air Pollutants**

2.3 The more common (non-toxic) pollutants are particulates, sulfur and nitrogen oxides, carbon monoxide and volatile organic compounds (VOCs); their health impacts are also described in Annex 2, Box 2. Particulate emissions appear to be the most serious problem generally in Ukraine; they can trigger acute and chronic respiratory problems. Research in the US suggests that fine and ultra-fine particulates ($\leq 10$ and $\leq 2$ microns respectively) are especially dangerous to health because they combine with other trace elements (sulfur ions, trace hydrocarbons and heavy metals) and then penetrate the lining of the lungs.[2] Long term exposures may contribute to other health problems, such as cancer. *Particulate control, which can also capture some heavy metal emissions, is relatively inexpensive (compared to $SO_2$ control, for example), leading to a suggested strategy for many resource-constrained countries to focus first on effective dust control.*[3] This would include addressing the serious problem of "fugitive" particulate emissions by improved housekeeping and maintenance, which are much cheaper measures than installing end-of-pipe controls.

2.4 Estimates of the gross tonnage of emissions nationwide in 1990 are 9.4 million tons from large stationary sources and 6 million tons from traffic. The breakdown for large stationary sources by principal air pollutants is described below in Table 2.1. These estimates are very rough. In most cases, emissions are self-reported by plants and estimated using material balances, rather than based on actual measurements.[4] The contribution of more dispersed, smaller stationary sources (with lower stacks) is not inventoried, nor are fugitive emissions considered in such estimates.

2.5 The principal stationary sources are the metallurgical and electric power industries, contributing an estimated 35 percent and 29 percent respectively of estimated total air pollutant loadings in 1990. A domestic survey of the 30 most polluting plants in Ukraine includes: 10 major iron & steel plants, 6 coke plants, 6 power plants, 2 smelters, 5 chemical plants and 1 refinery. Table 4 in Annex 2 shows a declining trend in emissions from stationary sources since 1985, principally attributed to declines in emissions from the electric power and metallurgical industries. The trend in the electric power industry is reportedly due to increased use of natural gas over the period. In the last two years, declines have occurred generally because of lower economic activity, and this may continue for some time.

---

2/ For this reason, the U.S. has recently changed its particulate measurement from "total suspended particles" to particulate matter of 10 microns or less (PM10).

3/ For a comparison of costs, see Table 6.4 in chapter VI.

4/ Measurements of NOx emissions, for instance, appear low; see the discussion on NOx emissions from the power sector in Chapter VI and EMEP estimates in Table 4 of Annex 2.

Table 2.1: Main Air Pollutants
From Large Stationary Sources, 1990
(thousands of tons per annum)

| | |
|---|---|
| Particulates | 2,000 |
| $SO_2$ | 2,780 |
| NOx | 760 |
| Hydrocarbons | 460 |
| Other Pollutants | 3,400 |
| Total | 9,400 |

Source: MEP

**Ambient Air Quality**

2.6 *The best indicator of the impact on human health from common air pollutants are measurements of ambient air quality, i.e. the concentration of individual pollutants in the air people breathe.* Ambient concentrations are affected not only by the gross volume of emissions, but also by the location and height of pollutant sources, local topography and meteorological conditions. Thus, an evaluation of the most important ambient sources would include not only large sources, but also fugitive emissions at plants and low-level dispersed sources, for example smaller industrial and commercial stacks (e.g. activities related to mining, asphalt and cement plants and small industrial boilers), household sources (e.g. heating boilers and stoves), and mobile sources.

2.7 Fortunately, household energy use in Ukraine is now dominated by natural gas, electricity and district heating. Problems created by small scale fuel oil or coal use--indoor or very low level pollution problems--are therefore not as common. There are some areas, though, where coal is still used in households--in the coal-producing communities in the Donets basin (Luhansk and Donetsk Oblasts) and in Odessa, where coal burning combined with frequent fog cover creates ambient air pollution problems. In Donetsk Oblast, as an example, 60 percent of private home heating is by gas, but 40 percent is still by coal burning; hence, two-fifths of households (about 2.1 million people) use coal.

2.8 While among the larger emission sources, thermal power plants in Ukraine have particularly high stacks, generally much higher than in the EC or the US. Thus, they are probably less important than major industrial and smaller (low stack) sources in contributing to ambient air pollution in a number of cities, although this varies according to other features, such as location and weather patterns. Investments in SOx and NOx controls at power plants often get considerable attention because they are the focus of environmental protection in many other industrialized countries (see Chapter VI). In Ukraine, however, much greater pollutant reductions are achievable at lower cost by giving attention first to particulate control in all industries, especially with so many large steel and chemical plants close to residential areas. Better site characterization to identify principal sources of ambient pollution would also help in establishing control priorities in individual airsheds.

**Priority Air Pollution Areas**

2.9 Based on a preliminary examination of air quality data for the country and discussions with air quality officials in MEP, eight cities or areas have been identified as "priority air pollution areas" because

of the threat to public health within industrial plants and in areas nearest to the large industrial complexes. These priority cities are listed and described briefly in Box 2.1, and further data are provided in Table 2.2.[5] Longer descriptions about these cities and individual plants are found in Annex 3.

**Box 2.1: Priority Air Pollution Areas**

**Donetsk Oblast: Donetsk & surrounding communities, Kostiantynivka, Mariiupil**

The city of **Donetsk**, itself, does not appear to suffer the most acute air pollution problems; rather, it is the center of an airshed encompassing several communities **(Yenakiieve, Horlivka, Makiivka)** with a series of large metallurgical and chemical plants, as well as activities associated with adjacent coal mines and use of coal by the population. The airshed covers a population of close to two million. **Kostiantynivka** is a small community not far away, considered a particularly serious problem because of a history of lead emissions from the local secondary lead/zinc smelter; what was initially an air pollution problem may now also be a problem of lead in the soil, further exposing children who play in the soil (see Box 2.2). The air pollution problems of **Mariiupil**, on the Azov Sea, are largely the result of three metallurgical operations located in or adjacent to the city (see Box 2.7).

**Zaporizhzhia Oblast: City of Zaporizhzhia**

**Zaporizhzhia** has an industrial area within the center of town, which includes an array of metallurgical and machine building industries. In all, there are over 1100 plants in or adjacent to the city. Its pollution problems appear to be concentrated within the industrial area, where an estimated 90,000 people reside.

**Dnipropetrovsk Oblast: Dnipropetrovsk, Dniprodzerzhinsk and Kryvyi Rih**

**Dnipropetrovsk** is a large city and has a diverse range of industrial and military industries, as well as local steel and power plants. **Dniprodzerzhinsk** is a smaller community nearby with intense industrial activity related to steel, coking and chemical production. **Kryvyi Rih** is the home of the largest steel plant in the country, possibly in the world, and has various associated industries, most located within one elongated industrial district, where air pollution is extreme; it is also the center of iron ore mining and beneficiation.

**Odessa Oblast: City of Odessa**

**Odessa** is a large city with various industries (chemical, refining, and port activities), and there is significant use of coal in households. Odessa's weather conditions (heavy fog at times) play a role in its air quality problems.

2.10 The ambient air quality measurements in Table 2.2 show generally high annual average concentrations of particulates, indicating serious air pollution problems. The maximum readings--derived from a 20-minute sampling period--are extremely high and would indicate severe health impacts if

5/ Additional data on emissions and ambient concentrations in a range of cities are at Annex 2, Tables 6 and 7.

sustained over a longer period.[6] Questions have been raised about the accuracy of these data because of various problems: the use of outdated monitors, the location of those monitors, the sampling period for maximum exposure, and quality control (all discussed further in Chapter IV). These data are provided here simply to give an indication of relative problems in individual cities. The annual averages for $SO_2$ are generally within international standards, but the maximum exposures in some cases are extremely high. Similar data problems also exist in the case of $SO_2$ monitoring; they are based on older wet chemistry methods, and quality control is uncertain.

**Table 2.2: Data on Priority Air Pollution Areas, 1990/91**

| City | Population (million) | Estimated Gross Emissions[a] (000 tons) | Ambient TSP ($\mu g/m^3$)[b] | | Ambient $SO_2$ ($\mu g/m^3$)[b] | |
|---|---|---|---|---|---|---|
| | | | *Annual Averages* | *Maximum Exposures* | *Annual Averages* | *Maximum Exposures* |
| Dnipropetrovsk | 1.18 | 336.2 | 200 | 3400 | 10 | 200 |
| Donetsk | 1.09 | 272.0 | 500 | 4000 | 40 | 730 |
| Dniprod-zerzhinsk[c] | 0.3 | 284.7 | 300 | 2800 | 10 | 240 |
| Kostiantynivka[d] | 0.11 | 36.2 | 400 | NA | 20 | NA |
| Kryvyi Rih | 0.7 | 1,100.9 | 400 | 3300 | 30 | 550 |
| Mariiupil | 0.53 | 645.0 | 300 | 3400 | 20 | 280 |
| Odessa | 1.1 | 187.0 | 300 | 2200 | 50 | 190 |
| Zaporizhzhia | 0.88 | 353.0 | 300 | 2300 | 20 | 200 |

a/ From stationary sources and transport

b/ Samples in Ukraine are typically taken 4 times a day for 20 minutes 6 days a week. The data are used to construct daily mean concentrations, which are then computed into annual averages. Maximum exposures represent the highest reading in a 20-minute period. For a comparison with Ukrainian and other national and international standards, see Table 4.1 in Chapter IV.

c/ Also known as Kamiansk.

d/ Formerly Konstantinovka.

Source: MEP

2.11 Over the next five years, the bulk of resources for air quality management should be directed towards these priority air pollution areas. This study recommends setting up *special air quality management programs* to improve evaluatory and regulatory activities and to create short and long term

6/ A 20-minute exposure period is not a good measure of the health impact; it is too short. Also needed are daily and seasonal information, which would give some indication of trends in peaks.

action plans for reducing air pollution in these cities.[7] Additional efforts to reduce fugitive emissions in all major plants in a variety of cities could easily go forward as well.

2.12 It should be pointed out that a number of the same cities mentioned as priorities here are also priority candidates in regard to improved water quality and waste management, *suggesting the need to work on cross-media strategies.*

**Opportunities for Short Term Actions**

2.13 Clearly, major investments in modernization and end-of-pipe pollution control are generally unaffordable right now. They will come over time as changes in the structure of the economy occur and as plants and industries restructure to become more commercially oriented and competitive. Only then will competitive firms be able to generate the cash flow (or financing capability) to undertake needed modernization or direct pollution control investments. But problems of worker safety or pollution in industrial plants are not solely a result of technology. They occur also because of lack of attention to safety, housekeeping and maintenance, and general lack of supervision. In many plants visited during this study, fugitive emissions were very high and a danger to workers, safety measures were not always in place, and pollution control equipment tended to be poorly maintained and not working well. *Hence, there are opportunities to take quite inexpensive actions at the plant level now which could improve safety and reduce pollution, particularly in the workplace itself.* They include:

- introduction of better safety procedures and equipment to reduce the high level of industrial accidents;
- aggressive cleaning, housekeeping and materials handling programs to reduce fugitive emissions;
- repair and maintenance of process and pollution control equipment;
- attention to operating performance generally, including that of utilities, to enhance efficiency and reduce emissions;
- installation of minimum instrumentation and controls;
- strengthening of emergency operating procedures, when weather inversions or other adverse air quality conditions are predicted: and
- more generally, attention to conservation of energy and water.

2.14 Such measures should offer returns economically and in terms of worker health and productivity. *There is no reason to delay in undertaking them.* Inclusion of short term action plans should be made part of the environmental permitting process, with MEP responsible for working with major plants to develop such plans (see Chapter IV). They might be supported by local ecological funds set up to use revenue from the pollution fee system. The introduction of environmental and operational audits would

7/ Discussed in greater detail in Chapter IV.

**Box: 2.2: Kostiantynivka**

Kostiantynivka is a town with 108,000 inhabitants that is located in Donetsk Oblast, approximately 50 km from the city of Donetsk, in the eastern part of Ukraine. In the center of town, in a valley that is approximately 70-80 meters deep and 6-7 km wide, are located a lead and zinc smelter (with a 180 meter smokestack), a chemical plant, and a metallurgical plant. The smelter accounts for 33 percent of estimated gross air pollutants in the town; the chemical/fertilizer plant, 15 percent; and the metallurgical plant, 15 percent. The smelter is considered the most serious because of heavy metal emissions.

The zinc/secondary lead smelter, built in 1930, is very large and based on the old sinter route with furnaces to refine the lead. In the past, it received vehicle batteries from various parts of the FSU, reclaimed the lead, and sent it to Russia for production of new batteries. Production capacities are 32,000 tpa of zinc and 19,000 tpa of lead. The plant is now operating at about one-third of capacity because of shortages of raw materials. Zinc ore is not produced in Ukraine, and its sources from the FSU have dropped dramatically. Despite its heavy production in the past, virtually no investments in modernization were made at the smelter for the past 20 years. The plant is outdated compared to plants in Russia itself (reportedly 7 plants) which generally have much better technologies.

Sixteen hundred workers (600 of whom are women) work at the smelter. (Some women are restricted from certain jobs because of health risks.). Plant managers claim that there have been few cases of lead poisoning among workers in recent years-only 15 cases in the 1985-1990 period. Although annual physical examinations are performed on all workers, modern blood lead testing is not undertaken. Despite the small number of reports of lead poisoning among workers, data from the San Epi station (MOH) document high levels of inorganic lead in several different parts of the smelter. In the past, a confidential evaluation of the health impact of industrial emissions in Kostiantynivka was undertaken by health officials under the FSU. It was impossible during this study to locate the confidential report; the only available copies may be filed in archives in Moscow.

The plant has dust/heavy metal control (via bag filters) but the level of performance is not satisfactory. To provide comparison, estimated emissions of zinc and lead at the plant are 29 kg/ton and 1.7 kg/ton respectively; typical emissions of lead in EC plants would be 0.3-0.5 kg/ton; "best available technology" in the world offers emissions of 0.1 kg/ton. $SO_2$ recovery at the plant is about 80%; in Western Europe, it is 95%. In regard to Water pollution, zinc and lead in effluents are estimated at 322 mg/liter and 18 mg/liter respectively. The normal EC standard would be 2 mg/liter and 0.5 mg/liter respectively.

Staff at the San Epi station estimate that about 15,000 people live within 1 km of the smelter, chemical plant, or metallurgical plant. The San Epi station has found high levels of lead in ambient air and soil near the smelter. What was initially an air pollution problem has now turned into a problem of lead in the soil, exposing children at play. Many of the town's residents (23% of whom are children 14 years old or younger) may be heavily exposed to lead with the potential for serious adverse health effects over time. Of most concern is possible brain damage in young children.

This is a case of a plant unlikely to survive over the longer term as market forces come into play. It also appears to be a major health hazard. These two considerations combined make this a plant which should be an early candidate for evaluation for possible shut down. In any case, a short term action plan should be developed at the plant immediately to try to mitigate pollution through low cost measures as far as possible.

help in identifying specific plant by plant actions; the audits will also be useful in developing longer term compliance plans and conducting restructuring analyses for major heavy industries (see Chapter V).

**Longer Term Issues Concerning Transport**

2.15 Vehicular emissions are reportedly a significant source of emission loadings in several cities, especially in Kiev and Kharkiv. Authorities attribute 70 percent of emissions in Kiev to transport emissions. Those emissions have fallen over the past two years, however, because higher prices and shortages of gasoline have reduced vehicular traffic.

2.16 Emissions from transport can be significant sources of ambient concentrations of various pollutants (lead, VOCs, SOx, NOx). They may also contribute to regional air quality problems (ozone). Traffic levels and associated emissions are likely to grow over the medium to long term; therefore, it would be worthwhile to start planning ways to minimize transport emissions, beginning with a program to improve combustion and reduce emissions from the public transport fleet and to introduce stronger inspection programs for other vehicles. Better traffic planning and continued support for public transport are also important measures in minimizing urban air pollution.

2.17 Consideration should also be given to phasing out the use of leaded gasoline over a reasonable time frame, perhaps 10 years. Evidence in the US suggests that full introduction of unleaded gasoline brings dramatic declines in blood lead levels in children. Unleaded gasoline is produced in Ukraine but not extensively. *Full scale introduction of unleaded gasoline involves major infrastructural changes, including revamping of refineries and requisite changes in car designs,*[8] *overall an expensive proposition. It should be a longer term program, but planning for the transition to unleaded gasoline should probably start soon, particularly in parallel with refinery restructuring* (see para. 6.71 in Chapter VI). Actions to convert to unleaded gasoline and change the design of new cars should probably be undertaken as a part of an agreement with other nations of Eastern Europe. Attempts to phase out leaded gasoline without a broader international agreement are unlikely to be successful because of the relative unavailability of automobiles and light duty trucks designed to burn unleaded gasoline.

## B. Regional and Transboundary Air Pollution Issues

**Regional Deposition of Toxic Pollutants**

2.18 Regional or transboundary air pollution problems have not been closely examined to date. Regional scale deposition of hazardous toxic pollutants (lead, mercury, cadmium, etc.) have not been systematically measured, but there is the potential for a number of regional air quality problems to exist. Regional deposition of heavy metals could be coming from the large metallurgical and chemical complexes in the country. In addition, there are no ozone monitors which might identify ozone problems downwind of those urban areas where large amounts of VOCs and NOx are emitted.

2.19 Regional toxic monitoring could be phased in to determine the extent of deposition of persistent toxic pollutants such as mercury, lead, cadmium, and benzo-a-pyrene. Monitoring stations could be set

---

8/ Ukrainian/FSU autos generally have low compression engines, suitable for low octane (leaded) gasolines produced in local refineries. Also, in some of the older engines, cylinder heads may not have appropriate metallurgy in the valve seats to prevent valve recession if lead is eliminated from the gasoline.

up downwind of the major metallurgical industries in the country. This monitoring should be supplemented by testing fish at the top of the food chain in the major waterbodies of the country to determine if there are levels of accumulation of those compounds in the biological chain which would threaten public health.

**Acid Rain Problems--Regionally and Transboundary**

2.20 Ukraine does not appear to have the aquatic resources which would be sensitive to acid rain, and evidence of vegetative and materials damage is lacking. Waterbodies which are sensitive to acid rain are low pH lakes and streams which receive little or no recharge from groundwater sources.[9] The characteristics of Ukrainian waterbodies are high pH and eutrophication; these types of water resources are generally unaffected by acid rain. There is also little evidence of forest or vegetative damage which might be associated with acid rain, but there has not been a systematic effort to identify and monitor such problems.

2.21 Ukraine is probably upwind of most of the major sources of $SO_2$ and NOx emissions in Europe, although authorities are concerned about emissions from Eastern Europe possibly affecting the Carpathian mountains of western Ukraine. Two stations for transboundary monitoring are set up in Lviv Oblast, but they are presently not operating because of lack of resources. More information is also needed concerning the long-distance transport (and direction) of pollutants from the Donbass/Krivbass regions, where pollutant emissions are largest; the likely transfer would be towards the northeast, based on hemispheric wind patterns. Regional monitoring and use of dispersion modeling tools would help to gain more insight into expected regional or long range transport. Also, EMEP[10] and IASA[11] have been developing models for transboundary emissions; their estimates (see Annex 2, Table 5) indicate that the bulk of deposition of acidifying emissions from Ukraine occurs within Ukraine, the secondary recipient being Russia. *Ukrainian authorities concerned with transboundary pollution should seek opportunities to work more closely with EMEP and IASA to understand transboundary effects more clearly.*

2.22 Ukraine is a signatory to various European agreements on transboundary pollution, but will want to meet these commitments in a manner which allows it to address local pollution problems in parallel. There may be opportunities for direct aid from or for offsetting arrangements with EC countries as part of regional efforts to reduce transboundary air pollution. These issues are discussed in Chapter IX.

## C. Water Quality Issues

**Water Resources in Ukraine**

2.23 **Hydrology**. Water resources are unevenly distributed throughout Ukraine. The most favorable situation is found in the northern and the northwestern parts of the country, while the southern regions often experience water shortages. Problems of water supply are also heavily influenced by seasonal variations in precipitation and river flow. The most fertile, heavily cultivated agricultural areas, as well

---

9/ Low pH indicates acidity; high pH indicates alkalinity.

10/ The European Monitoring and Evaluation Program.

11/ International Institute of Advanced Systems Analysis.

as the most water-intensive industrial concentrations, are situated in the southern, water deficit regions.

2.24 The four largest rivers--the Dnieper, Dniester, Siverskodonets and Southern Buh--all drain south towards the Black Sea and thus provide water to the dry regions of the country. Other major rivers include: the Northern Buh, running northwest into Poland and the Baltic Sea; the Tisa, which flows into Hungary as a tributary of the Danube; and the Prut, another Danube tributary, which forms the border between Romania and Moldova after leaving Ukraine territory. The largest of the three Danube branches which comprise the Danube Delta, the Kiliia, constitutes the border between Romania and Ukraine, although only a small portion of it drains directly from Ukrainian territory into the Danube.

2.25 Considerable water engineering works have been carried out in the last 30 years, particularly on the Dnieper, in order to regulate river flow, store water for the dry season and transport water to deficit areas. They have ensured a reasonably good supply in most of the country, but demand is reportedly rapidly growing, putting stress on planning and investment capacities. Hydraulic works have also created a situation where the normal hydrological river regimes are so dramatically changed and overexploited that fundamental ecological changes have probably occurred. As many as 1087 water reservoirs have been constructed up to now, the most predominant being six large reservoirs on the Dnieper with total storage volume of 55.1 $km^3$. A system of large channels and water conduits also has been constructed. The capacity of some of these channels is so great that they have a considerable impact on natural water distribution. For example, the Kakhivka Channel and the North Crimean Channel (each 400 km long) are both able to divert 400 $m^3$/sec and from the lower part of the Dnieper.

2.26 **Water Use.** Ukrainian sources have reported that total water use is about 30 billion $m^3$ per year of the 52 billion $m^3$ available (95 percent yearly average), while generation of wastewater is about 4.3 billion $m^3$ per year. Such calculations of water use and wastewater generation are in general difficult to interpret, however. The real figures are difficult to measure, and the terms "use" and "waste" are both a matter of definition. It is clear, though, that Ukraine uses its water resources intensively, often to a level above the ecological capacity. Usage is broken down as follows:

| | |
|---|---|
| ◦ Agriculture | 35.8 percent |
| ◦ Power production | 31.3 percent[12] |
| ◦ Other industry | 13.5 percent |
| ◦ Metallurgical industry | 8.3 percent |
| ◦ Domestic purposes | 11.1 percent |

2.27 The agriculture sector's large share of water usage would suggest that this sector is a good candidate for review and identification of conservation opportunities, particularly in regard to irrigation. But in each category of use there are opportunities to improve water demand management. Economic water pricing, of course, will be very important in promoting conservation.

2.28 General water management is the responsibility of the State Committee for Water Resources, and each major river has its own river basin management unit. These units are responsible for:

12/ Hydroelectric capacity is 4.7 GW, representing 9 percent of total installed capacity. The Dnieper has six major facilities, the Dniester one facility.

- regulation of water flow;
- allocation of available water to different users; and
- operation of water transport and channel management.

The management units operate the water regime based on a multi-purpose evaluation of water needs and availability, reportedly based on the following priority: water supply, downstream ecological situation, fisheries, transport and hydropower production. In practice, though, these units appear to be most concerned with allocation of water, particularly for hydropower and agriculture, with little attention given to water quality management.

**Water Quality Problems in Key Surface Waters and Groundwater**

2.29 Ukraine is heavily dependent on surface water supplies for drinking. According to the State Committee on Geology, 70 percent of the population is supplied from the Dnieper River, 15 percent from other surface water sources, and only 15 percent from groundwater. The problems of surface and groundwater pollution appear serious, although actual water quality data are unreliable. The main sources of pollution are municipal sewage, agricultural activities, and a variety of industrial activities, including chemical, metallurgical and extractive industries.

2.30 Reportedly close to 50 percent of the total wastewater volume is produced by municipal sewage. In roughly 80 cities, towns and settlements, treatment facilities are said to be operating unsatisfactorily or are overloaded, resulting in direct discharges of raw wastewater into rivers and seas. There are problems throughout the country, ranging from western Ukraine to the southeast. The situation is particularly critical in some of the larger industrial cities along the Dnieper, in Odessa and Mariiupil, and in the towns and settlements in the Crimea. Specific problems are discussed in Section D of this chapter.

2.31 Industrial wastewater discharges vary greatly in pollutant content. Some industries discharge water containing hazardous pollutants such as heavy metals or chlorinated hydrocarbons, which have the potential to cause severe health and ecological effects even in low concentrations; others cause harm due to the large volume of substances discharged. The heaviest industrial water pollution is associated with the following activities and locations:

- chemical complexes in the Lysychansk-Rubizhne area (Luhansk oblast) and northern part of the Crimea;
- metallurgy industries in Dnipropetrovsk, Zaporizhzhia, Mariiupil and Kryvyi Rih; and
- mining and mining-based industries in the western and central Donbass (Donetsk and Luhansk oblasts) and in the Krivbass (Dnipropetrovsk oblast).

2.32 A survey of large industrial plants suggests that most have treatment facilities, but they are overloaded, working above capacity; hence treatment efficiency may be lower than design, and considerable untreated water is inevitably discharged into the river. While some industries have made remarkable efforts to recirculate water (some firms reported close to 100 percent recirculation), considerable wastewater volumes are still discharged.[13] Improvements in water treatment at some plants are offset by an increase in the amount of water insufficiently treated. The volume of pollutants

---

13/ Those plants visited during the study which had good recycling facilities were: the Azot plant in Siverskodonetsk; a dye factory in Rubizhne; and a car assembly plant in Zaporizhzhia.

discharged as industrial wastewater seems to have stabilized or decreased in the last few years; this may be a consequence of generally reduced industrial production.

2.33 In addition, many smaller industries *do not pretreat* their chemical and heavy metal wastes before discharging either directly into rivers or into municipal sewers. Lack of pretreatment before discharging into municipal sewers has further effects in regard to treatment and disposal of wastes. High inorganic loads retard biological activated sludge treatment in municipal sewage treatment systems, reducing the effectiveness. They also make it more difficult to dispose of the sludge. Heavy metal contamination prevents the sludge from being used again, on agricultural land for instance, thus exacerbating the already difficult problem of waste disposal.

2.34 In the mining areas, e.g. the Donbass region where coal production is centered and the Krivbass region where iron ore production is considerable, the dumping of mine and washery waste and acid mine drainage are serious problems. A large amount of groundwater is released during coal mining, and as mines become deeper, the amount of water as well as its salinity increases. The Institute of Mines in Dnipropetrovsk estimates that about 800 million $m^3$ of salt water from mining is released into rivers. An estimated 100 million $m^3$ is discharged directly into the Dnieper, and much of the rest is discharged into the Siverskodonets, which flows into the Don River. The average salinity of the water is 4 g/l, but the maximum figure cited is 100 g/l. This salty effluent can damage drinking water supplies, limit water available for irrigation and industrial processes, and may penetrate into and impair groundwater aquifers. The iron ore mines of Kryvyi Rih produce almost 50 million $m^3$/year of effluent, which is not only saline but also contaminated with heavy metals. Though the volume of water is much less than that discharged from coal mines, it is far more hazardous, given the reportedly high concentration of heavy metals.

2.35 Soil erosion and nutrient runoff from agricultural fields represent significant non-point source pollution, but quantitative data are few. Unit fertilizer and pesticide use is not high; therefore, contamination from related residues are probably related to erosion and runoff, inadequate on-farm storage and poor application techniques and equipment. Changes in agricultural practices are needed in order to reduce these non-point sources, as discussed in Chapter VIII.

2.36 **The Dnieper River**. The Dnieper is the dominant river in Ukraine. It traverses the entire country from north to south and drains 286,000 $km^2$ or about 47 percent of the total Ukrainian territory. It also drains large areas of western Russia and Belarus.[14] In addition, some of the largest rivers in the northwestern part of Ukraine run northwards into the Dnieper tributary, the Prypyat, on the Belarus side of the border. The Dnieper serves as the most important source of domestic, agricultural and industrial water supply in the country. *At least 30 million people and the most important industrial areas are dependent on its water.* Water consumption along the Dnieper is reportedly about 20 billion $m^3$ per year.

2.37 The Dnieper is fed from heavy, stable rainfall in the north and west, and it carries water to the dry regions in the south. The high and rather stable water flow has also resulted in generally better water quality than in most of the other rivers running in the south. Nevertheless, the state of the Dnieper is a matter of major concern in Ukraine, and is considered a priority. Among other effects, pollution is reported to have reduced fish production in the river. The annual catch has dropped sharply in the last decades, the reason for which may be a combination of pollution, river regulation and overfishing.

---

14/ The Dnieper's drainage basin is 503,000$km^2$, its mean annual runoff is 53 billion $m^3$ (variance between 18 and 73 billion $m^3$), and it falls 220 meters on its course from Russia, through Belarus and Ukraine, to the Black Sea.

2.38 The stability of water supply capacity has been improved by the construction of a chain of reservoirs along the Ukrainian part of the river. Also, channels have been constructed to divert Dnieper water to high demand areas in the southern part of the country, such as the heavily populated industrial centers in Donbass and Krivbass and the industrial and agricultural areas in the Crimea. Most of the six large reservoirs on the Dnieper are rather shallow, making total retention time short and creating ecological conditions in between those of a river and a lake. Considerable eutrophication has been reported in the reservoirs, resulting in seasonal blue-green algal "blooms" in the shallow and slow-moving parts of the reservoirs, impairing drinking water quality and clogging water intakes for domestic and industrial water supply. These problems were most predominant in the first years after the dams were built, due to the mobilization of biogenic material in the inundated areas. The situation now seems to have stabilized on a somewhat reduced, but still quite serious eutrophic level.

2.39 The function of the reservoirs in the total nutrient and pollution mass balance in the river is little understood. The reservoirs level out the water flow and consequently the water quality over the year. They may also trap nutrients such as phosphorus and nitrogen, thereby preventing eutrophication in the lower part of the river and the Black Sea. Persistent pollutants, e.g., organic micropollutants (pesticides, PCB, dioxin etc.), heavy metals and radionuclides, may also be trapped in the sediment. Data on the present levels of such toxic substances in the sediments of the reservoirs are minimal. Such "hidden" pollution sources could be mobilized during extreme low water situations and in periods of high turbulence, but the concentrations and health impact are uncertain.[15]

2.40 *It is also difficult to get a clear picture of the ambient water quality of the Dnieper.* The only published monitoring data is from the Hydromet network,[16] although various research institutes have additional data. According to Hydromet, the main stream of the Dnieper is polluted for most of its length (Tables 2.3 and 2.4), and water quality standards are exceeded for BOD, nitrite, petroleum products, phenol, and in particular copper in many of the stations. However, the standards applied are the most stringent "fish production standards." When compared with both Ukrainian and western standards for "raw water for drinking water supply," the situation appears less alarming. In addition, after a long period of increasing pollution levels, the figures for most parameters have fallen in the last two to three years.

2.41 Hydromet observations for 1991 would indicate that the Dnieper is less polluted than other big European rivers, such as the Rhine or the Danube. This relatively pacifying picture is difficult to understand in light of the high volume of wastewater discharges into the Dnieper and the heavily polluting industrial activities in the catchment area. One remarkable characteristic in the official figures is the very low levels for total nitrogen (maximum levels of less than 1 mg/l) in the lower part of the river. These levels are less than one-tenth of what would be expected based on experience with similar rivers. By contrast, the central water laboratory of MEP has also conducted analyses for the lower Dnieper, inwhich much higher (and more normal) figures for nitrogen in the Dnieper (in the range of 6-7 mg/l) have been observed. Since the question of data reliability can be raised for standard water quality parameters such as nitrogen (both total nitrogen and nitrate), there is also reason to question the analytic results for parameters which are more difficult to analyze, such as those for some heavy metals. Given this background, it is difficult to provide conclusive statements on water quality in the Dnieper at this time.

---

15/ Refer to Chapter VII concerning radionuclide contamination from the Chernobyl accident.

16/ State Committee on Hydrometeorology, with the largest monitoring network. See Chapter III and Annex 7.

In addition to the issue of measurement reliability, some key components have not been analyzed. There is at present no analytic capacity for some important micropollutants for which high concentrations could be expected. Concerns about monitoring, laboratory performance and quality control will have to be addressed before the issue of Dnieper water quality can be settled.[17]

2.42 The Center for Water Protection (Kharkiv) under MEP is planning to undertake *a baseline survey of water quality in the Dnieper. Such a survey is a high priority, particularly along the southern reaches of the river where the heaviest industrial activity exists.* It is strongly recommended that the Center conduct this survey collaboratively with external experts, who can introduce modern monitoring equipment and analytical methods, thus offering a clearer picture of the state of the river and, in the process, providing training and feedback to local experts.

2.43 **The Dnieper River Basin Commission.** In early 1992, the Ukrainian government set up a commission to evaluate and find solutions to the pollution problems of the Dnieper River. Its work was slowed, though, by insufficient budgetary resources and delays in staffing at the working level. The commission has again started up in 1993, chaired by the current Minister for Environmental Protection. *It is strongly recommended that the activities of the commission be oriented toward supporting integrated river basin management and water quality regulatory objectives rather than being research oriented.* In this regard, it is very important for the State Committee on Water Resources and MEP to work closely together to integrate better management of water uses, protection of water quality and conservation of resources such as fisheries.

2.44 In respect of water quality, two activities are suggested as priorities. First, it would be worthwhile to seek external donor support for a *baseline survey of water quality* in the Dnieper river, using modern monitoring equipment (see para. 2.42). Second, the commission should try to identify early on *priority actions* which can be taken in the medium term and not get so involved in data analysis and comprehensive water modeling that all action is forestalled for some time to come. *The industrial cities of the south--Dnipropetrovsk, Dniprodzerzhinsk, Zaporizhzhia and Kryvyi Rih*[18]*--are easily identified as priority areas along the Dnieper* (see also section D). Analyzing the multiple problems and regulatory needs of a sub-basin of the river, e.g. the southern reaches, in conjunction with the baseline survey mentioned above, would be a desirable way to start.

2.45 Looking at the needs of the water basin strategically involves a longer term planning exercise. That exercise would need to consider the following: all significant sources of effluent discharges (point and non-point) along the river; all abstractions for water supplies, including those for irrigation and electric power; and average and seasonal river flow. It should also consider policies to improve water conservation broadly, such as: improving charges for water usage and wastewater discharge; promoting recycling opportunities at factories; introducing leakage control programs; and identifying opportunities in agriculture to conserve water and reduce runoff. Projecting future uses based on economic and environmental scenarios, such an exercise would then formulate and cost out possible options for meeting needs and mitigating impacts. Priorities for longer term action could then be determined, based on impact and cost effectiveness.

---

17/ See Chapters III and IV and Annex 7.

18/ Kryvyi Rih is on the Inhulets, a tributary of the Dnieper.

| Table 2.3: Water quality at Dnieper Monitoring Stations 1991[19] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oxygen mg/l | | $BOD_5$ mg/l | | $NH_4$-N mg/l | $NO_2$-N mg/l | | $NO_3$-N mg/l | | Tot-N mg/l | Tot-P mg/l |
| MAC Fish Production | >4.0 | | 3.0 | | 0.4 | 0.02 | | 9.0 | | - | - |
| MAC Drinking Water Use | >4.0 | | 3.0-6.0 | | 1.6 | 0.8 | | 10.0 | | - | - |
| | avg. | min. | avg. | max. | max. | avg. | max. | avg. | max. | max. | max. |
| At Ukraine - Belarus border | | 8.1 | | 2.3 | 0.29 | | 0.007 | | 0.04 | 0.302 | 0.766 |
| Kiev reservoir Novopetrivsk | 10.4 | 9.2 | 1.3 | 1.8 | 0.37 | 0.008 | 0.048 | 0.089 | 0.24 | 0.390 | 0.296 |
| Kaniv reserv. 6 km downstr. Kiev | 11.7 | 8.8 | 2.1 | 4.0 | 0.49 | 0.003 | 0.013 | 0.043 | 0.080 | 0.562 | 0.632 |
| Kremenchuk reserv. Cherkasy | 9.8 | 5.7 | 3.8 | 13.0 | 0.85 | 0.036 | 0.175 | 0.112 | 0.390 | 0.944 | 0.714 |
| Dniprodzerzhinsk reserv. 7 km dnstr. Verkhniodniprovsk | 10.3 | 6.2 | 2.2 | 3.2 | 1.30 | 0.035 | 0.139 | 0.154 | 0.340 | 1 591 | 3.140 |
| Dniproprovski reserv. 3 km dnstr. Dnipropetrovsk | 10.9 | 7.5 | 3.5 | 4.3 | 0.40 | 0.024 | 0.051 | 0.211 | 0.600 | 0.940 | 0.430 |
| Dniproprovski reserv. 8 km dnstr. Zaporizhzhia | 9.8 | 7.1 | 2.0 | 5.1 | 0.15 | 0.023 | 0.098 | 0.411 | 0.720 | 0.815 | 0.176 |
| Kakhivka reserv. 11 km dnstr. Nykopil | 9.5 | 6.3 | 1.9 | 5.5 | 0.15 | 0.013 | 0.040 | 0.483 | 0.700 | 0.840 | 0.166 |
| At entrance Black Sea Kherson | 10.0 | 6.4 | 1.9 | 3.5 | 0.18 | 0.015 | 0.045 | 0.428 | 0.680 | 0.732 | 0.220 |

Source: Hydromet 1991 Yearbook

19/ See Tables 4.2 and 4.3 in Chapter IV for comparable EC and USEPA standards.

| Table 2.4: Water Quality at Dnieper Monitoring Stations 1991[20] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cu µg/l | | Zn µg/l | | $Cr_6^+$ µg/l | | Petroleum prod. mg/l | | Phenol mg/l | |
| MAC Fish Production | 1 | | 10 | | 1 | | 0.05 | | 0.001 | |
| MAC Drinking Water Use | 1000 | | 1000 | | 50 | | 0.3 | | - | |
| | avg. | max. | avg. | max. | avg. | max. | avg. | max. | avg. | max |
| At Ukraine - Belarus border | 16 | 28 | 76 | 170 | 3.6 | 5.4 | | 0.21 | | 0.002 |
| Kiev reservoir Novopetrivsk | 19 | 46 | 55 | 97 | 5 | 6 | 0.062 | 0.370 | 0.001 | 0.001 |
| Kaniv reserv. 6 km downstr. Kiev | 8 | 30 | 35 | 87 | 4 | 7 | 0.072 | 1.370 | 0.001 | 0.010 |
| Kremenchuk reserv. Cherkasy | 19 | 53 | 264 | 844 | - | 2 | 0.011 | 0.030 | 0.005 | 0.016 |
| Dniprodzerzhinsk reserv. 7 km dnstr. Verkhniodniprovsk | 39 | 78 | 112 | 308 | - | 2 | 0.015 | 0.030 | 0.002 | 0.008 |
| Dniproprovski reserv. 3 km dnstr. Dnipropetrovsk | 25 | 29 | 49 | 58 | 2 | 6 | 0.053 | 0.140 | 0.004 | 0.006 |
| Dniproprovski reserv. 8 km dnstr. Zaporizhzhia | 17 | 29 | 53 | 97 | 9 | 21 | 0.018 | 0.040 | 0.002 | 0.006 |
| Kakhivka reserv. 11 km dnstr. Nykopil | 18 | 59 | 51 | 89 | 9 | 27 | 0.015 | 0.030 | 0.001 | 0.004 |
| At entrance Black Sea Kherson | 16 | 47 | 63 | 280 | 10 | 26 | 0.017 | 0.060 | 0.001 | 0.010 |

Source: Hydromet 1991 Yearbook

20/ See Tables 4.2 and 4.3 in Chapter IV for comparable EC and USEPA standards.

**Other Surface Water Resources**

2.46 There are many unspoiled water bodies in Ukraine, particularly in the mountainous areas. Nevertheless, the general picture indicates that incidents of water pollution occur broadly. The highest concentrations of pollutants are likely to be found in smaller rivers and brooks, due to low water flow and dilution capacity during long periods. Both in the Dnieper River basin and in other catchment areas, the smaller tributaries show far higher pollution levels than the main rivers. Based on Ukrainian standards for fish production water quality, Hydromet reports that the most frequently and heavily violated standards are those for oil products, organic material, nitrogen, phenols, zinc, copper and manganese. However, as mentioned above, the monitoring techniques, the lack of analytic capacity for key parameters, plus overly strict standards in some cases reduce the reliability of these evaluations.

2.47 According to MEP and based on the observations of Hydromet, the most contaminated major rivers in Ukraine are:

- the **Siverskodonets** (Northern Donets), a tributary of the Don River, particularly in the vicinity of the towns of Siverskodonetsk, Lysychansk, and Rubizhne which also suffer water shortages. It is polluted by toxic effluents from chemical plants in the area and from mining activities further downstream. In 1991, the concentrations of nitrite, ammonia, oil components, phenols, copper, zinc, and manganese reportedly far exceeded Ukrainian water standards. The saline water discharged from coal mines has increased the salinity of the river, making it corrosive and unfit for other uses. About one million people use the water from this river, not only in Ukraine but also in the Rostov region of Russia. Management of this river ideally should be coordinated with that of the Don River, considering both water usage and water quality;[21]

- the **Inhulets**, downstream of Kryvyi Rih, supplying drinking water to the cities of Mykolaiv and Kherson. It is seriously contaminated with oil products, metals and salts from water discharges from iron ore mining, and metallurgical and chemical industries in Kryvyi Rih;

- the **Northern Buh**, which according to 1991 observations is contaminated with organic material, nitrogen and heavy metal compounds. Extreme concentrations of nitrogen (close to 100 times the standard) have been observed near the towns of Vinnytsia and Pervomaisk; and

- the **Southern Buh**, which is contaminated with organic material and nitrogen compounds at all observation points. The discharges from industries in the vicinity of the town of Sokal have reportedly led to marked pollution from heavy metals.

**Groundwater Problems**

2.48 As mentioned earlier, only 15 percent of the population uses groundwater sources for drinking water supplies, primarily in rural areas. An estimated 27 percent of the expected potable groundwater resources are utilized. Use of groundwater varies considerably by oblast, however. In Dnipropetrovsk

---

21/ Under the FSU, these rivers were under the same river management unit.

Oblast, for example, groundwater serves approximately 30 percent of the 3.9 million inhabitants, almost exclusively in rural areas. While there is anecdotal information on natural or human-induced contamination of groundwater in the oblast, only 10,000 inhabitants are served by trucked-in supplies.

2.49 In 1990, the USSR Ministry of Geology estimated that nearly 4 percent of the underground water resources of the Ukraine were contaminated. This percentage rises sharply for areas that are heavily industrialized. For example, reported contamination of underground water resources in Crimea, Odessa and Luhansk are 23 percent, 19 percent and 13 percent respectively. Reported cases of groundwater pollution in 1990 came from nine cities in Donetsk and Luhansk Oblasts, near the industrial cities of Kryvyi Rih and Dnipropetrovsk, and mining areas (both iron ore and plutonium) in the Krivbass region. Most involved spills, effluents or seepage from wastewater impoundments associated with chemical and mining industries. Several aquifers in the Luhansk Oblast, near the Siverskodonets River, are considered so contaminated that they are unusable for domestic purposes; this is an oblast which chronically faces water shortages. Problems with the usage of agricultural chemicals are reportedly the major sources of groundwater pollution in the Crimea and in Odessa Oblast. Agricultural runoff and poor sanitary or waste management practices, associated with both informal and large cooperative livestock production, are sources of contamination of rural groundwater supplies more generally.

2.50 There are significant gaps in data on local groundwater quality despite considerable monitoring by the State Committee on Geology. This reflects two problems: (i) the absence of advanced monitoring and lab equipment which prevents obtaining information on site-specific or area-wide contamination from specific toxic organic constituents, such as pesticides and chlorinated solvents; and (ii) the lack of requirements for monitoring landfills, waste impoundments, and industrial sites.

**The Black Sea and Sea of Azov**

2.51 The **Black Sea** is distinctive as a very large marine water body, covering over 420,000 $km^2$ and reaching a depth of 2212 m, which is almost completely isolated from the world's oceans. The northwestern part of the sea receives discharges from two of Europe's largest rivers, the Danube (203 $km^3$ water/year) and the Dnieper (54 $km^3$/year), as well as from the Dniester (9.3 $km^3$/year) and other smaller rivers. The Sea of Azov, connected to the Black Sea by a neck of water, receives the flowg of the Don and Kuban rivers (28 $km^3$/year and 13 $km^3$/year respectively). The isolation of the Black Sea and its low level of water exchange with the Mediterranean has resulted in permanent oxygen deficiency below a depth of 150-200 m, meaning that about 90 percent of the sea's total water volume is biologically dead. The upper water layer and the shallower northwestern part of the sea are still biologically productive, due to better oxygen mixing, but are under serious environmental pressure.

2.52 *The evidence is overwhelming that major areas of the shallow parts of the Black Sea, in particular the northwest shelf and the Sea of Azov, are critically eutrophic.* The sea is clearly affected by the activities of the estimated 160 million inhabitants of the drainage basin, almost one half of which are from the catchment area of the Danube. Both point and non-point sources contribute to the heavy nutrient load and the microbiological and chemical pollution of the Black Sea. The nutrient load (nitrogen and phosphorus) from the Danube has increased dramatically during the last 25 years, and similar developments are occurring in other rivers in the region. It has been estimated that the phosphorous load is attributable to domestic sources for 40-50 percent, industry for 10-20 percent, agriculture and natural runoff for 10-20 percent, and atmospheric deposition for 5-10 percent. The eutrophication effects include:

- increased phytoplankton production, resulting in decreased light penetration and massive loss of shallow water benthic algae and marine life habitat; and

- profound changes in the fish populations, also affected by overfishing; a number of sensitive, high value species have been replaced by a few species of low value: of the 26 species of commercial fish available in the 1960s, only 6 remain in significant quantities today.

2.53 Eutrophication and microbiological pollution have together resulted in a blow to the tourism potential of many coastal areas because of unpleasant water conditions on popular beaches and outbreaks of salmonella and enteric viruses at bathing resorts. A particularly serious situation exists near Odessa, where several beaches are routinely closed during the summer. This is the result of the direct discharge into the sea of more than 70 million $m^3$ of practically untreated sewage each year.

2.54 Data on chemical pollution are fragmentary. It is clear, though, that almost all rivers draining into the sea from Ukrainian territory are affected by industrial and mining waters, and many coastal industries appear to discharge directly to the sea with little or no treatment. Dumping of hazardous waste and sludge reportedly occurs frequently. Ship traffic and port activities have created problems of oil pollution.[22] Heavy metal contamination seems to be confined to specific areas. It has been reported that seafood samples taken near the Dnieper estuary have a mercury content above the limits recommended for human consumption, but actual values are not known. Local measurements of pesticide levels in the sea indicate there may be problems in some areas.[23] Box 2.3 discusses the multilateral efforts now being organized to address the problems of the Black and Azov Seas.

2.55 The **Azov Sea** is an extremely shallow and isolated part of the Black Sea. Its main inflow, the Don River, receives drainage from the industrial and mining region of the Donets basin via the Siverskodonets River and is reportedly polluted with heavy metals and saline mine water. The most important polluters discharging directly into the Azov are said to be the integrated iron and steel works of "Azovstal" and "Illycha" and an associated merchant coke oven facility at Mariiupil on the sea coast. The total inflow of fresh water into the Azov has been reduced in recent years due to heavy withdrawal of water from the rivers, resulting in a higher concentration of minerals and nutrients in the remaining discharged water. The eutrophication process this has triggered is even more dramatic than in the rest of the Black Sea. Together with a rise in the salt concentration in the Azov basin, and probably overfishing, this process has contributed to a catastrophic reduction in fish harvest and migration patterns. The fish catch reportedly declined from 170,00 tons in 1980/81 to 8,500 tons in 1990; the variety and size of fish also declined. *An investigation of what can be done to revive fish production in the Azov, an important economic activity, is badly needed.*

---

22/ See discussion of problems at Odessa, paras. 6.72-6.73, Chapter VI.

23/ Reported values of DDT from the Strait of Kerch between Azov and Black Seas are in the range of 8-20 ng/l, two orders of magnitude higher than in Mediterranean coastal waters and far above the U.S. standard of 1 ng/l.

**Box 2.3: Saving the Black Sea**

In the past year, those countries located along the coast of the Black Sea, including Ukraine, have signed two agreements aimed at reducing pollution of the sea--the Bucharest Convention on the Protection of the Black Sea Against Pollution and its three protocols (April 1992), and, most recently, the "Odessa Declaration," the Ministerial Declaration on the Protection of the Black Sea (April 1993). Providing support for implementation of these commitments is the three-year **Program for Environmental Management and Protection of the Black Sea**, funded by the Global Environment Facility (GEF) and various multilateral and bilateral donors. The Black Sea Program will include the following activities:

- identification of an urgent investment portfolio, for which feasibility studies will be prepared, and identification of needs in respect of coastal zone management and biodiversity protection;
- preparation and adoption of a Black Sea Action Plan; and
- technical assistance, training and capacity-building and related support for environmentally sound investment policies.

The "urgent investment portfolio" is limited to coastal cities along the Black and Azov Seas; in Ukraine, three cities have been identified: Mariiupil, Odessa and Sevastopil-Balaclava. The Black Sea Program recognizes, though, that coastal cities constitute a relatively small percentage of the total water drainage basin, and it is clear that any comprehensive management program must consider the activities upstream in the major river basins--the Danube, Dnieper, Dniester, Don, Kuban and others.

Also under preparation, through the GEF, is a conservation management project for the Danube Delta, a major wetland on the Black Sea along the coast of Romania and Ukraine, which acts as a natural filter for water flowing from the Danube River Basin to the Black Sea (see Annex 6 for a more detailed description).

## Other Transboundary Water Issues

2.56 A number of rivers originate in the western part of Ukraine and flow into neighboring countries. The most important of these is the **Dniester River**, which is affected by Ukrainian industry before it runs into Moldova. Other transboundary rivers are:

- the **Northern Buh** which flows into the Vistula and ends up in the Baltic Sea;
- the **Sian**, also flowing into the Vistula;
- the upper **Tisa** and other Tisa tributaries which run from Ukraine into Czechoslovakia and Hungary before joining the Danube in Yugoslavia;
- the Danube tributary **Siret** (Syren), which runs into Romania; and

- the **Prut** which, after leaving Ukraine, forms the Romanian/Moldovan border down to the confluence with the Danube.

2.57 In relation to water volume, these western rivers seem to be relatively heavily loaded with polluted wastewater in their Ukrainian reaches. In addition to significant municipal sources, there are a range of chemical factories, refineries and other industrial enterprises located along these rivers, although this area is less industrialized than the south-southeastern part of the country. Consequently, a good deal of controversy has occurred over transboundary water pollution, and international efforts are underway to address these complicated questions (see Box 2.4).

**Box 2.4: Other International Waters Programs**

Ukraine is a participant in two other international waters programs -- for the Baltic Sea and Danube River. Activities of those programs include: identifying sources of pollution (both specific and dispersed), preparing short and long term action plans for investments to address the problems, preparing related pre-investment studies, and strengthening monitoring and data management. Pre-investment studies under ***the Baltic Sea Joint Comprehensive Environmental Action Program*** have covered various rivers feeding into the Baltic Sea, including two tributaries of the Vistula River in western Ukraine: the Northern Buh and Sian. Sites in Ukraine which have been identified as particularly important are: (i) municipal wastewater treatment and related sludge treatment in Lviv (a city of 800,000), (ii) wastewater treatment in the western coal mining region, and (iii) high mineralization of wastewater from the Yavoriv sulfur mining region.

***The Environmental Program for the Danube River Basin*** is funded jointly by a group of international and bilateral donors, including the Global Environmental Facility (GEF); Ukraine participates in the Danube River Basin Task Force. The Tisa, Siret and Prut Rivers are included in the Danube Program as tributary rivers, for which pre-investment studies began in late 1992.

## D. Priorities for Drinking Water and Wastewater Treatment[24]

2.58 Practically every municipal area has problems with water and wastewater treatment; in many cases, expansion projects have been started but have slowed because of lack of resources and remain under construction for extended periods, resulting in large cost overruns and idle assets. Water and wastewater treatment investments are very expensive, especially the more advanced forms of treatment (see Table 2.5). Unfortunately, the strict ambient water standards currently used in Ukraine push municipal authorities (the "Vodokanals" in charge of water and wastewater treatment) to plan for advanced treatment investments (see Box 2.5).

2.59 A more affordable policy is to try to assure better operation of existing plants and basic treatment more broadly throughout the country. *This study recommends making smaller investments and emphasizing better management to improve the efficiency and throughput of existing plants.* It also suggests that MEP establish minimum technology standards for treatment plants, which can be phased

24/ Also see Annex 3 for information on individual cities and plants.

in as resources permit, rather than trying to meet overly strict ambient standards. Municipal utility reform should also be part of any effort to rationalize urban water use and reduce water pollution.

**Strengthening Municipal Utilities**

2.60 Reform of municipal agencies is a step which can get started immediately; it is not dependent, as so many actions are, on questions of industrial restructuring or longer term economic viability. Allowing greater operating and financial autonomy for the Vodokanals should spur them to achieve higher operating efficiency and would relieve the municipal government from the financial burden of supporting these operations. At present, plants are operated by large numbers of partially trained or untrained personnel; with greater instrumentation, future operating methods will require a smaller number of staff but with specific training in the areas of plant operation, process control, and mechanical, electrical and electronic instrument operation.

2.61 Affordability is the obstacle to making many needed investments in this sector. The Vodokanals need the power to set "economic" rates for drinking water and water treatment which cover actual costs and create a self-financing capability to meet operational and investment needs. Currently, the Vodokanals are responsible for covering their operating costs through water tariffs, and some do cover nominal costs (which do not reflect full economic costs). Many others receive compensatory funding from the central government, normally channeled through the local government. As noted in Chapter I (para. 1.15), water rates have gone up by several multiples for various users over the past two years, but they are still low in real terms. Rates for the general population (households) are held extremely low by central government mandate, while the Vodokanals have the flexibility to charge higher rates for other users, and in fact cross-subsidize households by charging higher rates to industry. Higher rates in the household sector will need to be phased in over time because incentives for conservation are important in this sector too. Charges for wastewater flowing into municipal sewers are also low, although they too have been raised recently; not only should they be higher, but they should also be based on the content and strength of pollutants in the wastewater, in addition to volume.

**Improving Drinking Water Treatment**

2.62 Due to the extremely variable quality of raw water being extracted from the Dnieper and other rivers, water is heavily chlorinated at treatment plants to assure a safe drinking water supply. This is a necessity at the present time. Doses of chlorine in the range of 6-9 mg/l are used in prechlorination at the intakes. The treatment process which follows includes aluminum sulphate added as a flocculent and rapid gravity sand filtering. The treated water is further chlorinated to maintain a residual level of about 0.5 mg/l in the distribution system. The monitoring of chlorine residual levels is carried out, as in the case of raw water, by manual sampling and analysis in plant laboratories. None of the water treatment plants surveyed in the study was equipped with adequate instrumentation. The need for on-line organic pollution monitors and chlorine residual analyzers and controllers was evident.

2.63 **Water Leakage.** A brief review of water treatment plants suggests that most plants would benefit from water leakage control programs to reduce losses from the distribution system. While officially leakages are reported to be 25 percent or less,[25] they could be as high as 35 percent since it appears that no operational arrangements are in place for monitoring and controlling leakage. Before building new

25/ Leakages in EC plants run about 20%.

water treatment capacity, it is essential that a program be undertaken to estimate the amount of leakage in the distribution system and that steps be taken to bring this under control. This should include provision of valves and flow meters for dividing the distribution system into zones and, as field data become available, zoning analysis of the water supply network should be undertaken using computer techniques. Areas of excessive leakage should be identified and repair of mains undertaken (which can be considerably expensive in itself).

2.64 **Filtration and Sludge Disposal**. Relatively low cost measures to improve the efficiency of filtration (thus increasing the volume of water which can be handled) and to reduce backwash effluents are also important. Rapid gravity sand filters are used for filtration of the raw water, with aluminum sulphate added as a flocculent. In the backwashing of the filters, there are two fundamental problems that need to be solved:

(i) lack of air scour; and
(ii) insufficient dewatering of sludge from the backwash water.

2.65 The present systems of backwashing do not include air scour in the cycle to loosen the sand bed prior to flushing with backwash water. Consequently, the backwashing operation is inefficient, and this has the effect of reducing the filter run time between backwashes, which in turn leads to a greater demand for backwash water and hence a higher loss of treated water within the plant. Problems with disposal of the sludge are widely apparent also. At present, backwash water is returned directly to the river, representing a further pollution load. Schemes are needed to dewater the filter backwash sludge and then dispose of it in landfills (dewatering will reduce landfill requirements, a serious problem in itself).

**Improving Wastewater Treatment**

2.66 All wastewater treatment plants visited during the study had the same basic treatment technology. Preliminary treatment comprised grit removal in channels followed by mechanical screening, primary sedimentation in circular tanks with mechanical scrapers, and biological treatment using the activated sludge process. Standards of design and construction tended to be poor, particularly with regard to safety aspects. For example, there appear to be no design standards for ladders, staircases, handrails or machinery guards. There is virtually no instrumentation available. Where provision had been made in the original design and construction of plants, the instruments are either recording incorrectly, are not working, or have been removed because they are no longer operable. Staffing at each treatment plant is typically about 150 employees; equivalent treatment plants in western Europe would employ only about 25 people.

2.67 Almost all wastewater treatment plants, industrial and municipal, surveyed during the study had acknowledged problems concerning treatment processes and disposal of sludge, attributed to the following causes:

- inadequate technology and lack of expertise in the design and operation of anaerobic sludge digestion plants;
- lack of technology for mechanical dewatering; and
- increasing difficulties in finding solutions to the sludge disposal problem.

2.68 *Various steps at both industrial and municipal treatment plants would help improve the effectiveness of wastewater treatment facilities and economize in regard to water use and sludge disposal.* Many of the treatment plants visited had anaerobic sludge digestion installations, but none of them operated effectively. At Zaporizhzhia, for example, sludge was digested in tanks heated by natural gas, but the methane produced, a potential fuel for the heating boilers, was instead vented away to the atmosphere. At Dniprodzerzhinsk, sludge digestion tanks were not included as part of the treatment process because they were considered too complex to operate. Well designed and operated sludge digestion plants offer the following advantages in treatment and disposal of sludge:

(i) biological stabilization of the sludge to reduce odor;

(ii) reduction in the volume of sludge solids, thereby enabling economies to be realized in subsequent treatment stages, particularly mechanical dewatering of the sludge; and

(iii) production of methane gas for possible use as an energy source in power generation at the treatment plant.

With the introduction of pre-fabricated digestion tank installations and modular generating plants operating on methane gas, used in various countries, the difficulties presently experienced with anaerobic sludge digestion at the treatment plants could be overcome.

2.69 Aeration efficiency also seems poor and below that achieved in EC plants. Improvements in oxygen transfer efficiency will have a direct bearing on energy consumption; consideration needs to be given to the introduction of modern aeration equipment in any new activated sludge plants.

2.70 Another priority is to dewater the sludge, thus reducing it by perhaps 50 percent (about 90 percent of the sludge is water). In mechanically dewatering, it would be helpful to introduce western technology such as filter belt presses or centrifuges. Where sludge is treated by anaerobic digestion, followed by mechanical dewatering, it could be used in agricultural applications, provided any heavy metal concentrations in the sludge can be controlled within acceptable limits. Alternatively, the dewatered sludge could be deposited in landfills. *Dnipropetrovsk, Zaporizhzhia and Kiev are all cities which badly need to develop a strategy for managing and disposing of sludge from their treatment plants (see Box 2.5).* Other large cities, e.g. Kharkiv, may also have similar problems.

2.71 At all plants, better instrumentation and controls would improve operations and highlight operational problems for managers to address. Efficient operation of activated sludge biological treatment plants, for example, is wholly dependent on accurate measurement of oxygen input, electricity consumption, dissolved oxygen, sludge concentrations etc. Substantial improvements in the level of instrumentation throughout the treatment plants is a prerequisite to improvements in effective management and operational control. Introduction of instrumentation should be phased, not overly elaborate initially. Over time as better instrumentation is introduced, the opportunity should be taken to install automatically operated control systems, e.g. automatic control of oxygen input and sludge solids concentration in the biological activated sludge plants.

2.72 **Comparing Costs of Different Forms of Wastewater Treatment.** Building new wastewater treatment facilities will be expensive, and that expense multiples as more advanced forms of treatment are introduced. This is an important issue to consider in shaping environmental policy and strategies for investment in municipal infrastructure. A useful illustration of the trade-offs in terms of efficacy and

**Box 2.5: Wastewater Treatment in Zaporizhzhia**

Zaporizhzhia is served by a wastewater treatment plant on each bank of the Dnieper River; both have primary and secondary treatment. The plant on the left bank, which is presently being extended, has a treatment capacity for 175,000 cu.m per day, but receives an inflow of 350,000 $m^3$ per day. Only 200,000 $m^3$ per day is passed through the treatment plant, the remaining 150,000 $m^3$ are discharged directly into the river without treatment. Completion of the extension was planned in 1994, but lack of funds is delaying this investment.

In March 1991 the State Committee for Nature Protection (now MEP) and the Ministry of Health set new standards for the quality of effluents discharged from treatment plants: a BOD limit of 3 mg/l, compared to a previous limit of 15 mg/l; and a suspended solids limit of 5.25 mg/l, compared to a previous limit of 15 mg/l. Meeting those standards demands construction of advanced treatment systems at both plants in Zaporizhzhia, increasing substantially the investment costs involved. This is an example where introducing strict standards pushes plants into expensive investments when funds might be better spent putting in less sophisticated treatment in *more* areas.

Both treatment plants have serious operational problems in the treatment and disposal of sludge. Previous attempts at mechanical dewatering of sludge using Soviet built centrifuges have not met with success as the mechanical equipment lasted only two years. At present sludge is pumped from the plant to lagoons where it dewaters by a combination of surface evaporation and gravity. The drainage water is returned to the plant for treatment. Some of the air-dried sludge is used for agricultural purposes but over the years considerable quantities have accumulated: 150,000 tons on the left bank, 30,000 tons on the right bank. Clearly, both plants need to develop an integrated plan for treatment and disposal of sludge.

costs is provided in Table 2.5.

2.73 This study recommends a practical strategy of trying to assure basic treatment, commensurate with the ability of a local Vodokanal or firm to finance the investment on a timely basis and meet operating costs, rather than moving too quickly to more advanced forms of treatment. The irony in Ukraine is that well-meaning environmental authorities may be encouraging costly investments in advanced treatment to meet environmental standards which are unrealistic at this point in time (see Box 2.5, which is representative of experience in other cities as well).

2.74 **Wastewater Charges and Incentives for Pretreatment.** There is clearly a need to introduce more effective systems in regard to the following:

- the setting and controlling of concentrations of constituents in the effluents discharged to the sewers; and
- introduction of an improved wastewater charge system to encourage the pretreatment of effluents before discharge to the sewers.

**Table 2.5: Removal Rates and Typical Costs of Wastewater Treatment Processes[26]**

| Treatment Process | Typical Removal Rates (%) for: BOD | Total Phosphorous | Total Nitrogen | Suspended Solids |
|---|---|---|---|---|
| Mechanical (primary) | 30 | 15 | 15 | 60 |
| Chemically enhanced mechanical | 60 | 80-90 | 30 | 80 |
| Traditional biological (secondary) | 70-90 | 30 | 30 | 80-90 |
| Biological-chemical (secondary) | 90-95 | 90-95 | 35 | 90-95 |
| Advanced | 95-97 | 90-95 | 70-85 | 97 |
| | **Typical Cost Ratios (Mechanical Treatment = 1)** | | | |
| | Capital Costs | Annual OMR Costs [a] | Total Annual Costs [b] | |
| Mechanical (primary) | 1.0 | 1.0 | 1.0 | |
| Chemically-enhanced mechanical | 1.1 | 1.6 | 1.3 | |
| Traditional biological (secondary) | 1.5 | 1.7 | 1.6 | |
| Biological-chemical (secondary) | 1.7 | 2.7 | 2.0 | |
| Advanced (biological-chemical) | 2.4 | 3.0 | 2.6 | |

[a] OMR = Operation, Maintenance and Replacement (includes dewatering and anaerobic stabilization for sludge treatment.
[b] OMR plus amortization of capital costs @ 12 percent interest rate over 20 years of economic life.

Particular attention should be paid to applying limits to hazardous effluents, especially heavy metals, since the concentration of these metals in the municipal wastewater will directly affect the possibilities for use of the sludge on agricultural land. With regard to charge schemes, various models exist in the EC. They are based on formulae incorporating factors for volume and strength of wastewater discharged. *MEP may want to take further steps, through its regulatory permit system, to encourage broader and more efficient pretreatment of wastewater at industrial plants, even at smaller plants.*

2.75 Centralized pretreatment facilities have been suggested as a way of meeting the needs of smaller plants, but experience in other countries indicates success is difficult because of differences in effluents from individual plants and the additional pipeline infrastructure necessary for centralized pretreatment.

**Duplication of Laboratories**

2.76 There is considerable duplication of laboratory facilities undertaking sampling and analysis of effluent and water samples. For example, it is usual to find a fully staffed laboratory at each wastewater treatment plant and water treatment plant. Their work is usually duplicated by similar laboratories at the

26/ Source: "Environmental Action Program for Central and Eastern Europe" Lucerne, Switzerland, 30 March 1993, pp. V-26.

Vodokanal regional office. Laboratories are also maintained by the regional office of MEP and the sanitary service of the municipal authority. None of the laboratories surveyed during the study were equipped to standards expected in Western European or American water testing laboratories. A policy for rationalizing these laboratories needs to be established. Ideally, in each regional center, only one fully equipped, modern laboratory is required, staffed by trained scientific officers and technicians. This laboratory should be capable of handling all samples from wastewater and drinking water treatment plants as well as effluent and river water samples.

**Priorities for Water and Wastewater Treatment**

2.77 This study has identified priority cities for improvements and some expansion of drinking water and wastewater treatment facilities, based on potential dangers to health and prevention of water quality deterioration in major waterbodies. They are: Zaporizhzhia, Dnipropetrovsk, and Dniprodzerzhinsk along the Dnieper River, Kryvyi Rih near the Inhulets River, Mariiupil on the Azov Sea, and Odessa and Sevastopil on the Black Sea. There are also serious water management and water quality issues along the Siverskodonets River (from Kharkiv down through the Luhansk Oblast) which demand further investigation. And, finally, there are sites of high natural and touristic value which merit consideration: Yalta in the Crimea and possibly selected towns in the Carpathian mountains.

2.78 The relatively lower cost activities and equipment investments mentioned above in the previous sections of this report should come first, with sensible expansion investments being considered after taking into account gains achievable through efficiency improvements in existing operations. Technical assistance is needed to improve the structure and management of the systems, to rehabilitate and renew some technical installations, and to install and provide better instrumentation and control facilities.

2.79 But setting priorities is not enough. Affording better treatment facilities will be largely the responsibility of municipal areas. *It is those communities which commercialize their water utilities first, developing their capacity to recover costs and generating internal funding for investments from their revenue stream, which are likely to realize investments in improved treatment the earliest.* This depends also on the willingness of consumers in those communities to pay for improved services.

## E. Hazardous and Solid Waste Management

2.80 In 1990, reportedly over 2,000 enterprises produced hazardous wastes totaling about 105 million tons, 95 percent of which came from metallurgical industries. These estimates are problematic as they tend not to distinguish between the truly hazardous and other wastes. The bulk of waste disposed off-site goes to sanitary-industrial landfills, where wastes are mixed together. Apparently, lack of appropriate equipment, such as bulldozers, dump trucks and compactors, means sanitary practices are not always observed. The wastes are often dumped in unprepared, unconfined areas, which has led to concern about contamination of surface waters and groundwater. Problems with liquid hazardous wastes can be traced to disposal practices and poor housekeeping (e.g. spills and leaks from chemical storage facilities).

2.81 Waste management is a problem in many cities. Again, the worst problems appear to be associated with the industrial cities of the south-southeast. For example, Donetsk Oblast, with all its mining and industrial activities, faces serious problems of waste disposal; the most evident (though not the most hazardous) are the unsightly coal waste terricones dotting the landscape. Authorities in Donetsk

are considering advanced technologies for incineration of waste;[27] plans to adopt such technologies have not been subjected to any cost-benefit analysis, however. *Indeed, more practical, less expensive steps have not been taken, for example separating different types of waste in order to manage them individually. In addition, industrial practices to minimize waste production and opportunities for recycling must be considered in an overall waste management strategy.*

2.82 Landfills would benefit from low cost, passive measures, such as the following:

- lignite liners to clean hazardous chemicals geochemically from seepage;
- compaction of dump surfaces to minimize infiltration of precipitation and eliminate the driving head for seepage;
- water diversion on and around the waste dumps;
- leachate collection and passive treatment; and
- monitoring of groundwater around disposal facilities.

Such measures are only partially effective, but they are low cost. Introduction of sound cost recovery mechanisms (e.g. tipping fees) will also be essential in order to raise funding for needed investments.

2.83 *At the present time, no national or regional agency seems to be inventorying and regulating hazardous waste. In fact, no real distinctions are made between hazardous and other solid waste. This responsibility should be taken up by MEP with urgency.* It is important to have a good inventory of sites, a compliance schedule for any necessary short term mitigation measures, rules regarding transport, reporting requirements, and procedures to track compliance carefully. Legislation should be introduced for the forward looking regulation of major hazardous wastes and the use, storage and transport of hazardous chemicals. Environmental audits of military chemical facilities are warranted as soon as feasible because of concern over their hazardous wastes.

2.84 Considerable administrative capacity is needed even to inventory and prioritize sites. It would be most practical to begin with a short list of sites considered potentially most hazardous to health, then to undertake careful assessments of them, prioritize them, identify remedial options, and finally decide on the most cost effective measures to contain such sites and restrict usage.

2.85 *The most practical steps may be low cost containment of sites considered an immediate health risk (e.g. cordoning off areas or lining land fill sites), rather than full clean up of the site, which would typically be very costly.* An important task, therefore, is to determine the extent of contamination and health risks to workers or the nearby community. Sensible criteria need to be established in setting priorities. The level of restoration will depend on the risk to health and the use of the site. In cases where groundwater contamination is expected, the most cost effective approach may be shipping in bottled drinking water. During privatization, it may be necessary to keep such sites under public ownership to prevent use. The issue of environmental liability and privatization is discussed in Chapter V.

---

27/ Incineration of toxic substances occurs in various industrialized countries, but is expensive. See Annex 3 for a discussion of the proposal in the section on Donetsk Oblast.

**Box 2.6: Clean up of Hazardous Waste Sites in Other Industrialized Countries**

Experience with clean up of hazardous waste in various industrialized countries is sobering--the costs are overwhelming, and even wealthier countries have not been able to afford prompt clean up of all sites. A well known example is the "Superfund" in the United States, the nickname for the ambitious hazardous waste clean up program legislated in 1980 under the "Comprehensive Environmental Response, Compensation and Liability Act." Reportedly, more than US$11 billion have been spent or committed to date, while only 63 of more than 1187 priority sites identified by 1991 have been cleaned up. Because the burden of this program falls on the private sector, litigation costs have been significant.

Several EC countries have also confronted high costs when faced with a detailed inventory of clean up sites. Germany, for instance, is seeking to clean up sites in both western and eastern parts of the country; funding has only been possible for risk mitigation measures, rather than full remediation, however. An interesting arrangement is taking place, though, in the form of integrated site planning to try to bring together local, state and federal authorities, cooperating closely with industry, to identify priorities and cost effective solutions.

General source: "Environmental Liability and Privatization in Central and Eastern Europe," World Bank Report no. 11686-ECA, June 5, 1993.

2.86 Opportunities to introduce recycling schemes (via deposit-refund or taxation schemes) should be explored. One suggested activity is to develop a "recycling registry," perhaps initially in selected oblasts, consisting of an inventory of all recoverable waste materials from industry, including hazardous wastes. Many such materials have uses as raw materials, solvents and catalysts in other production processes. The register should include data on the purity of recoverable materials and volumes available. Various authorities have expressed interest in acquiring recycling or material recovery technologies, but careful cost-benefit analysis should be employed before making particular investments. Without more realistic pricing of materials, many such investments will not be financially viable.

2.87 There are also reports of dumping of hazardous wastes from other countries in Ukraine, an international problem which is getting more attention now as a result of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (effective 1992). Ukraine is not a signatory and probably does not have the resources to meet member obligations. But some of the countries originating this waste may be signatories and therefore accountable.

## F. Other Potential Hazards

2.88 Little information was available during this study on the high pressure ammonia pipeline (pressurized at 80 atmospheres) which originates in Russia, crosses the southern half of Ukraine (fed along the way by various ammonia plants), and terminates at Odessa where much of the ammonia is exported. This pipeline is a potential hazard because the ammonia is at high pressure, and the pipeline crosses areas of uneven terrain, due to land subsidence from mining activities; leaks in the pipeline could create a life-threatening chemical cloud.

**Box 2.7: Cross Media Pollution Problems at Mariiupil**

Mariiupil is a community of about 530,000 people on the Azov Sea; its population doubles with the influx of tourists in summer. Mariiupil's landscape is dominated by its two major steel plants (Illycha and Azovstal) and an associated coking facility. These enterprises are major employers in the city. Mariiupil is reminiscent of former steeltowns such as Pittsburgh in the US. *It is a typical industrial city with cross media pollution problems.* Its environmental problems will be solved only in parallel with rationalization of metallurgical facilities in the city.

The two iron and steel plants and the coking plant are major sources of air pollution in the city, creating 97% of all the air pollution from stationary sources. The Illycha complex contributes an estimated 396,000 tons of air pollutants, Azostval 183,000 tons, and the coke plant 18,000 tons. In addition, fugitive emissions within different workshops of the plants are high. One of the plants, Azovstal, and the adjacent coke oven are located in the center of the city, contributing to high ambient particulate concentrations in the city. Some of the wastewater discharges from Azovstal go into the sea. Others flow to a 300,000 $m^3$ lagoon. The lagoons used by Illycha are almost overloaded, only two years of capacity remaining.

A major problem at the coke plant is that it has over 20% leakages from its coke oven doors, even at the newest battery, compared to a minimum US standard of 5.5% leakages for older facilities and 3.8% leakages for new plants. Only the newest battery at the Mariiupil facility has a hood to capture coke charging emissions, and it is undersized. The pollutant of primary concern at the coking plant is benzo-a-pyrene. Concentrated phenolic wastes from past plant production have been deposited in a lagoon some 20 km from the plant. Leachate from this lagoon has contaminated borehole water supplies which served a small town nearby, and the coke plant now makes available alternative supplies of water. In summer, however, these supplies are insufficient, and the town has recommenced abstractions from the boreholes on a limited scale, a potential public health risk.

While much of Mariiupil is sewered, a number of serious problems exist with the integrity and coverage of the collection system. Unsewered areas, failure of pumping and collection systems and frequent surging all contribute to chronic water quality problems and contamination of beaches during the bathing season. The rate of enteric and other waterborne diseases reportedly rises 2.5 times during summer months. Several existing open dumps or landfills serving Mariiupil are nearing capacity. Available land for municipal solid waste disposal is in short supply within the boundaries of the city.

Drinking water is chlorinated prior to distribution, but system problems, such as supply interruptions and wastewater infiltration, reportedly lead to contamination of water delivered at the tap. Interruptions in the drinking water supply occur daily, due to a highly corrosive water supply as well as the quality of pipeline materials. Little or no metering is undertaken.

City officials are concerned about a recent health study under the auspices of the Institute of Hygiene, MOH, which suggests a relationship between health problems in Mariiupil (increased miscarriages and birth defects) and local pollution. Closer examination of such data is warranted, and corroboration through controlled epidemiological studies is essential before any conclusions can be made. Still, the data are noteworthy and disturbing.

2.89 There are numerous other potential hazards in the shipping and handling of defense-related or other hazardous chemicals, which again argues for sensible, enforceable regulations. A possible example of the danger is the outbreak of alopecia (hair loss) in children in the city of Chernivtsi in 1988, which may have been due to a spill or release of a hazardous chemical (the ultimate source was never confirmed).[28]

## G. Suggested Priorities Across Media

2.90 The extent of pollution problems in Ukraine and the competition for resources among different media and sectors appear overwhelming. The resources available for pollution abatement (whether from central or municipal government budgets, the cash flows of individual companies, or as part of foreign investment) are scarce. This argues for setting priorities where possible, establishing practical standards with appropriate phase-in periods, and recognizing what can be accomplished in the short term and what actions or investments will take a much longer period of time.

2.91 The discussion in this chapter suggests some priorities:

- *Addressing the very serious urban air pollution problems in a number of industrial cities, including worker exposures, where the impacts on human health appear greatest.* Luckily, as pointed out, there are low cost measures which will make a start in reducing fugitive emissions and improving the performance of existing equipment. Various preventive measures (eg. the quality of fuels used or gains in operating efficiency) would also be effective. Beyond operational improvements, encouraging installation of good particulate control (which can help reduce some hazardous emissions also) is an inexpensive strategy relative to other air pollution control investments or, indeed, investments in wastewater treatment.

- *Taking steps to understand better the state of water quality in the Dnieper River and improving river management, balancing river use and water quality objectives.*

- *Supporting utility reform, operational improvements and, as necessary, modest extensions in water and wastewater treatment plants, including industrial pretreatment, in priority industrial cities or areas of high natural or recreational value.* This is a sector where the goal, over time and as resources permit, should be to try to reach minimum standards of treatment over a broad number of communities rather than reaching the most advanced forms of treatment for only a few cities.

- *Looking for low cost solutions to waste management, including considering opportunities for introducing recycling programs.* In respect of hazardous waste, the emphasis should be on prioritizing sites based on health impact and undertaking low cost mitigation and containment efforts wherever possible.

---

28/ See Annex 3, section on Chernivtska Oblast, for details.

**Municipal Environmental Management**

2.92 *It is also clear that many of the most serious pollution problems are centered in urban areas, thus the bulk of responsibility for pollution abatement is likely to fall on municipal and oblast authorities and their respective environmental branches.* Complicating the task of pollution abatement in urban areas is the fact that some of the larger industrial sources have uncertain economic futures over the longer term. It is in this difficult set of circumstances that abatement strategies must be developed and managed.

2.93 In those cities reliant on heavy industry, identifying opportunities for business diversification and area development (including generating recreational or tourism revenue in those areas with such potential) will be essential in building a new economic base, which will eventually generate resources for pollution abatement. In addition, efforts at the national level to begin to restructure some of the larger state-owned industries would help in clarifying their potential for long term viability (see also Chapter V). *In the meantime, municipal and oblast authorities, including environmental authorities, should try to introduce programs to identify and implement short term, low cost actions, across media, which can be taken now to mitigate urban pollution problems* (such as those mentioned at para. 2.13 and in other sections of this chapter).

2.94 In selected priority cities, it is suggested that this activity be accompanied by *pilot programs to improve evaluatory and regulatory activities in order to strengthen environmental management and develop cost effective longer term strategies for environmental compliance.* Resources to support these endeavors might come, in part, from local pollution abatement funds and from external donors, including environmental agencies in other countries.

# III. BUILDING THE INSTITUTIONAL AND REGULATORY FRAMEWORK



## A. The Legislative Mandate

**Background**

3.0 Environmental law in the FSU has evolved from natural resource law formulated in the 1960s and 1970s. This body of law covered the "rational use" of natural resources (land, waters, forests, minerals), flora and fauna, and the atmosphere. It was later extended to include protection from damage resulting from misuse of natural resources and ecological violations. Every Union Republic had its own codes or acts on natural resource management, which paralleled those of the central government. The laws tended to be declarative in nature, expressing high ideals, but not specific about implementation and enforcement mechanisms. Three fundamental factors hampered the effectiveness of the laws: (i) the lack of political interest or will to implement the laws in the face of strong pressures to emphasize production in a centrally planned economy (the owner-regulator conflict); (ii) a weak judicial system which lacked any independence from the central government; and (iii) little government accountability before the public which might have created the necessary political pressure.

3.1 After the Chernobyl accident in 1986 and the ensuing public outrage, which coincided with "glasnost," more attention was paid to environmental issues. What might be called an "environmental bureaucracy" was set up at all levels of the FSU government, building on an earlier but weaker structure, led by Goskompriroda, the State Committee for Ecology in Moscow. Various elements of regulatory policy were put in place, some very sophisticated, including permitting activities, ambient air and water modeling, and regional experiments with pollution fee programs. An ambitious bureaucracy for data collection also developed. The system was able to shut down polluters occasionally, usually when there was also strong public pressure. But it still lacked a strong, fundamental enforcement capability. From this legacy, with a basic structure for environmental management in place, Ukraine is now making its own way.

3.2 Presently, there are about eight principal natural resource or environmental laws operating in Ukraine, some of them inherited from the FSU,[1] others newly passed by Ukraine's Parliament. The new ones include:

- the Law on Protection of the Environment (June 1991), the "Basic Law" which sets out the principles of environmental management in the country;

---

1/ In particular, the Forestry Code of the Ukrainian SSR (December 1979), the Mineral Code of UkrSSR (November 1976), and the Water Code of UkrSSR (June 1972).

- the Protected Areas or Territories Law (June 1992) covering protected areas;[2] and
- the Law on Air Protection (October 1992); and
- the Protection and Use of Fauna Act (March 1994).

3.3 An Information Act, which authorizes access to environmental information (see para. 3.63), was also recently approved. Two other laws are currently pending agreement and adoption, namely. an Ecological Expertise (EIA) Act (see paras. 3.57-3.61) and an act concerning classification of areas of ecological emergency. In addition, there have been various resolutions by the Supreme Council of Ukraine.[3] A January 1992 resolution established a new pollution fee system in Ukraine (discussed in Section C). A November 1993 resolution specifies conditions for import or transport of waste products into the country. Clearly, a considerable number of environment-related laws and directives have been passed or drafted in the last two years, but they generally tend to be overly declarative in nature and not specific enough about implementing mechanisms. A case in point is the "Basic Law."

3.4 **Law on Protection of the Environment, June 1991 (the Basic Law)**. The basic environmental law touches on virtually all aspects of environmental management and sets forth idealistic goals. Article 4 declares public ownership of all natural resources, and Articles 9 and 38 establish individual rights to use natural resources. Article 40 requires "citizens, enterprises, institutions and organizations" to use resources efficiently and without damage to the environment. The law lodges ultimate power with the Cabinet of Ministers, which sets policy, controls budgets and determines procedures for setting standards and pollution charges. Article 20 gives the Ministry for Environmental Protection (MEP) a broad mandate for regulatory policy and basic enforcement responsibility, including the following powers:

- to conduct on-site inspections;
- to subpoena information from industrial enterprises;
- to bring suits into the courts seeking compensation for damages and losses;
- to impose administrative fines;
- to curtail or suspend (temporarily) operations of polluting enterprises; and
- to alter its own bureaucratic structure.

The law also gives local governments and the Cabinet of Ministers powers to shut down industries or to overturn MEP's authority. Only the Cabinet of Ministers can shut down an enterprise permanently.

3.5 While the principles expressed in the basic law are very important, the law remains primarily a declarative document. It defines few clear commands or enforcement mechanisms and does not empower MEP to undertake the rulemaking necessary for implementation of the law. It does not clearly delineate the process for specific activities nor sets priorities or deadlines. The law also provides no guidance about how competing claims for natural resources are to be resolved, nor how to balance demands for consumptive use against maintenance of natural ecosystems. It is also weak in providing guidance on

---

2/ Discussed in Chapter VIII.

3/ For a brief overview of sources of law and a list of environmental laws or resolutions since 1992 see Annex 2, Boxes 1 and 2.

dispute resolution. Finally, this legislation, as others in the past, lacks direct provisions on remedies.[4] Hence, the legislative mandate, though stronger than ever before, still is not as direct and forceful as would be desirable.

3.6 **Drafting of Environmental Legislation.** Legislation is drafted by several groups--the Parliamentary Committee on Ecology, various academic institutes, and MEP. MEP's Legal Department is understaffed and cannot easily take the initiative in preparing environmental legislation. It would benefit from external support, e.g. a part-time legal advisor with regulatory experience or a working group of external advisors to provide advice on drafting more specific legislation and to introduce comparative national approaches to key legislative issues. *Also, it may be best to take the time necessary to draft fewer, more specific pieces of legislation rather than to rush to put forward an array of legislation which is overly declarative.*

## B. Institutional Issues and Needs

### Introduction to the Ministry for Environmental Protection

3.7 Ukraine's new Ministry for Environmental Protection (MEP) was established in August 1991, building on the former "State Committee for Protection of the Environment" created in 1987,[5] itself arising from an earlier committee with less formal authority. In contrast to its predecessor, MEP has a broad mandate to be the primary agency responsible for environmental management. The Ministry is underfunded and understaffed, though, both at national and local levels, in relation to its responsibilities and the magnitude of problems. Moreover, it is commencing its role during a time of economic crisis, when environmental protection seems low on the list of national priorities. In terms of its budget, it is *one of the least endowed* Ministries in Ukraine. The lack of resources severely undercuts MEP's ability to be effective.

3.8 The Ministry has a staff of about 2,800,[6] of which about 178 are in the central office in Kiev, organized into 17 largely functional departments reporting either to the Minister or his three Deputy Ministers (see Figure 3.1). MEP inherited regional offices in all of the oblasts,[7] which were established in 1988/89. The first Minister for Environmental Protection replaced 40 percent of the heads of the oblast offices at the outset of his administration. The branches typically have 60-100 people, some assigned at the district (raion) or municipal level. They are responsible for working with oblast and municipal authorities and industries to agree on permit requirements and to conduct inspections (stack and discharge monitoring) and assess fines. The budgets for the oblast branches are approved separately by the Council of Ministers and controlled in part by local authorities.

---

4/ Chapters which declare liability refer to other acts (Administrative Violations Code, the Criminal Code of UkrSSR) which provide punishment and fines against individuals.

5/ The State Committee was a replica of and reported to Goskompriroda, the State Committee for Ecology established in Moscow at that time.

6/ In contrast, the Ministry of Health has some 20,000 people.

7/ And in the two cities, Kiev and Sevastopil, which have separate legal status.

3.9 The first Minister for Environmental Protection, Dr. Yuri Scherbak, was formerly a leader in the Green World Party (Zeleniy Svit). He began the process of shaping this new Ministry and was active internationally in trying to bring attention to Ukraine's environmental problems and need for resources. Within MEP, he was closely advised by a group of 11 staff members, from central and local offices, called the Kollegiya. The current Minister for Environmental Protection, Dr. Yuri Kostenko, is a member of Parliament who was active in the Parliamentary Committee on Ecology and on nuclear power issues. He took office in November 1992, bringing with him three new Deputy Ministers and launching a further reorganization of the Ministry. The reorganization adds nuclear safety issues to MEP's purview and new divisions concentrating on industry and agriculture, paving the way for cross-media approaches. The current Minister is also advised by a Kollegiya.

3.10 Established under the Ministry are three entities, two of which are new:

(i) the State Ecological Inspection, formerly the largest department within MEP with separate divisions devoted to air, water and waste management, now reorganized as a separate body under the Ministry; its staff works with oblast branches overseeing plant inspections;

(ii) a new "Ecological Bank" to help finance environmental investments; and

(iii) an Environmental Education and Information Center to provide training courses targeted at various groups, within MEP and outside.[8]

3.11 **Ties with Research Institutes.** Over the past year, MEP has formed close ties with several research institutes specializing in water quality research and environmental technology. Now formally under MEP are: (i) the Ukrainian Scientific Center for Water Protection (USCWP) in Kharkiv, formerly the primary institute in the FSU responsible for water quality management (including developing water quality standards and undertaking water modeling); and (ii) the Ukrainian Scientific Center for Ecology of the Seas (UNCES) in Odessa, active in research and monitoring activities in the Black and Azov Seas. Several other institutes have signed preliminary agreements of cooperation: the Institute of Technical Ecology in Donetsk (expertise in metallurgical and energy industries); the Technical Project Bureau in Kharkiv (expertise in water purification technologies and sewerage systems); and, most recently, the Ukrainian Scientific and Technical Center in Cherkasy. In this way, MEP is trying to secure a solid technical foundation, but there is still some confusion about how to utilize these institutes in a way that serves regulatory programs, rather than more academic goals. Moreover, *an important question is whether MEP should assume full financial responsibility for these institutes or contract work as needed.*

3.12 **MEP's Regulatory Activities**. The basic elements of regulatory policy in Ukraine are:

(i) a system of ambient standards for air, water and soil, largely drawn from the FSU;[9]

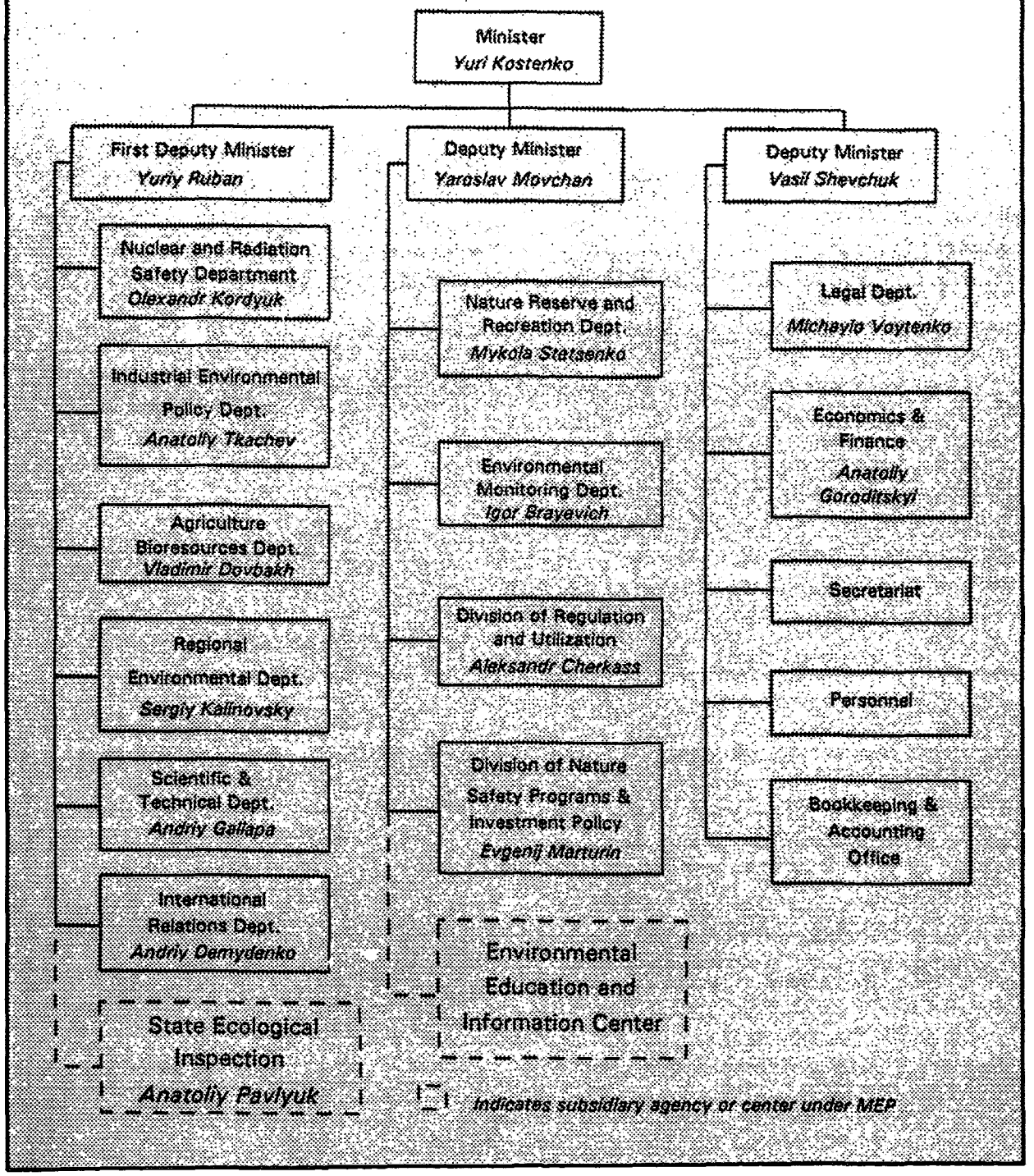
---

8/ With start-up funding from the US Environmental Protection Agency (USEPA).

9/ These standards were established over the last 15-20 years by various institutes under the direction of the central Ministry of Health in the FSU. The Institute of Hygiene under Ukraine's Ministry of Health is now working with MEP to revise Ukraine's standards.

Figure 3.1:

Ministry for Environmental Protection
Organizational Structure



(ii) a permitting process for each major stationary source of pollution, which sets limits for each pollutant to bring plants into compliance with ambient standards; most permits (called "ecological passports") were revised in 1992;

(iii) monitoring and enforcement activities to encourage plants to achieve compliance with their permits, including the ability to impose small fines or penalties on violators;

(iv) a pollution fee system, adopted in January 1992, but based on experiments with charges over the previous 2-3 years; and

(v) an "ecological expertise" review of new investments, similar to an environmental impact assessment, again drawn from the FSU system, soon to be supplemented by pending legislation.

MEP manages these activities and made a major effort in 1992 to revise permits and implement its pollution fee system. The various regulatory instruments are described later in this chapter, and the regulatory systems for air and water quality management are discussed in greater detail in Chapter IV.

**Other Actors in Environmental Policy**

3.13 MEP is not alone in conducting environmental policy. The Parliamentary Committee on Ecology takes the lead legislatively. In addition, the Cabinet of Ministers has its Department of Environmental Protection with 4 permanent staff members. The Ministry of Health (MOH) takes the lead role in setting standards and also monitors air and water near residential areas. Various other agencies undertake monitoring activities, the largest being Hydromet (see Box 3.2), and research activities, for example institutes under the Ukrainian Academy of Sciences. Local municipal councils, through a locally appointed environmental representative, actively participate in inspections and enforcement at municipal levels; along with MEP, they have the power to suspend plant operations temporarily or to order the selective elimination of polluting sources within an enterprise.

**Central vs. Decentralized Environmental Management**

3.14 Ukraine needs a simple system of environmental management which can respond to the serious pollution problems facing the nation. The present structure provides a good starting point. *It would seem undesirable and even confusing to add another regional layer at this point, as some authorities have discussed.* Clearly, stronger authority should go to MEP to develop all aspects of regulatory policy and to undertake the necessary rulemaking for implementation. Activities logically falling under the national office are: legislation and rule making; standard setting; oversight and review of activities of the oblast and municipal offices; organization and quality control in monitoring; and provision of technical services and advice in areas

**Box 3.1: Structure of Environmental Agencies**

Most countries follow a model of organization, which provides for *national* authority and responsibility for formulation of policies, but *decentralized enforcement*, either (a) at provincial/state (Germany and US) or (b) county/municipal levels (Netherlands), or both. There are various models in Europe and the US for organization of environmental management between national and local levels, with some structures being more decentralized than others.

such as ambient modeling, setting of emission factors, health risk assessments, and information about technologies related to particular industries.

3.15 Actual implementation and enforcement responsibility is best given to MEP's oblast and municipal branches, working closely with local authorities, because pollution abatement activities must be planned and undertaken at local levels. This means also that more resources need to be directed to the local level. Decisions of the local office might be appealable to the national office, but the national office should use a deferential standard of review, altering a decision only if it clearly fails to conform to the applicable law. MEP's authority should be backed by the ability to impose penalties if local responsibilities are not taken seriously.[10] MEP may ultimately want to allow oblast or municipal governments to adopt more stringent requirements in individual areas or cities, if they wish to do so (as local communities in Japan and the US can do).[11] But it undermines national environmental policy if local governments are allowed to weaken the national directives (which still appears to be the case in Ukraine, through various local powers of exemption or appeal to the Cabinet of Ministers). On the other hand, the strict standards which now prevail (discussed in Section C and Chapter IV) need to give way to a more flexible, problem-oriented system, based on achieving some practical protection in priority areas over a realistic period of time and avoiding deterioration in areas which are not heavily polluted.

**Staffing and Internal Issues**

3.16 Many of MEP staff are dedicated employees who understand the ultimate goals of their jobs, but they are understaffed, underpaid, and not provided with the tools and training needed to perform their jobs.[12] MEP needs to find a way to remedy the problem of low salaries for staff; it is competing with other Ministries and the emerging private sector for quality staff. One avenue is to direct more of the pollution fee revenue to strengthening the MEP and its branches, including earmarking funds to support the salaries of well-qualified staff, along with the necessary equipment and training to conduct regulatory activities effectively (see para. 3.46). MEP urgently needs assistance in building up the capability of its staff to undertake all aspects of regulatory policy at national, oblast and local levels. This includes: (i) technical and managerial training and opportunities to work with environmental professionals from other countries in order to familiarize themselves with a range of managerial, regulatory and technical approaches; (ii) introduction of basic information management and budgeting systems; and (iii) introduction and training in the use of improved monitoring and analytical equipment.

3.17 **Budgeting**. An improved budgeting system is needed in the Ministry so that managers within the organization know what resources they have to implement the tasks and responsibilities assigned to them. Currently, there is no budgeting system by which department directors can propose and then set their activities for the year. Managers do not know whether or not they will have funding for specific projects or activities.

---

10/ In the US, for example, states must file State Implementation Plans (SIP) with USEPA, explaining how they intend to enforce federal policy. There are penalties for not meeting federal deadlines.

11/ Interestingly, Germany does not allow local governments to enact stricter environmental regulations.

12/ At mid-July 1992, the average monthly salary in MEP was only Rb 4200. It has been raised since, in terms of Karbovanets.

3.18 **Information Management.** A great deal of time and resources is used to collect data in Ukraine, and lots of data are collected without any clear objective. The lack of information management systems and availability of computers results in a situation where most information is stored in handwritten form in almost inaccessible files.[13] Manual storage and current formats render the data useless for analytical purposes or for public information. Sharing of information is not formalized and therefore occurs largely through personal relations. MEP staff lack filing systems and copying facilities[14] as well as computer databases and networks.

3.19 MEP needs to review data gathering activities more broadly as it revises its regulatory objectives and programs; it also needs to formalize reporting at all levels and across agencies, but in a way which serves regulatory objectives. *A careful analysis of information management needs, in conjunction with an analysis of how best to meet regulatory needs, would be the first step in designing an appropriate system.* If technical assistance and equipment can be made available, the feasibility of establishing one computerized database in every oblast center should be investigated (starting perhaps with a pilot program in a few oblasts), linked to computers in the central office. Data from other agencies conducting monitoring could be integrated into the system, although it is preferable to do this in conjunction with a rationalization of monitoring systems.

3.20 **Training.** It will take time and more resources to build up staff expertise in managerial and technical aspects of regulatory programs. Training should cover a range of skills: options for environmental management and regulatory policy; technical training in regulatory techniques and environmental control options in principal industries; financial analysis; economic valuation of natural resources; approaches to public participation; preparation of environmental impact assessments (EIA); and basic managerial skills, e.g. proposal writing and procurement methods. Inspection staff at national and local levels especially need to be trained technically in order to be able to talk constructively with industry about options for pollution abatement. *Experience in other countries indicates that good training of environmental authorities leads to greater mutual respect between industry and regulators.*

3.21 **Coordination Internally and Externally.** At the national level, staff presently seem too compartmentalized. Greater emphasis should be put on teamwork--communication and cooperation among different units--so that staff as a whole can perform their responsibilities more effectively. Communications and information flows should be improved within the center and between the center and oblast-level branches. Seeking the views and feedback of oblast and municipal level staff will be very important in policymaking. In seeking international assistance, it would be appropriate to form a working committee within the Ministry, perhaps under a deputy minister, which would include representatives of various functional departments and participants from oblast and municipal branches, *to assure that proposals for international assistance reflect the true needs of "on the ground" regulatory authorities and that assistance programs are well integrated with primary activities within the Ministry.* The Foreign

---

13/ Individual plants keep records of emissions and discharges, some estimated and others measured, which are then reported to various authorities. In this fashion, a lot of data on emissions and discharges are collected and used at the national level for summary reports. The quality of these data comes into question for a variety of reasons: estimates are often based on material balances, using emission factors which may need revision; "fugitive" emissions are not included; and the accuracy of measuring equipment is poor.

14/ MEP suffers from a severe lack of simple office equipment. Filing cabinets, bookshelves, paper, folders, staplers are all in short supply. MEP also lacks modern office technology to receive and transmit information.

Assistance Implementation Division, within the International Department, could then service the committee and carry out its directions.

3.22 **Staffing Concerns at Oblast and Municipal Levels.** Most of the implementing and enforcement activities (monitoring, agreement on compliance schedules at the plant level, enforcement action) will inevitably take place at oblast and municipal levels. *The local inspectors who deal with the day-to-day problems of regulating sources of pollution are the backbone of the environmental management program in Ukraine, and their performance is critical to the ultimate success of the program.* At the present time, there are not enough inspectors, and they are also poorly paid. Inspectors, as a whole, lack the tools and resources to do their job, e.g. basic measuring instruments and cars to undertake their work (in some regions, inspectors use buses or even horses for transportation). A quote from one of the inspectors in Kryvyi Rih illustrates this point: "All we have are a pen and paper; we have no other tools or equipment." Local inspectors often need to call the plant they are inspecting to arrange for transport to take samples; they then use the facility's lab for analyzing the sample. Unannounced inspections, a means of checking compliance, are therefore not really feasible, limiting any restraints on illegally high emissions or discharges, e.g. at night or over the weekends. In addition, many inspectors lack the expertise to undertake visual inspections at plants (e.g. stack opacity checks, a common technique used by regulatory authorities elsewhere).

3.23 It will take time to staff the oblasts to adequate levels and to train people and provide them with the equipment to perform their jobs in an efficient fashion. *Some of the targets the Ministry is advised to work towards are:*

(i) Increasing staffing at oblast and municipal levels so that no single inspector handles more than 20-40 sources depending on the size and complexity of these sources.

(ii) Providing training for all inspectors in modern regulatory techniques and on the features and operation of control equipment and the industrial processes they are expected to regulate. This training should be an ongoing process to update and refresh skills on an annual or biennial basis.

3.24 **Organization of Monitoring**. A number of monitoring networks have been operating in Ukraine for some time, under the responsibility of several Ministries and State Committees (see Box 3.2). Various research institutes, such as the Academy of Science, also conduct monitoring. These various networks generate a lot of data, but much of it does not serve regulatory objectives (see Chapter IV), and the data of some research institutes are not necessarily available to regulatory authorities. All the networks suffer from use of older equipment; they have not benefited from recent technical advances. Hence, in many cases, they cannot measure accurately the pollutants or constituent parameters which are regulated. MEP's own monitoring--spot checking at individual sources of emissions (plant stacks) or effluents (plant discharges into water)--also suffers from similar problems of poor equipment and quality control and insufficient training.

3.25 Under the 1991 environmental law, MEP is authorized to take responsibility for monitoring to assure better integration and quality control of these activities and to improve reporting, so that the results can be used more effectively by policymakers. Currently, though, MEP is still compelled to work out a series of lengthy protocols on information exchange with monitoring counterparts. To complicate

**Box 3.2: Environmental Monitoring**

**MEP's** monitoring is limited to spot checking of stack emissions or wastewater discharges for enforcement purposes. It relies on the longstanding monitoring networks of other agencies to measure ambient air, water and soil pollution and to monitor biological resources. Most cities have one or two stations, but major cities such as Kiev may have ten or more.

The **State Committee on Hydrometeorology (Hydromet)** operates the most extensive network. Air quality monitoring consists of 167 permanent sites in 49 cities. Hydromet also manages 186 meteorological stations. Surface water monitoring takes place at 244 points, covering 144 rivers, 7 lakes and 15 water reservoirs. The water monitoring network was originally designed to study natural water quality; consequently, the best coverage of stations is in the Carpathian and Crimean mountains, rather than in the most polluted areas. Reportedly, some 51 specific pollutants are evaluated over the network as a whole. Hydromet has 103 monitoring sites for ground water, concentrating on temperature, water level, and the presence of chemicals. About 175 monitoring posts are dedicated to evaluation of marine water. Agricultural soil is monitored at 9 permanent posts for pesticide pollution; 8 posts are dedicated to detecting the presence of heavy metals in urban soils.

The **Ministry of Health** (MOH) operates "sanitary epidemiological" (San-Epi) stations. These stations monitor ambient air pollution levels in residential areas close to major industrial sites and roads. MOH has a network of over 2000 sites for air quality monitoring and analysis, designed to evaluate approximately one hundred substances; both stationary and mobile testing are conducted. MOH also monitors drinking water and recreational water sites along rivers, reservoirs, and seashores; its emphasis on the health impact is reflected in the importance of biological indicators in the monitoring program. Water quality monitoring appears to be rather infrequent, though.

The **State Committee on Water Resources** maintains 233 monitoring posts for surface water. Enterprises are required to provide effluent data to the committee by filing the 2TP-WATER form. Accordingly, the committee has desegregated effluent data for 16,000 individual enterprises. It forwards this information to the Ministry of Statistics, which is presented in an aggregated form as summary loading figures for towns, districts etc. The **State Committee for Geology and Utilization of Mineral Resources** has a Directorate General for Hydrogeology and Geo-ecology which operates about 1,000 groundwater monitoring sites, sampled 4 to 12 times a year. The samples are used to analyze some 56 chemical and physical parameters, relating to: temperature, chemical concentrations, pesticides, heavy metals, and radionuclides. It also investigates natural resource extraction and utilization processes.

The **Ministry of Agriculture** maintains 98 monitoring posts for measuring pesticide and nitrate levels in surface water. Soil pollution is evaluated through a series of over 900 posts, 345 dedicated to pesticides, and 596 to fertilizer pollution. In addition, close to one thousand posts monitor biological resources (animals & plants): 659 for radiation, 180 for pesticides, and 211 for fertilizers. The **Ministry of Forestry** operates 155 monitoring sites dedicated to evaluating primary forestry indicators: defoliation, effects of pests, blights, and other tree-related phenomena.

Individual enterprises are also required to file environmental information with the **Ministry of Statistics**. For example, enterprises provide atmospheric emissions data to the oblast statistical agency by filing what is called the 2TP-AIR form. Summary aggregates for urban areas are then forwarded by these oblast agencies to the Ministry of Statistics in Kiev, which become the basis for annual reports on environmental problems.

matters, as mentioned above, there are no electronic links between MEP and its counterparts, and information can only be provided in printed form.[15] *More effective use and concentration of current resources and facilities for both ambient monitoring and control would make it easier to improve the equipment base for monitoring devices and to develop a few high quality centers for specialized analyses.* When resources become available, MEP plans to restructure and integrate the monitoring systems in order to develop a more representative sample of stations. This should be a priority in order to build a credible system, but the reorganization should build on existing strengths among monitoring agencies, not try to re-create or duplicate existing capabilities.

3.26 Ukraine also participates (though it is unclear how actively) in EMEP and BAPMON[16] programs of the World Meteorological Organization and the United Nations Environmental Program.

3.27 **Laboratories.** Similarly, the laboratories which analyze the monitoring samples belong to different monitoring agencies, including MEP, Hydromet and MOH. Most of them are organized in a hierarchical manner: central, oblast and local units. A striking characteristic of the system is that *there are only minor differences in the professional and equipment standard of the laboratories,* even though the higher level laboratories are said to provide quality control and supervising functions for those below. All those visited appeared to have the same types of shortcomings and quality assurance problems. In the case of water analyses, for instance, the lack of modern analytical equipment restricts the number of parameters analyzed to those that can be handled with old fashioned net chemistry methods and reduces the capacity of routine analyses to traditional inorganic parameters and gross organic indicators. Moreover, the laboratories seemed to be organized more as research units, handling the samples in an individual, ad hoc manner instead of having organized, effective high capacity procedures. In Zaporizhzhia and Dnipropetrovsk, two large cities, typically 2-3 people work in the labs at one time. There is a need for more modern equipment to improve efficiency, but if effective services are to be provided, organization and procedures must be improved as well.

3.28 Over the medium term, the feasibility of concentrating laboratories facilities in the oblast center should be investigated; a system for transport of samples from the district would need to be organized. Trying to set up complete district level labs is too costly. A unified system for quality control and standardization of sampling and analyses should be established. *Recommended is institution of a competent national laboratory,* responsible for quality control, e.g. through a system of ring testing (distribution of samples of known concentration for local analysis), and for training.

**Cross-Sectoral and Cross-Ministerial Cooperation**

3.29 Environmental activities are interrelated with all forms of economic and human activity, dictating that environmental authorities work closely with many different sectors and industries. MEP has sought to establish working committees with several Ministries or State Committees, whose activities have an important environmental impact or where environmental policies need to be integrated. Continued efforts

---

15/ MEP has set up a specific unit for environmental monitoring to develop environmental databases and present this information in aggregated form for policy purposes. At present, only data from a few of the Hydromet stations are loaded into the system.

16/ Background Air Pollution Monitoring Network.

are needed in this regard. It should be noted, though, that this kind of coordination is never easy to do--in any country--but it is an effort worth trying, particularly in view of the changing policies and circumstances in Ukraine. Some of the key areas where cooperation is needed are:

- Ministry of Health--revising ambient standards, integrating pollution monitoring activities and encouraging the introduction of modern epidemiological studies.

- State Property Fund--working with them to assure that environmental issues of concern to private and foreign investors are taken into account in legislation and implementing regulations, for example establishing mechanisms for addressing liability for past pollution.

- Ministry of Electric Power and other energy-related State Committees--establishing priorities for introduction of better operating and pollution control techniques in energy industries based on cost effectiveness.

- Ministry of Industry and Ministry of Military Conversion--as initiatives are taken to restructure major industries, participating in them to assure incorporation of environmental considerations and costs; and identifying opportunities to encourage development of domestic manufacturing capabilities for a variety of environmentally friendly equipment.

- State Committee on Water Resources--working together for better integrated management of the Dnieper and other rivers.

- Ministry of Agriculture--finding opportunities to support demonstration projects to introduce minimum tillage systems and low input agricultural techniques and to encourage protection of wildlife habitat and use of shelterbelts along edges of farms; developing education programs to improve sanitation practices in rural areas, particularly related to livestock management.

- Ministry of Forestry--working together to find ways to cooperate at the local level to improve forestry operations in a way that reduces the impact on forest resources themselves, at the same time protecting wildlife habitat and plant species.

- Ministry of Finance and Ministry of Foreign Affairs--working together in respect of international aid coordination and obligations arising from international agreements on environmental issues.

International assistance may help in bringing Ministries and agencies together in cooperative efforts.[17]

---

17/ A good example is recently agreed Dutch assistance for power sector rehabilitation planning and for energy and environmental audits in selected industrial plants; both exercises will involve the participation of the functional Ministries and MEP.

## C. Regulatory Instruments: Standards, Permits and Pollution Fees

3.30 The fundamental bases of the current regulatory program are (i) the system of ambient standards for air, water and soil quality, (ii) the related permitting system, the mechanism by which sources of pollution are held accountable for pollution reductions to comply with the mandated norms, and (iii) the nascent pollution fee system. These three elements are discussed below, and various recommendations are offered to improve their effectiveness.

**Ambient Standards as the Basis for Regulatory Policy**

3.31 An ambient-based system is appealing because it offers the flexibility to tailor abatement requirements to individual airsheds or waterbodies. It is not as blunt as establishing "across-the-board" emission standards for particular industries based on what available technologies can achieve.[18] Actually, many countries have a combination of ambient and technology-based standards.

3.32 Several broad concerns apply to the ambient-based system in Ukraine. First, the number and, in some cases, the excessive strictness of standards are impractical. The resulting complexity of the system undermines enforcement and also overwhelms understaffed, underequipped regulatory authorities. Moreover, as presently conceived, the system of standards in practice does not ensure protection of health; this is discussed in more detail in Cnapter IV. Second, sole reliance on ambient standards may make the system too arbitrary and subject to negotiation, especially if the data on which regulators rely are not very accurate, which is the case in the FSU generally. Third, and relatedly, reliance solely on ambient standards allows plants to pollute up to the target ambient value; thus, they fail to protect airsheds or rivers which currently meet or are below standards from steady deterioration.

3.33 The conclusion of the external regulatory experts, who reviewed the standards for air and water quality under this study, was that some changes should be introduced, *in particular reducing the number of standards and relaxing the strictness of some of them.* Ukrainian authorities should consider adopting EC or US ambient standards, or a combination of both, since both have been set based on careful review of health impacts. This practical approach would avoid the cost of Ukraine developing its own set of standards. Regulatory authorities would still need to phase in those standards over a reasonable time period, perhaps 20 years, as resources permit, giving priority where possible to those situations most seriously affecting worker and community health. It should be noted that in Europe, for instance, the difficulty of member countries meeting standards without innordinate cost is leading to more of a "program" approach, considering individual situations and the seriousness of pollution in each case.

3.34 Alternatively, if MOH and MEP decide to go ahead with setting their own standards, it would make sense to benefit from the research already undertaken in other countries. A way to do this would be to submit the scientific approach used in setting standards to peer review by international colleagues. In addition, in selective cases, introducing minimum technology-based standards is recommended (see specifics in Chapter IV).

---

18/ Technology standards are called by various names and imply different levels of strictness. Examples are: RACT (Reasonably Available Control Technology), BATNEEC (Best Available Technology Not Entailing Excessive Cost), and BACT (Best Available Control Technology). They are typically preferred by regulators because they are standard and transparent.

**The Permitting Process**

3.35 **Setting Plant Limits.** Ambient standards are used to set plant emission or effluent limits--via algorithms or modeling exercises which try to calculate the contribution to ambient pollution of an individual source. An enterprise manager contracts an industry or research institute to undertake the analysis to establish pollutant limits, employing standard (air) dispersion or (water) dilution models. The models rely heavily on data provided by the plants themselves. The proposed limits must then be formally approved by MEP and often by MOH, after consultation with the plant manager. However, it is unclear how well the models are understood by regulatory staff in MEP so that they can assess the appropriateness of the limits proposed.

3.36 The target limits go into the "ecological passport" and become the basis for the plant paying pollution fees. The permit also typically records the equations used to calculate the limits and sometimes specifies the technology options to achieve them. After a permit is established for a plant, it is revised every five years (assuming no modifications) if the enterprise has a regular permit and annually if the permit is temporary.

3.37 **Permitting of New Investments.** The process for permitting a new source, or an established source seeking approval for new construction or process modifications, seems lengthy and complicated. This is in part due to the number of pollutants to consider in establishing plant limits and also *the lack of any "de minimis" levels* of emissions/discharges below which plant modifications do not require a new permit. This lack of permanence in operating approval is compounded by the fact that there is no concept of "grandfathering" in the program; in other words, any time a new change is made in the enterprise, all the existing limitations are considered reviewable. It is unclear what actually occurs in practice. On paper, though, the system would seem to be overly cumbersome, unnecessarily delaying a plant's ability to upgrade capital and discouraging innovation. It should be possible to streamline the permitting process but at the same time make it more effective.

**Pollution Charges: Enforcement Mechanism or Revenue Earner?**

3.38 In conjunction with the permitting process, MEP undertook a major effort in 1992 to implement a pollution fee system for air emissions, water effluents, and waste disposal, as mandated by a January 1992 resolution by the Cabinet of Ministers. In principle, pollution fees are the primary mechanism employed to induce polluters to reduce pollution to levels to meet ambient standards. *In practice, though, the system, in large part, is not operating at the present time because of the difficult economic situation in the country.* A pollution fee system can be an important adjunct to a regulatory program and hopefully, over time, the Ukrainian system will be able to operate more effectively. This section describes the fee system and suggests some modifications which might improve its effectiveness over the longer term.

3.39 **Structure of the Pollution Fee System.** Each pollutant is assigned a unique rate per ton, based on an estimate of damage caused by the pollutant (the estimates were prepared by an institute of MOH). Box 3.3 gives examples of fee levels for air pollutants; the fee system includes 300 air pollutants.[19]

---

19/ Joint ventures which sell goods for hard currency must pay fees in hard currency in proportion to sales for hard currency.

3.40 From 1992 until 1996, the "interim" maximum allowable limits for each pollutant were set based on historical limits developed for each plant, although they can be reviewed annually.[20] In January 1996, the maximum allowable limits are to be reduced to conform to the level of emissions or effluents from each facility which will enable it to meet the ambient standards. The 1996 maximum allowable limits were established during 1992 in order to give the facilities adequate time to undertake whatever actions are required to meet the new limit.

**Box 3.3: Examples of Pollution Fees for Air Pollutants**

| Pollutant | Rb/ton |
|---|---|
| $NO_x$ | 495 |
| $NH_3$ | 240 |
| $SO_2$ | 160 |
| Pb | 49,280 |
| $H_2S$ | 3,680 |

3.41 The amount of money each plant is assessed is a function of the following formula for each pollutant:

Sum of { [Fee x 0.5 (tons of pollutant below 1996 limit)] +
[Fee x tons of pollutant above 1996 limit] } x C

A plant pays fees on 50 percent of pollutants below the 1996 limit and full fees above the 1996 limit. The coefficient (C) takes into account the local economic conditions and population exposure. In Donetsk Oblast, for example, the coefficient is set relatively high because of its heavy pollution problems and population density. In addition, if a facility emits above the interim (1992) allowable limit, it is required to pay fines (ranging from one to five times the fee level), although local governments have the right to suspend payment when a plant is in financial distress. Fees below the interim maximum allowable limit are included in the operating costs of the enterprise. Fines are taken out of profits. Figure 3.2 provides a picture of how the fee system is designed to operate.

3.42 Various exemptions apply, however. By the decision of local authorities, enterprises which are unprofitable or suffering low profitability can be partially or totally exempted. Thermal power stations operating on organic fuels have been exempted from paying all but 10 percent of pollution fees until January 1996. Finally, in 1993 and 1994, payments by all enterprises were restricted to not more than 5 percent of the taxable profit of an enterprise. Moreover, in some areas, payments are not being paid at all or are being paid in arrears without adjustment for ongoing inflation.

3.43 The fees are supposed to be paid quarterly--directly to three levels of government, as follows:

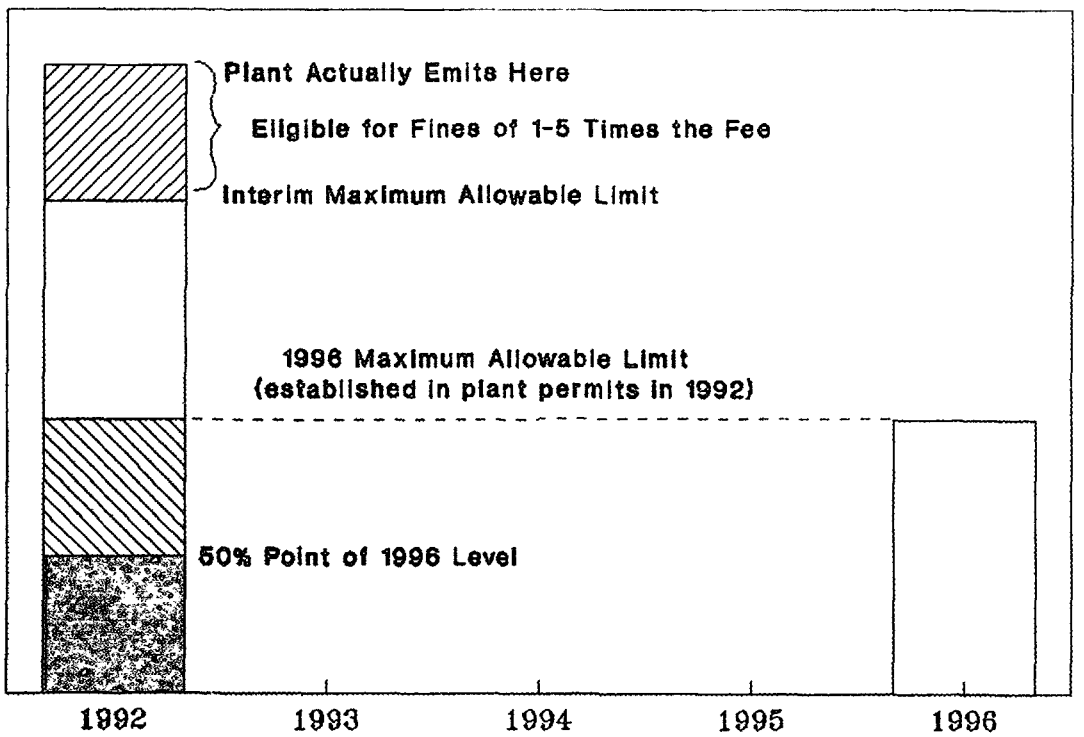
70 percent to local municipalities
20 percent to regional oblast governments
10 percent to MEP

3.44 In Kiev and Sevastopil, municipalities with special status, 90 percent of fees go to the local municipality and 10 percent to MEP. Theoretically, payments which are late may be withdrawn directly

20/ The limits described here were set based on the procedures described in setting plant permit limits (see paragraph 3.34 and more detailed sections on air and water in Chapter IV).

from an enterprise's bank account. The resolution by the Cabinet of Ministers specifies that 90 percent of the funds should be spent for environmental improvements, and MEP has some responsibility to oversee how the money is spent to be sure that it is "wisely directed." Some municipalities are setting up local ecology funds for this purpose. It is unclear, though, what the criteria are for disbursements from the funds.[21]

Figure 3.2
Diagram of the Pollution Fee System




3.45 **Recommended Changes in the Pollution Fee System.** The structure of the system would eventually benefit from the following changes:

(i) The number of pollutants for which fees are charged should be reduced, and the fees adjusted upwards on a smaller number of pollutants. Right now, current charges are very low and *probably raise less money than the cost of administering the system.*

(ii) Fees should be automatically adjusted every year to reflect inflation.

21/ In 1992, total fee revenue was Rb 936 million, of which MEP received Rb 93 million.

(iii) The 1996 maximum allowable limits should be recalculated to reflect changes in the ambient air and water quality standards as recommended in this study (see Chapter IV).

(iv) A larger share of revenue from the pollution fee system should be plowed back into regulatory activities, particularly to oblast and municipal MEP branches, to purchase improved equipment, to support salaries and to increase staffing.

(v) Strict and open criteria should be established for use of revenue going into local ecology funds and a system of auditing put in place to assure appropriate use.

3.46 **Enforcement Mechanism or Revenue Earner?** The pollution fee system is based on the theory that by internalizing externalities into the economic decisionmaking of the enterprise manager, he or she will make investments to reduce plant emissions to avoid pollution charges. There is no strong evidence that this will occur in Ukraine, however, for three reasons. First, the fees are not set high enough to equal the "marginal cost" of pollution control or pollution damage and, therefore, do not provide the needed economic incentive to reduce pollution.[22] Based on the levels of these charges relative to other costs, the plant operator will simply pay the fees and consider them part of doing business (see Box 3.5). Second, in any case, subsidized state enterprises are not fully accountable for costs. Third, the fees may be reduced or waived by local authorities if they cause financial distress.

**Box 3.4: Pollution Fees in the US**

The recent Clean Air Act in the US requires every state regulatory agency to develop an emission fee system. The fee systems vary somewhat but, at a minimum, they cover cover the costs of regulating the larger stationary sources of air pollution. The fees are paid based on the tons of regulated air pollutants emitted by the large stationary sources. They range from a low of approximately $25 per ton up to about $50 per ton depending upon the cost of regulating the covered sources. These fees are not expected to provide any significant incentive to reduce emissions since the cost of controls range from 10 to more than 100 times as much as expected annual fees. Some local areas in the US have had pollution fee systems for some time. The South Coast Air Quality District in Los Angeles, for instance, has had a long standing pollution fee program, which raised over US $33 million last year, all of which went to finance its regulatory program. On the other hand, the state of Wisconsin recently started its a program. It expects to raise approximately US$9 million per year by charging a straight fee of $30 per ton of regulated pollutant.

3.47 To be realistic, though, *most regulatory agencies worldwide have not successfully structured a pollution fee system with fees set high enough to induce pollution abatement investments*. When fees are

22/ Indeed, worldwide, there is a great deal of uncertainty associated with determining marginal costs. Most economists agree that damage estimates can vary considerably based on a person's perceived damage and willingness to pay for clean up. It is also widely held that true damage estimates for dust, $SO_2$ and other pollutants are very high, nowhere near the values being proposed by MEP.

set very high, they oftentimes become politically impossible to sustain, for example if they cause firms to go out of business. On the other hand, the fee system will generate some much needed revenue for regulatory authorities and will certainly increase the awareness of facilities concerning the pollution they are emitting. *Pollution fees are commonly used in various countries in the world to pay for the costs of operating regulatory programs* (see Box 3.4). Over time, they can play this important role in Ukraine.

Box 3.5: **Impact of Pollution Fees: Local Example**

The financial impact of the fees is difficult to assess based on field interviews, but one lengthy discussion with officials of Zaporizhzhia Steel supported the impression that the impact has been minor. Zaporizhzhia Steel discharges to a lagoon on its property which also receives the effluent from 8 other major facilities. Effluent from the lagoon enters a 10 kilometer-long canal, before final discharge to the Dnieper. The steel plant is held accountable for all fees and in turn places contract requirements on the other dischargers to its pond.

Zaporizhzhia Steel appears to budget for fees as a normal cost of doing business and pays on a consistent quarterly basis. The total paid in 1991 for all discharges of all media (air, soil, and water) was Rb 3 million; Zaporizhzhia Steel passes costs on to the other facilities that use the lagoon. The plant has already calculated and budgeted for fees under the new system, which should be perhaps 10 times higher. Given the high rate of inflation in Ukraine, this may not be a significant increase in actual effect. Despite the apparent lack of industrial pretreatment prior to discharge in the lagoon, no fines were paid in 1991. The implication that there were no exceedances of plant limits by the nine facilities is difficult to believe. Plant officials believe that the new schedule of fines is more severe, but without exceedances of limits, no fines are assessed.

## D. The Enforcement Dilemma

### Background on Other Enforcement Measures Besides the Pollution Fee Program

3.48 Besides the new pollution fee/fine system, other penalties are possible, although the actual levels are very low. There have been several cases where plants or parts of plants have been shut down--temporarily or even permanently--but they are rare.

3.49 **Fines and Penalties.** Current law specifies fines and penalties if emissions or effluents exceed permitted levels. Although theoretically the fines are due any time an inspector finds a violation, presumably by independent monitoring, fines are often not collected. It is also doubtful that most violators notify the MEP when their internal monitoring detects an exceedance of standards. In any case, the current penalties imposed on an enterprise which violates the law are very small. The maximum penalty which an inspector can impose on the manager of a violating source was increased in 1992 from Rb 100 to 1,000. An MEP inspector can also recommend that the bonuses of individuals at the enterprise, directly responsible for the pollution violation, be reduced between Rb 1,000-7,000. This protocol is simply a recommendation to plant managers, though, and they are free to ignore it or reduce it as they see fit. This puts the inspector in the position that he or she is at the mercy of plant managers to impose any penalty above the very low and meaningless Rb 1,000 mentioned above.

3.50 In addition to fines, the violating plant may have to pay damages in accordance with the rules of the existing civil codes, which define specific rates for various types of damage related to national resource use.

3.51 **Special Directives.** If fines are not paid, or compliance measures not taken, the MEP can also issue a "special directive", similar to an "administrative order" used in the US (see Box 3.6). This is considered an exceptional action, requiring extraordinary cooperation among MEP, the Ministry of Health, and local authorities. Nevertheless, "special directives" have had some, albeit limited success. One should note, however, that court action to ensure compliance with a special directive is not believed to be viable under the current system in Ukraine (see para. 3.55)

**Box 3.6: Use of Special Directives**

Kryvyi Rih is cited as a case where special directives have been used. Local officials report that, in 1991, only one-third of the facilities fined by MEP actually paid those fines. A small number of those violations (eight in total) were the cause for issuing special directives signed by MEP, Ministry of Health, and local officials. As a result, six of the eight took measures towards compliance. For the two remaining problems, the regional MEP staff, accompanied by the other organizations, entered the facilities and physically sealed off the water supplies to the specific shops in question.

**Strengthening Enforcement Capabilities**

3.52 Despite the effort going into designing regulatory policy, there is clearly little enforcement occurring. The reality is far from the ideals expressed in Ukraine's environmental legislation. It ultimately comes down to the question of political will--to give environmental authorities the resources and authority they need to undertake effective enforcement action. At the same time, greater authority for environmental regulators also demands greater responsibility to be judicious and reasonable in phasing in regulatory standards, particularly during the difficult economic transition.

3.53 Enforcement authority could be strengthened by giving greater administrative and rulemaking authority to MEP. Absent such authority, MEP is constrained by the small number of enforcement mechanisms that have expressly been made available to it. The kind of flexible enforcement authority MEP needs will require a graduated spectrum of enforcement tools that can be tailored to the circumstances of each case. These include: (i) the authority to place conditions on individual discharge permits, violations of which can be sanctioned independently from violation of the permit limits; (ii) authority to negotiate detailed compliance schedules which outline a realistic path to compliance and provide MEP with incremental stages at which to monitor progress and apply sanctions; and (iii) multiple factor penalty calculations which allow fines and other penalties to be adjusted upward or downward in appropriate cases. The combination of these tools avoids saddling MEP with an all-or-nothing decision between ignoring the violation or threatening a high fine or plant closure that will likely be overturned because of economic hardship.

3.54 Over time, the penalty system should be overhauled and the level of penalties increased. Normally, penalties should have the following features:

- They should recapture the benefit of delayed compliance; this may be determined by calculating the time of non-compliance and the overall cost of correcting the violation.

- They should try to ensure there is no repetition of the violation and should account for the severity of the violation. The level of the penalty should include consideration of whether it is a repeat penalty and/or reflects a pattern of non-compliance by the affected enterprise.

- Provisions should be made to adjust the penalties for inflation.[23]

3.55 The possibility that some plants release high concentrations of effluents or emissions when inspections are far less likely should be the subject of major enforcement investigations and actions. For example, special enforcement teams, perhaps formed by short-term consolidation of inspectors from several areas, should be used to work together on a few problem cases in one oblast. Strong criminal penalties against plant managers and others should be considered for significant, intentional releases above limits. Additional resources for hiring inspectors and purchasing vehicles and sampling equipment will be especially critical in this regard.

**Role of the Courts[24]**

3.56 Traditionally, the judiciary has not played an important role and thus there is no real litigation experience in regard to environmental matters. The standing of judges is not high, and they are not well paid. In spite of the fact that Parliament adopted a special resolution in April 1992, "The Concept of Reform of the Judiciary in Ukraine," the court system is in a very difficult state right now, reflecting the general economic crisis in the country. It will take time to build up the legal system, and therefore legal recourse is presently not a viable option. As the legal system is strengthened and becomes more independent, it hopefully will play a constructive role, primarily as an independent means of enforcing action against chronic violators. Elements of both the EC and the US models might be considered in developing a judicial system which fits Ukraine's needs (see Box 3.7).

**Box 3.7: Role of Courts in Other Countries**

The roles of courts in the US and EC are quite different. The influence of courts is very substantial in the US regulatory system. Courts can interpret laws and regulations at almost any stage; they can enforce regulatory policy at national, state and local levels; and they allow class action as well as private suits. The breadth of legal recourse has encouraged litigation from all sides, private firms or individuals and NGOs launching class action suits. The extent of litigation has been time-consuming and costly overall, although it has brought national and worldwide attention to various environmental issues. Most European countries, on the other hand, tend not to rely on courts for enforcement except in cases of serious, chronic violators. Citizens in Germany and France can go to court to try to force pollution abatement (or to stop upcoming projects in Germany) when they are directly affected, class action suits are not permitted, which is the case generally in Europe. Enforcement is largely by negotiation or issuance of abatement orders.

23/ Please note that some provisions for adjustment do currently exist.

24/ The roots of FSU law lie in European civil law tradition. Ukraine, therefore, does not have a common law or case law tradition. The decisions of the courts cannot develop or expand rules of law.

## E. Role of EIA

3.57 **Background on "Ecological Expertise" (Environmental Impact Assessments, or EIA).**[25] "Ecological expertise" is a review process which has been in place for several years in the FSU. Reviews of investments equal to or below Rb 100 million (value of construction, not equipment) are the responsibility of oblast or local MEP authorities. MEP at the national level undertakes the review of investments over Rb 100 million; it also reviews investments at enterprises which are particularly dangerous. Each firm is obliged to file a report on the environmental impact of its prospective investment, taking into account the opinion of local authorities. On receiving the report, MEP forms a board of specialists (10-15 people) to review the investment. Each expert files his or her own evaluation, and a summary is prepared and submitted to a designated Deputy Minister in MEP, who ultimately provides the official assessment. The process takes 30-40 days; there usually are no public hearings. If the assessment is negative and amendments are needed, they are considered and reportedly usually adopted. If the assessment is wholeheartedly negative, the project is excluded by law. It is unclear, though, how well this process has worked in practice.

3.58 **The Mandate from the Basic Law.** The Law on Protection of the Environment (June 1991), states that environmental assessments will be completed on a very broad range of projects and activities (Article 28). *By making coverage so broad, however, it appears to be impossible to enforce and cumbersome for smaller investors.* As a comparison, the National Environmental Policy Act (NEPA) in the US is much narrower. It requires an assessment only of "major" actions of the national government that "significantly affect the environment." The 1991 Basic Law also provides for "public" assessments (Article 30), described as voluntary private efforts that can be taken into account by bodies making state ecological assessments, as well as by those planning investments.

3.59 **Comments on the Draft EIA Legislation.** EIA legislation (called the EIA-draft) was under preparation in Fall 1992; during this study, it was reviewed by a US lawyer and regulator, whose comments are reflected here. The EIA-draft mirrors declaratory sections in the Law on Environmental Protection. Article 15, for example, lists activities subject to EIA; that list is overly comprehensive and thus impractical. *A more practical approach in Ukraine would be to require complete expert assessments of major new projects and only a simple public statement of expected impacts for minor projects.* The permitting process, rather than a full blown EIA, would take care of ongoing regulation.

3.60 The EIA-draft also seems to authorize EIA experts to both assess a project *and* to decide whether or not it should be approved (Articles 9, 36 and 37). This creates a conflict between assessment and decisionmaking, which are separate functions requiring separate skills. The assessor should be neutral, describing the facts and their consequences as they are, without regard to other considerations. Decisionmakers, on the other hand, must balance numerous considerations in deciding how to respond to the facts. The EIA law should set out criteria and a process that the competent authority must follow in considering a completed EIA. The competent authority could be MEP or another body. Establishing specific criteria will strengthen the position of MEP in responding to major investment proposals and will

---

25/ Provisions for EIA in the FSU were incorporated in the 1988 decree which established Goskompriroda. Even before that, GOSPLAN had a system of "ecological expertise" for proposed major projects. In May 1990, Goskompriroda issued guidelines for use of assessments more generally for all Union projects and projects in individual republics. This is the origin of Ukraine's ecological expertise process.

provide clear guidance to those preparing proposals. Detailed written decisions can serve as an enforceable license or permit for the project to assure that it fulfills promises made in the EIA.

3.61 Public participation can be difficult for sponsors of a project and for the EIA preparer, but it can also be the key to assuring that decisionmakers confront environmental impacts honestly. Public participation is mentioned in the EIA-draft (Article 13), but specific commands or directions are needed concerning the form and timing of public hearings. The public should have an opportunity to comment on the issues before the EIA is prepared and then afterwards, before a draft becomes final. The public should also have the opportunity to ask questions of the experts who prepare the EIA. On the other hand, Article 66 (Subsection a) of the draft appears to authorize individual citizens to demand an EIA of commercial enterprises. This appears unrealistic; there are practical limits to what the public can demand. *Again, it is very important that the law be specific in its criteria for undertaking EIA and the process of review.*

## F. Public Participation and Environmental Education

### Role of NGOs

3.62 In Ukraine, underlying public discontent with a vast number of environmental problems was galvanized by a singe event: the explosion at Chernobyl on April 26, 1986. Several public pressure groups, most notably Green World, date their creation from that event. The Ukrainian environmental movement has experienced a rapid growth and quite a public role. A range of NGOs (local, national and international) and "green-oriented" political parties have formed in the last six years and are active. The leading NGO, Zeleniy Svit (Green World), unites nearly 120 independent and diverse grassroots organizations, as well as individuals, and is now a political party. Other NGOs include: the National Ecological Center (a group of scientists, many affiliated with the Ukrainian Academy of Science) with national and local chapters, a chapter of Greenpeace International, an organization representing "The Children of Chernobyl," and various groups established at local levels to save the main rivers and Black and Azov Seas. The strength of NGOs has been demonstrated in several cases, where they have been able to stop projects at the local level because of public concern over environmental consequences. Some of their successes include: stopping the building of the Danube-Dnieper canal and achieving a moratorium on nuclear power station building.

### Avenues for Public Participation

3.63 Article 9 of the Basic Law establishes a citizen's right to participate in decisions relating to legislation, program implementation, environmental assessments and siting. The law does not, however, specify what participation means nor how it is to take place. More recently, a new Information Act authorizes broad access to environmental data, but the sweep of the law is so broad that it may not be practical; again, actual procedures and mechanisms are not well defined. *MEP should seek specific authority to develop rules for public participation and access to information in various aspects of the regulatory process.*[26]

---

26/ MEP currently operates an "environmental hotline" which citizens may phone one day a week to ask for specific information on the environment.

3.64 Public access to information can be a forceful tool in realizing stronger environmental management; it also encourages public trust in the environmental authority. Various approaches are used in other countries to assure some form of external participation (see Box 3.8). Public access can be aided by the professionalism of NGOs and others who speak publicly about environmental matters. NGOs also have a responsibility to provide sound information and informed judgement to the public. The NGO movement in Ukraine will be strengthened as experts from within gain training and information about technical aspects of the environmental field, as well as comparative regulatory approaches.

**Box 3.8: Other National Experience Concerning Public Participation**

Approaches to public participation in Europe and the US provide interesting contrasts. In the US, environmental information is usually made publicly available. In addition, various legislation provides for public hearings, review and comment in a range of environmental programs. In Europe, environmental policy making and review generally tends to be conducted in a more confidential way, with environmental information and data being closely held by policy makers. An exception is Sweden, which makes environmental information available to the general public. In Germany, public hearings can be called by Parliament, the Ministry of Environment, and political parties when considering new policies or particular projects; this occurs quite frequently. The Government of the Netherlands rarely holds public hearings, but it consults with NGOs and industry, sharing information and seeking comments in formulating environmental policy. Indeed, the Dutch government funds part of the core budget of major national NGOs, which are well respected for their professional expertise. Public access to environmental information in all members of the European Community is expected to widen in the future as a result of a new directive adopted by the Community (after long negotiations) which mandates greater access.

**Environmental Education**

3.65 Training to improve technical expertise and management skills are sorely needed. While many universities possess ecology departments, these departments largely specialize in the biological functions of ecosystems. *Environmental management is just developing as a field.* It is imperative that staff of MEP benefit from mid-career training opportunities and, over time, that skilled environmental experts (technical and policy oriented) enter the work force. Various groups in several cities in Ukraine (Kiev, Odessa, Kharkiv, Lviv) are active in setting up environmental education programs. This includes the new Environmental Education and Information Center in Kiev established under the Ministry for Environmental Protection and the University of Kiev Mohyla Academy.

**Modern Epidemiology--Its Importance to Sound Environmental Management**

3.66 An important parallel effort in training should be introduction of modern epidemiological methods in health research. Right now, the lack of controlled studies and risk assessment techniques is leading to claims about the impact on health of environmental factors which are unreliable, and in some cases they may be causing an emotional public reaction which may be unfounded. The most cost effective approach would be to take up opportunities for collaborative studies between Ukrainian and external authorities on health issues within Ukraine. A lot of health data have been gathered through domestic studies; it would be useful now to revisit some of these studies using modern epidemiological techniques (see para. 7.16 in Chapter VII and health data on specific oblasts in Annex 3).

## G. Financing Mechanisms for Environmental Investments

3.67 As mentioned above, this study recommends, first, directing more of the pollution fee revenue to strengthening regulatory activities, particularly at the local level. With remaining funds, the idea of pooling them into local or national ecology funds has been popular in various CEE countries. This section discusses some of the criteria which should be considered in setting up such funds.

**The Proposed Ecological Bank and Some Words of Caution**

3.68 Various Eastern European countries are setting up ecological banks as a form of financing pollution control investments, but with mixed results because of lack of commercial banking experience and associated credit risk analytical tools, the narrowness of a portfolio dedicated solely to pollution control investments, and resulting portfolio problems. Ukraine is planning to set up a bank of its own, presumably to be capitalized using pollution fee revenue. Also, various local governments have set up local ecological funds for the same purposes.

3.69 The experience of other countries would suggest some careful guidelines are needed in starting up "ecological banks." *Indeed, a better approach may be to set up more broadly based financial institutions, providing credit in a municipal area or oblast for a variety of activities, thus broadening the potential portfolio of the lending institution.* The other following considerations are suggested:

- start with a very small portfolio and establish strict criteria for lending, e.g. lending to enterprises which can demonstrate financial viability and ability to repay;
- broaden the scope of the portfolio by permitting lending for productive activities, area development, and municipal projects;
- in regard to environmental investments, emphasize priorities and cost effectiveness; this would include measures to improve energy efficiency and reduce pollution at low cost, generating cost savings and enhancing productivity; and
- lend at commercial rates (not subsidized rates) commensurate with the portfolio risks taken.

Only through use of such guidelines will it be possible to protect the financial soundness of the bank and assure its ability to operate in the longer term.

**Local Ecology Funds**

3.70 Local ecology funds represent a source of support for environmental investments at the local level, where the burden of solving pollution and other ecological problems truly rests. Because pollution fee revenue will likely remain small compared to the needs, careful criteria need to be established for their use, considering priorities and what can be achieved quickly with the funds available. This study recommends that (i) the objectives and operations of the funds be simple and straightforward, (ii) with the principle of "keeping it simple" in mind, disbursements be grants rather than loans, and (iii) the grants be targeted in support of activities or small-scale investments which are achievable in a short time frame. Both Chapters II and IV discuss the importance of supporting short-term action plans in industrial

and municipal plants. Creating incentives for implementation of those plans could be a major objective of local ecology funds. Funding could be structured to provide an incentive for firms to take low-cost measures without completely subsidizing them. Another objective might be to support low-cost containment of hazardous waste sites (those truly threatening local health), perhaps in support of privatization efforts (see Chapter V). *The main point is not to overload these funds with objectives which cannot be met with the resources available. Ultimately, healthy firms and healthy cash flows are the route to realizing major investments in modernization and sound pollution control. Local ecology funds can only play a small, intermediate role.*

3.71 Various international and bilateral donors are experimenting with programs in support of national pollution abatement funds, by channeling some resources into them, with specific criteria for their use. Ukrainian environmental authorities may want to explore such assistance, especially to support pilot programs in key cities and short term action plans in selected plants.

# IV. STRENGTHENING AIR AND WATER REGULATORY PROGRAMS



4.0 Developing an environmental regulatory program is a continuing process in all countries. *One of the weaknesses of Ukraine's regulatory system is its overambitiousness, in contrast to its very scarce resources, combined with reliance on older techniques and technology.* This chapter offers some suggestions for changes which could strengthen existing regulatory programs, specifically focusing on air and water quality programs, by making them more practical and introducing new techniques.[1] It proposes that environmental authorities in Ukraine experiment with several new approaches through pilot programs in priority cities. It also discusses the scope for market-based regulatory approaches.

## A. Suggested Changes in the Air Quality Regulatory Program

### Revising Ambient Air Standards to Make Them More Practical

4.1 Over 1000 air pollutants are identified under the FSU system. What are called "maximum acceptable concentrations" (MACs) are specified for about 540 air pollutants: (i) for 20-30 minute exposures; and (ii) in some case, for 24 hour exposures. A number of these standards are stricter than health-based standards established by the US, EC and WHO.[2] A selective comparison is shown in Table 4.1. *Especially problematic is the heavy dependance on the very short term "20 minute" standard,* which appears to be the result of the ambient monitoring methods used in the country, rather than a good measure of the health impact.[3] In most cases, such short exposures would not cause serious health problems if the high levels did not persist. Moreover, for many compounds, the primary health impacts are caused by chronic, long-term exposures to a pollutant. Cancer, mutagenic effects, nerve damage, and chronic respiratory diseases are examples of impacts resulting from *chronic* exposures.

4.2 Table 4.1 illustrates that few pollutants in the US or EC have standards for time periods of less than one hour (only CO and formaldehyde are exceptions). Most acute effects are observed over a 1-24 hour period, with standards protecting against chronic effects generally being set at an annual level. Some pollutants demonstrate different impacts (e.g. $SO_2$) over longer time frames; for those pollutants, multiple standards are developed.

---

1/ The recommendations reflect the views of several US and European air and water quality experts who worked with regulatory authorities in Ukraine to review the country's air and water quality regulatory programs during the course of this study. There was insufficient time and resources to undertake a detailed review of soil quality standards and associated regulatory activities.

2/ Ukraine's 24-hour particulate standard is an exception; it is equivalent to that of the EC. The EC does not have a fine particulate measure in contrast to the US.

3/ It reflects the wet chemistry methods employed and the difficulty in getting good long-term measurements.

**Table 4.1: Comparison of Ambient Air Quality Standards for a Number of Common Pollutants ($\mu g/m^3$)**

| Pollutant | Duration | Ukraine | USA[a] | WHO | EEC[b] |
|---|---|---|---|---|---|
| Particulate | 20 minutes | 500 | | | |
| | 24 hour | 150 | 260 | 150-230 | 100-150 |
| | Annual | | 75 | 60-90 | 40-60 |
| Fine Particulate (PM10) | 24 hour | | 150 | | |
| | Annual | | 50[d] | | |
| $SO_2$ | 20 minutes | 500 | | | |
| | 1 hour | | | 350 | |
| | 24 hour[c] | 50 | 365 | 100-150 | 250-350 |
| | Annual | | 80[f] | 40-60 | 80-120 |
| CO (in mg/m3) | 15 minutes | | | 100 | |
| | 20 minutes | 5 mg | | | |
| | 1 hour | | 40[e] | 30 | |
| | 8 hour | | 10[e] | 10 | |
| | 24 hour | 3 mg | | | |
| $NO_2$ | 20 minutes | 85 | | | |
| | 1 hour | | | 400 | |
| | 24 hour | 40 | | | |
| | Annual | | 100 | | 135 |
| Ozone (O3) | 20 minutes | 160 | | | |
| | 1 hour | | 235[g] | 200 | |
| | 24 hour | 30 | | | |
| Pb (Lead) | 24 hour | 0.3 | | | |
| | 3 months | | 1.5[h] | | |
| | Annual | | | 0.5 - 1.0 | 2 |
| $H_2S$ (Hydrogen Sulf) | 20 minutes | 8 | | | |
| | 24 hour | | | 150 | |
| Hg (Mercury) | 24 Hour | 0.3 | | | |
| | Annual | | | | |
| $CS_2$ (Carbon disul.) | 20 minutes | 30 | | | |
| | 24 hour | 5 | | 100 | |
| Formaldehyde | 20 minutes | 35 | | | |
| | 30 minutes | | | 100 | |
| | 24 hour | 3 | | | |

a/ Some of the US standards are actually specified in part per million (ppm). The approximately equivalent concentration (in $\mu g/m^3$ or $mg/m^3$) are given here. See Annex 9 for a fuller explanation of US standards.
b/ The standards shown here are those using the gravimetric method of measurement.
c/ Both of these are old US standards, now preempted by the PM10 standards. New PM standards were promulgated in 1987, using PM-10 (particulates less than $10\mu$ in diameter) as the new indicator pollutant. The annual standard is attained when the expected annual arithmetic mean concentration is less than or equal to 50 $\mu g/m^3$; the 24-hour standard is attained when the expected number of days per calendar year above 150 $\mu g/m^3$ is equal to or less than 1; as determined according to Appendix K of the PM NAAQS.
d/ Annual arithmetic mean.
e/ Not to be exceeded more than once a year.
f/ Annual arithmetic mean. The US also has a secondary standard of 1,300 $\mu g/m^3$ over a 3-hour averaging time, not to be exceeded more than once per year.
g/ This is a maximum daily 1-hour average. The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1, as determined according to Appendix H of the Ozone NAAQS.
h/ This is a maximum quarterly average.

4.3 *The number and strictness of the standards in Ukraine complicates, rather than aids, air quality management.* The standards are used as the basis for setting plant level emission limits, which are in turn the basis for the pollution fee system. It is time consuming to be setting and ultimately monitoring about 300 air pollutants, which is the number currently included within the pollution fee system. To provide a comparison, the US regulatory system at the national level specifies only 6 "criteria" pollutants for which ambient targets are set. For hazardous pollutants, the US is just now establishing a new system based on technological standards; it will cover 179 pollutants.

4.4 *This study strongly recommends that the MOH and MEP undertake a re-examination of the current ambient air quality norms to establish standards which more closely reflect public health needs and create realistic, attainable air quality goals.* In particular, the standards based on 20 minute exposures should be reconsidered, particularly as new monitoring equipment is introduced. The new standards should be fewer in number, including only those compounds which are common or potentially serious pollutants currently representing a threat to public health. Such an approach would concentrate the limited resources available in Ukraine on controlling the most important pollutants over time periods which truly reflect health risk. Pollutants which are possible candidates for inclusion are:

**General Air Pollutants**

a. Total Suspended Particulates and Fine Particulates (PM10)
b. $SO_2$
c. $NO_2$ and NO
d. Carbon Monoxide
e. Ozone (VOCs and NOx are the precursors)[4]

**Hazardous Pollutants**

a. Lead
b. Mercury
c. Cadmium
d. Chromium
Hydrogen Chloride
e. Nickel
f. Benzo-a-pyrene
g. Benzene
h. Polycyclic organic matter (POM)
i. Phenols
j. Formaldehyde
k. Arsenic
l
m. Hydrogen Sulfide
n. Hydrogen Fluoride
o. Carbon Disulfide

4.5 **Technology-Based Standards for Hazardous Emissions.** "Ambient standards" imply there is some safe level of ambient concentration. In the case of toxics, that cannot be assured. *Establishing "technology-based emission standards" by industry category is recommended for persistent toxics which tend to accumulate in the biological chain.* The rationale underlying technology-based standards is to try to reduce such emissions to the extent possible with available technology. The pollutants for which this approach would make sense include heavy metals, such as cadmium, chromium, lead and mercury, benzo-a-pyrene emissions in certain industries (e.g. coke ovens), as well as persistent compounds such as dioxins, furans, and PCBs. It is suggested that, in Ukraine, emission targets for such pollutants be set based on "best practical" technology rather than "best available" technology. The very best technological solution may mean major process changes or high costs which are unaffordable right now.

---

4/ There was no evidence of ozone problems seen during the study, but it should be evaluated further. Ozone may become a bigger problem in the future as vehicular traffic increases.

But it may be possible to find intermediate solutions which would substantially reduce emissions (good baghouse filters, for example, which reduce hazardous particles along with dust). Plants emitting toxic substances would also be obvious candidates for early economic evaluation of their long term viability.

**Improving Evaluatory Techniques and Methods of Setting Plant Limits**

4.6 Under the present system, the 20-minute MACs are typically used as targets for setting emission limits. Air dispersion models are used to set the limits for each applicable pollutant at each source within a plant. While the dispersion models can be sophisticated (as described in Box 4.1), they are used in Ukraine solely to focus on individual plants and their impacts at the perimeter of a plant's "sanitary protection zone," or SPZ. They are not used to analyze the overall impact and contribution of all potential sources (not only large industrial sources, but also smaller industrial stacks and mobile and non-industrial sources) in order to identify priorities for pollution abatement in the airshed as a whole. Also, they are not supplemented by good ambient data (see section below on emissions data). In some cases, the plant limits specified may be greater than available technology can even achieve. Furthermore, the process does not protect areas which have good air quality nor does it prevent future air quality problems from arising because it permits plants to release emissions up to the limit of the MAC.

**Box 4.1: Air Dispersion Modeling**

Models of varying sophistication exist to trace the contribution of individual sources of pollution to ambient air pollution in an airshed. They are called source-receptor or dispersion models, and they range from simple screening tools to complex models with calculations for weather patterns and building effects. The dispersion models of the FSU, created by the Geophysical Institute in St. Petersburg, compare well with similar models in the US (based on some comparative exercises undertaken by USEPA staff during the World Bank's Environment Study in Belarus). They are sophisticated and could easily be adapted to more appropriate standards (specifically, 24 hour standards rather than 20 minute standards).

Perhaps the biggest difference is in their use. In the US, dispersion models are used as one of *several* regulatory tools giving information about the link between individual sources and ambient pollution. They help regulatory authorities plan abatement strategies throughout an airshed, considering large point sources along with mobile or more diffuse, smaller sources. In the FSU, the models are used more mechanically to set emission limits for stationary sources. The models are employed primarily by industrial institutes, not by regulatory authorities, who in fact often may not understand how they work.

In addition, there are two other concerns in using the FSU models. First, while there are options for incorporating the mixing effects of buildings, they are apparently not generally used; depending on the case, this may either overestimate or underestimate the impact of emissions. Second, the models make assumptions about background pollution using data which may not be very accurate. A lot of emissions data is based on estimates using material balances provided by the plants themselves; even the data developed by monitoring are not reliable, as they suffer from problems of inaccuracy because of reliance on poor equipment and inadequate quality control.

4.7 A broader approach to an air quality strategy would be to employ--for each municipal area or larger airshed--a combination of dispersion models (screening models and, as necessary, more detailed models) and better monitoring and testing methods to characterize pollution problems more carefully in individual airsheds and to evaluate the range of potential sources.[5] While, in some key cities, several large industrial plants are dominant air polluters, one cannot ignore lower level sources--activities associated with coal mines, asphalt plants, cement plants, coal-fired stoves and boilers--as well as mobile sources. Such an exercise would lay the basis for developing municipal or regional abatement strategies, identifying priorities and trying to devise cost effective ways to achieve pollution reductions. Plant limits would still need to be set, but that process would be more realistic and would be combined with efforts to address pollution from small scale sources as necessary. Compliance would have to be phased in, with schedules agreed based on the seriousness of the emissions, the contribution to ambient pollution, and economic prospects of the enterprise.

4.8 In designing regulatory programs, the authorities should also make distinctions between areas which exceed ambient standards ("non-attainment areas") and those areas which are below ambient standards ("attainment areas"). In "attainment areas," the goal of regulatory programs would be to prevent serious deterioration of air quality.

4.9 **Eliminating Reliance on Sanitary Zones.** The current system for establishing emission limits assumes the existence of "sanitary zones" near the polluting enterprise, where *theoretically* no people reside, thus serving as a dispersion zone for pollutants. In fact, sanitary zones often contain large populations.[6] *The concept of the sanitary zone would best be eliminated from the air pollution program.* Emission limits should be developed in such a manner that ambient air quality standards are attained on all land not under the ownership of the polluting enterprise, or all places where people live.

4.10 **Problems with Emissions Data.** The determination of emissions is inadequate to develop and maintain a proper air quality management program. One of the reasons is the reliance on the major industries to determine their own emissions, with little or no verification of this data through source testing and stack sampling because regulators lack the equipment. In addition, the emission factors used in making emission estimates may not be adequate; they would benefit from a detailed review; then, updated emission factors could be applied to all enterprise estimates.[7] Estimates of fugitive emissions also appear to be poor. Rough emission factors for these types of emissions are employed in Ukraine, but they are apparently developed assuming a relatively good level of housekeeping as well as maintenance of pollution control equipment for organized ("stack") emissions; this is not typically the case. A system of "fugitive" emission factors should be developed based on the level of general housekeeping and maintenance of pollution control equipment which is actually attained by a facility. For example, a three level system could be developed (based on: 1-poor; 2-average; 3-good management) with a rating applied to each facility.

4.11 **Suggested Improvements in Air Quality Monitoring.** The process of defining plant contributions to ambient pollution--and monitoring plant compliance--is also hampered by measurement

---

5/ See Annex 9 for a description of site characterization analyses used in the US.

6/ For example, in Zaporizhzia, the sanitary zone near an industrial district has 20,000 inhabitants; in Kryvyi Rih, the sanitary zone around the Krivorozhstal plant contains 3,000 permanent residents.

7/ The United States Environmental Protection Agency (USEPA) provides detailed guidance on emission factors in Air Pollution Guidance Document 42 (AP42); it could be used to compare emission factors of the FSU.

problems related to the use of older monitoring equipment, which have not kept up with technical advances, as well as insufficient quality control. In addition, sampling is lacking for a number of important pollutants: ozone and other photochemical pollutants, hazardous organic components, fluorides, and some heavy metals.

4.12 *The monitoring for particulates is of special concern.* Ambient air quality measurements indicate a level of particulates which is unlikely to be as high as reported. This may be due to a number of factors, most important of which are: the low placement of the intake points for the monitors, the very high volume of air taken into the monitors, re-entrainment of roadway dust at monitors near roadways, and the conversion of $SO_2$ and NOx to sulfates and nitrates on the filters.[8] Both the quality of the equipment and the siting of the monitors are to blame, and both could be substantially improved. *Environmental authorities in Ukraine are strongly advised to switch to modern hi-volume particulate samplers, typically used in the EC or US.* The particulate samplers can also be used to provide samples of heavy metals for analysis, which cannot be detected with gaseous monitors. MEP's branches would also benefit from having emissions monitoring vans in priority areas to verify the accuracy of the self-reporting of the major industrial polluters and to assure compliance by smaller sources of pollution. In addition, in selected locations, where the dust problem appears to be especially high, a fine particulate sampler (PM10) might be co-located to determine the extent of the public health problem which is actually present, but this approach may need to be postponed until more resources are available.

4.13 All samples of gaseous pollutants are currently taken using wet chemistry methods. The quality control procedures used in taking these samples are questionable. The measurements generally lack required refrigeration before the chemical analysis, and there are a number of opportunities for chemical transformation and contamination, including during transport back to the lab.[9] The laboratories themselves do not use proper quality assurance procedures for determining precision and accuracy of analyses, including: blind field sampling, internal standards, and calibration of standards against a national standard.

4.14 Over time, as resources permit, MEP will want to undertake a program to install real time automatic monitoring equipment for gaseous pollutants in the major industrial complexes where serious ambient air quality problems occur. In the long term, all gaseous monitors ideally should be continuous, but the cost of making such a transformation for the entire country is not feasible or warranted in the medium term.

**Proposed Action Plans for Priority Air Pollution Areas**

4.15 In the discussion at Chapter II, about 8 cities were identified as "priority air pollution areas," where threats to public health seem paramount: Dnipropetrovsk, Dniprodzerzhinsk, Kryvyi Rih, the Donetsk airshed, Kostiantynivka, Mariiupil, Zaporizhzhia, and Odessa. In these cities or airsheds, it would be helpful to characterize pollution problems better, in order to develop air pollution abatement

---

8/ The high volume particulate monitor is a relatively simple device which operates on the same basic principles as a vacuum cleaner. Ambient air is pulled into intake line and through a filter which removes any particulate matter in the air. The filter is a fixed weight, following the monitoring period the filter is weighted. The difference between the fixed weight and the weight following the monitoring period is the amount of pollution in the air. This is adjusted to account for the time period and volume of air pulled through the filter.

9/ Reports suggest that shortages of glass are affecting the quality of containers used to carry the samples, which may be a factor in quality control.

**Box 4.2: Suggested Air Quality Management Programs in Priority Areas**

**First Phase: Short Term, Low Cost Action Plans in Major Plants.** These short term measures would be actions which are not capital intensive and could be implemented relatively easily to decrease pollution at the source. They could be as basic as an aggressive sweeping program of particulate matter at the plant site. Other measures might include repair of existing equipment in a timely manner (e.g., repair of leaking coke oven doors), while still others could be minor changes to existing processes or control equipment which would improve their efficiency as well as reduce unorganized emissions. The measures could also include developing stronger emergency action plans, when pollution is extreme (e.g. during weather inversions).

**Second Phase: Development of Air Quality Management Plans** (beginning with pilot programs). Steps would include the following:

(i) An increase in the staff and equipment available to the local branch of the Ministry for Environmental Protection. A priority would be introduction of improved monitoring equipment, for example installation of new high volume particulate sampling monitors for particulate matter and related toxic compounds. The increase in equipment might also include a modern emission monitoring van to be used in verifying the self-reporting of major sources and sampling smaller sources. As funding permits, installation of continuous air quality monitoring systems should be introduced to supplement the current system of wet chemistry methods for gaseous pollutants.

(ii) Preparation of an individual air quality management plan for the city or airshed, considering both stationary (industrial and non-industrial) and mobile sources, to reach over a specified period of time (e.g., the year 2000) designated ambient targets for selected "criteria" pollutants. In devising this plan, receptor-source screening and more complex dispersion models could be employed to evaluate both the collective impact as well as individual contributions to pollution in the airshed. This exercise would be followed by costing and prioritization of options, leading to an abatement strategy for the area. It would also take into account opportunities for creation of new economic activities and diversification of industry in the region.

(iii) Using the air quality management plan, revised targets and compliance schedules would be developed and negotiated with individual plants. New permits would be issued for individual sources, outlining longer term actions (5-10 years) and a clear timetable for reductions of emissions. Those compliance plans would be made publicly available.

(iv) The new permits would also include emergency action plans. With installation of continuous air quality monitors, giving "real time" air quality information to regulatory authorities, enforcement of these emergency action plans could be more aggressively pursued.

(v) The air quality management plan should also identify efforts to reduce more dispersed or mobile sources of pollution, such as a plan for use of cleaner fuels in smaller boilers or inspection programs for vehicles.

(vi) Finally, the plan should allow opportunities to introduce market based regulatory approaches (emissions offsets or "bubbling" of one or more plants) as the regulatory infrastructure (and baseline information) becomes stronger and property rights are better defined.

plans identifying cost effective strategies to reduce pollution in these cities over the medium to long term.

4.16 These suggested air quality management programs should comprise two phases (see Box 4.2). The *first phase* would include the development of *short term action plans in major plants,* which could be implemented immediately, and early *strengthening of "emergency response" plans.* The major industries are supposed to have plans to undertake temporary measures to reduce pollution during extreme episodes, but they are not operating well at the present time. Annex 8 outlines the elements of a sound emergency action program. A timetable for completion of these actions should be agreed upon and recorded in the ecological passport.

4.17 The *second phase* would include more *detailed characterization of air pollution sources, hopefully with the support of better equipment, in order to develop a cost effective longer term air quality management plan.* In doing so, it will be important to have improved baseline inventories of emissions and discharges, a better understanding of ambient conditions and sources, and information on the cost of different abatement options. To strengthen overall air quality assessments for specific areas, environmental and health authorities in Ukraine would benefit from exposure to approaches and equipment used in other countries. With perhaps international assistance, one or two of the priority cities could be selected for pilot programs to experiment with developing air quality management programs based on improved monitoring and evaluation. The air pollution plans for the priority areas would be the primary responsibility of the local MEP branch but it would need considerable assistance from Hydromet, local public health officials, and municipal authorities.

4.18 In addition, *a special program should be instituted at Kostiantynivka* to clarify how serious the lead emissions problem there actually is. This program should include blood lead testing of workers and children, which will probably require public health support from abroad.

**Comparative National Approaches**

4.19 MEP's air quality regulatory authorities would benefit from exposure to other national regulatory approaches, so that they can select aspects which might be helpful to the Ukrainian program. An example of a broad air quality regulatory program, that of the US, is presented in Box 4.3.

**Opportunities for Market-Based Approaches in Air Quality Regulation**

4.20 Several economists in Ukraine have expressed interest in embracing other "market-based" approaches besides the pollution fee system, such as marketable permits or offset programs. The glamour of "emissions trading" and the promise of large cost savings tend to obscure the practical aspects of implementing such programs in Ukraine right now. Worldwide, among environmental economists, much attention is given to the debate between "command and control" (CAC) mechanisms and market-based (MB) mechanisms. In reality, however, both approaches require good baseline emissions data and strong permit programs. Perhaps 90 percent of the administrative, permitting, data requirements and other aspects of any good regulatory system will be the same, whether or not the system is command-and-control or market based. It is that 10 percent difference in MB programs, however, which could give industry increased flexibility, possibly lowering compliance costs significantly. But Ukraine first needs to build up its regulatory infrastructure as discussed in this chapter and in Chapter III. *MB approaches ought to be considered after the regulatory infrastructure is strengthened and property rights become clearer.*

4.21 Most of the experience to date with MB approaches has come from the US, primarily in local air quality programs (described in Box 4.4). It is also worth noting that emissions trading in the US is still

limited, although it expanded in 1993 with commencement of the new $SO_2$ allowance trading system for electric power utilities. Air credit trading, according to one expert in the field, does not command even 1 percent of the resources spent on air pollution control in the US. Risk aversion and other factors which complicate the process of identifying and securing trades have led to fewer trades than expected. Moreover, they are not generally used for hazardous pollutants. The cost savings achieved in air credit trading transactions in the US are not really known (because most transactions are confidential), but are estimated to be sizeable--about US$1 billion. On the other hand, there have been few, if any, real world successes in water trading programs. Existing regulatory requirements in the US have made water trading administratively difficult; this factor, combined with risk aversion among potential participants, has limited the interest in water trading programs.

4.22 For any incentive-based system to work well, a number of requirements apply:

(i) Good baseline data on emissions are essential. Without good emission inventories, no regulatory program can be effective.

(ii) Ambient air quality targets must be predicated on good ambient monitoring data. Absent good monitoring, translating emissions into impacts is very difficult, and establishing plant level limits will be arbitrary and not cost effective.

(iii) The human capital, systems, and procedures need to be in place to assure regulators and the public that emission baseline are real, targets meaningful, and the monitoring of regulatory outcomes are reliable.

(iv) Property rights or quasi-property rights must be well defined.

(v) Incentives for compliance must significantly outweigh the incentives for avoiding compliance. Compliance monitoring must be certain and penalties meaningful.

(vi) Where possible, economic incentive based regulation should be built into environmental laws and regulations, not added-on.

4.23 Particular programs which may eventually have applicability for domestic air quality regulation in Ukraine are "offsets" and "bubble" programs, especially to achieve intra-facility emission reductions (see Box 4.4). Similar programs across facilities may be feasible, but are more complicated. If regional air pollution problems are identified, then the potential application of inter-facility bubbles could be explored. It is for these types of applications, where the exact location of a particular facility within a region is not particularly significant, that inter-facility bubbles could be used. Chapter IX discusses the applicability of marketable permit programs to transboundary and global environmental concerns.

4.24 Other countries which are pursuing air credit trading programs are: Chile (Santiago airshed), Brazil (bubbling for several large steel works), and Canada (Vancouver area and possibly Windsor-Montreal for NOx and VOCs; and nationally for acid deposition control).

**Box 4.3: Air Quality Management in the US**

The United States' system of air quality management is complex; it has evolved over a long period of time and is still evolving. The U.S. program is a three-tiered program in some states (federal, state, and local) and two tiered in others (federal and state only). States and local units of government cannot override federal standards. The federal government, through the Clean Air Act, establishes a minimum framework for air quality management. This framework includes, but is not limited to:

(i) Ambient Air Quality Standards for the most common "criteria" pollutants--fine particulates, carbon monoxide, ozone, lead, nitrogen oxide, and sulfur dioxide.

(ii) New Source Technology-Based Emission Standards for all new sources which may contribute to the formulation of the six common pollutants listed above.

(iii) A process to ensure that areas of the U.S. which do not meet the ambient air quality standards (called "Non-attainment Areas") develop and implement plans which will return these areas to attainment of the standards by a certain date.

(iv) A process which ensures that areas which are currently attaining the ambient air quality standards (called "Attainment Areas") maintain a high level of air quality.

(v) A new technology-based program to control the emissions of 179 toxic pollutants from all significant industrial categories.

(vi) A permitting program which applies to all significant sources of either the common (criteria) pollutants or the toxic pollutants.

(vii) A new mandate that all states set up emissions fee programs.

(viii) A new program for $SO_2$ allowance trading among power utilities to reduce SO2 emissions and prevent increases in acidity precipitation in the nation.

(ix) A program to control the emission of all pollutants from mobile sources.

The states are responsible for developing their individual air quality management programs within the framework provided by the Environmental Protection Agency (USEPA). The framework provides a set of minimum requirements which the states must build into their programs. The states prepare the plans and implement the directives of USEPA. The states are, in general, able to develop a more stringent set of requirements than those contained in the minimum federal framework, but they cannot be less stringent. Many states have chosen to develop air quality standards and regulations more stringent than those required by EPA, while other states have not done much beyond the federal minimums. If a state fails to meet or enforce the federal minimums, EPA has the responsibility and authority to step in and directly impose those federal requirements.

The states may in turn choose to delegate some of their responsibility under the federal and state programs to local units of government. The level of formal responsibility varies tremendously across the United States. It ranges from local units which have a very great level of responsibility and authority, such as the air quality management districts in California, to states such as Wisconsin where the local units of government have no formal responsibilities. At the state and local level, there are also various ongoing emissions fee programs and small emissions offsetting or trading programs (trading is largely for VOCs).

A separate agency, the Occupational Safety and Health Administration (OSHA), sets standards and enforces indoor air quality issues in the workplace. There is no federal regulation of indoor air quality for private dwellings. though USEPA does undertake research and distributes information on overall indoor air quality issues.

**Box 4.4 : Marketable Permit Programs for Air Pollution Abatement in the US**

The US introduced its first marketable permit program in 1976, thus it has had over 14 years of experience with various trading programs in different parts of the country. Most of these programs are implemented at the municipal or state level. "Marketable permits" is a concept in which new or existing sources meet emission control obligations by using extra emissions reductions achieved by other emitting sources (either within a facility or across facilities), presumably at lower cost. The concept encompasses several different programs--offsetting, bubbling, netting, and emissions credit banking. The approach was extended to cover $SO_2$ emissions in 1990 under Title IV of the amended Clean Air Act. *The most important element in any marketable permit program is having a good permit program in place with good emission baselines and operating data.* This is a prerequisite to a successful program.

Emission reductions must meet certain tests before they are considered emission reduction credits (ERCs). One requirement is that they must be surplus to other regulatory requirements. Offsets are ERCs applied to meet regulatory requirements affecting new sources and major modifications in "non-attainment" areas. If a firm's planned expansion or new investment will emit more than a "de minimis" level of a regulated pollutant, then "offsets" for that pollutant must be secured from other firms or sources in the relevant airshed. Generally, the rules require that the firm secure offsets greater than a 1:1 ratio relative to the expected emission increase to achieve a net benefit to the airshed. Offset programs are facilitated by "*emissions credit banks*," which provide a means for certification and registration for future use or sale. *Netting* is the use of an ERC within a plant, netting emission increases with reductions, to avoid "new source" review requirements, which might lead to stricter requirements for control technologies. These programs (along with bubbles) are used most frequently to control VOCs because control costs can vary greatly within and across facilities (ranging from $100-$1000 per controlled ton p.a.), making them good targets for trading programs. Still, complicating factors do exist: sometimes difficult monitoring requirements and coverage of toxic VOC constituents under more stringent regulatory requirements.

A *bubble program* is an alternative emission control strategy which allows a combining of emissions from an array of emission points at a facility and establishing a single emission limit for the facility; in its simplest form, it is essentially "emissions averaging." It allows a plant to select the most cost efficient set of emission controls to meet the single emission limit. In practice, the situation can be complex because not all emission points at a facility are equal in environmental impact (because of different heights, discharge temperatures, velocities, and locations at a facility). This is addressed by making conservative assumptions concerning location of emission points. This often results in a tighter overall emission limit, but it is probably offset by lower control costs derived from the flexibility to choose the lowest cost combination of pollution controls. Conceptually, the most interesting bubble programs have had problems in practice and are slowly declining in uses. A broader application of the "bubble" approach is to allow the averaging of emissions across facilities. Multi-plant bubbling is difficult because of the novelty, the cooperation with other plants, and sometimes unclear liability rules. What makes multi-plant bubbling possible is having a good emissions banking program which defines liabilities and certifies tradable credits.

The newly mandated *$SO_2$ allowance program* is a form of bubbling or emissions averaging to reduce $SO_2$ emissions across electric power utilities. With full operation having started in 1993, the program is somewhat different from other permit trading programs in that allowances (each worth one ton of $SO_2$) have been issued to each affected power utility (about 108 plants in the first phase). The affected units are required to hold a sufficient number of allowances to cover actual $SO_2$ emissions in each year of the program. The intent is to try to cut $SO_2$ emissions by about 50% to 10 million tons by 1996/97. New units must secure sufficient allowances to cover new emissions in and after the year 2000. In principle, other $SO_2$ sources could be brought into the program.

It is important to note that emissions trading and $SO_2$ allowance trading are voluntary programs; sources are not required to trade or to reduce compliance costs. Risk aversion and other factors have led to fewer trades than would be desired; yet cost savings due to these voluntary programs have probably saved firms over $1 billion (the actual amount is unknown since trades are confidential). While some observers allege that the reason firms have achieved less than the optimal amount of savings is due to the inefficiencies in the underlying CAC program, a more complete analysis would point out that the administrative requirements and search costs of market-based programs are significant. In addition, firms do not necessarily seek cost-effective pollution compliance strategies; they are more often risk-minimizers, not profit maximizers, when it comes to pollution control, especially if new programs involve further administrative review.

## B. Proposed Changes in the Water Quality Regulatory Program

### Suggested Changes to Ambient Standards for Surface Water Quality

4.25 Some 4,000 water quality indicators are specified under the FSU system. Each chemical, physical or biological indicator defining acceptable water quality is represented by a standard for maximum acceptable concentrations (MACs), and these standards can vary according to type of water body. In setting the MACs, the intended water use (drinking, fish propagation, or industrial processes, etc.) is supposed to be a factor in the decision.[10] Most MACs are based on fish production water quality, however, which is the category with the strictest standards. Some of these MACs are more strict than the ones applied in other industrialized countries, as noted in Tables 4.2 and 4.3.

4.26 Research institutes, such as the Institute for Hygiene in Kiev and the Center for Water Resources in Kharkiv, are now starting to revise water standards (MACs) in conjunction with MEP. Conversations during this study indicated they want to tighten water standards further. *In contrast, this study would recommend a more practical approach--adopting water quality standards in use in the EC or US rather than developing a completely independent approach. In any case, it should be recognized that compliance will have to be phased in, as resources permit. In doing so, it is also recommended that chemical-specific standard limits be supplemented by effluent toxicity limits, or other biological criteria.* Contrary to the single parameter approach, a system using test organisms and indicators for ecosystem changes is able to detect the sum effect or synergistic effects of a mixed pollution load to a recipient. It would also make sense to establish an incremental schedule for revising standards, with an early focus on the most common standards noted in permits and collected in monitoring programs, such as those for dissolved oxygen, BOD, ammonium, phenols, petroleum products, copper, and zinc. Finally, as discussed below, there is scope for introducing minimum technology standards as a means of simplifying the current regulatory system.

### Suggested Improvements in Water Quality Monitoring[11]

4.27 The various existing monitoring networks are insufficiently targeted to regulatory purposes; they were designed for purposes other than developing baseline information for pollution control and policy development. Moreover, some waterbodies and sites are doubly monitored, while others are not covered at all.[12] There is also not a good system of reporting to environmental and health authorities when alarming water quality problems are observed. Almost all monitoring is based on traditional physical and chemical analysis of the water; the equipment and quality control in sampling and laboratory analysis appear to be poor. Despite the array of standards, monitoring is probably limited to about 50 constituents, of which semi-reliable results are possible for about 20 constituents. Present methods are not satisfactory for detecting the level of exposure to micropollutants, such as heavy metals, pesticides and chlorinated hydrocarbons. Such pollutants should be monitored by analyzing biological indicators and sediment samples.

---

10/ There are four "categories of water use" in Ukraine, varying from the cleanest drinking waters (number 0) to waters only suitable for limited industrial supply (number 4).

11/ Additional background is provided at Annex 7.

12/ For example, the Inhulets River, which receives considerable discharges of wastewaters from Kryvyi Rih, is insufficiently monitored.

**Table 4.2: Water Quality Standards for Fish Production**

| Parameter | $BOD_5$ | Ammonium | Nitrates | Copper | Zinc | Mercury | Phenols | Hydrocarbons |
|---|---|---|---|---|---|---|---|---|
| | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l |
| Ukrainian MAC | 3 | 0.5 | 9 | 0.001 | 0.01 | 0.0005 | 0.001 | 0.05 |
| EC Mandatory figures for salmonids | 3* | 1 | - | 0.04** | 0.3 | - | No taste | No visual sign or taste |
| USEPA Freshwater "chronic" guidelines | - | pH & temp. dependent | - | 0.012** | 0.11** | 0.000012 | 2.56 | - |

* Guide; ** Dependent on water hardness

**Table 4.3: Raw water quality standards for drinking water supply**

| Parameter | $BOD_5$ | Ammonium | Nitrates | Copper | Zinc | Mercury | Phenols | Hydrocarbons |
|---|---|---|---|---|---|---|---|---|
| | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l |
| Ukrainian drinking water standard | 3-6 | 2 | 45 | 1 | 1 | 0.0005 | 0.001 | 0.3 |
| EC Mandatory Category $A_2$ treatment (physical, chemical) | 5.0* | 1.5 | 50 | 0.05* | 5 | 0.001 | 0.005 | 0.2 |
| USEPA Tapped drinking water standard | - | pH and temp. dependent | 10 | 1.3 | - | 0.002 | - | - |

* Guide

4.28 MEP does not conduct regular ambient water quality monitoring. The only information on general water quality it collects regularly is from samples taken 500 m upstream from registered discharge points; this is used to help determine the "allowable dilution" of discharges (to calculate the MAD). It also tests downstream of discharge sites for enforcement purposes. Ambient water quality data are normally provided by Hydromet and MOH (San-epi stations).

4.29 The following changes in the monitoring system are recommended:

(i) Water quality monitoring systems should be better integrated and coordinated to focus more on pollution control and environmental planning. A revised system--defining the network of sampling stations, sampling frequency, parameters monitored at each point, level of automation, etc.--needs to be designed with a view to cost effectiveness.

(ii) Monitoring and laboratory equipment should be upgraded after a revised monitoring system and its objectives are defined.

(iii) Monitoring should be expanded to include biological indicators. Biological material and sediment samples should be collected on a regular basis for analysis of inorganic and organic micropollutants. Testing for synthetic organic chemicals, especially solvents and pesticides, should be expanded.

(iv) Control monitoring and inspection should include other locations besides official discharge points in order to track deliberate permit violations or discover previously unknown discharges. Control monitoring should be done closer to the processes themselves.

(iv) Some non-fixed station monitoring activities might also be included for special surveys of waterbodies of particular interest, from time to time.

**Suggested Improvements in Setting Plant Limits**

4.30 The regulatory system is based on controlling point source discharges. Each municipal or industrial facility which directly discharges into the surface waters of Ukraine is permitted by MEP. Complex mixing zone models (described in Box 4.5) are used to calculate a plant's maximum allowable discharge limit (MADs), so that the MAC values for that stream segment are not violated. Compliance with MACs is calculated 500 meters downstream of the discharge point. An industrial or research institute contracted by the plant actually closes the analytical work to set the MAD. The permittee is required to send the mixing zone analysis and resulting permit limits to the MEP. MEP reviews the analysis and proposed permit limits, corrects them as needed and issues the permit. This so-called "ambient-based" system, therefore, theoretically leads to each discharger having a customized maximum allowable discharge (MAD) for each parameter.

4.31 The system also applies to municipal sewage treatment plants which receive industrial discharges. The treatment plant is the entity that is legally held responsible, and MADs are set in its permit. The wastewater authority then establishes contractual agreements with upstream industrial dischargers, specifying acceptable concentrations, service fees, and any penalties for contract violations. This is similar, in principal, to pre-treatment programs in the West, but charges are low and based on volume, not type or strength of discharge.

4.32 Supporters of this ambient-based approach believe it is technically sophisticated and fair, since each facility is evaluated on an individual basis, and the ability of local receiving waters to dilute the

**Box 4.5: The Dilution Model**

A dilution model is used throughout the FSU to establish discharge limits at individual plants to meet ambient water standards. The mixing zone equation uses a variety of information to calculate the available dilution in the receiving stream: discharge design flow, stream 95% low flow, background concentration of pollutants, mixing coefficients and velocity, depth, width and meander length of stream. Even this complex methodology, however, is unable to predict properly the effect of oxygen consuming compounds such as BOD, ammonium and nitrite. The calculation is made using a basic Streeter-Phelps equation which cannot handle the combined effect of a mixture of oxygen consuming elements. This equation was developed in the US in 1918 but is no longer used without the addition of terms to provide for oxidizable forms of nitrogen. One problem might be that the lowest oxygen levels will occur far downstream of the typical 500 m control point. For toxic pollutants and for a single pollution point discharge into a river, the mixing zone methodology results in a more stringent permit limitation than would be calculated in the US.

wastes is taken into account. It results in some practical problems, though, which Ukraine now faces. *The existing ambient program is complex to administer, creates and sustains the existence of "pollution havens," and poses direct conflicts with drinking water protection policies.*

4.33 **Technical Problems and Administrative Complexity.** While the approach for back-calculating each MAD from its respective MAC seems technically sophisticated, it is hampered by a lack of suitable calculation methods for all but the most conventional parameters (See Box 4.5). While Ukraine is believed to have appropriate methods for assessing oxygen-demanding discharges (BOD, COD, DO), scientifically sound procedures for more complex constituents such as solvents and metals appear to be lacking. Along with these technical problems, the administrative complexity is a serious constraint. When one considers that Ukraine theoretically has thousands of potentially applicable MACs/MADs for each discharger on each waterbody, both practical and methodological problems result. Technical reviews of these large sets of calculations must then be performed by the very small MEP staff at oblast and municipal branches. MEP staff often lack the technical skills to review such calculations, and such work diverts them from other pressing duties, such as enforcement. In fact, the oversight by MEP is probably minimal; indeed, it also appears that the permits normally include only 5 to 12 MADs, not the hundreds that are specified in the list of standards, because it is simply not practical to monitor so many.

4.34 **The Danger of Pollution Havens and Degradation of a Waterbody.** Another policy consequence of this system is that it allows dischargers to pollute up to the MAC even if the ambient quality in the waterbody is better than the MAC. This policy could cause degradation of a waterbody over time. All other things being held constant, smaller waterbodies have less ability to dilute wastewater discharges. In order to meet the MACs, industries on smaller waterbodies theoretically must clean up their wastewater effluent to a much greater degree that industries on larger waterbodies. Large industrial dischargers, therefore, tend to cluster along the main channel of the Dnieper River, given its tremendous capabilities for diluting wastes. This condition is sometimes referred to as a "pollution haven" since polluters tend to congregate in such locations where the cost of compliance would be reduced. Due to the enormous dilutive capacity of the Dnieper, it is rare that any one discharger can be shown to have caused an exceedance of a MAC in the main stem of the Dnieper, furthering the logic that the discharge should be continued. Given the limited monitoring data available for the Dnieper, it is difficult to assess the net effect of this policy; it is very probable, though, that steady deterioration in overall water quality might result. The Dnieper serves as the water supply for more than 70 percent of Ukrainians.

Continuation of an approach which allows individual dischargers to rely on dilution to disperse pollution is in direct conflict with the need to preserve long-term drinking water quality.

4.35 **Other Concerns in Permitting Dischargers.** Two other practical problems appear to impede compliance. First and most importantly, the point of compliance is often set at the outermost boundary of a facility, even on a site with extensive breaks in the wastewater collection system, or one with unlined canals. This can foster on-site groundwater contamination. *On-site compliance points closer to the outlet of major plant sections should be established. Having only one point of compliance for permits of very large facilities can transfer a surface water problem to a groundwater problem.* Groundwater contamination has probably resulted from allowing percolation of effluents through leaking pipes and unlined collection canals on site. The point of compliance should not be extended beyond the boundaries of the operating plant except for unusual situations. One site surveyed during the study had a point of compliance off site, at the discharge point from a canal to the Dnieper River some 10 kilometers away from the facility boundary. This represents de-facto approval of offsite contamination.

4.36 Second, vagueness as to whether compliance is based on annual loadings of pollutants or continuous discharges has probably delayed enforcement. The permit specifies the MADs on both an annual loadings basis and an average concentration basis. This has created difficulties for enforcement when dischargers argue that temporal exceedances will not cause the annual loadings to be violated. The triggers for enforcement should be the actual monitored data, not the annual loading. Self-monitoring and reporting by dischargers of any violations should be included in the permits.

**Suggested Changes in the Regulatory Structure**

4.37 *This study recommends that MEP make the regulatory program more practical by setting consistent, clear minimum "technology-based standards" for each major category of discharger.* A technology-based approach focuses on setting consistent discharge limits for all facilities in a given industrial and municipal category, regardless of the waterbody on which they are located. The standards for an industrial discharge category might be expressed, for example, as "X kilograms of pollutant per Y million kilograms of industrial product output." For municipal dischargers, a given level of enhanced primary, or possibly secondary treatment, might be adopted. *Technology-based programs would avoid the problems mentioned above and would also simplify the approach to developing discharge limits.* The limits would typically be set by MEP on an industry-specific basis, thereby easing the burden of technical analysis on both the discharger and MEP staff. This places the responsibility for developing industry-specific standards at the central government level, where technical resources should be strongest and most easily supported by in-house experts and research institutes. It is interesting to note, by the way, that most water quality programs in the West which began on an ambient water-quality basis quickly shifted to technology-based standards as the primary approach.

4.38 Modeling exercises could then be used to augment the technology-based standards. Once technology standards are put in place, for instance, some unique water quality problems are expected to emerge which might best be handled on a more waterbody-specific, tailored basis. Examples include continued dissolved oxygen deficiencies, loadings of metals to sensitive stream segments, and impacts from the combined effects of discharges from different waste streams. Sub-basin modeling of discharges and wasteload allocation among them would be the typical next step.

**Prioritizing and Phasing In Investments**

4.39 Whatever the standards, it will be necessary to have a long transition period, recognizing that the investment costs of wastewater treatment are high and thus prioritization is essential. Investment

targets in the medium term should focus on minimum needs rather than the most advanced or complete technologies. The time frame for compliance should be based on the relative economic impact of the changes, the desirability of improving conditions in the receiving waters, and the known effects of the discharges on receiving waters. Priority right now should go to those industrial cities along the Dnieper, where a large population is concentrated, and major cities, or tourist areas along the Black Sea Coast because of its economic and recreational importance. These criteria suggest the following cities: Zaporizhzhia, Dnipropetrovsk, Dniprodzerzhinsk, Odessa, Mariiupil, Sevastopil, Yalta, and cities along the Siverskodonets River. Other areas of natural value, earning secondary priority, are resort areas in the Carpathian mountains. Clearly, though, another determinant of whether or not investments go forward will be opportunities for revenue generation and affordability in individual cities.

## C. Short Term Action Plans and Long Term Compliance Programs

4.40 Because of the condition of industry, and the economy in general, MEP will need to take a long term view in meeting its goals. With its limited resources, MEP must develop a practical strategy for achieving some success in pollution abatement--not trying to manage everything at once and thus perhaps achieving nothing.

4.41 *This study recommends setting realistic schedules in the permitting process--with achievable intermediate steps specified along the way--to reach target standards.* It's very important to be realistic. A suggested goal is to think in terms of the next 10-20 years as the range of time needed to achieve good pollution control, especially in some of the larger industries, where restructuring and downsizing is likely to be needed. Enforcement of a compliance schedule can be simplified by letting the factory propose its own schedule as a starting point for the negotiations and having a factory official certify that the agreed schedule can be met. These tactics take advantage of the factory's knowledge of its own production process and waste streams and foreclose later claims that the MEP arbitrarily imposed a schedule which was impossible to meet. Compliance agreements should be open and available to the public, along with later information on any problems of non-compliance; this assures public oversight and creates support and momentum for the program.

**Priorities Over the Short Term**

4.42 Taking this long term view does not mean that nothing can be done right now, however. Priority actions would be as follows:

- **Short Term Action Plans for Major Plants**

4.43 Over the next 2-3 years, oblast and municipal authorities, along with environmental authorities, should *focus on encouraging major industrial and municipal plants to develop and undertake short term action plans*. These plans could include: improving housekeeping and maintenance; repairing control equipment where practical; and making small investments to improve energy and water efficiency. The authorities might want to launch a public campaign to get support for agreement on low cost actions in major plants or industrial operations. Such efforts might begin with pilot programs in a few cities, with incentives offered to firms which participate (eg. some financing from the ecology funds for meters or testing equipment). The Ministry could also seek external assistance to support such action plans, beginning with technical assistance in conducting environmental audits of plants as part of pilot programs.

- **Regulating Plants with Hazardous Emissions or Effluents**

4.44 MEP should *concentrate regulatory efforts primarily on industries with truly hazardous air emissions and water effluents.*[13] These industries should take priority for early action plans and for environmental audits to identify what can be done quickly. Ideally, these would be good candidates for early evaluation of restructuring needs and future commercial prospects. An important factor to consider is whether the plant is a good prospect for survival over the longer term. If such plants are creating immediate public health dangers, a decision will need to be made as to how long they continue without adequate pollution control and how pollution control is funded.

4.45 For those facilities that do not undergo a major improvement of their operations and continue to be hazardous polluters, a final compliance date must be established. This date might be 10 years into the future, depending on the current condition of the plant and the level of pollution from the facility. If the plant cannot meet this final compliance date, a program for shutting the facility should be considered--to be prepared and implemented over a set time frame.

- **Pilot Programs in Priority Cities**

4.46 In addition to encouraging implementation of short term action plans, *MEP should seek external assistance to strengthen it regulatory infrastructure*, again beginning with pilot programs in a few cities--to improve monitoring, site characterization and regulatory techniques and to prepare cost effective strategies for pollution abatement over the medium to long term in those cities.

**New Sources or Upgrades**

4.47 Any new facility or plant which undergoes a major improvement in its productive operations should be subject to immediate upgrading of its pollution control equipment. For example, if a facility were privatized and new production equipment were installed to replace outdated processes, good control equipment should also be installed at the same time, with the intent to meet reasonable emission limits upon start-up of the new production equipment. The cost of implementing reasonable emission control systems should be built into any investment decision making process. This does not necessarily mean that the "best available" technology would need to be mandated. Installing "best practical" technology, as negotiated between the plant and regulatory authorities, might be a satisfactory and sensible course of action.

**Enforcement Mechanisms**

4.48 As discussed in Chapter III, having a menu of enforcement mechanisms to deploy, as needed, is extremely important in carrying out regulatory activities in a flexible and practical way. Credible penalties for non-compliance need to be established for non-compliance. And, over time, regulatory policy will be strengthened by ultimate recourse to a sound judicial system. Developing these mechanisms will take time to achieve. *Building a sensible regulatory framework and enhancing the skills of regulators, so that they command more respect, along with encouraging public education and outreach, all will help to build public and political consensus for stronger enforcement.*

---

13/ With existing, overly strict standards, everything looks like a priority.

# V. ADDRESSING ENVIRONMENTAL PROBLEMS IN INDUSTRY



## A. Background on the Industrial Sector

5.0 This chapter focuses on environmental problems in industry, where the most serious environmental problems lie. The state industrial sector includes an estimated 6,000 large enterprises, more than 40,000 small to medium size enterprises, and many tens of thousands of small enterprises. A breakdown of principal industries, ranked according to contribution to GDP, is provided in Table 5.1.

**Table 5.1: Enterprises and Employment in Major Industrial Sectors, 1990**

| Industrial Subsector | Assets in Rubles (Millions) | Number of Enterprises | Number of Employees (000s) |
|---|---|---|---|
| Machine Building[a] | 43.7 | 1,868 | 3,058 |
| Food Processing | 11.8 | 1,582 | 684 |
| Metallurgy | 24.3 | 152 | 491 |
| Light Industry | 4.8 | 1,300 | 756 |
| Chemicals | 16.5 | 692 | 623 |
| Fuel and Energy Processing | 39.7 | 491 | 793 |
| Building Materials | 7.4 | 853 | 695 |

a/ Including military industries.

Source: "Ukraine: Country Economic Memorandum," World Bank Report No. 10029-UA, June 2, 1993.

5.1 There are a range of industries which are potential sources of significant environmental problems, and they are listed and roughly ranked below in Box 5.1.[1] In the past, funds for pollution control in the industrial sector came through the central planning process, along with other investment funds; some basic pollution control equipment was installed in major industrial and energy plants, though not always comprehensively across all workshops of a plant. The emphasis on production, though, meant insufficient

1/ Information from specific plant visits is in Annex 3.

capital was available to maintain or improve pollution controls, especially in recent years; much of the existing pollution control equipment appears to be quite old. The fact that Ukraine had very little manufacturing capability for pollution control equipment within the FSU also hampered access to new technologies and spare parts. The lack of competitive pressures to operate more efficiently is also an important factor underlying the poor environmental conditions existing today in some plants.

**Box 5.1: Industries or Facilities of Primary Concern from an Environmental Standpoint**

| | |
|---|---|
| Large-scale: | Non-ferrous smelters<br>Chemical industries<br>Military industries and related electronics<br>Ferrous metallurgy<br>Pressurized ammonia pipeline across southern Ukraine<br>Mining (iron ore and uranium)<br>Building materials: asbestos, cement and asphalt plants<br>Machine building: galvanizing and electroplating<br>Tanning and textiles<br>Pulp and paper<br>Food processing |
| Energy-related: | Coal (both production and use)<br>Refineries<br>Electric power industry<br>Oil and gas production and transportation |
| Small-scale or Service facilities: | Gasoline stations or related facilities<br>Paints<br>Dry cleaning facilities |

5.2 At the moment, industry in general is undergoing a severe disruption of raw materials and markets and is buffeted by rapid inflation. There appears to be little central managerial control; the result is that technical managers who are aggressive enough have taken control of their individual enterprises. This has both positive and negative effects. The positive side is that they are negotiating new commercial arrangements (frequently barters) with their old suppliers and customers and trying to keep operating. They are preoccupied with the short term, though. Little strategic or longer term business and financial planning is in evidence, and there are few resources for investments of any kind.

## B. Opportunities from the Economic Transition and Privatization

5.3 Sound macroeconomic policies and the transition to a market economy will bring changes in economic incentives and the structure of the economy over time which should have important positive effects on environmental problems. Pricing changes and greater accountability at the firm level should lead to significant waste reduction and more efficient use of energy, water and other resources and

ultimately more output per unit of investment and level of inputs. Acknowledging the true cost of capital will help shift the economy away from overemphasis on heavy industry. Expected changes include:

- a drop in demand for output of heavy industry, and downsizing of some industries in this category;
- demand for improvements in product quality and thus changes in operations and technology;
- growth of lighter industries, consumer product industries and transport services.

These structural changes will take a long time. And, as the nature of industry changes, new environmental challenges will emerge, as there will be different, perhaps more diffuse pollution problems with the emergence of smaller private firms.

5.4 Most of the funding for process changes and direct pollution control will come largely from enterprises' cash flow, and the ability to make major capital expenditures will depend on the operating and financial health of individual enterprises. The transition to a healthy private sector should create more accountable and responsive enterprises and more opportunities in the future for investment in more modern process technologies.

5.5 The privatization process in Ukraine is starting very gradually with some small and medium scale enterprise privatization. Several cities are now implementing or planning privatization programs. They are: Lviv, Kharkiv, Kiev, Zaporizhzhia, Donetsk, Dnipropetrovsk, Odessa and Yalta. The process is expected to take some time, though, because of legal and administrative barriers or issues which must be worked out. But it is an important first step in stimulating new economic activities in municipal areas. With experience gained from small and medium scale privatization, it will then be possible to move to privatization of larger enterprises over the medium term, although there are some industries, e.g. coal, metallurgical and oil refining industries, which will require restructuring before privatization.[2] Some enterprises will remain in the public sector for some time.

5.6 Also, in planning and implementing land privatization at the municipal level, there are opportunities to improve siting of commercial and industrial activities and general land use planning, which could prevent or ease environmental pressures. Consultations with MEP and its local branches should be encouraged as part of the process of developing land privatization programs.

5.7 Opportunities to attract foreign investment are important in bringing in needed capital and facilitating access to modern technologies (see example in Box 5.2). But the macroeconomic and legal climate, discussed briefly in Chapter I, will be an important factor in deterring or attracting external investment. There has been little such investment to date.

5.8 More attention to energy or water conservation and environmental activities could also stimulate new businesses, for example in manufacturing energy efficient equipment or controls and metering devices, equipment to improve water conservation and treatment, and improved pollution control equipment in a variety of industries (including the energy sector, as discussed in Chapter VI).

---

2/ Including evaluation of environmental requirements and costs and allocation of responsibility for environmental clean up.

Introduction of new techniques in agriculture and forestry will require new farm and forestry equipment (see Chapter XIII). The phase out of ozone depleting substances in aerosol products and refrigeration could stimulate new business opportunities (see Chapter IX). Such opportunities should be explored aggressively by the Ministry of Industry and the Ministry for Military Conversion. Attracting licensing arrangements or joint ventures with other industrialized countries would be important to create access to modern designs and technologies. Obviously, broader efforts to encourage the private sector and attract foreign investment will help in this regard.

**Box 5.2: Kherson Pulp & Paper Combinat, Tsjurupinsk**

This pulp and paper plant, based on a chlorine bleaching process, produces 34,000 tpa of bleached sulfate cellulose, of which 18,000 tons is sold overseas. It also produces 10,000 tpa of filter paper. It has a well-operated biological treatment plant for its wastewater, which also treats sewage from the local community. Despite its good operation, it cannot meet the current strict environmental standards, and last year it paid fees of Rb 3 million for discharging suspended solids and organic chlorine components.

As a result of foreign investor interest in the plant as a joint venture, the enterprise is now planning a complete process change, introducing the production of non-chlorine bleached pulp, which will result in an elimination of the discharges of chlor-organic compounds. The plant has also arranged foreign commercial financing for the investments, in part secured by a government guarantee. The loan is expected to be repaid from the future cash flow of the enterprise. The foreign investor also commissioned an environmental audit of the enterprise as part of its business evaluation. The experience of this enterprise serves as an illustration of the links between economic restructuring and foreign investment, on the one hand, and opportunities for environmental improvements, on the other.

## C. Environmental Liability and Privatization[3]

5.9 Environmental considerations are a factor in privatization and foreign investment. *Investors will want to know what obligations they have with regard to past and ongoing pollution and will look for stable and reasonable regulatory policies under which to operate.* Specifically, there are two concerns:

(i) In respect of ongoing pollution and occupational health problems, what are the regulatory requirements and time frame for meeting them?

(ii) What are the legal obligations (and any liability for damages) of new investors in respect of clean up of past pollution and contaminated sites?

Experience in Eastern Europe indicates that potential foreign investors are concerned about these issues. In Ukraine, the government's actions should be directed toward creating a climate of certainty in which privatization transactions can take place. Chapters III and IV addressed the first concern--the need to develop reasonable and credible regulatory policies to encourage reductions in ongoing pollution. This

3/ This section draws from discussions in: "Environmental Liability and Privatization in Central and Eastern Europe," World Bank Report No. 11686-ECA, June 15, 1993.

section discusses the second concern--the issue of liability for past pollution and how it might be addressed in the context of privatization.

5.10 The question of environmental liability is a difficult one, which various CEE countries are now trying to address. It means balancing several important concerns. First, there is the general policy question of how to deal with contaminated sites and how far to go with clean up, discussed in Chapter II (Section E). The experience of other industrialized countries highlights how expensive full scale clean up of many sites are and how uncertain those costs are at the time of initial identification of a serious site. *For countries with very limited resources, an appropriate strategy is to take short-term mitigation or containment measures to reduce direct hazards to health, leaving full scale clean up for a time when the economy is stronger. National legislation setting out a consistent policy and criteria for remediation is an important step.* MEP will then need to initiate programs to inventory, evaluate and prioritize sites; external assistance may be needed in this effort, perhaps through pilot programs in one or two oblasts.[4]

5.11 Second, one must weigh the priority between addressing ongoing pollution and the legacy of past pollution. *On balance, devoting scarce financial and administrative resources to control ongoing pollution is likely to be more practical and cost effective than attempting to clean up the many existing contaminated sites*, beyond that which is necessary to reduce serious and immediate health risks.

5.12 Third, *it is extremely important not to delay privatization or burden it with too many additional considerations*. The administrative burden of requiring environmental audits for all transactions during privatization would be too heavy, and the capacity domestically to evaluate the problems would be limited. Related potential problems are lack of realistic data about the environmental problems of privatizing enterprises and confusion about clean up requirements and measures needed for compliance.[5]

5.13 Still, the issue of liability for past pollution cannot be ignored; it is likely to come up in negotiations anyway with numerous foreign investors familiar with this issue because of hazardous waste clean up regulations in their own countries. The well-publicized pollution problems of Ukraine will probably also make investors more sensitive to this issue. If there are serious environmental problems to contend with at plants of interest, foreign investors are likely to adjust the value of their purchase offer. They might also use the issue as a bargaining tool. Lack of attention to correcting some existing environmental or safety hazards in advance of privatization or evaluation by a foreign investor may, in fact, derail some purchases. On the other hand, environmental liability is one of many factors considered by a purchaser, and many properties in Ukraine will remain attractive even with environmental liabilities attached.

5.14 Environmental audits are often undertaken in market economies to evaluate environmental problems at plants which are candidates for purchase. They are being introduced selectively as part of foreign investor inquiries and privatization activities in Eastern Europe. Foreign investors in Ukraine may commission such audits before deciding to invest (see Box 5.2 for an example and paras. 5.27-5.28 concerning the need to develop a domestic capability to conduct audits).

---

4/ Programs to inventory and assess contaminated sites are underway in Poland and the Czech Republic.

5/ If environmental standards are too strict (e.g. soil or water standards), this may cause investors to face massive clean up costs, unrelated to priorities based on health impact.

**Approaches to Environmental Liability**

5.15 Various approaches to addressing the issue of environmental liability are now being tried in Eastern Europe. They include one of the following or a combination thereof:

- liability passed on to the new owner and price adjustments made at the time of sale;
- liability passed on to the new owner, but with the government setting aside a percentage of the sale proceeds for clean up of the site; and
- indemnification arrangements, whereby the government assumes much of the responsibility for government-ordered clean up of past contaminated sites and for liability claims.

The last two options are discussed below:

5.16 **Set Aside Option**. In Poland and the Czech Republic, recent programs have been set up, whereby a percentage of funds from a purchase can be set aside in an escrow account to reimburse investors for clean up costs within a specified time period. However, there are still some issues to be resolved, for example the extent of clean up required. Very few privatization transactions have yet gone through these programs. Also, a major drawback is that the funds are tied to a particulate site, rather than being available for sites which are identified as priorities.

5.17 **Indemnification**. The advantage of indemnification arrangements is that they relieve individual investors, thereby moving the privatization transaction forward and hopefully preventing a reduced price offer by the investor. They also preserve flexibility on the part of the government to undertake clean up based on a broader review of environmental priorities. The issue of potential civil damages is probably not a major issue under current Ukrainian law, so indemnification would not create an inordinate risk of major future claims. Moreover, an indemnification does not necessarily mean the government will pay all clean up costs; indemnifications can be capped (see Box 5.3).

5.18 In some instances, the government may direct some percentage of the proceeds of privatization transactions to a general clean up fund, to be used at sites requiring immediate attention. A *"pooled" fund* is much more attractive than an escrow fund (para 5.16) while there are many claims on the proceeds of privatization, allowing a small percentage to go to a pooled clean up fund seems sensible and helpful in moving privatization transactions forward. Management of such a fund can only work meaningfully, however, if clear criteria are established for prioritization of sites and the level of clean up necessary.

5.19 A meaningful policy on environmental liability depends in large measure on the ability to determine baseline conditions and thereby draw a line between past and ongoing or future pollution problems. However, lack of reliable data, lack of capacity to investigate sites and the imperative of moving ahead fast with privatization are all factors that make this extremely difficult. Establishing a reliable baseline record of past damage places a heavy administrative burden on the government; this has been the experience of the German government (see Box 5.3). Hence, if such indemnification arrangements were introduced in Ukraine, they would have to be limited to specific industries, those which are potentially hazardous but which are also likely early candidates for privatization.

**Box 5.3: The Indemnification Program in Germany**

An example of an indemnification program is the German program which, through an exception to regular law, indemnifying some new investors, upon approval of an application, against much of the risk of liability for past contamination (occurring up to July 1, 1990), while requiring that they make some contribution to costs--at least 10 percent; the exact level of indemnification--between 50-90 percent) is negotiated. There are also drawbacks in that the administrative requirements are high. The program has been slowed because of the administrative inability to process some 40,000 or more indemnification applications the Treuhandanhalt has received and to establish a baseline record of contamination. Additional contractual arrangements have been necessary in order to keep the privatization process on track.

Authorities estimate that some 60,000 contaminated sites will be found in the eastern Länder, the former DDR, compared to the larger former West Germany, with about 80,000 such sites identified. The authorities expect to pay for clean up through public funds for some time to come in view of the economic circumstances. Germany has transitional regulations in place to allow time for the enterprises of the new Länder to have time to comply with federal standards.

**Provisions in Ukraine's Foreign Investment Program**

5.20 As formulated on April 10, 1992, Ukraine's proposed foreign investment rules rely primarily on offering special privileges as an incentive to foreign investors to assume environmental responsibilities.[6] Section 2.7 concerning "Participation of Foreign Investors in the Privatization Process" states:

> "If, as the outcome of a competition, the investor takes upon himself responsibilities for cleaning the environment, for preserving a certain level of employment, or for modernizing the plant, then the following special benefits will be given:
>
> - a privileged exchange rate will be set for all transactions;
> - repayment for losses incurred in fulfilling general demands imposed by the state;
> - special rates of taxation for 3-5 years; and
> - the possibility to reach an agreement by which the State Property Fund will give the investor administrative control over the shares of the enterprise that remain in the hands of the state."

The clause above is general and open-ended, particularly in regard to "repayment of losses in fulfilling general demands of the state." It creates too much potential upside budget risk for the government. Also, it appears to give differential treatment to foreign investors compared to domestic investors, with

6/ It is not known whether this program has been finally adopted.

regard to exchange rates and taxation, for instance. Such differential treatment is distorting and should be avoided.

**Suggested Approach for Addressing Environmental Liability**

5.21 Any interventions in regard to environmental problems during privatization will necessarily be limited. The government will probably need to indemnify investors, domestic and foreign, for potentially large clean up projects, which in any case will need to be addressed over time, as resources permit. *A recommended approach is to set up a program which offers indemnification of investors in specific industries for government mandated clean up (and any future third party damages) of major contaminated sites (on-site or off-site), based on applications by investors within a specific time frame. To be practical, such a program should be limited to specific industries which are likely to be early candidates for privatization or foreign investment and where the most serious hazardous pollution problems potentially exist.* At the same time, it will be important to try to assure that some actions are agreed during privatization in targeted industries for low cost containment measures to mitigate any dangerous contamination on site and to relieve the worker environment.[7]

5.22 It is recommended that MEP work with the privatization authorities to establish a process for achieving some level of baseline knowledge for sites where health hazards or liabilities may be a major issue or risk in privatization. There are ways to narrow down the number of facilities that might require auditing and limit the number of cases where extensive auditing might be necessary. Such a process, if well-designed, might also help the country establish national priorities and an action plan in terms of clean up or remediation.

5.23 **Screening.** A possible approach would be to establish an environmental review process consisting of (i) initial screening of privatization candidates according to potential risk to human health, based on criteria such as type and size of activity and location; (ii) depending on the outcome of the initial screening, a "Phase 1" environmental audit (a relatively short and inexpensive audit) for those candidates where the privatization process is proceeding; and (iii) depending on the outcome of the Phase 1 audit, a "Phase 2" investigation for those candidates where there are major risks and uncertainty remaining and where the privatization process is still proceeding with one or several interested buyers. Where foreign investors are involved, they could be required to contract the Phase 2 audit in return for some indemnification from state-ordered clean up requirements beyond low cost containment, something they would probably be interested in anyway.

5.24 **Coordination with Privatization Authorities.** One interesting development in Poland within the last four months, which might be considered in Ukraine, is the creation of an inter-ministerial environmental unit within the Ministry of Privatization (MOP) to deal with environmental issues related to privatization. This unit is initiating an environmental audit process by sending questionnaires to industrial facilities considered candidates for privatization and consulting local environmental branches, in order to determine whether there are outstanding environmental issues. If such issues exist, the matter is discussed with the MOP project manager assigned to work on privatization of the facility to determine next steps, perhaps starting with a Phase 1 audit. This is still an informal process, but one which appears to have potential.

---

7/ The Czech Republic and Slovakia are requiring large-scale enterprises to include information on current environmental compliance and past pollution problems in their privatization plans.

5.25 **Pooled Fund.** Also helpful might be the establishment of a pooled clean up fund, to which a small percentage of the proceeds from privatization transactions would go, in order to finance the clean up of priority sites (as described at para. 5.18).

5.26 **Compliance in Reducing Ongoing Pollution.** Compliance schedules for reducing ongoing pollution should be agreed through the normal permitting process, as discussed in Chapters III and IV. If major new capital investments in process changes are planned, that would be the time to assure that reasonable pollution control equipment is installed.

**Developing a Domestic Capability in Environmental Audits**

5.27 It would be worthwhile to encourage a domestic capability in Ukraine to undertake operating and environmental audits (covering safety aspects and energy and water use as well as environmental aspects) for several reasons. The first is to have a capability to undertake at least "Phase I" audits which will help clarify environmental issues in privatization transactions. Second, as firms face higher input prices and greater accountability for their financial position, they increasingly will need to improve operating efficiency and may need help to do so. Third, environmental regulatory action initiating short term action plans at plants (as recommended in this study) will further stimulate the need for environmental audits. Ideally, these audits should go forward in parallel with analyses of the business prospects of the firm or industry. Finally, environmental audits will also be necessary parts of restructuring analyses for major heavy industries.

5.28 Audits by foreign consultants are expensive; therefore, their use is likely to be limited. *Fostering a domestic capability in this field could create a new local business activity; also, learning how to do environmental audits would be good training for regulatory personnel.*

## D. Issues in The Metallurgical Industry

5.29 One of the most polluting industries in Ukraine is the metallurgical industry, which encompasses ferrous and some non-ferrous metallurgical production, coking, finishing and various support facilities. The majority of the sector is related to steel. Given the age and inefficiency of capital stock in the industry (dating back to the 1930s, with major reconstruction after World War II), anticipated reduction in domestic demand as the military industry is downsized, and problems of oversupply in the market throughout Europe, significant downsizing is expected over time. Nevertheless, some parts of the industry are expected to remain viable, given low labor costs, good technical staff and opportunities in certain lower quality product niches of the world market. Restructuring to achieve world competitiveness is likely to be politically difficult, painful and expensive, though. The extent of employment in this industry means the transition will occur gradually, which is the experience in several Eastern European countries. *Structural issues, poor energy efficiency and environmental problems are intertwined in this industry.* They are discussed here together, in an environmental study, to emphasize the close relationship between industrial restructuring and major progress in resource conservation and pollution abatement.

**Business Prospects and Environmental Concerns at Non-Ferrous Smelters**

5.30 There are only two major non-ferrous smelters in the country: the zinc-secondary lead smelter in Kostiantynivka and a large aluminum smelter in Zaporizhzhia. Both of these smelters rely on very old

**Box 5.4: The Aluminum Smelter in Zaporizhzhia**

The aluminum smelter was built in the 1930s (reportedly, the largest in Europe at the time) and rebuilt after the war with the Soderberg technology. It produces about 90,000 tpa of aluminum in addition to other alumina products and silumin (commercial silicone). Its energy efficiency and pollution control performance are much lower than the most advanced technology (e.g. "pre-baked" technology, which is actually older technology but has been refined and improved over the years). More importantly, they appear lower than what is achieved at other plants in Europe based on the Soderberg technology. Aluminum production is energy intensive; hence, an important aspect of competitiveness is how energy efficient a plant is. The Soderberg technology generally requires 17.5 kWh/kg alumina; the pre-baked technology is less than 14 kWh/kg alumina.

Of most concern are two pollutants emitted at the plant: fluorines and tars. Estimated emissions of fluorides in the form of hydrogen fluoride are 2.2-3.2 kg/ton alumina. This translates to more than a half million kilograms of hydrogen fluoride per year. Emission in Europe and the US are 0.5-1.5 kg/ton. "Best available technology" can bring emissions down to 0.3 kg/ton. There are also tar emissions from the electrolysis process in the plant which are a serious problem because they are carcinogenic (emissions in a plant like this can be higher than those in coke ovens). The degree of containment of all pollutants in the Zaporizhzhia plant is probably about 50 percent, compared to Soderberg-based plants in Western Europe which achieve 70-80 percent. Also, fugitive emissions in the plant are high; they could be reduced by better control of furnaces, maintenance and housekeeping. Such steps could be taken immediately.

To revamp the entire process in the plant would cost in the order of US$ 1 billion, an expensive proposition. Installing good pollution control equipment would cost an estimated US$ 20-25 million; pollution control, though, would also bring some commercial benefits--recovery of aluminum fluorides, the raw material--which could help pay for the investment (in Sweden, they payback period was 3.5 years for an improved pollution control system which recovered the raw material). Whether such an investment would be sensible or not depends on a more careful analysis of equipment and processes in the plant, expected input and output prices, and the plant's underlying competitiveness in what is currently a difficult world market.

technology, and they are emitters of hazardous emissions--heavy metal emissions in the case of the smelter at Kostiantynivka and fluorines at the aluminum smelter. Both cases warrant detailed operational and environmental audits to identify some immediate actions to improve efficiency and reduce worker exposures. They both are also candidates for an analysis of their medium to long term prospects and viability. The plant at Kostiantinyvka (discussed at Box 2.2 in Chapter II) is a likely candidate for early closure on economic as well as environmental grounds.

5.31 The aluminum plant in Zaporizhzhia, with over 4,000 employees, is also a site of serious environmental problems due to hydrogen fluoride emissions (see Box 5.4). Aluminum plants are also very energy intensive; hence as energy prices rise to world market levels, the longer term viability of the plant may come into question. Ukrainian authorities are eager to continue operating this plant because it is the only aluminum plant in the country. Its viability may well depend on foreign investor interest.

**Structural Issues in the Steel Industry**[8]

5.32 **Background and Competitive Outlook.** Ukraine has a crude steel capacity of 52.6 million tons, making it the fourth largest producer in the world after Japan, Russia and the US. In addition, 16 coke ovens in the country produce 28.2 million tons of coke (1991), of which 20 million tons are used domestically. Crude steel production in 1990 was 45.4 million tons and rolled products 38.6 million tons. Production declined in 1991 and 1992; preliminary data for the first half of 1992 indicated that production was down by 20 percent.[9]

5.33 The industry has eight integrated plants, four partly integrated plants and three plants using electric arc furnaces (EAF). Integrated plants account for 90 percent of production. About 80 percent of crude steel and 70 percent of rolled products come from five integrated plants: Krivorozhstal,[10] Azovstal, Illycha, Dzerzhinsky (Dniprodzerzhinsk) and Zaporozhstal. This pattern contrasts with most operations outside the FSU where steel is increasingly produced from scrap in electric arc furnaces.

5.34 The industry's products are oriented to heavier, non-flat production, rather than to lighter, flat products which represent the growth area in world demand. The market for products in Ukraine was previously controlled to serve a large geographic area, which is now essentially multi-national; undoubtedly there will be shrinkage in that market. The domestic market shift from defense to consumer durable goods, as well as generally stronger world demand for flat products, will affect non-flat demand in particular. Several large plants, such as Kryvyi Rih, Dneprovsky, Yenakiieve, and Makiivka, are concentrated on non-flat products and will be under pressure to make changes or become uncompetitive.

5.35 The technology employed in much of the industry is outdated and energy inefficient, although there are modern sections found in individual plants (e.g. one of the blast furnaces at Kryvyi Rih and rolling mills in various plants).[11] Table 5.2 below provides an example of the age of technology by showing crude steel production capacity by furnace type. About 60 percent of production is by open hearth furnace, an antiquated technology which is costlier to operate, less efficient, and generally more polluting than the more modern basic oxygen furnace (BOF). Only 4 percent of production comes from electric arc furnaces, which are more efficient and save energy and other inputs.

5.36 Another sign of the age of equipment is that various units are of a relatively small size. Existing BOF units and sinter machines are of smaller size than international standards, with implications for overall operating efficiency. Only the biggest blast furnaces at Illycha (2300 $m^3$) and Krivorozhstal (2000 $m^3$ and 5000 $m^3$) match the standards of the leading international blast furnaces; the smallest have a capacity of 1000 $m^3$.

---

8/ See Annex 4 for summary data on the steel and coking industries, including plant level pollution data.

9/ Reports at several plants suggested that production was down further, by 25-30 percent.

10/ See Box 5.9.

11/ In the last fifteen years, almost all new investments in technology went into Russian plants: 3.5% of assets were reinvested annually in Russian plants compared with only 1% allowed in the Ukrainian ones.

| Table 5.2: Crude Steel Production Capacity by Furnace Type | | | | |
|---|---|---|---|---|
| | Open Hearth | BOF[a] | EAF[b] | Total |
| Production (million tpa) | 31.0 | 19.5 | 2.1 | 52.6 |
| Percentage share | 58.9 | 37.1 | 4.0 | 100.0 |
| Percentage in OECD countries | 2.6 | 63.9 | 33.5 | 100 |

a/ BOF: Basic Oxygen Furnace
b/ EAF: Electric Arc Furnace

5.37 Continuous casting, another energy saving technology, represents about 10 percent of steel production, compared to almost 90 percent in the EC.[12] Finally, modern computer control systems, needed to ensure quality, are almost totally absent. These various technology gaps constrain the industry from producing the highest grades and qualities of steel now in use in other industrialized countries. The extensive layout of these plants is noteworthy also, with often haphazard siting of facilities, again reducing operating efficiency and resource conservation.

5.38 Competition worldwide will force steel users to reduce their manufacturing costs, and there will be a general move towards lighter products. One analyst suggests that, in eight years time, steel products will be 20 percent lighter and there will be various substitutions in key markets.[13] Plant management will need to redirect its efforts to achieving competitive costs, improving quality and service, and developing new products and new applications. But heavy capital costs will be required in Ukraine to introduce modern steel-making processes, raising plant productivity and efficiency, as well as addressing pollution problems.

5.39 All the plants surveyed during this study have ambitious plans for virtual revamping of their entire plant; the list of proposed investments would be in the order of US$3 billion.[14] No consideration has been given to the likely shrinkage of the Ukrainian and FSU market. *The cost of modernization across the board would, of course, be prohibitive and impractical and is an argument for early restructuring*. Some coordinated effort to rationalize operations is required, in order to avoid all plants expending scarce capital to make slow adjustments in process technology. It is also important to take the proper horizon, perhaps 10-20 years, in which to complete the transition, considering: social feasibility, funding capability, and anticipated needs in regard to technology changes and retooling, without interrupting current production. But having a vision of what to do as early as possible is desirable in order to encourage the direction of future investment.

12/ Continuous casting provides energy savings and therefore less air pollutants; it also allows a better iron yield and therefore means less production of coke and sinter etc.

13/ Communication from E&E Corporation in the US.

14/ See Annex 4 for a list of proposed investments by plants surveyed during the study.

5.40 The size and complexity of Ukraine's steel and coking industry requires a fresh look at not only steel but also related industrial sectors. The steel industry originally developed in Ukraine because of plentiful and high quality domestic resources of iron ore and coal. In both these industries, however, the best reserves have been depleted. The premise of the steel industry relying on cheap domestic inputs may no longer hold to the same degree (see paras. 5.59-5.60 and Section C of Chapter VI)

5.41 Reaching a reasonable level of environmental compliance should be a requirement and an economic factor in rationalizing plants and in selecting steel-making processes at remaining competitive plants. *In this regard, environmental audits should go forward in conjunction with plant level restructuring analyses and plans for environmental compliance should be developed as part of restructuring programs.*

5.42 A number of the plants are in communities which have developed because of the plants themselves; they provide most of the employment and related social services. Examples are Kryvyi Rih, Makiivka, Yenakiieve and Dniprodzerzhinsk, which are virtually company towns, complicating restructuring and underscoring the need for regional economic diversification.

**Box 5.5: Restructuring of the Steel Industry in France**

The iron and steel industry in France, like those in most OECD countries, underwent a long period of crisis between 1975 and 1987. The French plants began their restructuring late and therefore ended up undergoing a number of successive restructuring operations. Because underlying structural changes were occurring which were not fully appreciated at the time, over investment in individual plants continued for too long, and some new operations ended up being closed after only operating a few years. Estimates are that the French government spent some $20 billion in supporting the restructuring and modernization of its iron and steel industry.

The French experience, which is fairly typical, shows a fall in production of about 28 percent from 1974 to 1990--from 26.5 million tons to 19 million tons. Although output fluctuated over this period around a declining trend (and fell as low as 17 million tons in 1986), the decline in employment fell from 160,000 in 1974 to about 60,000 in 1990. Thus, productivity in this sector increased dramatically over the period from 177/tons per person to 380 tons/person, but the social costs of reducing employment were high and required government support.

At the same time that the size of the industry was reduced, so too the structure changed. The dirtier, polluting activities, such as sintering and coking, were almost completely phased out, replaced by imported pellets, scrap iron and coke. Production now is almost entirely based on continuous casting while in 1975 only 12 percent was continuously cast, the bulk of production being based on steel ingot casting. By gradually tightening the permitted emissions of pollutants at different stages, environmental regulations influenced the restructuring of the industry. But one should not exaggerate this influence. Regulatory permits were based on what the technology could achieve at reasonable cost, and the rate of phasing was influenced by the need to keep the costs of the transition reasonable.

5.43 **Other Restructuring Experience**. Several countries have recently restructured their iron and steel industries, in some cases as a prelude to privatization. They include several EC countries,[15] Brazil, Mexico, New Zealand, and Turkey. Poland is now just starting the process of restructuring and consolidating its steel industry. In each case a sectoral study was first carried out, considering operating, technical, market, financial and environmental factors. It would be useful to review the historical experience of the countries listed above in addressing restructuring, modernization and parallel environmental improvements (see the example of the French steel industry in Box 5.5).

**Energy Efficiency in the Steel Industry**

5.44 Metallurgy is a major energy consuming industry in Ukraine. In 1991, it consumed 18.0 bcm of natural gas (16.4 percent of total domestic consumption) and 36.8 million tons of coal (35 percent of total domestic consumption). The steel plants consumed 20 million tons of coke and 0.7 million tons of coal in 1991. Energy consumption per ton of raw steel is estimated in the range of 22.5-25.9 GJ, 20-40 percent higher than unit energy use in the EC steel industry. Potential energy savings are about 200 million GJ per year.

5.45 Greater energy efficiency over the long term will come from restructuring of the industry, accompanied by modernization and process integration at competitive plants, including investments in the following:

- retirement of open hearth furnaces and introduction of improved sizes of new BOF and sinter machines.
- expansion of EAF furnaces, along with greater utilization of scrap;[16] and
- expansion of continuous casting, replacing ingot casting over time;

5.46 In the short to medium term, there are various operational steps and more modest investments which could reduce energy consumption. Incentives for undertaking them undoubtedly will increase as energy prices are raised and subsidies eliminated. One important operational measure is injection of tar, oil, gas, or coal in the tuyeres of the blast furnace, thus providing heat and "reducing gas" (hydrogen and CO). This measure reduces the coke required per ton of pig iron (the "coking rate"). Savings of 100-200 kg of coke per ton of pig iron are feasible. Plant managers in Ukraine seem reluctant to use this well-established technique, however.[17]

---

15/ Belgium, France, Italy, Spain and the United Kingdom.

16/ This implies further development of a domestic scrap market. There were conflicting reports about the availability of scrap; one report suggested much of the available scrap is exported.

17/ The Donetsk plant, one of those visited by the Bank team, employs coal injection, though.

5.47 Other problems affecting the coking rate are: (i) the relatively poor quality of the blast furnace burden;[18] (ii) the lack of sinter and its partial replacement by calibrated iron ore; and (iii) the relatively poor quality of coke, with rather poor mechanical properties and a high sulfur content (1.7-2 percent vs. 0.8 percent in the EC). Efforts to improve the quality of coke, perhaps through improved beneficiation of the coking coal, might raise energy efficiency and productivity in the steel industry also, and should be investigated further as part of efforts to restructure the coal sector (see Chapter VI).

5.48 Other potential measures, with varying time frames for introduction, include:

- better utility management at plants;
- heat recovery from the sinter cooler;
- recovery of gas from the BOF without combustion;
- use of regenerative burners for heating furnaces;
- installation of top pressure recovery turbines on the blast furnace (an example is the No. 9 blast furnace at Kryvyi Rih);
- installation of thermal insulation of heating furnaces (an example is the new heating furnace at Kryvyi Rih); and
- better process controls.

**Environmental Priorities in the Steel Industry**

5.49 The environmental problems of the steel plants are related, in part, to the older technology employed and the age of equipment generally, as described above, although other countries have been able to improve pollution control on their older capital stock (e.g. US steel industry). Environmental compliance will be achieved through a mix of operational and housekeeping changes, process changes and technology improvements, shutdown of some facilities and, where cost effective, retrofits. The important task will be to phase in compliance as the industry is restructured.

5.50 **Air Pollution**. The metallurgical sector accounts for 35 percent of total gross air emissions, and is especially a source of particulates and CO. While some air pollution control equipment is installed, generally the equipment is old and breaks down frequently; problems with performance are frequently related to poor maintenance. Primary fume emissions are generally wet cleaned (venturi scrubbers are common). Much more rarely are the fumes dry cleaned via electrostatic precipitators or bag filters,[19] both of which offer higher emission reductions. Secondary dust emissions are not collected and cleaned. Some open hearth furnaces (OHF) are equipped with primary particulate control, reducing perhaps 80 percent of dust. Examples are Zaporizhzhia and Kryvyi Rih; at other plants, OHF have no controls.

---

18/ This is related to the quality of the iron ore and affects the performance of the blast furnace.

19/ In Ukraine, bag filters are installed on minor workshops only, eg. lime production, because the bags manufactured in the FSU are not very strong and wear out quickly.

**Box 5.6 Pollution Control in Sinter Workshops.**

The sinter workshops in Ukrainian steel plants are examples of poor productivity and pollution problems, due to: poor physical quality of the local iron ore (uneven grain size and excess fines); the small size of equipment (62.5-85 $m^2$, compared with advanced plants in the West reaching 400 $m^2$); the rudimentary design or even complete absence of waste gas retention systems; the poor maintenance of circuits; and no sinter cooling equipment.

Sinter workshops are major sources of air pollution. Much of the pollution is due to poor housekeeping and failure to capture fugitive emissions. Many workshops visited were caked with mud and dust-filled. Frequently, there were holes in the ceiling where dust was pouring out. Simply installing pollution control devices will not solve these problems. In several cases, parts of sinter workshops have been shut or are planned for shutdown because of the high emissions and proximity to residential areas (e.g. Donetsk, Zaporizhzhia and Azovstal). The work environment in a number of these plants is so poor that it constitutes a serious health hazard to the workers. Some of the worst sinter workshops surveyed in the study were: Krivorozhstal, Zaporozhstahl, Makiivka, Yenakiieve, and Illycha.

Improvements in housekeeping are urgently required and could be addressed by environmental authorities through incorporation of short-term action plans in regulatory permits. This would involve, first, a sweep up and cleaning program. Material bins and conveyors require suppression systems and/or local capture at material transfer points and relatively inexpensive collection and control equipment. Once the internal environment has improved, ceilings could be repaired.

Pollution control of sinter machines requires windbox fans with sufficient capacity to capture and clean the waste gas prior to stack discharge. The fact that sinter machines in Ukraine are small does not mean they could not have effective pollution control equipment, although there may be other reasons for moving to larger units. What is important is to assure sufficient fan capacity. A more fundamental change would be to resort to more iron ore pelletization, thus shutting down many of the sinter plants.

5.51 Table 5.3 compares estimated emissions from six Ukrainian steel plants[20] with those of typical EC plants; dust emissions are 210 per cent higher, $SO_2$ emissions 144 percent higher, and NOx emissions 160 percent higher. In regard to CO emissions, the average for all workshops at six plants is 26 kg/t raw steel vs. 15.2 based on an EC reference.[21]

5.52 Every main production shop in the plants visited appeared to have high fugitive emissions, a source of significant air pollution. General maintenance and housekeeping are poor, with dust accumulating in the work environment and apparently never cleaned up. Fugitive emissions from processes and raw material handling also much higher than they should be. They can often be captured by primary process systems at little additional cost. Dust generating surfaces, such as roads, can be paved and vacuumed or periodically wetted and compacted. Trucks delivering materials could be more careful in loading and unloading. *More or less "common sense" approaches by environmentally concerned managers could greatly reduce airborne particulates and improve ambient air quality in such plants.*

---

20/ Based on plant data, not including fugitive emissions.

21/ See Annex 9 for EC regulations in the steel industry.

**Table 5.3: Comparison of Emissions from Ukrainian and EC Steel Plants**

| | DUST | | $SO_2$ | | NOx | |
|---|---|---|---|---|---|---|
| | UKR | EC | UKR | EC | UKR | EC |
| Sinter Plant (kg/ton sinter) | 1.7 | 0.6 | 1.3 | 1.3 | 0.5 | 0.9 |
| Blast Furnace (kg/ton pig iron) | 2.7 | 0.4 | 0.4 | 0.09 | 0.1 | 0.04 |
| Basic Oxygen Furnace (kg/ton of raw steel) | 0.9 | 0.3 | n.a. | 0.01 | n.a. | 0.03 |
| Rolling Mills (kg/ton of raw steel) | 0.6 | 0.07 | 0.3 | 0.2 | 0.2 | 0.16 |
| Overall Plant (kg/ton of raw steel) | 5.7 | 2.7 | 2.6 | 1.8 | 2.1 | 1.3 |

5.53 **Water Usage and Treatment in the Steel Industry.** Water consumption in the industry appears high, averaging 18.9 $m^3$/ton raw steel at the plants surveyed in the study, compared to 5-10 $m^3$/ton raw steel in some EC countries. This suggests that there is large scope for reduction of water consumption, even though some plants do recycle.

5.54 Wastewater oftentimes is insufficiently treated before discharge in rivers or sewage systems, impoundments are overloaded, and sludge disposal is problematic; this was true in virtually all plants visited (see Annex 3). Some of the worst effluents (phenols, aromatics and cyanide) come from the coking industry; two coke plants surveyed during the study with particularly bad problems were those at Kryvyi Rih and Mariiupil. The recommendations for improving wastewater treatment in Chapter II are pertinent to many of the large steel and coke plants, particularly operating improvements achievable at relatively low cost.

5.55 **Short Term Action Plans to Reduce Pollution.** There are numerous low cost measures at individual plants which could be taken in the short term to reduce pollution. While these measures will not bring the plants into compliance with existing standards, they would have an important impact in reducing worker and community exposures. Suggested short term actions include:

- development of quality control procedures not only for production activities, but also for equipment and installation maintenance, and attention to conserving energy in utility operations;
- emphasis on housekeeping and operational measures to reduce fugitive air emissions and also in improving existing cleaning equipment;
- emphasis on water conservation;
- improved materials handling throughout plants;
- stronger regulations for workers to use protective gear;

- repair and maintenance of existing pollution control equipment;
- development of waste and wastewater recycling strategies at the plant, including better dewatering of sludge; and
- training in association with these efforts.

**Air Pollution Control and Energy Efficiency in the Coking Industry**

5.56 Coke ovens are of special concern from an environmental and occupational health standpoint because coke oven emissions contain high levels of polynuclear aromatics (PAH) which are known carcinogens (such as benzo-a-pyrene). Coke tars, used in Ukraine to make chemicals, are similarly dangerous. The industry's 16 merchant coke plants, some of them 40-45 years old, are notable for generally high coke oven emissions (beyond levels now tolerated in the EC and US).[22] Door leakages (20 percent or more) are a major problem at the batteries surveyed. In part, this is due to the old design of the doors; it is also due to insufficient door cleaning. The other concern in terms of worker health is that workers do not use protective gear or respirators (in some plants, workers receive some gear, probably not respirators though, but workers often do not want to use them). Also, the practice of using untreated water for quenching (causing further hazardous emissions) should be discontinued as quickly as possible.

**Box 5.7: Regulations at US Coke Ovens**

In the US, the following compliance criteria apply:

- less than 5% of doors leaking at all times;
- less than 1% of gas offtakes leaking at all times;
- less than 1% of lids leaking at all times; and
- visible emissions during charging for a maximum of 60 seconds for 5 consecutive ovens.

Manual door and jamb cleaning is done in the US, although automated door and jamb cleaning is more common in newer facilities. Respirators and protective clothing are required for personnel working on the benches of coke batteries, however.

5.57 In the context of restructuring, it would be well to consider shutting down the very old coke oven batteries which emit high levels of hazardous pollutants, concentrating investment in upgrading the younger, better operating coke oven batteries. Investments in the coking industry need to be considered in the context of a restructuring analysis of the larger steel industry and pollution abatement strategies in the communities in which they operate. In this regard, the coke ovens in Mariiupil and Zaporizhzhia

22/ See Annex 9 for EC regulations.

are in the centers of these cities; hence, there is a strong environmental case for reviewing closely whether or not these plants can be phased out.

5.58 Improving energy efficiency in the coking industry, as mentioned earlier, should start with improved beneficiation of coking coal to improve coke properties, if further analysis indicates that it is cost effective (see Chapter VI, Box 6.4 on coal washing). Energy conservation should involve, as well, further recovery and utilization of coke oven gas. Production of gas at the 16 domestic coke ovens is estimated at 11.3 bcm. Most of it is used, but still a significant volume, perhaps 10 percent or more, is flared. For instance, the gas flared by coke ovens in communities near Donetsk represents a significant volume per annum:

| | |
|---|---|
| Ardiivka | 250 million $m^3$ |
| Horlivka | 160 million $m^3$ |
| Iasnovska (Makiivka) | 100-150 million $m^3$ |

One practical problem with utilization of the gas is, again, the reportedly high sulfur content (2 percent S cited); sulfur removal would be necessary before the gas could be used, and the cost effectiveness of doing so would need to be examined.

**Box 5.8: Ardiivka Coke and Chemical Plant, Donetsk Oblast**

**Avdiivka Coke and Chemical Plant.** This plant appears to be the largest in Europe, capable of producing 7-10 million tpa of coke. Currently, it produces over 5 million tons of coke, 400,000 tons of tars, 50,000 tons of ammonium sulfate, 400 tons of phenols and 80,000 tons of assorted organic specialty chemicals. It treats about 250,000 tons of tar residues p.a. The plant appears to be one of the cleaner and more efficient facilities in the domestic industry. Managers hope to reconstruct some units in order to produce higher value-added products, which would have better export potential. They need foreign investment to modernize and replace older equipment.

The plant badly needs to reduce its gas flaring, currently at 250 million $m^3$ p. a. It also should take steps to reduce the hazardous waste it generates (60,000 tpa). All water effluents are biologically treated and included with domestic sewage. The effluent BOD is down to 6 mg/l after treatment, due to very long retention times in sewage treatment.

## Environmental Problems Related to Iron Ore Production and Use

5.59 Ukraine's best iron ore reserves are depleted, and the quality of ore affects operating costs, energy consumption, blast furnace productivity and pollution. Iron ore quality is often as low as 52-54 percent, compared to ore of 64-67 percent used in the most efficient blast furnaces in the world. Ukraine's ore also has a rather high $SO_2$ content, even after beneficiation.

5.60 Improvements in beneficiation practices could be economic as well as environmentally beneficial, since considerable iron is left in the waste product. About 13 million tons of waste products come from iron ore beneficiation plants. Present beneficiation practices include only magnetic separation to remove magnetite species of ore; little is done to remove the oxidized iron ore, and a sizeable amount of magnetite fines is escaping as well. The addition of density and gravity separation circuits should be

considered for enhanced efficiency. This could improve the quality of the concentrate and decrease the content of labile metals in the waste. If the overall yield and quality of the beneficiated concentrate were improved, it is possible that this would then reduce the current practice in the steel plants of sintering very low grade amalgamated ore.

5.61 Another option to consider, in the context of overall restructuring, is iron ore pelletization to improve the input to the blast furnace and to replace sintering. Pellets are produced from ores which have been ground to very fine particle size, while the sinter process uses larger fines; therefore, it requires more energy to prepare ores for pelletizing. Pellets are readily handled and shipped with little degradation, however, while sinter must be carefully handled to reduce degradation and, with a few notable exceptions, is not shipped long distances. The economics are based on delivered costs to the blast furnace and the operating efficiency gained.

5.62 The saline water problem from the underground iron ore mines near Kryvyi Rih is worrisome. The salinity of the water is ten times greater than the salinity of sea water; it is contaminating the groundwater under present disposal methods. A detailed assessment should be undertaken to evaluate the magnitude of the saline water disposal problem and to develop a plan for treatment and disposal after evaluation of options (e.g. deep well injection). There is also concern about contamination of the water from heavy metals and radionuclides from uranium production in the oblast (see Para 2.34, Chapter II).

These problems need to be evaluated further. Wastewater from the mines is pumped to settling and evaporation ponds for storage. However, the capacity of these ponds is nearly exceeded, and the authorities worry that eventually they will have to discharge the water into the river system. Already, water is penetrating the storage reservoirs and infiltrating the ground table, making groundwater unfit as a source of drinking water for the local district.

## E. Issues in the Chemical Industry

### Structure and Competitive Aspects

5.63 The chemical industry is more diverse in terms of production, and its process technologies, on average, are not as old as the steel industry. The Ukrainian chemical industry was an integral part of the vast chemical industry of the FSU.[23] It includes petrochemical, and other organic and inorganic chemical complexes. In terms of per capita chemicals production, though, Ukraine lags Russia and Belarus, as well as most EC countries.

5.64 The ages of domestic chemical plants vary from nearly 100 years old to fairly modern, about 10 years old. The bulk of the industry was built after 1950; average plant age is about 20 years old. The

23/ Ukrainian chemical production in 1990 was valued at approximately $15 billion, compared to total FSU chemical production valued at $85 billion in 1990 at world chemical prices (see Table 15, Annex 4).

**Box 5.9: Kryvyi Rih's Industries**

The Kryvyi Rih iron ore basin (Krivbass) encompasses only a small land area (1500 $km^2$), but it has a large concentration of industrial enterprises. Located among residential developments are 17 iron ore mines, 5 ore-enriching mills, metallurgical plants, cement mills, and a lead factory. Each year there is an effluent of 60 million $m^3$ of highly mineralized water from its iron ore mines. Over 5 billion $m^3$ of waste from ore-enriching combines have accumulated in waste dumps and tailing storage sites.

The city of Kryvyi Rih is dominated by one of the largest iron and steel plants in the world. In addition to the plant itself, a coking plant, a number of ore agglomeration (beneficiation) plants nearby, and a city cement plant are major sources of air pollution. More than half of the adult population is employed in industry, with over 25% in mining and metallurgical enterprises. Workers are continuously exposed to occupational hazards such as inorganic dusts and chemical substances. Measured ambient particulate concentrations stand out as being very high and may be higher in the sanitary zone of the iron and steel plant, where 1,000 people live. Kryvyi Rih is a candidate for establishing a stronger emergency action program to reduce emissions during high episode periods. Data on health problems in the community are provided in Annex 3.

Krivorozhstal is a major producer of non-flat products, primarily used in construction. It has 33,000 employees and covers an area of 2,200 ha. In 1991, it produced 9.2 million tons of iron, 10 million tons of steel, and 7 million tons of rolled products. In every workshop of this massive plant there are opportunities to reduce both individual sources of emissions and fugitive emissions. The plant has 8 relatively small blast furnaces (working volumes of 1,316 and 2000 $m^3$) and one large, more modern blast furnace (working volume of 5000 $m^3$). A program of cleaning all the small blast furnaces is in progress. The plant's sinter workshop, built in 1951, is in terrible condition. It uses high iron content waste and sludge as inputs, which contributes to the dust problem and affects the efficiency of the process.

The steel plant discharges 13 separate wastewater streams to a 14 km long canal running through the complex. The canal also receives wastewater streams from the coke plant and the iron ore mine. Overflow water from the canal passes through two settlement/storage lagoons before discharge to the Inhulets River. These lagoons, which are operated in series, have capacities of 960,000 $m^3$ (primary lagoon) and 800,000 $m^3$ (secondary lagoon). The average daily flow of wastewater entering the lagoons is in the region of 340,000 $m^3$ per day, of which 110,000 $m^3$ per day is recycled through the steel plant for use as cooling water and rinse water. The discharge of polluted wastewater to the Inhulets River is of the order of 230,000 $m^3$ per day.

The associated coking plant is also large, producing over 4 million tons and employing 3,500 workers. It has highly visible door leakages, and six of the twelve batteries at the plant require replacement. Housekeeping generally is very poor and represents a serious hazard to workers. There are two wastewater discharges associated with the coke production process: effluents from the primary gas plant and phenol discharges. The wastewater stream from the primary gas plant contains ammonia in concentration up to 500 mg/l. Most of the effluent is pre-treated in a wastewater treatment plant and is recycled as quenching water for the coke production plant, but a proportion of the effluent, up to 2,000 $m^3$/day, is discharged to the municipal authority's sewerage network.

industry suffered reduced allocations to it during the past 10-15 years.[24] Some of these plants are also

24/ The entire chemical industry's annual share of total industrial investment in the FSU dropped from 8.4% to 4.7% during the 1980 to 1990 period.

of very large size, employing well over 10,000 people each. Still, the diversity of plants and products and less advanced age of the technologies (compared to the steel industry, for instance) suggest more opportunities for long term competitiveness.

5.65 **Predominance of Bulk Commodities**. The product composition reflects the former integration of the Ukrainian chemical industry with that of the FSU. Most of the products, with some exceptions, are bulk and intermediate; consumer products form only a small part of total output.[25] Still, there is insufficient capacity to meet internal market demand for important classes of bulk chemicals. Ukraine's production of plastics and fibers, for example, does not satisfy internal market demand; in addition, over 30 percent of fibers produced are cellulosic fibers (acetates and rayons). In other industrialized countries cellulosics account for less than 10 percent of synthetic fiber output. Ukraine also depends on the FSU or outside imports for phosphorus and potassium-based fertilizers and chemical fibers.

5.66 **Elements of Future Competitiveness.** The international chemical industry has been in a recession during 1991-92, with the rest of the world economy, resulting in downward pressure on chemical commodity prices. It is a highly competitive business, and export business for bulk commodities goes to the least cost producer. In the short term, Ukraine may be successful in exporting bulk commodities, if production costs stay low. Joint venture arrangements, where bulk output pays for updating facilities, are obvious vehicles for financing necessary transitions. The future of the Ukrainian industry lies in diversification of its chemical industry into the downstream manufacturing of consumer products. A large array of consumer products are needed domestically, with likely unsatisfied demand for such products as tires, paints, textiles and household goods. The consumer product segment of the industry suffers not only from insufficient output but also from poor quality and lack of variety. Again, joint ventures that transfer external know-how in consumer product design, manufacture, packaging and distribution would improve the survival chances of some Ukrainian enterprises.

5.67 The principal raw materials for the modern organic chemical industry are natural gas and petroleum, neither of which are in sufficient supply in Ukraine. Modern chemical processes depend on adequate and predictably priced petroleum and natural gas. The expected rise of oil and gas prices to near world levels will require Ukraine to restructure its chemical industry for high value product output and for greater energy efficiency. The lack of low priced petroleum will also require refineries to restructure more optimally (see Chapter VI). Expected closures and revamps will force changes in the availability and price of some petrochemical feedstocks, inevitably affecting the downstream chemical industry.

5.68 Some of the petrochemical plants are still largely based on coke chemicals rather than on petroleum-based feedstocks. Coke chemical-based plants are likely to be uncompetitive in the future. Coke liquids as feedstocks have been replaced by petroleum-based feedstocks in most industrialized countries for economic reasons primarily. It is more difficult and complex, and thus more costly, to separate the appropriate fractions, such as aromatics (benzene, toluene, xylene), phenols and others from coal tars than it is from oil refinery fractions. In addition, the quantities of these chemicals from coking

---

25/ Those consumer products produced in Ukraine include: textiles, paints, household and industrial cleaning agents, and various types of plastic molded items.

operations are often insufficient to satisfy feedstock requirements for economically-sized chemical facilities. Also, coal tars are known for their carcinogenicity.

**Box 5.10: The Titanium Dioxide Plant at Armyansk**

Ukraine accounted for nearly all of titanium dioxide production in the FSU and is one of the significant producers of this commodity in the world. Production capacity at the largest plant, at Armyansk in the Crimea, is 80,000 tons. Another plant, at Sumy in northeastern Ukraine, has a capacity of 40,000 tpa. Titanium dioxide is principally used in paints. Worldwide, new capacity has come on stream in recent years, just as demand has weaker because of general economic conditions, and there currently is an abundant world supply. But, demand for paints should regain strength in the medium term, and if Ukraine can be competitive with world prices, there is an export opportunity in this industry.

The "Titan" plant at Armyansk, located on a neck of land between the Black and Azov Seas, is now trying to address its environmental problems. The plant operates on the sulphate route for the dissolution of its titanium ore, an older process. It generates large amounts of contaminated acid waste. A very large, shallow salt lagoon--43 $km^2$--is used as a dump for the waste (which is mixed with dilute process streams and heavy metals); about 52 million $m^2$ of waste have accumulated. Existing monitoring suggests that there is no leakage into adjacent waterbodies, but further confirmation (with better instrumentation) is probably needed. The plant is now seeking international assistance to deal with this waste problem by separating the waste streams and neutralizing the waste acid. The economics of a process change should also be considered.

## Energy Efficiency and Pollution Control

5.69 In those chemical plants surveyed, much of the energy inefficiency and pollution seemed related to the extensive size of plants and haphazard layout, the design and operation of utility systems, and poor safety, housekeeping and maintenance, rather than a question of technologies. *Energy and environmental audits are warranted at all energy intensive chemical enterprises. But they should be integrated with plant-level business evaluations.*

5.70 The most energy intensive industries are those using natural gas as a feedstock and energy source, e.g. ammonia and methanol producers. Early candidates for energy audits are the six ammonia producers (see in Annex 4, Table 17).[26] Several of these plants feed into the high pressure (80 atm) ammonia pipeline which crosses southern Ukraine, a potential hazard (see para. 2.88, Chapter II).

5.71 Chemical plants generally need to implement better housekeeping practices, reducing airborne emissions (heavy metal emissions, organic vapors, and irritant gases) and monitoring liquid chemical losses and water and chemical balances. Improved safety practices and use of protective clothing should be instituted and regulated more closely. Many of the airborne emissions are probably most hazardous to workers. Plants of special concern are those producing or using mercury, or toxic organics.

26/ Also, see the discussion of the Azot plant in Luhansk Oblast in Annex 3.

5.72 Most of the problems with liquid hazardous waste released into the environment in the past can be traced to primitive disposal practices and poor housekeeping (spills and leaks from chemical storage facilities). The pollution of aquifers from chemical industry discharges is one prime example of this neglect. Reports of serious pollution problems from chemical plants come from Lukansk Oblast, particularly the industrial communities of Siverskodonetsk and Lysychansk where there is a high concentration of chemical industries. There are chemical plants in many cities throughout the country, however, including in some of the most populous cities, e.g. Kiev and Kharkov. Many of the problems identified above could be addressed through plant by plant short term action plans (as outlined for the steel industry at para. 5.55). Larger investments in end-of-pipe air pollution controls and extensions of wastewater treatment facilities may be unaffordable in the short term and will come first at those plants which are competitive in their markets and can generate sufficient cash flow.[28]

27/ No information was available during this study in regard to possibly hazardous chemical production at military installations.

28/ Chemical plants may require some form of technology transfer to assist with effective treatment of their liquid hazardous waste.

**Box 5.11: The Lysychansk Soda Works, Luhansk Oblast**

This plant was founded over 100 years ago; over half of the factory has been rebuilt over the last 10 years, although reconstruction has now halted because of lack of funds. The plant produces sodium carbonate (soda ash) and its related products (sodium bicarbonate, ammonium chloride, calcium chloride, and others). The old Solvay process is used, which reacts calcium carbonate (limestone) with sodium chloride (common salt). Calcium carbonate is mined at open pits 18 kilometers away and transported by an elevated cable car system. Sodium chloride is mined 40 kilometers away, and the saturated brine is piped to the plant. In contrast, in several other countries, soda ash is produced by mining and processing naturally occurring minerals, which are easier and more energy efficient to process and cheaper to produce.

The plant operation seems inefficient, and its future viability is in question, although other downstream chemical plants may depend on its output. Current low operating costs are attributed to inadequate cost accounting at the plant and government subsidy of the operation. Because the plant is energy intensive, the cost of production is likely to rise with the increased cost of natural gas. In addition, the large capital investments that are needed for reconstruction of the facility and to bring it into compliance with modern environmental, health and safety standards could make the enterprise uneconomic.

An unusually high level of annual carbon monoxide emissions (27,000 tpa) was quoted for the plant. Chemical dust losses are evident at all dry steps of the process and at the wastewater storage sites. Heavy chemical dust is evident all over the site, sometimes completely covering large areas of the ground. This dust is also airborne during product loading of railroad cars via open loading chutes. The hot lime, from the lime kiln, is transported in an underground open tunnel to slakers. Workers in this pit are exposed to high levels of airborne lime. *It is obvious that dust control and appropriate breathing protection should be given highest priority at the plant.* Another potential hazard is mercury, due to operation of an old chlor-alkali electrolytic process in the past that used mercury cells, since abandoned and dismantled. The old site was covered with concrete, but clean up may have been insufficient.

**Box 5.12: Mikitivskiy Plant, Donetsk Oblast**

A facility of special concern is the Mikitivskiy mining and mercury manufacturing complex at Horlivka. This plant was rebuilt in 1968 and produces 400 tons of mercury per year. The plant is situated on a hill within the Donetsk airshed. Total mercury emissions from the complex are high--8,000 pounds per year, over 4 times the maximum emissions limit under existing US standards (see Annex 3). The current pollution control system (sulfur sorbent injection system) needs to be replaced with a more efficient mercury removal system. Installation of this technology may be difficult, though, because of the massive air flows used in the manufacturing process. The financial condition and competitiveness of the plant are unknown.

# VI. ADDRESSING ENVIRONMENTAL PROBLEMS IN THE ENERGY SECTOR



6.0 This chapter reviews environmental problems in the energy sector, focusing on four themes: safety in regard to nuclear power plant operation;[1] air pollution in the thermal power industry;[2] safety and environmental issues in respect of coal production and use; and environmental considerations in oil refining. This is a selective review of industries, as it was not possible to cover them all. Environmental issues are discussed in the context of underlying structural issues in the respective industries.

## A. Issues in the Electric Power Industry: Investment Needs and Nuclear Power Safety

**Background and Immediate Investment Needs**

6.1 The electric power industry in Ukraine has an installed capacity of 53,569 MW, of which 66 percent is thermal, 24 percent nuclear and almost 9 percent hydro. In 1991, total generation was 276.8 TWh (down 6.6 percent from the level in 1990), of which 66 percent was generated by thermal, 27 percent by nuclear, 4.4 percent by hydro and 2.6 percent by industrial cogeneration. Nuclear power plants have provided 25-32 percent of gross electrical energy over the past 5 years; hence, they are an important part of the national power system. The accident at Chernobyl in 1986 highlighted, though, the critical issues of adequate design and safety practices at nuclear power units in the FSU. Last year Ukraine's Parliament passed legislation mandating retirement of the remaining units at Chernobyl by the end of 1993, which will remove all RBMK units, considered unsafe in design, from the country. *Closing these units will be an important step for safety.*

6.2 A recent study commissioned by the G-7 countries, conducted by the World Bank and IEA,[3] analyzed the scope for replacing less safe nuclear plants with other electric power sources, as well as through more efficient use of energy. Its conclusion in regard to Ukraine's electric power industry is that closing the remaining units at Chernobyl poses no threat of capacity shortages within the next seven years under most reasonable scenarios. The reason is that electricity demand is not expected to reach pre-1990

---

1/ Chapter VII examines the continuing legacy of Chernobyl.

2/ This topic received emphasis during the study.

3/ See "Ukraine: Power Demand and Supply Options. A Joint Report of the International Energy Agency and World Bank," Report no. 11561-UA, May 6, 1993.

levels for a long time (perhaps beyond the year 2000) as a result of the current economic crisis, expected price increases and structural shifts in the economy.

6.3 *Two programs are essential over the medium term, however. They are: (i) rehabilitation of older thermal power plants to maintain capacity and improve the efficiency of production; and (ii) systematic upgrading of safety features at remaining nuclear power plants, which will require downtime at individual plants (to be phased).* There are substantial costs involved with both of these programs, which are discussed below. In addition, *creating incentives for energy conservation,* through economic pricing of electricity and technical improvements, is an essential step in minimizing demand growth.

**Anticipated Rehabilitation of Thermal Power Plants**

6.4 There are 17 major thermal plants in the country. Of the fuel used in thermal power plants in 1991, 45 percent was natural gas,[4] 34 percent coal, and 21 percent mazut. About 75 percent of the coal-fired plants and 28 percent of dual-fired plants using mazut or gas are over 20 years old, which reflects the attention given to nuclear development over the past 13 years. Many of the plants suffer from boiler problems, turbine aging and deficiencies in controls and instrumentation; they are becoming increasingly unreliable and must either be retired or reconstructed. Also, boilers in Ukraine tend to show "wear and tear" much earlier than similar boilers in other industrial countries. This suggests that current operating practices are very hard on the boilers. Two causes could well be the extensive diurnal (daily) cycling and use of poor quality fuels (causing slagging in the boilers); these same practices increase air pollution problems.

6.5 The closure of the Chernobyl plant and the safety upgrades of other nuclear power plants will require the generation of additional electricity by thermal plants: about 16 TWh of electricity p.a. to replace the electricity which would otherwise be generated by the two remaining blocks at Chernobyl and one additional nuclear plant taken out of service at a particular time for safety upgrades. It is important, therefore, to rehabilitate thermal power plants in order to assure sufficient capacity. The additional thermal generation also assumes either an increase in natural gas imports of about 5 bcm or use of a further 9 million tons of domestic coal per year.

6.6 As mentioned earlier, the Ministry of Electric Power has developed a plan for rehabilitation of its thermal plants through a phased program. Some units need only moderate rehabilitation, while others (those which are very old) need radical or complete reconstruction. Elements of the proposed program include:

- Rehabilitation and repowering of 800 MW units with the addition of single 150-MW gas turbines;
- Repowering of existing 200 and 300 MW units with atmospheric fluidized-bed combustion (AFBC) boilers and high efficiency fly ash collection equipment;
- Installation of sulfur removal technologies at power blocks that are expected to operate for at least another 10 years;
- Installation of high efficiency particulate (dust) collection equipment at coal-fired stations;

4/ 29% of total natural gas consumption was in the power sector.

- Modification of burners at oil, gas and coal-fired stations to reduce formation and emissions of NOx.

6.7 The World Bank-IEA study cited above endorsed the need for rehabilitation of existing non-nuclear units, but it questioned the economic viability of some of the elements, where the potential costs may outweigh benefits. For instance, it is questionable whether it is economical to remove and replace turbogenerator sets and entire boilers in plants where the remaining life of the plant has not been established with sufficient certainty. *Individual plant investments also need to be subject to a careful cost-benefit analysis.* Funding from international and bilateral organizations has been organized to conduct studies which will help to evaluate and prioritize investments under the rehabilitation program. The costs of such rehabilitation are estimated at US$250 million per year in the period 1993-95 and US$500 million per year in the period 1996-2005.

6.8 The environmental elements in the plan are discussed further in this chapter. *The most questionable are proposals to invest in expensive flue gas desulfurization without considering first the impact of emissions from individual power plants on local ambient pollution and how to reduce sulfur emissions across industries and sector most cost effectively.*

**The Issue of Safety at Nuclear Power Plants**[5]

6.9 The G-7 communique of 1992 in Munich categorized two reactor models as unsafe: the RBMK-1000 and the VVER-440/230. The Chernobyl units are of the RBMK type; Ukraine does not have any VVER-440/230. Its remaining units are VVER-440/213 (two units at Rivne) and VVER-1000 at other plants. Opportunities to address safety at these remaining plants and to strengthen nuclear regulatory policy generally are obviously very important. Ukrainian authorities are cooperating with various external agencies to improve safety in operating domestic nuclear power units. The recently completed G-7 study outlined the steps being taken to improve the safety of ongoing plants, and they are summarized below.

6.10 The two units at Rivne represent the second generation of VVER-440 models. They have additional safety systems compared to the earlier 230 model, but they still lack the redundancy of systems, diversity and physical separation required by international standards. A full containment structure is also missing. In addition, safety improvements depend on increased operator training, stricter procedures and development of a "safety culture." Some system upgrading, carefully considering cost effectiveness, is also warranted. IAEA is now organizing a technical assistance program for the upgrading of VVER-440/213 units through a demonstration project in the Czech Republic, which will benefit all operators of this model.

6.11 The VVER-1000 units are a later vintage and are equipped with the safety systems necessary to meet international standards. There are still problems, though, related to the quality of construction and adequacy of instrumentation and controls, fire protection systems, and steam generator performance. The operators of these units are aware of their shortcomings and are already planning programs for safety improvements. At Zaporizhzhia, for example, a training simulator is planned. Contacts have been

5/ This section is drawn from the following report: "Ukraine: Power Demand and Supply Options. A Joint Report of the International Energy Agency and the World Bank." Report No. 11561-UA, May 6, 1993.

established with international organizations[6] to arrange the exchange of staff and operating experience.

6.12 In addition, IAEA has recently initiated a comprehensive review of VVER-1000 units, at the request of Bulgaria, the Czech Republic and Ukraine. Bilateral and regional assistance programs are also being organized. For instance, the US has authorized US$25 million in 1992/93 for its "Nuclear Safety Initiative." This will include a training center and full-scope simulator for Ukraine, to be installed at the Khmelnitskiy site, as well as regulatory assistance from the US Nuclear Regulatory Commission. Assistance is also planned by the Commission of the European Communities (CEC) to include operational safety improvements and risk assessment studies. Out of these initiatives will come specific plans for upgrading of existing nuclear units over the next 10-15 years. *One of the most important elements in determining any future expansion of nuclear power plants will be a demonstrated improvement in the safety culture of these plants.* The cost of necessary safety upgrades at existing nuclear plants are estimated at US$100 million p.a. for the next 10-15 years.

6.13 An important environmental concern is the storage of low, medium and high-level wastes, including spent fuel, from the twelve nuclear units (not counting any of the Chernobyl units). If the Russian Federation refuses to accept these wastes, a solution needs to be found in the territory of Ukraine. The authorities are aware of the fact that shortage of spent fuel capacity may pose, in the near future, a severe constraint in the operation of certain units. A long-term storage facility would probably cost in the order of US $200-300 million. Owing to the potential hazards posed by any future spent fuel storage facility(ies) to human health and the environment, a well-considered and countrywide plan must be developed, taking into account hypothetical accidents, siting considerations, and needed modern design and operational measures to ensure maximum safety. A longer-term solution, perhaps in a regional context, although not an immediately pressing requirement, could also be studied.

6.14 The retirement of Chernobyl does not seem, in most realistic analyses, to require capacity additions at least in the short-to-mid-term. However, the shifting of the load to other units may require a reconfiguration of the transmission system and hence some additional high-voltage transmission lines.

6.15 *Building a credible nuclear regulatory capability is also extremely critical.* The above-referenced G-7 study recommends stronger authority and sufficient resources go to the State Committee of Ukraine for Nuclear and Radiation Safety (SCUNRS) in order for it to take up full responsibility for regulation. It is important to note also that MEP has set up a division concerned with nuclear safety. How its responsibilities would be differentiated and coordinated with SCUNRS is unclear at the present time, and should be clarified.

**Future Demand and Investment Requirements**

6.16 An important issue in the industry is the extent of growth in energy demand over the medium to long term. The above mentioned analysis of electricity demand by the World Bank and IEA suggests that official projections of demand are too high, especially over the medium term. Expected continued declines in GDP over the next few years, combined with structural changes in the economy and efficiency gains, are expected to lead to considerably lower demand for electricity than what was assumed by Ukrainian authorities for planning purposes in 1992. On the demand side, increases in energy prices to

6/ For example, the World Organization of Nuclear Operators (WANO) and the Institute for Nuclear Power Operations (INPO).

economic levels and parallel efforts to improve energy efficiency in a variety of sectors should realize substantial savings in terms of delaying additional investments in new capacity. This allows time to consider various options for capacity additions to meet longer term demand. Those choices will also have environmental ramifications.

6.17 The Bank-IEA analysis suggests that completion of construction at three additional nuclear units (at Zaporizhzhia, Rivne and Khmelnytskyi) is the most economic option for investments in new generation capacity and would defer the need for other new capacity beyond the year 2000. *Lifting the moratorium on nuclear power construction, however, requires a clear demonstration that nuclear power plants in the country can be operated safely, consistent with international safety regulations.* If the three outstanding units are completed, costs would be in the order of US$500-700 million, although the savings in terms of avoiding installing additional thermal capacity is estimated at US$1.6 billion.

6.18 Over the longer term, capacity additions will be needed, and the decision whether to invest in gas-fired or coal-fired units will depend on relative economic prices for gas and coal and whether or not long-term gas supply agreements can be negotiated with Russia and Turkmenistan. The option of installing single or combined cycle gas generating units should be seriously considered, on several grounds: low investment cost per installed kW, short construction time, high thermal efficiency and good environmental results. The option of constructing new coal-fired plants would depend on the availability of low cost, high quality steam coal, which in turn depends on restructuring of the coal industry, phasing out high cost mines and putting greater emphasis on production of prime steam coal. Investment planning in the power sector should incorporate in the analysis the costs of good environmental controls for the two options, gas versus coal.

## B. Air Pollution From Thermal Power Plants

### Estimates of Gross Emissions From the Thermal Power Industry

6.19 Thermal power plants are the second largest source of estimated gross air pollutant emissions, after metallurgy; they reportedly account for 29 percent of total TSP emissions, 61 percent of total $SO_2$ emissions, and 54 percent of total NOx emissions in the country. According to data provided by MEP, general air pollutant emissions in the electric power sector have declined over the period 1985-1991 from 4.5 million tons to 2.6 million tons (see Annex 2, Table 4). Much of this is attributed to substitution of natural gas for coal and low cost efforts to control NOx. There is some question about those estimates, however, as discussed below.

6.20 The composition of principal emissions are set out in Table 6.1. Also shown are estimates made during this study, using emission factors for similar boilers in the US (column II) and using the most recent fuel consumption data (column III). Assumptions about average fuel quality (e.g. ash and sulfur content) and performance of control equipment are also given. In general, coal and fuel oil quality are low, hampering efforts at emission control. Only particulate control equipment is installed at plants, and performance is substandard (see paras. 6.33-6.38).

**Table 6.1 Estimated Emissions from the Thermal Power Industry**

| Pollutant | I. Official Estimates in 1990 (000 metric tons)[a] | II. 1990 Ukrainian Estimates Using US Emission Factors[b] (000 metric tons) | III. Estimates During This Study[c] (000 metric tons) based on updated fuel consumption data | |
|---|---|---|---|---|
| | | | 1990 (revised) | 1991 |
| Particulates (TSP) | 580 | 291-536 | 436-816 | 371-703 |
| $SO_2$ | 1,690 | 1,770 | 2,530 | 2,145 |
| NOx | 414 | 804 | 958 | 840 |

a/ As reported. Based on fuel consumption as follows: coal--25.8 million tons, mazut--13.4 million tons, and natural gas--38 bcm.
b/ US emission factors employed in this analysis are explained in Annex 5, Table 1. Energy consumption figures are the same as those in footnote a. Assumptions for average ash and sulfur content and particulate control performance are those cited at footnote c.
c/ Assumptions: Fuel consumption for 1990 and 1991: coal--40 and 35 million tons; mazut--16.3 and 11 million tons; natural gas--33.35 and 30 bcm. US emission factors were applied, assuming average ash content of 38 percent in coal, and $SO_2$ content of 2.5 percent in coal and 2.4 percent in mazut. Average efficiency of particulate control is assumed to be in the range of 90-95 percent. See Annex 5, Table 1.

**Table 6.2: Thermal Power Plants Among Top Air Polluters (based on gross emissions)**

| Name | Location | Capacity (MW) | Gross Emissions in 1991 (thousand tons) |
|---|---|---|---|
| Starobeshevskaya a/ | Noviy Svet, Donetsk Oblast | 2000 | 230 |
| Krivorozhskaya a/ | Kryvyi Rih, Dnipropetrovsk Oblast | 3000 | 435.4 |
| Pridniprovsk | City of Dnipropetrovsk | 1200 | 138.3 |
| Zaporozhskaya a/ | Enegodar, Zaporizhzhia Oblast | 1200 - Coal<br>2400 - Oil/Gas | 193 |
| Zmeyevska | Komsomolske, Kharkiv Oblast | 2400 | 234 |
| Burshtynsk | Burshtynsk, Ivano-Frankivsk Oblast | 2400 | 167.6 |

a/ Surveyed during this study. See Annex 5.

6.21 A number of points can be drawn from Table 6.1. First, particulate emissions will vary significantly depending on the actual ash content of coals used and the operating performance of pollution control equipment. Second, using US emission factors raises estimated $SO_2$ slightly and estimated NOx emissions substantially (compare columns I and II of Table 6.1); NOx emissions appear significantly underestimated. The emission estimates using most recent fuel consumption data (column III) raise $SO_2$ and NOx emissions further. These estimates, in general, are crude, but they underline the need to review current emission factors and assumptions employed in Ukraine and ultimately to understand the actual situation better through improved monitoring and other evaluatory techniques.

6.22 Table 6.2 lists six thermal power plants considered among the top air polluters in the country, in terms of gross emissions. Three of these plants were visited during this study, in addition to a fourth plant, Kurakhovskaya, in Donetsk Oblast (see Annex 5 for descriptions and recommendations).

**Effect on Ambient Pollution Problems**

6.23 While power plants are large *gross* emitters, their contribution to local pollution problems is more complicated. Stack heights at Ukrainian power plants are generally very high (e.g. 250 m), well in excess of limits imposed in the EC or US, for example. All the plants surveyed during the study, with one exception, had stack heights in excess of what is called "good engineering practice" (GEP) in the US.[7] Consequently, the dispersion of air pollutants from these stacks tends to be good, with emissions probably dispersing over broader distances.[8] Smaller, lower emitting sources (eg. small boilers, asphalt plants, other industrial plants) are likely to be more important sources of ambient pollution. Still, the volume of power plant emissions makes them significant enough to warrant greater investigation. *Greater site characterization (through screening and more detailed dispersion modeling) would help to clarify the contribution of power plant emissions to local ambient pollution and thus help guide the priority of pollution control investments.*

6.24 Box 6.1 gives the results of a screening analysis of air dispersion for one of the plants surveyed during the study. It indicates that there may be local effects from the plant's emissions, although the results are only tentative and apply only to this plant; the analysis needs to be supplemented with further information about weather and topographical conditions. It highlights the importance of characterizing better the impact of power plant emissions on ambient pollution, and analyzing overall options for pollution reduction, especially before any higher cost pollution control investments (e.g. in $SO_2$/NOx control) are made.

---

7/ The concept of "good engineering practice" (GEP) stack height is used extensively in air pollution regulation in the US. In order to overcome the tendency of the interaction between the wind and the shapes of ground-level structures to draw a stack plume rapidly down to the ground, a stack must be constructed with a height 2.5 times that of the tallest building within 5 stack heights of the stack. The pollutants released from a stack with this height will be well dispersed. *On the other hand, additional dispersion of air pollutants resulting from a stack taller than GEP is not an acceptable substitute for emission reductions in the US.*

8/ The exception among the Ukrainian plants surveyed is the Starobeshevskaya Power Plant, at which two of the four stacks are right at, or possibly just below, GEP. Exacerbating the potential local air quality at Starobeshevskaya is the fact that the plant is located in a river valley with very significant rolling countryside in all directions from the plant. Ironically, this plant also has the least effective particulate control equipment.

6.25 *Several factors will influence abatement of air emissions in the electric power industry--some structural, others operational.* They include: (i) improvements in efficiency of plant operations, as well as the choice of units for base load and peak operation; (ii) the balance between use of cleaner natural gas (much of which is imported) and coal produced domestically; (iii) improvements in the quality of coal and fuel oil supplied to the power sector, perhaps spurred by higher energy prices and emergence of competitive coal and fuel oil markets; (iv) over the medium term, changes in electricity prices and restructuring more generally, leading to changes in overall electricity demand; and, finally, (v) improvements in pollution control, starting first with improved particulate control, introducing *over time,* as resources permit, more expensive $SO_2$ and NOx control. The various operating and technical options and their priority are discussed below.

**Box 6.1: Dispersion Modeling Case**

A simple screening model for air dispersion analysis, utilizing USEPA emission factors, was employed to get an initial view of the local impact of emissions from the Kurakhovskaya power plant, as a case study. The screening analysis is discussed in more detail in Annex 5 (in the review of the Kurakhovskaya plant). According to the analysis, the predicted ground level concentration resulting from the typical operation of Kurakhovskaya is 135 $\mu g/m^3$ (24 hour basis). The predicted average $SO_2$ concentration is 976 $\mu g/m^3$ (24 hour basis), and the average NOx concentration is 105 $\mu g/m^3$ (24 hour basis). The most serious result is that of the $SO_2$ concentration which is above air quality standards in the EC, US and Ukraine. The impact of particulate and NOx emissions would depend on the level of additional "background" concentrations (from other sources). The results indicate the maximum concentrations would occur 1530 meters downwind of the stack and significant concentrations occur 5,000 meters downwind of the stack. These results suggest that there are exceedances of ambient air quality standards, particularly of $SO_2$ standards. The major impact, though, is not directly around the plant, but within a district or oblast. Longer distance dispersion would also be expected.

This type of screening analysis is very simplified, and the ground-level impacts are based on very general assumptions about meteorological conditions. These results would typically be used to identify the most appropriate locations for air pollution monitors, to obtain actual reading of ambient concentrations. This analysis cannot be used on its own to develop a control strategy. More information is needed about background concentrations and other sources, combined with a more sophisticated dispersion analysis with more detailed local meteorological and topographical information. Such additional efforts are recommended before a decision on investment in control equipment should be made.

## Improvements in System Dispatch and Furnace Operation

6.26 Generally speaking, nuclear power stations form the base load of the power system, followed by thermal plants and then hydropower.[9] Many of the coal-fired thermal power boilers appear to be dispatched in a diurnal (daily) cycling mode; this may be because units fired with natural gas are given priority among thermal plants. It should be possible, though, to improve system dispatch among the available coal-fired plants to reduce the extent of diurnal cycling which is hard on boilers and disturbs

9/ Dispatch of power is done through use of computer programs which are designed to provide power according to least cost (although there may be problems in doing so because of existing price distortions). Transfers of power occur within each region of Ukraine, based on cost and security of supply at the time.

the combustion process, causing more emissions. The emissions of dust, CO, NOx and organics increase during periods of increasing or decreasing boiler load. The following operating tools would be helpful, the first two of which could be introduced immediately at low cost.

6.27 **Plan for Boiler Start-up.** Combustion instabilities during dispatching can be mitigated by careful furnace operation during cycling. Consequently, every power plant should prepare a plan for boiler startup and shutdown, developing its own set of specific procedures to follow during these operations. These plans should be on display both at the plant and at the local MEP branch, so that everyone knows exactly what is supposed to happen during critical periods of boiler operation.

6.28 **Portable Combustion Analyzers.** Ukrainian plants would also benefit from use of portable combustion analyzers. They facilitate boiler operational adjustments to improve combustion efficiency and also enable boilers to be fine-tuned from an emissions point of view by making direct measurements of the concentrations of CO, $O_2$, NOx, and $SO_2$ in flue gases. Since CO emissions are an accepted surrogate for products of incomplete combustion (many of which are regulated in various countries as hazardous compounds), boiler operational adjustments which result in reduced CO emissions imply reductions in hazardous air pollutants. Such instruments are relatively inexpensive ($5,000-$6,000) and potentially very cost effective.

6.29 **Tool for the Longer Term: Continuous Opacity Monitors.** Over time, as budgets allow, the plants might want to install continuous opacity monitors in each stack to gain a long-term understanding of dust abatement system performance, making it easier to make operating improvements.[10] Such monitors are expensive, however, and therefore a longer term acquisition.

**Fuel Acquisition**

6.30 Outside the FSU, thermal power plants allocate much of their operating budgets to fuel acquisition. Such a major expense forces corporate managers to be extremely selective when it comes to acquiring fuels for the plant. Moreover, stricter environmental regulations have encouraged greater attention to coal quality. Fuels must be matched to the boiler according to a comprehensive fuel acquisition strategy so that thermodynamic, economic and environmental requirements are all satisfied.

6.31 In Ukraine, plant directors and engineers typically complain about the poor quality of the coals they receive, usually in terms of ash content. Average ash content of coal delivered to power plants is reportedly 31 percent and sulfur content 2-3 percent. It is not uncommon, though, to have over 3.0 percent sulfur and over 40 percent ash in coals delivered to power plants, based on the survey of plants during this study.[11] Often the coal is a washery waste (the high ash byproduct after coal washing, see Box 6.4). The mazut used is also high in sulfur content (average of 2.4 percent). Hence, the quality of

---

10/ An opacity monitor is a monitor which continuously measures the ability of light to pass through stack emission gases. Visible stack emissions are evaluated on a relative basis, with 100 percent opacity representing a stack plume which is completely opaque; 0 percent opacity represents an invisible plume. Such a device would assist both MEP and the plant, since the plant would more easily be able to monitor and adjust furnace performance; the monitored operation would have to show compliance with the visible emissions standard at all times. Continuous opacity monitors are expensive, costing about $250,000 and require about $25,000 per year in maintenance and calibration.

11/ All the plants surveyed in this study were using coal with typically 40% ash, essentially washery waste.

fuels generates higher emissions before controls, making it much harder to operate with reasonable pollution control. Moreover, the resulting waste, from the boiler and captured from the dust control equipment, creates a solid waste problem out of what was originally an air pollution problem. In the past, a central agency determined the fuels plants would receive. Even now, they appear to have little control over fuel acquisition, particularly the quality of coal received. While they all conclude contracts with coal suppliers, none of the plants visited during the study seems to survey aggressively the available coals and take the initiative in contracting.

6.32 In addition, not enough attention is given to the chemical and physical properties of the coals prior to purchase. *Individual coals could be blended to achieve desirable chemical and physical properties and enhance boiler performance.* The ash chemistry also plays an important role in fly ash resistivity, which has a direct impact on ESP performance (see para. 6.37). Given the variety of local coals in the country, coal blending may be an economical means for upgrading fuel quality, thus reducing boiler and environmental problems. A more expensive route is to purchase washed coal, where the washing process reduces ash and, to a lesser extent, sulfur (see Box 6.4 in Section D). Better coal quality would significantly improve operating conditions and reduce the strain on boilers, thus enhancing efficiency, as well as reducing emissions and boiler waste.

6.33 *Each power plant in Ukraine needs to be more creative in acquiring fuels for the plant, as a start by establishing or expanding special departments to locate the best fuel, considering boiler operational needs, pollution control equipment performance, as well as delivered cost.* This depends, also, on emergence of a functioning coal market, where coal suppliers have an incentive to meet buyers' specifications (see Section C). As coal prices increase and greater accountability is introduced at individual plants, managers are likely to begin paying more attention to fuel quality.

**Particulate Control**

6.34 For particulate control, newer plants tend to have electrostatic precipitators (ESP); older plants rely on less efficient wet scrubbers (see Box 6.2 for a comparison of technologies). In general, installed pollution control equipment is performing below world standards. Some control devices are very old; others require more attention to maintenance. Other factors, such as coal quality, contribute to the problems, as discussed above.

6.35 Of those plants surveyed during the study, one plant (Starobeshevskaya Power) used wet scrubbers to control dust emissions, while all of the other plants visited had ESPs. The plants experience varying levels of success with these control systems. The venturi scrubbers at Starobeshevskaya are quite old (1970's vintage) and are not working well. The plant claims that it achieves 93 per cent control of dust, but this did not appear to be the case during the site visit, as emissions were very high. The other power plants, using ESPs, report measured efficiencies in the range of 96-99 percent. A properly functioning ESP can easily achieve more than 99 percent removal of dust (see Box 6.2).

6.36 The solutions to improving particulate control equipment rest with both the operating and technical sides. *Generally, particulate controls could be made to work better than they currently are.* As a basic first step, each plant should develop *a plan for control system malfunction prevention,* to focus on the needs and performance of the control equipment. These plans encourage proper maintenance practices and tend to minimize the time involved in making repairs or adjustments (which is a period of

reduced or no air pollution control). Items such as a spare parts inventory and emergency procedures are typically addressed in such plans.[12]

**Box 6.2: Particulate Control Options**

There are four principal types of air pollution control systems in use today for controlling particulate (i.e. dust) emissions: (i) inertial separators, more commonly known as cyclones; (ii) wet scrubbers; (iii) electrostatic precipitators (ESPs); and (iv) fabric filters, also known as baghouses.

**Cyclones** are 70-80 percent effective at collecting particles larger than 10 microns in diameter; for the $PM_{10}$ fraction, that is for particles with a diameter smaller than 10 microns, cyclones essentially offer no collection. A cyclone is a cone-shaped chamber which receives particle-laden gases tangentially at the wide part of the cone and imparts a swirl to the gases to force the larger particles to the outside of the chamber for capture.

**Wet scrubbers** are devices which spray a liquid at a flue gas stream. As particles collide with the liquid droplets, they are captured within the droplets. Well-designed scrubbers can capture 90-95 percent of total particulates, and can be designed to capture more than 99 percent of fine particulate.

Properly-functioning **ESPs** have control efficiencies of 99.8-99.9 percent, even for fine particulates (i.e., $PM_{10}$). These devices consist of long wires (discharge electrodes) suspended between parallel plates, grouped in a series of chambers. The plates are grounded, and the corona discharge of the electrodes generates particle-charging electrons. As the incoming dust is charged, it is attracted to the plates for collection.

**Fabric filters** also have control efficiencies of 99.8-99.9 percent, even for fine particulates. "Baghouses" are conceived very much like vacuum cleaners, with the fibers of a woven fabric available to intercept particles as they pass by.

In terms of the state of the art in particulate control, the debate centers around ESPs and baghouses. With the advent of the seven-field ESP (earlier designs rarely included more than four fields), electrostatic precipitation and fabric filtration are now on a par in terms of control device outlet loadings to the stack. In the US, for instance, there are now ESPs and baghouses at coal-fired power plants that operate in compliance with a particulate emission limit of 0.01 pound per million BTU (lb/MMBTU). However, baghouses are generally considered to be much more cost-effective than ESPs for fine particulate control. The large collection areas and multiple fields required of ESPs for fine particulate collection comparable to that of baghouses represent something of a stretch for precipitator technology in an economic sense.

6.37 *There are several strategies to consider for improving the collection efficiencies of ESPs at Ukrainian power plants.* The precipitators themselves may need refurbishment; if the plates have warped or the electrodes have become coated or broken, the particle charging process will be "suboptimal". Such occurrences are not at all unusual and are correctable with routine maintenance. Also, large metal hammers can be used to regularly "rap" the tops of the plates to dislodge the collected dust; if the rapping

12/ In the US, this is called a malfunction prevention and abatement plan.

sequence is inappropriate, some re-entrainment of collected dust back into the airstream can occur and manifest itself as diminished ESP performance. Even if the ESP itself is in good working order, the chemistry of the incoming flue gases may preclude top-notch ESP performance. Certain trace metals in fly ash can significantly reduce particle resistivity, resulting in particles which have a hard time retaining an electrical charge, making it difficult to collect in an ESP, although use of high sulfur coal will reduce the problem. These problems can be overcome through fuel switching or use of a flue gas conditioning agent to alter the flue gas chemistry (sulfur trioxide, $SO_3$, and ammonia work well).

6.38 Finally, it is likely that a number of power plants simply have undersized ESPs, possibly due to excessive dust loadings to the control device resulting from the combustion of fuels with excessive ash. In such cases, additional collection fields (i.e., chambers) must be added, either to follow the existing chambers or as taller plates to fit additional plate surface over existing real estate. A cheaper alternative, though, would be to switch coals used at the plant.

6.39 Ukraine is just starting to manufacture ESPs and other sophisticated air pollution control devices; in the past, this industry was centered in other parts of the FSU. *The combination of a large Ukrainian steel industry and system design expertise from outside the FSU might lead to a successful Ukrainian pollution control manufacturing industry.* Ukrainian industry may want to try to leapfrog to baghouse technology which appears to be gaining favor in terms of cost effectiveness in reducing fine particulates (see Box 6.2). Joint ventures might be pursued to establish the industry and the expertise in Ukraine; foreign manufacturing companies may want to invest in projects in Ukraine because of the additional technical experience to be gained with Ukrainian coals and boiler operating practices.

**The Issue of SOx/NOx Control Strategies[13]**

6.40 The issue of $SO_2$/NOx control investments is a difficult and sensitive one. While the costs of particulate control are quite cheap, the technologies to achieve major reductions in $SO_2$ and NOx are generally very expensive (see Table 6.4 for a comparison). *Expenditures on such controls (e.g. flue gas desulfurization) are not likely to be the best way to spend scarce resources, if the impact on local pollution is not high or indeed if other sources have a greater impact on health (e.g. heavy metal emissions from industrial sources).* Yet there is international pressure, as well as domestic, to control $SO_2$ and NOx. In various industrialized countries, $SO_2$ and NOx control at power plants is a major environmental focus, particularly as the most egregious sources of industrial air pollution have been largely addressed. Ukrainian regulatory authorities cannot help but be influenced by the attention given to these technologies in the world community. The costs, however, make it extremely important to analyze priorities and cost effective approaches not only within the electric power sector, but also across sectors.

6.41 This is not to say that there should be no attention to sulfur and NOx control in the power industry. More limited reductions of these pollutants may be achievable through a combination of improved operating procedures, acquisition of better quality fuel, and modest investments. There is already some experimentation with local and foreign technologies, and further opportunities to do some pilot testing on lower cost SOx/NOx removal options would be worthwhile. The recommended emphasis should be on some of the lower cost technologies, where reductions might be in the order of 30-50

13/ Also refer to Chapter IX which discusses European commitments in respect of SOx/NOx reduction.

percent, rather than 90 percent, but the costs are much lower. Regulatory priority, though, should depend on prioritization based on reducing ambient pollution and the most hazardous pollutants first.

6.42 **Sulfur Dioxide ($SO_2$) Control.** Power plant operators on Ukraine consider 2.0 percent sulfur to be "low sulfur". It is not uncommon to hear of 3.0 percent sulfur or higher in coals delivered to power plants. No plant presently has FGD (flue gas desulfurization), but various plants have official plans to invest in this technology when financing becomes available. Several plant directors expressed an interest in reducing $SO_2$ emissions, but they would prefer to do it through various fuel cleaning schemes.

**Table 6.4: TSP, $SO_2$ and NOx Removal Technologies Comparisons of Costs**

| Control Technology | Removal Efficiency | Investment per Ton Removed | O & M Costs/ Ton Removed | Boiler Size (MW) |
|---|---|---|---|---|
| **Particulates** | | | | |
| Multiple Cyclone | 92 percent | $2 | $5 | 250 |
| Venturi (wet) Scrubber | 95 percent (down to 0.5 $\mu$m) | $21 | $139 | 250 |
| ESP | 99.9 percent | $121 | $10 | 250 |
| Pulse - Jet Baghouse | 99.9 percent | $94 | $13 | 250 |
| Reverse - Gas Baghouse | 99.9 percent | $145 | $12 | 250 |
| **Sulfur Dioxide** | | | | |
| Dry Sorbent (duct inject.) | 50 percent | $150 - $400 | $115 - $300 | 300 |
| Flue Gas Desulfurization a/ (2.6 percent S coal) | 98 percent<br>95 percent<br>90 percent | $1500<br>$1640<br>$2200 | $120<br>$130<br>$190 | 300<br>300<br>300 |
| a/ For FGD offering 98 percent removal, a different system is used, and the overall investment cost is much higher; costs per ton removed are therefore not comparable. | | | | |
| **Nitrogen Oxide** | | | | |
| Selective Non-Catalytic Reduction (SNCR) | 50 percent | $750 (coal)<br>$580 (coal)<br>$850 (oil/gas) | $620 (coal)<br>$365 (coal)<br>$650 (oil/gas) | 280<br>500<br>185 |
| Selective Catalytic Reduction (SCR) | 85 percent (coal)<br>50 percent (coal)<br>80 percent (oil) | $1800-3500 (coal)<br>$580 (coal)<br>$2500 - $5000 | $2000 (coal)<br>$140-160 (coal)<br>$3915 (oil/gas) | 200<br>200 |

6.43 As mentioned above, there is tremendous pressure (international and from domestic environmental authorities) as well as professional interest within the industry to invest in $SO_2$ technologies. Clearly, this is an area of the industry in which considerable experimentation with international technologies is likely to go on. *But, given resource constraints, it would be unwise for regulatory authorities to push too strongly for the most advanced technology.*

6.44 As a low cost strategy, MEP should encourage the thermal power industry to blend fuels by adopting short-term sulfur dioxide ($SO_2$) emission reduction goals which are modest enough to be reasonably achieved through fuel blending. If MEP insists on 90 percent reduction of $SO_2$ right away, the power plants would have to import and install high-tech scrubbers at enormous cost. *If, on the other hand, a more modest requirement of 30-50 percent is enacted, individual plants could experiment with coal benefication opportunities (blending and washing) and lower cost sorbent injection technologies.* One example is dry sorbent injection (typically using limestone as the sorbent). Vendors of dry sorbent technology claim up to 50 percent removal, which may improve through further development. While not good enough for new power plants in many industrialized countries, it is used in some older plants which are not required to meet the most stringent standards. Cross-sectorally, at the national level, MEP needs to consider the cost effectiveness of other options for $SO_2$ control, e.g. the benefits of achieving lower sulfur in coal and oil products (see Sections C and D).

6.45 **Nitrogen Oxide (NOx) Control.** All of the boilers visited in Ukraine use wall firing, either front-wall firing or, more commonly, opposed wall firing.[14] For coal combustion, only cyclone furnaces emit more NOx. Consequently, these Ukrainian boilers would be expected to have relatively high emissions of NOx (nitrogen oxides).

6.46 Several of the power plants have already implemented NOx reduction technology in the form of low NOx burners. These special burners employ concentric firing and flue gas recirculation in a package rivaling the latest designs in the US, but the Ukrainian burners seen during the study do not have the capability to vary the burner tilt (up and down) or yaw (side to side) angle into the furnace. Because the Zaporozhskaya Power Plant has been using this technology since the 1970's, additional research and development at this plant would be particularly useful. The Zaporozhskaya station has also had success with the B.O.O.S. (burners out of service) technique to reduce NOx emissions. But they have, so far, only been able to achieve 18-20 percent reductions with special burners and B.O.O.S., while firms in other countries have been able to achieve 30-50 percent reductions with similar technologies. Another approach being demonstrated in Ukraine, under the sponsorship of USEPA and USAID, is the installation of a natural gas three stage combustion (reburn) system as a retrofit on a 300 MW coal-fired boiler to reduce NOx emissions; a 50 percent reduction has been achieved, but at somewhat higher cost.[15]

6.47 More advanced categories of post-combustion NOx reduction technologies applicable to power plant boilers in Ukraine are SCR (selective catalytic reduction) and SNCR (selective non-catalytic reduction), which offer 90 percent and 50-60 percent NOx reduction respectively. Both are very expensive, however (see Table 6.4).

6.48 This study recommends a low cost medium term strategy, focusing on improving domestic low NOx burner technologies over the next five years to address NOx emissions. If ambient monitoring of ozone demonstrates that there are serious local problems with ozone, then Ukraine may wish to expand

---

14/ Utility-scale boilers always have two or more individual burners to carry out fuel combustion in the furnace. "Opposed wall firing" describes the situation in which the burners are located on opposite walls of the furnace, generally at the same elevation.

15/ The capital cost of reburn technology (with the potential for 50-70% NOx reduction) is estimated in the $30-$35/kW range; the cost of low NOx burners is $10-$20/kW.

its efforts to reduce NOx emissions at that time. Therefore, looking ahead, conducting one or two demonstrations of more advanced technologies would provide experience for the longer run.

**Training of Plant Operators and Environmental Authorities Working in the Power Industry**

6.49 If environmental protection is to be a priority, it is essential that each power plant have a good working relationship with MEP. When industry and environmental authorities cooperate, both interests tend to get what they want--prospering industry and protection of the environment. Otherwise, misunderstandings can result in costly arguments and continuing environmental damage. An important part of this effort is to assure good technical training of plant operators and environmental authorities. Some areas of training are suggested below.

6.50 **Visible Emissions Training.** This training introduces air pollution control personnel to the practice of identifying the relative "darkness" of a smokestack plume. With the presumption that visible emissions indicate the level of dust emissions, the darker the plume, the higher the particulate loading to the atmosphere. In the US, for example, most states have a standard for visible emissions from the stacks of new air pollution sources. Some states require new sources to operate with no more than 20 percent opacity from the smokestack.[16] These determinations can be made by a trained observer, and it is perfectly acceptable for certified observers to make compliance judgements for regulatory agencies.

6.51 **Plant Inspections.** Regulatory personnel who perform compliance inspections must know what to look for as well as understand what they are seeing. Thus, a course in plant inspection techniques is strongly recommended, not only for the electric power industry, but for other industries as well.

6.52 **ESP Troubleshooting.** Since ESPs are generally the air pollution control system of choice at Ukrainian power plants, it makes sense to introduce comprehensive training in ESP troubleshooting for thermal power plant personnel. Such a course should cover the chemical and physical properties of Ukrainian coals that affect furnace and ESP performance and maintenance.

6.53 **Fuel Blending Strategies.** It is important for Ukrainian thermal power plant personnel to understand for themselves what the best fuels are for their boilers; training would help in this effort.

## C. Environmental Problems Related to Coal Production and Use

6.54 Coal represents 56 percent of Ukraine's primary energy. "Run of mine" coal production was 165 million tons in 1990 and 136 million tons in 1991 (109 million tons after washing); the decrease in production in 1991 was due to both shortages of equipment and materials and a month-long industry strike.[17] Production in 1992 fell by 3 percent, and again in 1993 the industry has experienced serious

16/ In other words, the plume leaving the plant's stack must attenuate no more than 20 percent of a traversing beam of light.

17/ The peak in coal production of 191 million tons came in 1976.

labor strikes. The coal industry is plagued by very serious problems, within a system which has not changed very much over the past three years. Major problems include:

- production and productivity declines;
- shortages of equipment and materials;
- lack of operating and financial accountability or any commercial orientation; and
- continued subsidization of non-viable mines by those which are viable, through a system of production associations.

Restructuring, institutional reform, and modernization are likely to take 10-20 years. Privatization of the industry is not a realistic option in the near future, until some restructuring is undertaken.

6.55 There are 300 underground coal mines in the country. About 90 percent of coal production comes from the Donbass (which includes Luhansk and Donetsk Oblasts) and 5 percent from Lviv Oblast. Employment in the industry is very high (1.2 million people, representing 5 percent of the labor force), and manpower productivity is well below international standards. About 60 percent of production is supplied by mechanized longwall. Utilization of underground equipment is poor, however, and this has led to low productivity per longwall face exploited. The average output per mine is less than 0.5 million tpa, compared to about 2 million tpa in Western Europe and Poland. While Ukrainian mines are compact and, on average, not as deep as West European mines, their geological conditions are more difficult.[18]

6.56 Considering that much of Western European underground coal mining is unprofitable, even at prevailing high levels of technical and managerial efficiency, Ukraine's more difficult geological conditions illustrate the economic difficulties which its coal is likely to face in the future as input and output prices are adjusted to reflect true costs, and as the industry competes with international suppliers. Concentration of mining in the best geological conditions will be a very important step for industry viability in the future. It may also be appropriate to shift more emphasis to steam coal production, rather than coking coal production, but this will depend on rationalization and downsizing of the domestic steel industry.

6.57 The method of mining in some of the mines is outdated and hazardous, particularly in those mines which are deeper and have very narrow seams. The biggest occupational and environmental problem in coal mining is the very high level of miner deaths--due primarily to roof cave-ins, accidents related to in-mine transportation, and dust and gas explosions. Between 1986 and 1990, MOH reports an average of 197 fatal injuries per year among coal miners in Donetsk Oblast; other reports put the figure at an average of 300 deaths per year. Western visitors to these mines comment on the lack of attention to safety and the problems of broken-down equipment and debris left haphazardly in the mines. *Improved safety procedures should be mandated immediately along with regular inspections and stiff fines for managers who do not implement them.* It will be important to work with the coal miner unions in this regard. There are also an estimated 35,000 cases of either black lung disease or chronic dust bronchitis

18/ The present average depth of mining is about 700 m, but about 15 percent of the mines exceed a depth of 1,000 m. Seam thicknesses in the Donbass are low, 60 percent of typical Western European mines, which makes mining more difficult and more expensive.

among an underground miner population of 300,000 in that area; in fact, such incidences may be underreported.[19]

6.58 Some of the most unsafe mines also may be uneconomic; hence, restructuring of the industry should help to phase out these mines. The process of restructuring will be difficult, though, because of expected opposition to some mine closures from the politically active mining community. Clearly, restructuring efforts will need to go hand in hand with efforts to encourage the growth of other economic activities and employment opportunities in the region.

6.59 Mining has contributed to other serious environmental problems as well: (i) vast areas of perhaps fertile land covered with waste rock and tailings dumps;[20] (ii) surface and ground water pollution from salts; and (iii) waste of large quantities of groundwater from mine dewatering (a continuing necessity as mines go deeper). Unrealistic production goals in the past resulted either in large percentages of waste rock being mined, or in mining only the highest grades, destroying the longer term potential of some mining operations. Some of the (generally non-hazardous) solid waste problems are due to the exploitation of probably uneconomically thin seams and also unsatisfactory beneficiation of coal. Additional work is needed to assess ways to improve the efficiency of coal washing plants by blending input materials to achieve a consistent input that meets the design parameters of the plants. This could reduce the level of coal and high carbon shales in the waste products, lowering the potential for spontaneous combustion of coal wastes.

**Box 6.3: Environmental Problems in Coal Mining**

Coal mining is the principal activity in the southern part of the Luhansk oblast, where there are over 120 coal mines, nine of which (primarily anthracite mines) are in and around the city of Luhansk itself. A visiting expert to one of these mines was taken aback at the hazardous mining methods and poor attention to safety (including debris strewn about the mine). The various coal communities nearby use coal for cooking and heating as well as mining activities, and all of these activities cause local ambient air pollution. Mine waters with total dissolved solids in the order of 3,000 mg per liter are reportedly pumped into the Siverskodonets River at the rate of 300 million $m^3$ per annum.

6.60 Treatment of the mine waters to remove dissolved solids would be prohibitively expensive on the scale that is required. As an alternative, further consideration might be given to disposing of the mine water by groundwater recharge. A detailed hydrological study would be needed to determine the feasibility of such a solution, preventing the pollution of aquifers used for drinking or any exacerbation of the flow of water into working mines.

6.61 **Recovery of Coalbed Methane.** Another opportunity which should be explored in conjunction with a broader review of the coal industry is that of recovery and use of coalbed methane. The coal

---

19/ See MOH data at Annex 3 under Donetsk Oblast.

20/ An example being the unsightly terracones of coal waste dotting the landscape of Donetsk Oblast, some of which are burning internally because of the remaining carbon content in the waste. There are also problems with slope stability and dust generation at some of them. Others have been reshaped and planted.

mines of the Donets basin are very gassy,[21] a danger to miners. But coalbed methane can be an energy resource if recovered properly and investments made to utilize it. The release of methane during mining was estimated by FSU officials at 3.4 billion $m^3$ in 1990 (from 211 mines).[22] About 34 percent, or 1.2 bcm, was captured by methane drainage systems in 99 mines, but only 17 mines utilized the methane exclusively in boilers at the mines (representing about 170 million $m^3$). Methane is a potent greenhouse gas and a fuel in high demand in Ukraine. Therefore, efforts should be made to recover more of it for safety, economic and global environmental reasons. Further assessment is needed to judge: (i) the applicability and economics of several methane recovery techniques which could enhance the quantity and quality of methane and (ii) the appropriate uses, which depend on methane quality. *Clearly, expanded utilization in mining communities would be a first step -- for generation of electricity and use in industrial and heating boilers, displacing the use of coal.* If sufficiently rich (or enriched after recovery), the methane could be fed into a natural gas pipeline.

6.62 **Coal Quality and Coal Use.** Operating and environmental problems are caused by problems with coal quality, which reflect various factors: the lower quality reserves now being exploited; the type of equipment employed; the lack of or insufficient beneficiation or blending practices; and, more generally, poor price signals and the lack of a true coal market or any incentive to meet client needs. As mentioned earlier in this report, users of coal in both the metallurgical and power industries complain about the quality of coking and thermal coal delivered to them (eg. high ash and sulfur). *Rationalization of the coal sector to concentrate on the most economic reserves and to improve product quality would be expected to lead to both efficiency gains in operations as well as reductions in pollution due to coal use. Just as importantly, conditions for a coal market need to be established, as well as the freedom to allow prices to reflect different coal types and quality.*

**Table 6.4: Coal Consumption** (millions of tons)

| | 1990 | 1991 | 1992 |
|---|---|---|---|
| Power Plants | 40.2 | 35.4 | 35.6 |
| Coking and Steel Plants | 52.7 | 40.1 | 33.5 |
| General | 38.9 | 32.2 | 40.2 |
| *Households* | *13.7* | *11.9* | *11.6* |
| *Other* | *25.1* | *20.3* | *28.6* |
| TOTAL | 131.8 | 107.7 | 109.3 |

6.63 There are about 70 coal washing plants in the industry, about 50 percent of which wash coking coal; the remaining 50 percent wash steam coal, primarily by basic mechanical cleaning (e.g. use of simple jigs). If there is a shift away from coking coal, some of the related washing capacity could be reconfigured for greater washing of steam coal, hopefully encouraging delivery of better quality steam coal to the various users--households, industry and power plants. More attention needs to be given to

21/ It is the southern extension of a larger basin where natural gas reserves have been found.

22/ This estimated volume of methane is several times larger than estimated fugitive gas losses from the natural gas transmission and distribution systems (at 768 million $m^3$ and 300 million $m^3$ respectively, or about 0.3 percent of throughput).

**Box 6.4: Background on Coal Washing**

Coal washing improves coal quality by separating ash and other matter from the carbon content of the coal. Coking coal has to be washed to reduce ash in order to produce strong coke used in modern steelmaking. The ash content should be reduced to 6-9 percent, although financial considerations may limit washing to 11-12 percent ash. It is almost impossible to produce bulk raw coal with modern mining methods at such a low ash level; therefore, coking coal is always washed. Thermal coal is washed to meet operating needs (eg. boiler specifications) and, increasingly in various countries, to meet environmental requirements.

Washing also reduces some sulfur in the coal--the pyritic sulfur (small particles of iron pyrite). But, generally, about half of the sulfur in coal is organic, forming one of various chemical compounds making up the coal, and cannot presently be removed by commercial processes. Sulfur reduction through washing therefore depends very much on the content of pyritic sulfur in a particular coal.

There are several different methods of washing with differing degrees of fineness and ash reduction. The common technologies, going from coarse to fine cleaning, are: jigging, dense medium bath, dense medium cyclone, and froth flotation. The first three operate on the principle of separation by specific gravity. Froth flotation involves separation via particle surface chemistry; it is for fine coal cleaning and follows a coarse coal cleaning circuit. Washing coal fines adds about 50 percent to the capital cost of the washing plant and ultimately increases the generating costs of the recipient utility boiler, but it minimizes damaging ultrafine particulate emissions. The design of plants and economics of washing depend on the characteristics of the coal feed. Hence, a specific coal analysis must be done as part of evaluating the economics of a particular washery investment.

Coal washing yields different products, depending on the type of coal. The washing of coking coal results in several products: washed coking coal (about 50-60 percent); "middlings" of about 4,000-4,500 kcal/kg (20 percent), which can be used in power plants; and the remainder, washery waste, which has still lower calorific value and higher ash. Because the requirements for the final product are less stringent, washing of thermal coal produces a higher yield of primary product--generally 80 percent of the yield is thermal coal. The remaining product is washery refuse; middlings are not necessarily produced.

Coal washing can cause pollution problems itself, if investments are not made to recirculate process water and manage process waste properly.

the coal washing industry and the potential for environmental benefits through broader introduction of coal washing and improved techniques and efficiency in the processes themselves. Given the high sulfur content of domestic coal, an important question is the extent of sulfur reduction achievable by washing Ukrainian coals (see Box 6.4 on the process of coal washing itself).

6.64 The issue of coal quality is particularly important for the household sector and other users of coal which have lower stacks and generate more ambient pollution, especially in winter. Despite substantial inroads by natural gas in households, many still use coal, particularly in mining communities; moreover, the fact that household coal is heavily subsidized means it probably is a recipient of very poor quality

coal.[23] Low level smaller industrial sources are also using both coal and high sulfur fuel oil to meet their needs. It is typically more difficult to address environmental problems related to dispersed, low level coal use, but it is clearly a priority in terms of health impact. *The key is to provide better quality coal to these users.*

## D. Environmental Considerations in Oil Refining

6.65 Available refining capacity in the country is about 60 million tpa; utilization fell from 54 million tons in 1991 to 34 million tons for the first 11 months of 1992. The refineries were designed and operated to yield primarily heavy fuel oil; the yield of higher value distillates is only 50 percent, compared to about 75 percent in Western Europe and 85 percent in the US. Total cracking capacity represents only 6 percent of refining capacity, compared to about 25 percent in modern refineries; moreover, about 60 percent of cracking capacity relies on older technology (thermal cracking and coking), rather than more modern catalytic and hydro cracking.

6.66 A brief review of the refinery sector was undertaken during the recent energy sector study conducted by the World Bank in cooperation with Ukrainian authorities. The results of that study indicate that all existing refineries badly need rehabilitation investments: continuing operation of refineries at Lysychansk, Kremenchuk, Kherson, and Nadvirna assumes considerable modernization, while those at Odessa and Drohobych (Lviv Oblast) need almost complete replacement of main processing facilities. The review also concludes that downsizing refinery capacity to about 45 million tpa is likely to be warranted. Moreover, as crude oil costs move towards world market levels, the operation of refineries which produce mainly low value heavy fuel oil will become increasingly uneconomic. The refineries which will survive are those which attract capital to install secondary conversion facilities to reduce fuel oil production and increase production of high value products, such as gasoline and diesel oil. Based on an expected continuing decline in demand for oil products, the two largest refineries (Lysychansk and Kremenchuk) have enough distillation capacity to supply the domestic market. In other words, the longer term viability of the Kherson, Nadvirna, Odessa and Drohobych refineries is in doubt. However, the closure of the Kherson and Nadvirna refineries would significantly increase product distribution costs due to the geographic location of those two refineries. Badly needed modernization investments could be carried out in a way which also reduces capacity.

6.67 Raising oil product prices is critical in sending the right signals to producers and consumers. The Bank's recent energy survey recommends that the liberalization of oil product prices (including the elimination of margin controls on refineries and distributors) should proceed in parallel with the following other steps: (i) corporatizing the refineries; (ii) abolishing the system of state orders; (iii) allowing open access to oil transportation pipelines; (iv) liberalizing export and import of petroleum products; (v) demonopolizing domestic distribution/trade; and (vi) privatizing gas stations. These measures will also make it easier for Ukrainian refineries to form joint ventures in the future.

### Environmental Issues

6.68 Environmental problems are related to both technology and operational issues. The technology employed in the refineries is, in general, outmoded and leads to excessive leakages of oil and gases in the normal course of processing. Excessive burning of gases in the flare also occurs. There are

23/ There was not time during the study, though, to survey the quality of coal going to households.

insufficient facilities and lack of modern technology for removing oil and other pollutants, particularly phenolic compounds, from the refinery wastewater. Disposal of oil-contaminated solid wastes and sludge occurs in open areas without proper containment efforts. Not surprisingly, energy efficiency in these plants is also low--in operation of process heating furnaces, steam generating boilers, electric power generating sets, and heat exchange systems--increasing the overall fuel consumed in refineries. Finally, visits to selected refineries during the Bank energy sector study revealed poor housekeeping and safety procedures.

6.69 Just as in the case of coal, the quality of oil products causes further operating and environmental pressures when they are used. Quality problems result from: (i) insufficient desulfurization facilities for fuel gas (and liquid fuel wherever it is used); (ii) lack of desulfurization facilities for vacuum gas oil, which is the feedstock for cracking units, to reduce sulfur content in diesel oil and fuel oil (potentially to below 0.2 percent and 1.0 percent respectively); (iii) lack of facilities to remove mercaptan sulfur from gasolines, which increases bad odor and ground level pollution in the refineries and along the roads; (iv) use of very low octane gasolines (72 and 76 octane numbers) in cars and trucks which increases the use of hydrocarbons per kilometer of distance travelled; and (v) the still widespread use of leaded gasoline. *Clearly, improved pricing, along with rationalization and modernization of the industry, will be critical steps in addressing a number of these environmental problems.*

6.70 The issue of $SO_2$ emission reductions, discussed earlier in the context of thermal power plants, is pertinent in the refining sector as well.[24] Indeed, given the use of high sulfur oil products in vehicles and small industrial uses, hence a source of ambient air pollution, and the urgent rationalization and modernization of this industry, oil refining may be the industry on which to focus investments for sulfur reduction. A useful exercise for MEP, in conjunction with authorities in the energy sector, would be to consider the cost effectiveness of reducing sulfur emissions in the refining industry, compared with $SO_2$ reductions in the electric power sector (through use of washed coal or post-combustion controls).

6.71 Concerning the problem of leaded gasoline, it was pointed out in Chapter II (para. 2.17) that conversion to unleaded gasoline involves an enormous change in infrastructure and substantial costs--revamping refineries, redesigning engines, and changing the gasoline distribution system. However, as major investments are undertaken in modernizing Ukraine's refineries, it is also the time to develop a plan for the needed infrastructural investments to make the full transition to unleaded gasoline over perhaps the next 10 years. A first step might be to revamp at least one refinery to produce sufficient unleaded gasoline, which could satisfy the requirements of new or foreign cars for unleaded gasoline.

**Crude Oil and Product Handling and Storage at Odessa**

6.72 The Government of Ukraine is planning to invest in both oil storage and oil import facilities at the Odessa port (Yuzhny) to assure an alternate source of petroleum imports vis a vis traditional suppliers in the FSU. Storage capacity of 8 million tons is anticipated. The first phase of planned oil terminal expansion would accommodate 10 million tpa, with a later second phase reaching as much as 40 million tpa. Various ancillary investments will also be needed (eg. modernization of existing oil jetties to receive

24/ The issue is further discussed in Chapter IX in respect of European commitments.

larger tankers and a product pipeline network connecting Odessa and the center of the country).[25] MEP is planning to undertake an environmental impact assessment of the oil storage investment, although this evaluation may need to be broadened to cover other related investments.

6.73 In parallel with the planned investments mentioned above, the municipal authorities of Odessa requested and received support from the national government and Parliament for a broader evaluation of oil pollution problems in Odessa's harbor area (related to both commercial and military harbor operations) and development of a management plan. This is an important step, as oil pollution prevention has been inadequate in the harbor, and the local community, through local NGOs, has expressed concern about existing and possibly future problems if Odessa's role as an oil terminal expands. One of the problems has been the poor facilities for receiving oil contaminated ballast water from tankers and no facilities for cleaning the water. Tankers often discharge their ballast water into the Black Sea before calling at Odessa. In addition, there have been cases of oil tanker spills near the harbor area (most recently in June 1993).[26]

25/ One option for consideration, suggested by the World Bank energy sector review for Ukraine (Report No. 11646-UA), is the conversion of storage tanks and other infrastructure available in the Odessa refinery into an oil import-export terminal by connecting the facilities to the harbor's oil jetties, once they are modernized. The refinery itself has almost reached its useful economic life, although the Government is considering revamping it.

26/ For further information on Odessa, see the relevant section of Annex 3.

# VII. MANAGING THE LEGACY OF CHERNOBYL

A. Outstanding Problems at Unit 4 and in the 30 km Zone
B. The Likely Long-Term Health Impact
C. Resettlement, Agricultural Measures and Food Control
D. Compensation
E. Recommended Actions Outside the 30 km Zone

7.0 Eight years have passed since the accident at the Chernobyl nuclear power station in April 1986, when radioactive dust spread across northern Ukraine and neighboring countries. The accident left a "prohibited" zone extending 30 km in radii around the plant and has caused ongoing fear and distress to millions of people. The legacy of the Chernobyl accident still haunts Ukraine, Belarus and parts of Russia. The high amount of radioactive debris in or near the destroyed unit 4 will remain a hazard for a long time. The priority now is to understand better the reported problems with the enclosure over unit 4 (the "sarcophagus") in order to address any potential hazards as cost effectively as possible. The other part of the legacy is the continuing concern over the health impact of the accident and the continued need to control food quality in areas categorized as contaminated. The Ukrainian Government has established a statutory dose limit which appears overly protective, and it carries an enormous burden in terms of compensation and resettlement costs. Urgently needed are modern epidemiological studies to understand the actual health impact and future health risks more clearly and, with those results in hand, a re-examination of ongoing compensation and mitigation programs. In regard to the latter, some planned decontamination activities appear overly ambitious and have not been subject to any cost-benefit analysis. This chapter discusses these issues.

7.1 To understand the discussion in this chapter, it is useful to have some background information and points of reference. Boxes 7.1, 7.3 and 7.4 describe the different forms of radioactive contamination, what "ionizing radiation" means, and the established health effects of radiation based on controlled epidemiological studies undertaken outside the FSU.

7.2 The Ministry of Ukraine on Affairs of Protection of the Population from the Consequences of the Accident at the Chernobyl Nuclear Power Plant (MinChernobyl) was established in May 1991, taking over from a former all union committee to manage payment of benefits to victims and mitigation activities, including the clean-up of contaminated areas and resettlement of people.[1] MinChernobyl has a small staff in Kiev as well as staff in affected areas, but the scope of its tasks is overwhelming. It funds various institutions involved in follow up activities--remediation and resettlement activities, agricultural research, food and soil monitoring, dose estimates and health impact assessments. Its substantial budget is discussed at para. 7.47. MinChernobyl is currently preparing a national plan, which reviews measures already planned over the 1993-1995 period and proposes measures over the period 1996-2000.

1/ Prior to 1991, the army was in charge of decontamination activities.

**Box 7.1: Types of Radioactive Contamination From the Chernobyl Accident**

**Iodine Contamination.** The most important contaminant in the early stages of the Chernobyl accident was radioactive iodine ($^{131}I$); but this decays rapidly, with a half-life of only 8 days. That is, by day 8, only 50 percent of the initial level of radioactivity is present; by day 16 only 25 percent; by day 24 only 12.5 percent, and so on, until by day 56 less than 1 percent of the initial radioactivity is left. $^{131}I$ was not the only short-lived nuclide released by the burning reactor, but it was one of the most plentiful. It is particularly dangerous because (unless "blocked" by large doses of inert iodine) it is vigorously absorbed by the thyroid gland, especially in children, who have more active thyroids than adults have. To make matters worse, near Chernobyl, the thyroid uptake of iodine was probably greater than it would have been in most other parts of the world, since the soil is abnormally low in natural iodine, and thyroid glands would be more eager than usual to absorb and retain any extra iodine presented to them.

Because of the rapid decay of $^{131}I$ and the other short-lived nuclides -- some of which have half-lives of only a few minutes or less -- initial levels of contamination declined very rapidly. Thus, it has been estimated that, by day 7, dose rates from surface contamination had declined on average to about 60 percent of what they had been on the first day of the accident. At one month, rates had fallen to 18 percent, and by the end of the first year (April 1987) rates were down to approximately 2 percent of the initial level.

**Cesium Contamination.** By the end of the first year, the most significant contaminant was radioactive cesium, especially $^{137}Ce$, a radioactive isotope with a half-life of 30 years and with chemical properties similar to those of potassium. Together with small amounts of the more short-lived $^{134}Cs$ (half-life 4 years), $^{137}Ce$ has accounted for 95 percent of recent contamination levels and will continue to do so for many years. The primary deposition of cesium occurred to the north and west of the reactor for about 60 km, involving Ukraine and Belarus. There was then a lighter degree of contamination for about 150 km, although a large area of heavy fallout occurred to the north of Gomel in Belarus, involving territory of both Belarus and Russia. An area of lighter fallout occurred in Russia some 300 km to the east. There were also some scattered areas of light fallout (1-4 $Ci/km^2$) to the west and south of Chernobyl.

**Other Contaminants.** In addition to cesium, there are other long-lived contaminants that are of concern, but they are present in relatively small quantities compared to cesium. One of these is radioactive strontium, $Sr^{90}$, which has a half-life of 28 years, similar to that of $^{137}Ce$. Another is $^{239}Pu$, a radioactive isotope of the heavy element plutonium; it is mainly found close to and inside the reactor. $^{239}Pu$ has the extremely long half-life of 24,000 years.

## A. Outstanding Problems at Unit 4 and in the 30 km Zone

7.3 The country is faced with the problem of what to do about the "sarcophagus," the concrete structure that covers the reactor at unit 4. The sarcophagus is said to be vulnerable to flooding or collapse. About 180 tons of radioactive material from the reactor core remain inside the building, in three forms: fragments of core; lava that formed during the accident and then cooled to a vitreous form; and radioactive dust particles (an estimated 10 tons of dust). The area is sprayed with water twice a week to suppress dust. Thus, any airborne releases from the enclosure are currently probably very small.[2] Only after a careful independent assessment would it be possible to suggest what the risks are if flooding occurs or the sarcophagus collapses. It may be possible, though, to find relatively low cost solutions to these potential problems, ones which reduce any significant health impact without being overly elaborate and costly. These issues are discussed further below.

2/ The main danger to workers is from dust inhalation with the dominant nuclide being plutonium. Workers stay on site no more than several days at a time.

**Potential for Flooding**

7.4 The nearby Prypyat River drains a very large marshy area, and there is considerable variation in the annual height of the spring floods. Sooner or later there is likely to be an unusually heavy spring flood. When this occurs, water could enter the base of the sarcophagus and dissolve some of the remaining highly radioactive material; this water would then drain off as the flooding subsided.[3] Some observers worry that the flooding would contaminate the Prypyat River, the Dnieper River, and ultimately the Kiev reservoir. There are reasons, though, to suggest that the impact would not be high. If water was to reach the level of the radioactive material left in the sarcophagus, the amount of cesium, strontium, and other soluble elements that would be carried into the Kiev reservoir would be small compared to the very large quantities that were previously deposited into the reservoir directly, as airborne fallout during the first 10 days, or indirectly, as a result of subsequent drainage of contaminated land via numerous streams and rivers. Furthermore, this water-soluble contamination does not stay in the water, but becomes bound to particulate matter. Thus, most of the earlier contamination is now found in the top 2 cm of sediment at the bottom of the rivers and reservoirs. The radioactivity of the water is itself very low (see paras. 7.23-7.24). Box 7.2 describes the precautions being taken at Kiev's water treatment plant.

7.5 After the accident, a thick layer of concrete was poured under the damaged reactor, and various dams and dikes were built to limit runoff from the site to the cooling pond and nearby Prypyat River. Deep vertical concrete walls were also put into the ground around it, with the express purpose of preventing migration of radioactive elements via the groundwater. A 35 meter deep concrete wall (8 km long) was built around the plant down to the impermeable clay layer to prevent flow of radioactive water to the Dnieper River. Thus, the sarcophagus already sits on a protective concrete basin, the edges of which could be raised to form protective dikes. With an adequate pumping system, perhaps it would be possible to ensure that the level of water is kept below the level of the remaining fuel, even at times of severe flooding. This is only one of several plausible solutions which need to be investigated.

**Box 7.2: Precautions at Kiev's Water Treatment Plant**

Following the Chernobyl nuclear power station accident in April 1986, emergency measures were taken to maintain water supplies to Kiev in the event of radioactive contamination of the Dnieper River. A floating intake pumping station was constructed on the Desna River and twin pumping mains laid to the Dnieper water treatment plant so that raw water supplies from the Desna River could be made available if required. This pumping station has been maintained in operational readiness, although to date it has not been necessary to bring it into use. Daily checks are made of the level of radioactivity in the raw water supplies from the Dnieper and Desna Rivers. The gross beta activity in the raw water is of the order of 16 picocuries per liter and beta radiation from $^{90}Sr$ is less than 0.1 picocuries per liter. By comparison with WHO's maximum level for gross beta activity in drinking water of 30 picocuries per liter, the presently recorded levels in the Dnieper raw water are satisfactory. However, the supply authority is concerned in the event of a flood occurring in the region of Chernobyl which could lead to rapid increases in the level of radioactivity. The floating pumping station on the Desna is therefore maintained in a state of readiness.

3/ Rainwater has also accumulated in the enclosure, as there are various holes in it.

**Potential for Collapse**

7.6 Concern exists about the structural integrity of the sarcophagus, which was originally erected under very difficult circumstances. Not only does it currently have many leaks, but it could conceivably collapse and send up a large cloud of dust that would again produce radioactive contamination of surrounding areas. The structure was weakened by a small earthquake in 1991, and some engineers believe that the building may only last another 5 to 10 years. If the structure were to collapse, there is concern that the radioactive dust would be dispersed. This problem needs to be evaluated further, but again there are reasons to believe the health risk could be minimized. The area of additional fallout is unlikely to extend very far or be very heavy. The principal danger would be to workers. After seven years, the level of radioactivity is much lower than it was at the time of the original accident. Moreover, for the short-lived isotopes, such as $^{131}I$, the level is now virtually zero. Most importantly, there may be some simple remedial measures that would significantly reduce the possible dispersion of dust.[4] *Both engineers and radiation health experts need to be engaged in finding an appropriate and cost effective solution.*

**Clean-up of the 30 km Zone**

7.7 Some 500 kg of radioactive material from the reactor core were buried in the vicinity of the reactor, under a 2 meter thick layer of concrete. Also, a large amount of low-level waste and contaminated equipment was hurriedly buried in some 800 sites within the 30 km zone. There is concern that these sites could be sources of groundwater contamination. This needs to be investigated, again with a view to the likely health impact. Another related question is whether it would be possible for the sarcophagus and surrounding 30 km "dead zone" to be cleaned up, and the radioactive materials buried safely in deep repositories, so that the area could return to normal human activity. Without such an attempt at permanent clean-up, the presence of very long-lived nuclides, such as $^{239}Pu$ (half-life of 24,000 years), in the old reactor and in the surrounding 30 km zone would mean that the area will presumably be uninhabitable "forever."[5] Any full clean up of the 30 km zone is so prohibitively expensive, however, that it is not practical, unless it is undertaken by wealthier countries as a form of applied research on remediation methods.[6] *It does not make sense for Ukraine to try to undertake such a costly job on its own, given severe resource constraints at the present time. Careful containment of waste is the most cost effective approach.*

---

4/ For example, a deliberate demolition of the building could be timed to occur during a period of low wind and steady rain, thus keeping the spread of dust to a very small area. Admittedly, this would leave an ugly ruin rather than a tidy sarcophagus, but resources would be saved and health risks minimized.

5/ Almost the entire 30 km prohibited zone has soil levels of $^{239}Pu$ in excess of 0.1 Ci/ $km^2$ (3,700 $Bq/m^2$). It thus poses a major obstacle to any attempt to reclaim the heavily contaminated areas.

6/ Resources might be available from other countries to use the Chernobyl site as a proving ground to help develop remote-controlled technology in measurement techniques, heavy machinery, safe burial, etc., that would be necessary to deal with any future situations where large quantities of highly radioactive materials need to be cleaned up. With coordination through a body such as the International Atomic Energy Agency, a well designed clean-up project could possibly attract international grant funding.

## B. The Likely Long-Term Health Impact

7.8 All living organisms have been exposed to some level of ionizing radiation for millions of years. This normal "background" radiation includes cosmic rays from outer space, which vary in intensity with altitude and latitude, and radiation from naturally occurring radioactive substances (e.g., radon) in rocks, soil, building materials, etc. The dose of radiation normally received by an individual during his or her life can vary widely. *Average world background radiation is 0.2 rem/year; average background radiation in Ukraine is reportedly 0.3 rem/year. The normal world range is 0.1-1.0 rem/year.*

7.9 To assess the relative importance of radiation to health, some appreciation of the normal level of health is useful. Although health data in Ukraine are difficult to interpret because of out-dated methodology, there seems to be little doubt that there is considerable room for improvement, with the normal expectation of life in Ukraine some 5 to 8 years less than in other industrialized countries. This is a very significant difference in life expectancy and would overwhelm the risks from radiation exposure due to Chernobyl, except in the most serious cases of exposure. *This suggests a reconsideration of health priorities.*

**Box 7.3: Definition of Ionizing Radiation**

As cesium and various other radioactive elements decay, they emit penetrating gamma rays which are capable of going right through all the cells in their path and emerging on the other side. However, a proportion of those rays will be absorbed if they strike a molecule inside the body and split the molecule into two ionized fragments--hence the term "ionizing radiation." These ions are "free radicals" and react vigorously with other molecules to form new compounds. If one of those compounds is a carcinogen, then a process will begin that, years later, may become a diagnosable tumor and may eventually cause the death of the patient. An increase in dose increases the probability that cancer will develop. Gamma rays are just one source of "ionizing radiation"; others include alpha and beta rays and neutrons, emitted by different radioactive or nuclear-related sources and having different characteristics.

### Risks of Cancer

7.10 Cancer is the only disease that is known to be increased by exposure to ionizing radiation after the acute phase has passed (see Boxes 7.3 and 7.4). Naturally, there is widespread apprehension among the general population in Ukraine about the increased risk of cancer resulting from radiation. It is true that some people (in particular the liquidators and others working or remaining close to the plant site) were exposed to high whole body doses of radiation of perhaps 50 rem or more. However, the external radiation (not including ingested radionuclides) received by individuals in the 30 km zone who were evacuated quickly has been estimated at a relatively low 3-5 rem. *The eventual overall increase in adult cancer in the local population (those in the 30 km zone who were evacuated quickly) is expected to be undetectable because the likely increase in risk is very small in comparison with the normal background*

*frequency of cancer (about 20 percent of all deaths).* Also, these cancers will generally not show up until about 15-20 years after the accident.[7]

7.11 The possible exception is thyroid cancer in children, resulting from heavy radiation of the thyroid gland (from radioactive iodine) during the first days and weeks after the accident (again see Box 7.1). It is also possible that a small increase in the frequency of leukemia will occur in those children who received whole body doses of radiation in the range of 50 rem.

7.12 A related but little understood problem is that radiation-induced cancers are the same as "ordinary" cancers. With current medical techniques, it is impossible to tell which cancers are due to radiation and which are not. Anyone who is exposed to radiation and then develops cancer will naturally tend to blame the radiation. This raises a very difficult policy question: if there is only a 1 percent increase in the cancer rate as a result of radiation, should every case be compensated, even though 99 percent are unrelated to the radiation? This question has received much study in western countries in recent years, in connection with occupational cancers. There are no easy answers, but it is an issue for which some policy needs to be developed. Indeed, the majority of the population in Ukraine is at greater risk of developing cancer because of smoking, diet and other factors.

**Claims Concerning Other Diseases**

7.13 There is a perception in Ukraine, a deep emotionalism, that a larger percentage of the population has been and continues to be affected seriously by radionuclide exposure. This perception is fed by reports of apparent increases in the frequency of a wide variety of other diseases besides cancer, which are attributed to the effects of Chernobyl *despite overwhelming evidence from previous experience outside the FSU that cancer generally is the only late effect of radiation* (see Box 7.4). Right now virtually any disease is attributed to Chernobyl, and no effort is being made either to prove or disprove these claims in a way that would satisfy standard epidemiological criteria of causality.

7.14 With modern epidemiological methods and a reliable data system, credible information could be obtained quickly and at relatively low cost to prove whether or not other illnesses are linked to the radiation from Chernobyl. This would require the collaboration of external epidemiologists trained in modern epidemiological techniques. They would also need to modernize existing systems for collecting morbidity and mortality data and to train people in utilizing them (see para. 7.16). If other illnesses can be traced to Chernobyl, then their identification could lead to proper management. If not, then the population could be reassured. Prompt and widespread publication of results could provide an invaluable basis for reducing present levels of anxiety, since any excess in rates of death or illness are almost certain to be much lower than people currently imagine and will probably be undetectable.

---

7/ As an example, an average dose of 3 rem is estimated to cause approximately 68 cancers during the lifetime of the 45,000 inhabitants in or near the community of Prypyat; this is in addition to the 20% of all deaths that are normally due to cancer (i.e. 9,000 out of 45,000). This gives a relative risk of 1.01 (or 9,068/9,000), or a 1% increase over the normal cancer rate. Unfortunately, because of the many confounding variables that exist in groups of human beings, epidemiological studies often have difficulty in reliably detecting a "relative risk" much below 2.0, and it requires very special circumstances (large numbers, a clear dose-response effect, etc.) to detect risks as low as even 1.2 or 1.3. Thus, with an anticipated relative risk of only 1.01, the evacuees from Prypyat will probably never show any *detectable* increase in cancer mortality.

**Box 7.4: Past Experience with Radionuclide Contamination**

The health effects of ionizing radiation have been the subject of many large scale studies of both humans and experimental animals. Based on epidemiological studies of (i) patients receiving therapeutic medical radiation, (ii) survivors of the atomic bombs at Hiroshima and Nagasaki, and (iii) health surveillance of nuclear power workers, it has been clear for many years that there are essentially only 2 *measurable* effects of ionizing radiation in humans. First, there are acute effects from large doses--"acute radiation sickness"--with associated vomiting, diarrhoea, loss of hair, suppression of blood forming capacity, and depression of the immune function. These symptoms appear when the equivalent of a whole-body dose of 100-150 rem has been received over a brief time period (minutes or hours). If the dose is as high as 600-800 rem, death is usually inevitable within a few days or weeks.

The second major effect of ionizing radiation is a delayed increase in cancer incidence. For most types of cancer, the interval between exposure and diagnosis is about 15-20 years, but increased rates of leukemia and thyroid cancer may begin to show up within 2-5 years, especially in children. Unlike the acute effects, the *severity* of the cancer illness is not affected by increases in dose. Rather, as mentioned earlier in Box 7.3, an increase in dose leads to an increase in the *probability* that cancer will develop in the exposed individual. Current internationally accepted estimates (UNSCEAR 1988, and ICRP 1990) are that 5 fatal cancers will be induced for every 10,000 "person-rem" (e.g. 10,000 people receiving 1 rem or 1,000 people receiving 10 rem). The normal background frequency of cancer is 20 percent of all deaths.

There have been no observed increases in the rate of any other disease, with two exceptions: (i) a recent report on the survivors of the atomic bombs at Hiroshima and Nagasaki indicates a rise in heart disease and stroke in the last 10-20 years of the 40 year follow-up, and then only in persons who had received a dose of at least 200 rem, i.e. those who had experienced acute radiation sickness; (ii) an increased rate of genetic defects in animal studies, but never observed in a human population. It is estimated that, if it did occur, the frequency would be about one quarter that of excess cancers, i.e. about 1.3/10,000 person-rem. To put this into perspective, it should be noted that the normal "background" level of genetic abnormalities is approximately 7 percent, i.e., 700 per 10,000 births.

7.15 External assessments of the impact on health have come from various groups, described below:

- **League of Red Cross and Red Crescent Societies (January 1990)**

  A team of experts spent one week in the affected areas and concluded: "Among the health problems reported it was felt that many of these, though perceived as radiation effects both by the public and by some doctors, were unrelated to radiation exposure. Little recognition appears to have been given to factors such as improved screening of the population and changed patterns of living and dietary habits. In particular, psychological stress and anxiety, understandable in the current situation, cause physical symptoms and affect health in a variety of ways. We feel

that there is a need for more objective information in order to allay many of the fears of the population."[8]

- **Greenpeace Chernobyl Medical Team (March 1990)**

  This Canadian team consisted of a pediatric psychiatrist, a pediatrician, an internist, and a radiation physicist. They spent 2 weeks in the polyclinics at Korosten and Narodichi some 60 km to the west of Chernobyl, in the "western trace" of the fallout. A total of 141 children were examined, some of whom had no symptomatic complaints but were brought in by anxious parents, while others were suffering from a variety of symptoms, often described as "sick (or tired) child syndrome." In approximately half the cases, a "traditional" physical illness was diagnosed, and there were no cases that appeared to be the result of any of the known effects of ionizing radiation. In those children in whom no physical disorder was diagnosed, the majority were found to have certain common features, including considerable parental distress, and were thought to be suffering from a form of post-traumatic stress disorder.[9]

- **Report of a UNICEF/WHO Collaborative Mission (February 1992)**

  This group found: "Generalized anxiety about health that is fed by a conspicuous absence of public health information. The onerous expense of programs to mitigate the consequences of Chernobyl are diverting badly needed resources from the deteriorating health infrastructure and other broad public health concerns...The government estimates the financial burden of expenses related to Chernobyl at 16-18 percent of the national budget...The psychological ramifications are already making themselves felt in the obsession with sickness, fear of imminent death and fear of perpetuating a tainted destiny."[10]

All of the above reports stressed the predominance of psychological problems and the absence of any evidence of radiation-induced physical disease in the general population.

7.16 **Use of Morbidity and Mortality Data.** Unfortunately there is insufficient awareness generally about the serious problems associated with morbidity and mortality data. Routine morbidity statistics (which can be the most misleading of all) are regularly used to "prove" that a wide variety of diseases are being caused by the radioactive contamination resulting from the Chernobyl accident. The type of form that is supposed to be filled in at the time of every visit to a doctor, hospital, etc., is lengthy and complex, making it unlikely that it is often completed. This is not to say that routinely collected morbidity and mortality data are of no value. On the contrary, even presently available data can be the starting point of useful epidemiological studies, provided the issue of completeness can be dealt with. However, considerable skill and experience is necessary to extract reliable information from such data. To realize its maximum potential, there needs to be a major reorganization of data collection methods and a training program to develop local expertise in related methodologies. Box 7.5 describes studies which

---

8/ Report on the Assessment Mission to the Areas Affected by the Chernobyl Disaster, USSR, by the League of Red Cross and Red Crescent Societies, January 1990.

9/ Source: Communication from Dr. A McTaggart.

10/ "Ukraine - Crisis and Transition: Meeting Human Needs," report of a UNICEF/WHO Collaborative Mission with the participation of UNDP, UNFPA and WFP, February 25-28, 1992.

**Box 7.5: Special Health Studies Related to Chernobyl**

A good example of a study using available morbidity data is seen in a recent report on thyroid cancer from Belarus. The number of childhood thyroid cancers reported to the tumor registry seemed to be rising. A collaborative study involving Belarussian and western scientists carefully checked the completeness of registration and documented the histological characteristics of the tumors. For the district of Gomel, a heavily contaminated area, the annual frequency was as follows:

| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 (6 mo.) |
|---|---|---|---|---|---|---|---|
| Gomel | 1 | 2 | 1 | 2 | 14 | 38 | 13 |

Thus, compared to an average of 1.5 cases per year between 1986 and 1989, the figures for 1990 (14) and 1991 (38) indicated an increase in frequency of approximately 10 and 25 fold respectively. To ensure that these figures were not simply the result of better detection rates, a collaborative effort is now being planned to estimate the dose of radioactive iodine received by the cancer cases, in comparison with a control group of healthy control children. If the effect is truly causal, this should show a typical "dose response gradient" in the probability of developing thyroid cancer. (Reported in *Nature*, Vol. 359, 1992, pp 21-22.)

A second example of using routine data in a selective and imaginative way was reported in a letter to the journal *Lancet* on November 23 1991 by a collaborative group of Ukrainian and British researchers. A careful study was made of the reporting of cancer data to the Ukraine Institute of Oncology between 1981 and 1989. There appeared to be a rise in overall cancer rates in contaminated areas since 1986, but this increase was only seen in persons over age 65. The rate of cancer was similar to those in other countries of Eastern Europe, rather than being about one third lower, as reported in the past. The study concluded that the *apparent* increase in cancer in the elderly was almost certainly due to a more thorough investigation of illness in old people following the Chernobyl accident, and thus an increase in the detection and registration of cancer. The absence of a true increase in cancer is consistent with the fact that there is usually a latent interval of at least 15-20 years before radiation-induced cancers begin to appear.

Another example of how current health effects can be studied efficiently is provided by the International Chernobyl Project (ICP), a study which has become politically unpopular, but was carefully designed and implemented. The health status of people living in contaminated areas was one of the issues the project addressed. The ICP employed a simple but well designed comparison of a random sample of individuals living in contaminated areas, versus an age and sex matched control group living in clean areas. In spite of relatively small numbers (about 4,000 in each group), it demonstrated at that point in time (1990) that the health of both children and adults was essentially the same whatever area they were living in. Further, it showed that while the health of adults--irrespective of radiation--was significantly lower than in most western countries, child development was similar to that in the west. *This type of study could easily be replicated by local researchers if trained in modern epidemiology.* Unfortunately, there have not been any repeat studies. (Please note: the study was not designed to predict any future thyroid cancer development in children who experienced high doses of radiation.)

have effectively used and cross checked local data.

7.17 **Psychological Stress**. Local authorities are well aware of the psychological problems that exist to a greater or lesser extent in a substantial proportion of the general population. Various officials acknowledged that the anxiety was based on fear of present or future radiation-induced physical illness in themselves, their family, or their friends. As in most countries, the general level of understanding of the health effects of radiation is poor, among health professionals as well as the general public. Coupled with an understandable fear of a toxic agent that is invisible, and where the effects include probably the most dreaded of all diseases, cancer, it is small wonder that rational debate becomes very difficult, and blind fear takes over. Add to this a poorly defined picture of the true frequency of many physical diseases, and the result is to perpetuate serious emotional distress in many people, including children.

**Ongoing Exposures and Related Risk**

7.18 For those people still living in areas categorized as contaminated,[11] what they may not be aware of is that the levels of cesium have gradually declined since the accident and are predicted to do so for some time. Some 10 years after the accident (1996), the external dose in any given area is expected to be almost half what it was in 1990. There are several reasons for the more rapid early decline despite the half-life of 30 years of $^{137}Ce$. First, cesium is initially in the top centimeter of soil, and much of it is gradually carried to deeper levels by rain and melting snow. Some of it will be dispersed through uptake by plants and trees. At increasing depth, more of the radiation is absorbed by the soil above it, providing more shielding. By 2006, after the first 20 years, what cesium is left is likely to be tightly bound to particles of soil, so no further movement will take place. The rate of decline in external radiation is then expected to slow down, and it will then approximate the 30 year half-life model.

7.19 The *external* dose received by an individual living in a contaminated location is greatly influenced by his or her pattern of daily activity. Thus, an individual who works outdoors in areas of untreated soil will receive a higher dose during working hours than someone who is working on land that has been deep-plowed to bury the cesium; the difference would be even greater for someone who worked inside a factory or other building, where radiation levels are typically lower. Similarly, the dose received during sleep is likely to be small because of the shielding provided by the structure of the house, especially if built of brick or concrete. Seasonal changes also affect external doses.

7.20 *The greater danger is the internal dose*. Internal doses can be reduced by adequate food control and careful practices by individuals. In many cases a high level of internal radiation is due to the type of subsistence farming that provides the major source of food for many rural families. One of the worst problems is the family cow, left to graze on wasteland or in the woods, where no remedial action has been--or probably can be--undertaken to reduce the level of contamination. Consequently, the milk and meat from these animals is much more contaminated than that from the collective farms, *where appropriate control measures have been applied, such as deep plowing, use of high potassium fertilizer, etc.* Another problem is the desire to supplement a monotonous diet with wild berries and mushrooms--again, found in wooded or other untreated land and high in radioactive Cesium.

11/ See Table 7.5 for figures. There are about 2,200 populated settlements in the zones categorized as contaminated (see Table 7.2 for definition of zones).

7.21 Roughly 50 percent of the land area which is contaminated is covered by forests. The highest individual radiation doses may be received by people living or working in forested areas or consuming contaminated forest products as a significant part of their diet.

7.22 In even the worst of the currently contaminated but inhabited areas, the projected excess radiation over a 70 year lifetime should be little more than twice the average worldwide level from normal background radiation. With adequate supplies of clean food, this level of excess radiation could be more than halved.[12]

**Other Health Related Issues**

7.23 **$^{90}$Sr in Water Supplies**. There is concern that the ratio of $^{90}$Sr to $^{137}$Ce is increasing in the water supply of Kiev and other communities. Upon investigation during this study, it was found that this change in ratio has indeed occurred, not due to a rise in the level of $^{90}$Sr but to a decrease in the level of $^{137}$Ce. The relevant figures from the Scientific Center for Hygiene are shown below in Table 7.15. The highest concentration of $^{137}$Ce occurred in 1987-88, when it was just over 1 Bq/liter. By 1990-91, it had fallen to about 0.1 Bq/liter. Over the same period of time, the level of $^{90}$Sr has been relatively constant, around 0.2 Bq/liter, so the *ratio* of $^{90}$Sr to $^{137}$Ce has indeed risen in the last few years, from about 1/10 to 2/1. Therefore, there is no reason that this should be a cause for concern.

**Table 7.1: Radionuclide content in Kiev drinking water in Bq/liter**

| Year | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| **Cesium 137**<br>WHO MAC 50 Bq/l | 0.4 | 1.1 | 1.2 | 0.40 | 0.1 | 0.1 |
| **Strontium 90**<br>WHO MAC 10 Bq/l | 0.2 | 0.1 | 0.1 | 0.3 | 0.2 | 0.2 |

Source: Scientific Center for Hygiene

7.24 Contrary to some claims, there is no evidence that $^{90}$Sr in the water supply poses any significant threat to human health. The figures cited above are very low compared to the standard international "maximum acceptable concentrations" (MAC) for water quality. These MACs are not levels designed to deal with nuclear disasters, but are part of the standard package of regulations used in most western countries to ensure that drinking water meets certain physical and chemical standards. The MACs for radioactive substances were developed by the International Commission on Radiological Protection (ICRP).[13] The average human intake of water is approximately 2 liters per day, so that the contribution

12/ Using the currently accepted figure of 5 fatal cancers per 10,000 person-rem (UNSCEAR, 1988, and ICRP 1990), it can be calculated that the average loss of life expectancy would be 70 days for a person born in 1990 into an environment with a contamination level of 40 Ci/km$^2$ of $^{137}$Ce. For lower levels of contamination, the average loss of life expectancy would be proportionately lower. These figures are small when compared to a "background" life expectancy in Ukraine that is 5-8 years below that of Canada and other industrialized nations.

13/ See ICRP Publication No. 30

of water-borne nuclides is trivial (at around 0.3 Bq/day) compared to that from food, which contributes up to 200-300 Bq/day at an "acceptably clean" dietary level in Ukraine.

7.25 **Dangers Associated With Plutonium Dust**. Scientists at the Institute of Radiation Medicine have pointed out that inhalation of plutonium or other radionuclides is of concern among agricultural workers cultivating land in some contaminated areas (e.g. near hot spots of heavy contamination), especially in dry and dusty weather. Various measures are taken, though, to help control this problem. Some people have also expressed concern about the persistence of small traces of $^{239}Pu$ in the air in many essentially uncontaminated areas, such as Kiev, where with modern radiation detectors it can be measured in extremely small quantities. A figure of approximately 0.0004 Bq/m$^3$ was cited as the average of recent measurements in the air of Kiev.[14] These traces, though, would probably not represent a significant health risk compared to the risks normally encountered from background radiation.

7.26 It is also worth noting that there is a widespread *natural occurrence of radon* in Ukraine because there is a broad band of uranium-rich rocks running in a NW/SE direction across the country.[15] Radon is a major source of background radiation in Ukraine and throughout the world. According to figures supplied by scientists at the Institute for Radiation Medicine, average measurements of radon nationwide are in the range of 50-80 Bq/m$^3$, but readings as high as 1000 Bq/m$^3$ have been found in some locations. To put these figures in perspective, the "safe" level in homes in the US is currently regarded as 150 Bq/m$^3$. It would be very useful to assess radon levels throughout the country more thoroughly and then to inform the public. This would provide a better perspective on the risks associated with Chernobyl versus other sources.

## C. Resettlement, Agricultural Measures and Food Control[16]

### Criteria for Contamination Limits

7.27 In 1991, the Ukrainian parliament set a statutory dose limit for the population of 1 millisievert (mSv) per year above the normal background radiation (which translates to 0.3-0.4 rem/year altogether).[17] Prior to that time, the statutory dose limit of the FSU had been 5 mSv per year (over a 70 year life, or a total lifetime exposure of 350 mSv). The FSU limit was considered too strict at

14/ No information was given about the time integrated activity in the air (Bq seconds/m$^3$ of exposure) which would be needed to calculate the dose to the lungs.

15/ Both radon and plutonium deposit alpha-emitters in the lungs, thus increasing the risk of lung cancer. In addition, soluble forms of plutonium may enter the blood via the lungs and gastrointestinal tract and become lodged in various tissues, including bone and liver.

16/ This section has benefited from information in the draft report entitled "Chernobyl Clean-up Strategy: Post Chernobyl Remediation in Ukraine" by a consortium including AEA Technology, Design Group Partnership and Currie & Brown for the UK Foreign and Commonwealth Joint Assistance Unit, 1993.

17/ This was done under Statute 200, entitled "The Status and Social Welfare Rights of Citizens Who Suffered from the Consequences of the Chernobyl Disaster," dated April 1991.

the time by international authorities[18] for management of a post-accident area, in contrast to precautionary limits which would be set for planning future operations. The reason for less strict limits in addressing a post-accident situation is the importance of using available resources on those measures which are most effective and avoiding measures which could do more harm than good at that point. The existing Ukrainian limit is even stricter than that of the former FSU and raises questions about its practicality and its actual effectiveness in protecting health. The dose limit and policies of relocation and compensation were set in an emotionally charged atmosphere and were probably considered politically necessary at the time.

7.28 To understand the strictness of the Ukrainian dose limit, it is useful to compare it with typical doses in another country. In the United Kingdom (UK), for instance, the average annual radiation dose to the population is 2.5 mSv, two and a half times the statutory limit set in Ukraine. About 15 percent comes from medical exposures and the remainder from natural sources (about 48 percent comes from naturally occurring radon and its daughter products). In one part of the UK (Cornwall), the average annual dose is 7.8 mSv, 81 percent coming from radon.[19]

7.29 The actual dose received in a given area of Ukraine is complex to estimate because it depends on both external exposure (including background radiation) and internal exposure (the extent of radionuclide intake through food). The latter can be controlled and depends on food control procedures and practices of individuals. As a result, in determining contamination areas and resettlement policies, secondary criteria--soil contamination levels--have been used; they are set out in Table 7.2. In those areas where there is an unusually high rate of transfer of radioactivity between soil and plants or crops, due to soil type (e.g. peaty soils encourage uptake of cesium), a lower limit of soil contamination is employed.

7.30 To understand the conservatism in the lowest soil contamination category, it is worthwhile to note that contamination at 1 Ci/km$^2$ corresponds to a predicted lifetime dose of less than 5 percent more than the normal average background radiation level, or living at 3,000 feet rather than sea level, thus increasing exposure to cosmic radiation.

**Resettlement Activity**

7.31 Based on the resettlement criteria, 370,000 people reportedly qualified for mandatory resettlement.[20] Another 350,000 qualified for voluntary resettlement paid for by the state. In practice, it appears that there has been considerable flexibility used in the application of these guidelines, with "compulsory" being interpreted more as persuasion than force, particularly where families do not include children. It is anticipated that those who wish to relocate will have done so by the end of 1993. It is well recognized that there is often a substantial social and psychological cost to families who move to unfamiliar areas, and some families have returned to their old homes. On

---

18/ For example, members of the International Chernobyl Project, 1990, the most thorough study of the post-accident response measures and health impact, undertaken by several teams of world experts led by IAEA.

19/ Cited in the report entitled "Chernobyl Clean-up Strategy: Post Chernobyl Remediation in Ukraine", by AEA Technology et al for the Foreign and Commonwealth Joint Assistance Unit, UK Government, 1993.

20/ In addition to those who were evacuated in 1986 after the accident. Please note, though, that the study team received differing information on the exact number relocated to date.

the other hand, the opportunity for government-supported relocation has been welcomed by others, quite apart from any hazard from Chernobyl (better opportunities for education and employment). The ability to receive government-assisted relocation has helped to reduce the level of anxiety and stress in contaminated areas, even though some of the families have chosen to move back. Thus, whether or not much of the relocation program could really be justified on a strictly cost-benefit basis, it does at least appear to have worked in the sense of lowering the level of fear and frustration that had been present in the affected areas.

**Table 7.2: Criteria for Contamination Zones and Resettlement Action**

| Contamination Zones | Soil Contamination Limits | Dosage Limits | Type of Action |
|---|---|---|---|
| 1. 30 km Zone | -- | -- | Prohibited Except for Plant Operators[a] |
| 2. Unconditional Resettlement | $\geq$ 15 curie (Ci)/km$^2$ $^{137}$Ce<br>$\geq$ 3 Ci/km$^2$ $^{90}$Sr<br>$\geq$ 1.0 Ci/km$^2$ $^{239}$Pu | > 0.5 rem/year | Mandatory resettlement |
| 3. Voluntary Resettlement | 5-15 Ci/km$^2$ $^{137}$Ce<br>0.15-3.0 Ci/km$^2$ $^{90}$Sr<br>0.01-0.1 Ci/km$^2$ $^{239}$Pu | 0.01 - 0.5 rem/year | Voluntary resettlement with support |
| 4. Radio-ecological Monitoring | 1-5 Ci/km$^2$ $^{137}$Ce<br>0.02-0.15 Ci/km$^2$ $^{90}$Sr<br>0.05-0.01 Ci/km$^2$ $^{239}$Pu | | Strict monitoring |

a/ The exposure limit for workers is 4 rems/year, close to international standards.

Source: Minchernobyl

7.32 Authorities still talk about further relocation of people from contaminated areas. If this is being driven by unnecessarily strict standards (e.g. the dose limit of 1 mSv per year), then such an effort would not be considered cost effective by international standards, given that there are significant human costs in relocating people away from their existing homes. *In view of the severe budget constraints of the government, it is essential to take only those measures which will truly reduce serious health risks.*

**Contamination of Agricultural Land**

7.33 Contamination of agricultural land is reported at two levels: (a) areas with levels greater than 1 Ci/km$^2$ $^{137}$Ce and (b) more seriously contaminated areas (more than 15 Ci/km$^2$ or > 5 Ci/km$^2$ for peaty soils which encourage uptake of cesium). Areas contaminated above 15 Ci/km$^2$ are relatively small and mostly within the 30 km exclusion zone, although contamination is spotty and variable.[21]

21/ According to Soviet data given to UNESCO in July 1990, the area of Ukraine contaminated at a level >40Ci/km$^2$ was 640 km$^2$, and in the range of 15-40 Ci/km$^2$ was 820 km$^2$.

Thus, islands of heavy contamination can be found in areas otherwise considered less seriously contaminated; these areas are reportedly cordoned off.[22]

7.34 An estimated 80,000 ha of land in category (b) have been withdrawn from agricultural use because of high soil-to-plant transfer factors. There has been no effort to clean up the forest areas outside the 30 km zone; unfortunately, some people still harvest forest products informally, though the practice is prohibited.

7.35 Various land and farm management techniques have been used to reduce uptake of cesium and strontium by crops or trees. Agricultural and pasture lands have been plowed, in some cases deep plowed (to about 20 cm) to reduce external radiation and uptake of some crops. Potassium and lime have been applied to soils low in natural potassium and calcium. The extent of such measures is reported as follows: extra liming of the soil--423,000 ha treated over the period 1986-1991; extra applications of potassium and phosphate fertilizers--735,000 ha treated during 1986-91. There has also been a program to convert some arable land to meadows (270,000 ha over the period 1986-91) and to change some of the crops and trees produced.[23] The Institute for Agricultural Radiology reports that good crop and animal management can potentially reduce food-borne radiation to 10-20 percent. The Institute claims that changing to non-traditional crops could help to bring much of the contaminated land back into production, but so far not all such ideas are being put into practice.

**Table 7.3: Estimated Contaminated Agricultural Land[a]**

| Land Type | Areas > 1 Ci/km$^2$ $^{137}$Ce | 5-15 Ci/km$^2$ $^{137}$Ce [b] |
|---|---|---|
| Arable Land | 3.1 million ha | 133,000 ha |
| Meadows | 0.8 million ha | NA |
| Forests | 1.5 million ha | 140,000 ha |
| Total | 5.4 million ha | 273,000 ha |

a/ MinChernobyl's national plan quotes a larger number : 4.6 million ha of agricultural land and 2.8 million ha of woodland. But these figures include areas contaminated to between O.1 and 15 Ci/km$^2$.
b/ Another figure calculated by the Ministry of Agriculture puts the areas contaminated between 5-15 Ci/km$^2$ at 325,000 ha.

7.36 In the seven years since the accident, levels of external radioactivity in inhabited areas have declined significantly (see para. 7.18) as the cesium has migrated deeper in the soil (especially in areas which have been plowed). Because the radionuclides are in the soil, the danger is primarily from intake through food.

22/ In Polesskoe, for instance, the contamination initially ranged from 15 Ci/km$^2$ to 60 Ci/km$^2$.

23/ For example, reportedly tree fruit picks up very little cesium compared to other crops such as potatoes.

**Food Control Procedures**

7.37 Various measures are taken to reduce internal doses, and maximum permissible doses have been established for foodstuffs, outlined in Table 7.4. Food is brought into some contaminated areas. Children in such areas are provided with three meals a day at school, or are given the raw materials to take home. Animal husbandry and food processing techniques have been changed to reduce contamination. Commercially produced food is subject to strict monitoring; hence, people living in urban areas are said to receive food that is "clean" by local and international standards. The Ministry of Agriculture has set up a system for monitoring all foods within the contaminated zone; various groups conduct monitoring and control activities through a network of over 2000 laboratories and measuring stations. With such a large network, though, it may be difficult to maintain quality control.

7.38 Changes in animal husbandry have also been important. Cesium in the body of an animal is lost very rapidly; therefore, animals can be fed uncontaminated fodder during the final stages of fattening to reduce the body burden of radiocesium. Cesium binders such as "Prussian blue" are used to reduce the contamination of milk and meat. At the Institute for Agricultural Radiology, a technique has been developed for measuring the internal radiation levels in cattle, so that slaughter of the animal can be postponed until it is clear that the meat will be at an acceptably low level. The Institute is also trying to encourage the use of various other techniques to reduce contamination, such as the use of ferrocyanide "boli" [24] in cattle to reduce the absorption of cesium.

**Table 7.4: Criteria for Food Control**

| Food Product | Dosage Limit[a] for $^{137}Ce$ and $^{90}Sr$ |
|---|---|
| Milk (for adults) | 370 Bq/liter [b] |
| Milk (for children) | 185 Bq/liter |
| Meat | 740 Bq/kg |
| Vegetables | 600 Bq/kg |
| Baby foods | 185 Bq/kg |

**Note:** Limits have been set by the National Commission of Radiation Protection.

a/ Milk, meat and potatoes reportedly make the largest contributions to internal dose. These dosage limits in a composite diet would be equivalent to 0.6 rems/year.

b/ The same limit is used in the EC.

7.39 Food quality control is reportedly exercised on state farms in areas at lower levels of contamination, but problems exist on private farms where countermeasures have been less extensively adopted. Scientists complain that traditions die hard, particularly among the "private" subsistence farmers. Also, increasing food shortages in the short term may force some people to seek unregulated sources in rural areas.

24/ Two very hard, cigar-shaped slugs that are inserted in the cow's stomach, and they slowly release the chemical by grinding against each other.

7.40 It is important to have good quality control assurances--on state farms and in monitoring food products generally from the contaminated areas. Existing measures should probably be supplemented by regular checks of control procedures. They might be supplemented further by external reviews periodically.

**Measurements of Contamination**

7.41 A number of agencies undertake human dose estimates and measurements of soil contamination. They include: the Ukrainian Institute for Agricultural Radiology, the Institute of Radiation Medicine, and the Institute of Radiology and Biotechnology of the Academy of Sciences. These various agencies operate independently of each other, and unfortunately there appears to be no framework nor a comprehensive database to provide an ongoing, consistent picture of contamination which would be helpful in providing a scientific basis for the decisionmaking of policymakers.

7.42 Some foreign researchers have also found discrepancies in contamination data and estimates, with Ukrainian measurements sometimes tending to be higher than measurements by others. A recent externally sponsored study on contamination levels and dose reduction options expresses concern over the accuracy and quality assurance of contamination measurements and human dose estimates in areas categorized as contaminated.[25] The abovementioned study notes that there is an overreliance on models to estimate human doses, and those models tend to overestimate dose levels.[26] More realistic models are available and can be applied, but most importantly they need to be validated by actual measurements--whole body (or "in vivo") monitoring and use of thermoluminescent dosimeters (TLD).[27] *Taking actual measurements (in areas considered contaminated and perhaps also for some spot checking in Kiev) would provide useful information to policymakers in planning further mitigation measures and to the public about actual doses received by affected communities.*

**Planned Decontamination Activities[28]**

7.43 One Ukrainian company, NTI's KORO, is licensed to manage decontamination and remediation activities in the contaminated zones outside of the 30 km zone, and it is pursuing some activities already. It is mandated to undertake ambitious plans for decontamination and soil clean up, to achieve the statutory dose limit, but those plans have not been subject to any cost-benefit analyses or comparisons of options considering costs and effective dose reductions. There is considerable interest in costly high technology solutions for clean up of "contaminated" areas, such as: removal of surface soil; soil treatment technologies; biological decontamination of soil; and removal of forest litter and debris. Again, there has been no assessment of their cost effectiveness or practicality. For instance, measures such as soil

---

25/ See the report entitled "Chernobyl Clean Up Strategy: Post-Chernobyl Remediation in Ukraine" by AEA Technology, Design Group Partnership, and Currie & Brown for the UK Foreign and Commonwealth Joint Assistance Unit, 1993.

26/ Models for estimating doses developed in the FSU tend to lump together many factors (dietary, crop uptake etc.) into composite proportionality factors relating dose to soil surface or consumption of a few staple foods. Such models generally overestimate radiation doses and are of limited value in estimating the benefit of specific countermeasures.

27/ The 1990 International Chernobyl Project (ICP) estimated internal doses based on environmental transfer models and whole body monitoring.

28/ This section draws on the study cited at footnote 152.

removal require large moving equipment for transport of the wastes and effective disposal and management of the wastes elsewhere in the country; such efforts are likely to be costly. There is also no system of nuclear waste categorization which would provide guidance on the relative dangers of particular wastes, which would in turn determine the type of disposal necessary and associated costs. There are wide differences in costs of disposal.

7.44 In view of Ukraine's severe budget constraints, *this study suggests re-examining relatively inexpensive countermeasures which are already being taken -- for example that more attention go to expanding and enhancing the effectiveness of agricultural methods and food control measures.* It is also important to review and even reconfirm monitoring data, perhaps with external assistance, to have as a starting point a good assessment of actual expected doses (external and internal) in affected communities. This would provide guidance on what measures are most effective--for example, decontamination of soil vs. greater emphasis on food control. This study also recommends focusing on containment of "hot spots", areas of high contamination, wherever possible, rather than trying to proceed with a broader and more costly clean up program involving soil removal and advanced technologies.

## D. Compensation

7.45 Ukraine's Parliament passed a law in April 1991, subsequently amended in December 1991, that authorized benefits for about 3.2 million people in some way affected by Chernobyl. The benefits range from pensions and free medical care for principal victims to double wages for those who worked in certain contaminated areas. The total benefits package was expected to cost Rb 45 billion in early 1992, broken down as follows:

**Table 7.5: Chernobyl Compensation**

| Category | | Original 1992 Budget (Rb billions) | No. of People |
|---|---|---|---|
| Category 1 | Those disabled completely or partially, and those suffering from radiation exposure or diseases caused by Chernobyl. | 0.42 | 15,200 |
| Category 2 | Those who lived or worked in the 30 km zone in 1986-87, who suffered and were evacuated. | 5.42 | 323,000 |
| Category 3 (a) | Those who lived or worked in 30 km zone in 1988-89 and who suffered some effects. | 0.77 | 111,616 |
| (b) | Those who live in contaminated areas ranging from 5-35 Ci/km$^2$ $^{137}$Ce. The benefits are based on the level of contamination. | 11.2 | 617,582 |
| Category 4 | Those who live in the zone of radio-ecological monitoring (1-5 Ci/km$^2$ cesium). | 17.2 | 1,294,000 |
| Affected Children--Children affected or living in the area of the accident, or born of victims. | | 9.7 | 662,600 |

7.46 Category 1 provides compensation to direct victims and also to people who can prove they have illnesses judged to be due to the accident. These pensions are awarded for life, and there appears to be significant potential for future growth in this category.[29] The reason for awarding benefits in categories 2-4 is mainly to compensate for loss of quality of life and for *possible* future ill health. Regular payments are also made to people who have resettled, or who live in areas designated as contaminated. The compensation also encourages adults to buy clean food at stores (rather than rely on home produce), if they are living in areas where soil contamination leads to food being above acceptable limits. The largest aggregate expenditures in the compensation package are for category 4, where the range of radiation levels are not much higher than background radiation levels normally found in high altitude cities throughout the world.

7.47 To pay for the legislated benefits, Parliament set a 3 percent tax on salaries (with various exemptions) in late 1991. In January 1992, the tax was raised to 19 percent, then reduced in April to 12 percent. The final budget for MinChernobyl in 1992 was 300 billion karbonvanets (krb), representing about 12 percent of the national budget. The overwhelming share went to compensation and resettlement. Allocations were as follows:

| | |
|---|---|
| Compensation | 50% |
| Resettlement | 20% |
| Health Care | 9.5% |
| Shelter & 30 km zone | 6% |
| Agricultural & Forestry Measures | 6% |
| Research & Education | 7% |
| Decontamination | 1.5% |

7.48 The budgetary burden attributable to Chernobyl is large and raises questions of affordability in view of the current economic situation. *While politically difficult, there needs to be a fundamental rethinking of the compensation program and the cost effectiveness of future mitigation activities.* A serious part of the problem is that benefits have not been bestowed according to health criteria or risk assessments. Obviously, those who are disabled from work as a result of injuries received at the time of the accident or during the clean up immediately thereafter deserve substantial support. Those who have had to be evacuated or relocated deserve temporary help to get back on their feet in their new location, but *permanent* pensions simply reinforce the dependency role and discourage attempts to get back to a reasonably normal life.

7.49 Another difficult issue is that benefits under Category 1 could increase over time as more claims of health impacts from Chernobyl are made; no policies or criteria have been established for treating these claims based on modern epidemiological methods and risk assessment analyses. For example, will every case of lung cancer automatically be given a full medical pension, even though 99 percent are unrelated

29/ Numbers and costs for this category could increase rapidly, because of further claims of diseases caused by the Chernobyl accident. Claims under this heading are decided initially by one of 11 local boards of "medical experts," with the right of appeal to a central board if the local board rejects the claim. The criteria used to decide which diseases are eligible are unclear. Reportedly, cancer is considered eligible, plus any disease that might be linked to stress (e.g. heart disease, high blood pressure) or reduced immunity (e.g. infection). Given the normal frequency of such diseases, the number of such claims could reach epidemic proportions.

to Chernobyl? Unless some policies are developed soon, precedents will be set that will lead to endless appeals and general dissatisfaction.

## E. Recommended Follow Up Actions Outside the 30 Km Zone

7.50 The following actions are recommended as part of a re-examination of ongoing compensation and mitigation programs in order to assure their cost effectiveness:

- **Reassessment of the Statutory Dose Limit** -- Reconsideration of this limit is recommended in order to design a cost effective and affordable mitigation program for the future. The epidemiological and contamination studies mentioned below should help provide the basis for this recommended reassessment.

- **Introduction of Modern Epidemiological Studies and Techniques** -- Collaboration is strongly recommended between the Ukrainian and foreign health experts in conducting controlled health studies, using modern epidemiological methods (e.g. standardization of morbidity and mortality data) and the risk assessment techniques, to evaluate data from Ukrainian studies in order to establish more clearly what the health impacts from Chernobyl are and what are the ongoing health risks.

- **Quality Assurance of Ongoing Contamination Measurements and Human Dose Assessments** -- After consolidation of existing data, it may be useful in selected areas to confirm current levels of surface contamination, improve estimates of internal doses, and thus assess better the overall expected human dosage of people living in areas categorized as contaminated. These studies should be conducted using modern monitoring equipment and selectively employing whole body monitoring, and body dosimeters (TLDs). An experienced radiation epidemiologist should review the results of these studies to establish the likely health risks.

- **Improved Information Management** -- Badly needed is an effort to consolidate existing monitoring and health data into a consistent and comprehensive database, so that all information concerning Chernobyl effects is readily accessible.

- **Improved Public Awareness Campaigns** -- The public needs greater information about background radiation, radon levels in the country, and health risks from radiation exposure established in studies worldwide.

- **Re-examination of Health Risk Basis for Compensation** -- With information from the epidemiological and contamination/dose studies, it should be possible to re-examine the existing compensation program to make it more cost effective and affordable.

- **Quality Assurance in Food Control Procedures** -- It is important to have good quality control assurances on state farms and in monitoring food products generally from the contaminated areas. Existing measures should be supplemented by regular checks of control procedures. They could be supplemented further by external reviews periodically.

- **Development of a Cost Effective Waste Management Strategy** -- Greater attention to prioritization of the current decontamination program is recommended, considering cost

effectiveness of dose reduction. Such an effort will be improved by securing better data on current external and internal contamination and expected human doses. Recommended first is a policy of improving existing low cost measures to reduce crop uptake and internal exposures. Low cost containment measures to restrict and contain particularly hazardous areas should also be examined. Also needed is a program to classify hazardous nuclear wastes using international standards as a first step in distinguishing how to contain or dispose of wastes of varying danger. *Caution is recommended in seeking high technology solutions to waste management, as these may not be the most cost effective way to reduce exposures; any such investments should be subject to careful cost-benefit analyses.*

# VIII. CONSERVING RENEWABLE RESOURCES AND PROTECTING BIOLOGICAL DIVERSITY

A. Agriculture
B. Forestry
C. The Protected Area Network
D. Game Management

8.0 This chapter highlights environmental and natural resource management issues related to agriculture and forestry. It also links these activities with the needs of the "protected area network" and wildlife management. All these activities are interrelated from the point of view of conservation of Ukraine's natural heritage. Agriculture covers some 33.4 million ha, forestry about 10 million ha, and the protected area network less than 1 million ha (or 2.1 percent of the land area of the country). Indeed, the protected area system really only captures remnants or islands of important ecosystems. It cannot by itself maintain the range and extent of habitats required for the continuation of free-living populations of flora and fauna. Relatively minor alterations to current practice and management in forestry and agricultural sectors, incorporating multiple use and sustainable management approaches, offer opportunities for significant biodiversity protection.

## A. Agriculture

**Background on Agriculture**

8.1 Ukraine has some of the best arable land in Europe and was formerly a major supplier of agricultural products within the FSU. Extraordinarily rich black soils (chernozems) are the foundation of the country's agricultural production, occupying 22 million hectares of the 42.2 million hectares of land classified as suitable for farmland.[1] About 30.1 million ha are under various crops--the majority under cereals, followed by industrial crops, potatoes and vegetables, and corn for silage. Wheat and other small grains are grown in all regions, with additional crops of mostly potatoes in the northwest and north, sugarbeet dominating in the forest-steppe zone, and a mixture of drought tolerant crops in the steppe zone. In addition to the primary food crop, winter wheat, the country produces barley, oats, potatoes, sugar beets, sunflowers, soybeans, buckwheat, maize for grain and for silage as well as an assortment of fruit and vegetable crops and forest products. Dairy and beef cattle, swine and sheep, as well as some horses, are the principal farm animals, some of which graze part of the year.

8.2 The kolkhoz/sovkhoz system[2] has not been able to harness the full productive potential of the land. Farm productivity is below standards achieved in the EC and US. Cereal yields are 50-55 percent of yields in western Europe and 70 percent of yields in the US. Feed conversion ratios in the livestock industry are almost twice those of the EC and US. About 70 percent of the farm sector is mechanized,

---

1/ Agricultural lands occupy nearly 70% of the country.

2/ The kolkhoz/sovkhoz system refers to the large scale collective (kolkhoz) and state (sovkhoz) farms organized in the FSU in the late 1920s and early 1930s.

but the machinery and equipment employed tend to be outdated and reportedly cause significant losses. There appears to be difficulty in transferring know-how and new techniques from agricultural research centers to the farm for practical application.

**Box 8.1: Soil Types in Ukraine**

Ukraine can be divided into three soil-climatic zones: (i) the forest zone in the north and northwest (with acid podsolic soils) with the highest annual precipitation; (ii) the forest-steppe zone, of which 45% are rich chernozem soils; and (iii) the steppe zone with mostly chernozem soils (82%) in the south and southwest, which is the driest area and relies on irrigation.

8.3 Structural changes in agriculture are likely to be gradual. Private farms are still negligible, although growing. They cover an estimated total area of 218,500 ha (average size 19 ha per farm), compared to the 26.8 million ha held by the kolkhozes and 8.7 million ha held by the sovkhozes. What seems to be occurring now is internal democratization within collectives, whereby farmers are allocated a share of the collective assets (including land). Farm support and supply of inputs are exclusively designed to serve the state and collective farms. But informal household plots managed by individual farmers have long been an adjunct to the collective system, with farmers able to access inputs through the collective. Machinery and equipment suitable for small scale farmers are unavailable.

8.4 Agricultural prices and prices of inputs are still regulated and markets underdeveloped. The sector as a whole is suffering a deteriorating financial situation, and the government response is to continue heavy subsidization. Clearly, markets need to be established and pricing policies changed in order to create sufficient incentives to raise productivity and increase farm incomes. Raising the prices of inputs will likely force changes in farm practices. As the sector changes, there will be opportunities to encourage better management and farm practices.

**Overview of Environmental Concerns**

8.5 Agriculture is a significant but not the leading source of pollution in Ukraine. The major environmental problems in the sector are erosion and water runoff which contribute silt and plant nutrients to waterbodies. This dispersed, "non-point" source of pollution is closely associated with on-farm practices and techniques. Current contamination of water by pesticide and fertilizer use is not likely to be far-ranging because recent usage has been low and is falling. Some previously applied agricultural chemicals, especially those in solution, may be entrained in the hydrological cycle, though, e.g., DDT, triazine, and nitrate. Manure storage and use and poor sanitation facilities in rural areas are sources of localized contamination of ground and surface water with bacteria and nitrate. These various concerns are discussed in greater detail below.

8.6 **Soil Erosion**. The naturally fertile black soils in much of the country present few physical obstacles to cultivation. Slopes are gentle to moderate over wide areas, permitting many regions to have more than 80 percent of the land under cultivation. The rainfall in Ukraine is relatively gentle and seldom excessive, but there are severe rainfall events that cause runoff and soil erosion. According to official statistics, about 35 percent of the arable land is affected by water erosion and 54 percent by wind and dust storms. While erosion is not uniformly serious in all regions nor on all soils in a local area, it is admittedly a concern of farm managers and local agricultural officials.

8.7 There appears to be no reliable quantification of nutrient loss in the soil. Natural processes may have been accelerated by farming practices geared to exploitation of the land rather than conservation.

Plowing of steep slopes, overgrazing and other practices that exhaust the soil and remove vegetative cover have been particularly damaging in the forest-steppe regions. In the dry steppe, bare ground is exposed frequently to strong dry winds, which remove the top layers of the soil, scattering it in the form of dust. The presence of a thick deposit of wind blown soil (loess) leads to another problem--susceptibility to formation of gullies and ravines during occasional downpours of rain in summer. This creates a network of gullies and ravines in some areas.

**Box 8.2: Effects of Soil Erosion**

The most easily identified effect of soil erosion is the presence of silt in streams and standing water. This silt attenuates the penetration of sunlight into water and thus seriously restricts the volume within which various types of autotrophic (photosynthesizing) organisms can grow satisfactorily. The silt can also cover stream beds and, in so doing, impairs the breeding and rearing grounds of aquatic animals. Another effect is the additional stress placed on water processing and delivery systems in both urban and rural areas. Another immediate effect, but less obvious, is the loss of inorganic and organic nutrients from fertilizer and manure added to the soil, thus reducing the economic benefits of such inputs and increasing the need for replacement later. This is important because some fertilizers are imported at significant expenditure of hard currency. The effect of such nutrients in water bodies is to promote the excessive growth of algae, leading to high biological oxygen demand (BOD) during decomposition and causing eutrophication. The long-term consequence of erosion, of course, is the slow destruction of the soil resource. This slow deterioration has the direct effect of requiring additional amounts of fertilizers to counteract topsoil losses and maintain production.

8.8 **Water Runoff.** Water runoff during the warm season is a consequence of the rate of precipitation exceeding the rate at which the water can be absorbed and transmitted through the soil. There is evidence from conversations with several farmers during this study that the soils tend to form a surface crust in response to rainfall; this reduces the infiltration rate, thereby increasing the possibility of runoff and erosion. Remedial action is needed both to protect the soil and, more importantly, to conserve moisture for crop use.[3] The problems of runoff and accompanying erosion can be prevented or greatly reduced by choice of appropriate tillage practices, cropping systems and machinery.

8.9 **Fertilizer Use.** Fertilizer use is not excessive in Ukraine,[4] including nitrogen application, usually the most serious threat to groundwater. Average fertilizer use over the period 1986-90 was 148 kg/ha; it was reduced to about 140 kg/ha in 1990. This compares with typical rates in the 1980s of 770 kg/ha in the Netherlands, 411 kg/ha in West Germany, and 310 kg/ha in France. Ukraine imports all of its phosphorous and potassium requirements. Fertilizer application is made by the same units which apply manure and pesticides. There reportedly are significant losses (10-15 percent of shipments) in transport and loading. The technology of fertilizer-spreading machinery is old; therefore, there cannot be a great degree of uniformity of spread, although it probably is adequate. Erosion of the more fertile surface

3/ Incidentally, these practices would lead to less water yield to streams and reservoirs but the water would be much less contaminated.

4/ There are deficiencies in applications of both nitrogen and phosphorous ingredients (9% and 40% respectively). Phosphorous is the limiting factor to yield improvement, since lack of phosphorous reduces the effectiveness of other nutrients.

layers may contribute disproportionately to the phosphorus availability in silted streams and thus accelerate eutrophication of streams an associated rivers. Because phosphorus is critical to crop production, *the remedy does not lie in reduced use, though, but in better farm and conservation practices.*

8.10 **Manure Application**. The application of animal manure also adds nutrients to the soil. To the extent that the manure enriches the fertility of the soil, the resulting silt also will carry more phosphorus during runoff. In addition, there is a certain amount of soluble phosphorus in manure which can be leached from it; this adds to the phosphorus load associated directly with silt-laden water runoff. Nitrate, which moves with water, can also accumulate in drainage ways and percolate to shallow groundwater tables. The reported statistics, though, indicate a shortage of "organic fertilizers" in all regions with the greatest shortage in the steppe region. Along with reported fertilizer use, applications are modest relative to use elsewhere. The uniformity of application varies depending on whether it is spread by hand or special machines.

8.11 **Pesticide Use**. Actual pesticide use is low (in 1991 averaging 2.7 kg/ha) compared to the US and EC (7-8 kg/ha and 6.6 kg/ha respectively). About 25 percent of required pesticides is produced in Ukraine, and about 50 percent is imported from other parts of the FSU; the rest is imported from other countries. Herbicides are considered to be the most scarce; about 35 percent is imported from outside the FSU. Pesticide supplies were drastically reduced during the past two seasons. Weeds are a serious problem threatening crop production, causing yield losses in many fields every year. While cultivation is an option for weed control, dependence on herbicides in recent years has reduced the competence and skills needed to be fully effective. There also appears to be an absence of the rotary hoe, which is an essential implement for weed control by cultivation in the absence of herbicides.

8.12 Pesticides come mostly in the form of formulated products to be diluted and spread. It is readily admitted by authorities that calibration of pesticide applicators is a problem. Consequently, the tendency is to dilute the pesticide more than is absolutely necessary in order to overcome, in some degree, the non-uniformity of application. The inability to calibrate adequately and the frequent failure of nozzles to function properly virtually assure nonuniform application. The nonuniform application in this way does not seriously influence the environment, but it does contribute to poor performance and reductions in yield which otherwise would not be a serious factor. Views about pesticide hazards differ among authorities. Some say that pesticides are not in high enough concentrations to be damaging. There are others, however, who feel that pesticides are a serious problem in water. Because some pesticide residue may enter surface water sources through runoff, *which also includes silt, anything done to reduce runoff and erosion would reduce pesticide levels in surface water because pesticides are either dissolved in water or attached to eroding soil particles.*

8.13 Operators who apply pesticides are instructed to protect the skin and respiratory system from pesticides and are also warned about ingestion. Admittedly, some do not follow all safety procedures nor take advantage of available safety clothing and protective gear; there is an admitted lack of protective clothing in some cases. Civil Air Patrol planes sometimes are used to apply pesticides, but apparently very infrequently. The damage from aircraft applications by inexperienced pilots would be the striking of unintended targets with chemicals and the potential for drift of pesticides beyond the target area.

8.14 **Storage and Transport of Pesticides**. Serious safety issues may arise from inadvertent spills in transportation and at storage and mixing sites. There are no dependable provisions for containment of spills on premises nor containment of leaks from defective containers in Ukraine. *It is this source of pesticides that may well be the greatest environmental hazard because pesticides spills have the potential*

*of reaching segments of streams in much higher concentrations during water runoff events than would likely come from fields.* Reportedly, a significant quantity of pesticides has gone out of condition and remains in defective and failing containers. MEP reports this as a serious problem because there are no incinerators or other ways of detoxifying and disposing of these materials. They have contemplated the burial of such chemicals in thick walled concrete silos, not unlike the silos used to house missiles, but no decision has been made.[5] A more thorough evaluation of the problem is needed in an effort to identify low cost solutions to reduce any potential for water contamination.

**Farm Practices to Prevent Soil Erosion**

8.15 Several changes in practices will help to reduce soil erosion and could have other benefits as well: reduced tillage programs, greater land contouring, better watershed management, programs to provide better shelterbelts for wind protection and livestock habitat. As mentioned above, reducing soil erosion and water runoff should stop any associated problems with fertilizer and pesticide contamination.

8.16 **Reduced Tillage Systems**. Reduced tillage systems which keep adequate crop residues on the surface are the least expensive erosion control and water management systems available. Defined as post harvest practices that provide at least 30 percent residue cover at the time of the next planting, they include no tillage, mulch tillage and ridge tillage practices. Maintaining a surface mulch is one of the quickest ways to reduce the rate of erosion and increase water movement through the soil to flow underground and become bankflow into streams. Not only does more water in the soil help plants, but it is then free of silt when it enters streams. This can be done by adopting production systems that maintain a crop residue or a living crop on the surface to the greatest extent possible. Ridge tillage is effective in erosion and water control because it presents mechanical impedance to water flow due to the ridges in addition to a deep residue cover in the inter-row areas. Properly managed and with appropriate planters, this system may require no herbicides, or at least infrequent use. Besides the specialized planters and cultivators needed, the system is essentially restricted to intertilled crops, e.g. maize, potatoes, sugar beet, etc.

8.17 An investment in teaching and training as well as technical help is needed to introduce such practices. Appropriate weed control chemicals, properly and timely applied, are one of the keys to reduced tillage systems, leading to erosion control and the improvement of surface water quality. The greatest limitation to their implementation is the supply of planting or seeding equipment adapted to surface residue conditions and designed to plant with precision under these conditions and subsequent cultivation machinery that operates effectively under these circumstances in intertilled crops. Such machinery is not produced in Ukraine. There is also a need for chisel tillers and other equipment that can be used to replace the moldboard plow where general tillage is needed and may be effective in breaking any "plow pans" present.[6] One such tillage tool, the paraplow, apparently is being manufactured in Ukraine, but the supply is insufficient. Once it was thought that residue systems would require greater inputs of herbicides, but it has been demonstrated recently that precise timing and correct

---

5/ In the US, USEPA specifies how waste pesticides are to be disposed on a case by case basis. Disposal methods include chemical denaturing, incinerating and burial.

6/ Compacted layers beneath the depth of plowing caused by heavy machinery operating when fields are too wet for optimum operation.

selection of chemicals make it possible to be fully successful without more. The keys are knowledge and information, and timeliness of operations, along with the selection of herbicides.

8.18 **Land Contouring**. The intensity of cropping and the degree of soil protection required to prevent erosion and unnecessary water runoff are also a function of the slope in the fields, both in terms of length of slope as well as the degree of slope. Soils, of course, vary in their erosivity as well. Potentially erosive slopes can be found throughout the country. Land contouring techniques would help in reducing erosion on steep slopes (outlined in Box 8.3).

**Box 8.3: Field Restructuring**

**Contour planting**. The practice of planting intertilled crops (and others) on the contour is effective in reducing water runoff and soil erosion on gentle and relatively short slopes and under moderate rainfall. This activity can be installed with machinery already in use. It is necessary to establish contour guidelines in the fields, a relatively easy procedure done with relatively inexpensive instruments. The entry cost of contour planting is low, but requires some new skills in operation; also it takes will likely take a little more field time, but saves fuel.

**Strip cropping**. This practice is also done on the contour and is easily followed once contour lines are established. It consists of alternate contour-planted strips of intertilled, sod-forming and closely seeded crops. Somewhat steeper slopes can be protected in this way with the technical information readily available.

**Terracing**. A highly effective water runoff management and erosion control practice, even on steep slopes, is the building of earthen dams on natural contours or with a slight slope in the channel to facilitate managed water runoff. Terraces on the true contour or with graded channels present some disadvantages for operating wide, high volume machinery.

**Parallel terracing and land forming**. This application of terracing forces all terraces in a field to be parallel, thus removing one disadvantage for high capacity machinery. A disadvantage in construction, however, is that large amounts of earth must be moved on steep slopes and special drainage systems need to be installed to dispose impounded water.

## Ecological Agriculture

8.19 **Removing Land From Cultivation**. Ukraine has a window of opportunity during reform to reduce conditions leading to soil erosion by redirecting land use to permanent vegetation in selected regions and parts of the landscape. Such efforts would help to protect streams and rivers, increase wildlife habitat, and support reforestation. The type of planting would depend on location and local objectives. There is already underway a serious reforestation program in the country because of insufficient mature timber. Now would be the ideal time to convert some of the sloping land (too steep to be farmed safely without severe erosion) into forest. This is a long term investment for the future, with the opportunity to harvest forests at a rate permitting maintenance of the forest in the future and simultaneously meeting demand for forest products. Other slopes could be placed into well managed high

quality grassland production.[7] Grasslands would be the primary solution for permanent vegetation in the dry areas of the south and southeast where forestry would not be well adapted. A forest-grassland boundary is generally attractive and conducive to a significant number of animals whose presence could be used for viewing as well as harvesting. Planting with woody shrubs also offers conservation benefits. More localized evaluation would be needed to determine the location and juxtaposition of the different land uses to achieve the desired goals of a friendly and enjoyable landscape and abundant wildlife.

8.20 Grasslands could very well be public lands just as the forests are. They present different problems in use, however, because they can be harvested every year. In many countries where public grasslands are available for grazing, they become overgrazed and become worse than if the land were in general cultivation. A country like Ukraine certainly has the capability to control grazing and make the right decisions based upon ecology of the grassland and economic principles of rental for grazing purposes. Admittedly, though, some countries have had difficulty in coming to grips with this problem (e.g. the US). The other course to follow would be to make sustainable grassland establishment a restriction in land ownership transfer, permitting grassland to be held as private property, but making the land owners responsible for maintaining its integrity and preventing excessive erosion. Either method will require monitoring and punitive recourse in case of violation.

8.21 **Watershed Management**. It is the judgement of staff in the Agriculture Ministry that an adequately wide band of forest is superior to grassland in the protection of streams from surface water flow and in stabilizing the banks. They expressed interest in planting forests along many streams in order to protect streams from encroachment of polluted water. This initiative should be encouraged and made a part of the reforestation program with appropriate harvest management in the future. If siltation and pollution by bionutrients is significantly reduced, it should also be possible to reestablish attractive aquatic life and perhaps even restore streams to recreative uses involving direct contact with water. This should certainly be within reach in a relatively few years at least for the upper reaches of tributaries of the major rivers. There are several thousand of these and they are widely distributed.

8.22 **Shelterbelts**. A large number of deliberately planted shelterbelts are evident in much of Ukraine. Shelterbelts can be designed for a number of different purposes, to reduce wind erosion or to protect animals. The shelterbelts viewed in Ukraine during this study, admittedly a limited sample, generally comprised deciduous trees planted in about six rows, spaced relatively far apart. With this design, it is doubtful whether they really protected the land area from wind erosion. The protective capability of shelterbelts depends on their density and height as well as orientation perpendicular to the prevailing winds causing soil erosion. While deciduous trees would tend to reduce windspeed significantly when fully leaved, they provide considerably less protection when dormant. That is why at least some evergreen trees should be included where they are adaptable. For many agricultural regions, shelterbelts are essential, and thus with changing land use environmental and agricultural authorities need to be concerned with their possible destruction. An incentive system may be needed to encourage development of shelterbelts because they are costly, a long-term investment and eventually probably benefit the general public more than individual landowners.

8.23 In other parts of Europe, hedge rows are planted along property lines and field borders to protect fields from water erosion; they also benefit wildlife. It is on the farm that small areas of habitat can

---

7/ The Czech Republic, which brought excessively steep land into cultivation since 1950, converting into grassland, keeping the land under state control.

attract many non-game animals, such as resident birds and farm game, provide resting areas for migratory birds on the flyways which cross the country, and offer corridors for animals which inhabit the system of protected areas around the country. Also predators which control insects, such as hawks, owls, etc., are harbored in small islands of farm habitat. The edges of fields, the riparian bottoms, woodlots, and small wetlands could be conserved or restored for such purposes.[8] Programs which provide incentives to dedicate a small, often less productive area of the farm for this purpose can constitute an important alternative to the edge-to-edge tillage of larger farms.

8.24 Questions such as the plausibility of conservation easements, soil banks, and extension services which integrate forestry and wildlife management with farming can only be addressed in the context of reform and through information, education, and extension efforts, mounted in parallel with supportive government policies.

8.25 **Potential For Integrated Pest Management (IPM).** Fortunately, most sovkhozes and kolkhozes are rather diversified and also produce one or more classes of livestock. Crops are rotated among fields in a fairly systematic manner with rotations that are five to ten years in length and often include perennial stands of forages. Because monoculture is not generally practiced, farming is spared some of the pest problems frequently associated with specialized single or two-crop systems. The rotation-based systems now followed allow application of some IPM principles in Ukraine. Certain crops, because of the way they have to be managed, influence certain pests either favorably or adversely. Careful attention to the sequencing and juxtaposition of crops may eliminate the need to use some agricultural chemicals in selected situations. Likewise, some pests infest crops under certain soil or seasonal growing conditions and not others, so the need for treatment can be better predicted..

**Box 8.4: Integrated Pest Management**

Integrated pest management (IPM) refers to a farming system that relies as far as possible on non-chemical measures to keep pest populations low. The focus is on plant breeding and practices aimed at keeping the crop healthy and resistant. IPM is strongly information based. It is applied effectively where the knowledge base is adequate to make informed judgements about imminent hazards of pest populations and an infrastructure exists which permits accurate assessment of emerging pest problems almost on a day-to-day basis. Given these two basic requirements, it is necessary to have the technological capability to respond effectively and with precision.

8.26 The key elements for *widespread*, formal introduction of IPM systems in Ukraine are missing at the present time, though. First, such a program depends on farmer accountability and responsibility and on a system that rewards superior performance. Second, farmers need to be backed up by an education and information system that is research-based and unbiased, but also practically oriented. The practical orientation seems to be missing in Ukraine. Academic and research institutes do not appear to be closely associated with the larger agricultural industry. Also missing is the presence of a trained cadre of professional consultants and observers who can recognize and estimate the seriousness of pest hazards. Finally, IPM requires carefully controlled inputs into farming. Neither the precision machinery nor an adequate supply of specifically formulated products are available for accurate and appropriate response. Application equipment in Ukraine is inferior and difficult to calibrate, and the

8/ A very large total area is associated with state-owned infrastructure in farming regions. Rights of ways, canal sides and levees, terraces, borrow pits (small areas where soil or gravel has been extracted), and other such areas are useful if developed in cooperation with a wildlife specialist.

right chemical compounds and formulations may not be available.[9] Perhaps the most important step towards introduction of IPM would be to secure better pesticide application equipment as soon as possible to assure accurate and uniform applications.

**Related Issues of Farm Size and Ownership**

8.27 Many environmentally-benign agricultural practices are not easily applied on large fields exceeding hundreds of hectares. The constantly varying practices needed to protect fields generally require smaller fields or smaller farms, or both. Fields need to be evaluated according to internal and surface soil features and operated as separate units. If agricultural land is eventually subdivided into somewhat smaller tracts, improved environmental management may be easier. Shifting to somewhat smaller farms will probably result in some declines in the absolute production of some crops. However, the per acre savings in labor and equipment efficiency may offset the high fuel costs associated with the big machinery and "farm to market" costs in a command economy. The competitive edge of big farms will erode as technology development addresses the smaller farm environment, for example in crop improvements which exhibit enhanced nitrogen-fixing, higher protein quality, pest resistance, and water efficiency, rather than simply *more* production.

8.28 The continuing needs for environmental protection and the emerging changes in ownership of agricultural land will change the demand for information dissemination in the country. The Agriculture Ministry claims it currently can get information to state and collective farms within a week. Given the limited number of farms, this is a relatively easy task in a centrally planned economy. The increase in the number of farms in the future will call for different information or extension methods--perhaps a new type of extension organization. To a conservative community of farmers and skeptical agricultural administrators and scientists, the power of a demonstration farm, which incorporates such habitat and harvest integration *and* keeps the books on farm finances, is essential.

**Sanitation at Livestock Farms**

8.29 Every large farm appears to have significant herds of dairy cattle and swine. but there are lots of small producers as well, growing in size right now because of economic problems in the formal socialized sector and the emergence of private farming. The bulk of the livestock industry, though, is made up of large, energy intensive production units, causing severe managerial, feeding, animal health and environmental problems. Waste management and storage at large and small plants (with the waste left open to the elements until it is transported to fields) has led to localized pollution of groundwater and shallow water sources.[10] The changes which are likely to occur in the industry--some downsizing in the public sector and more reliance on smaller units and individual farmers--may alleviate some of the problems caused by the large scale plants. But, assuming private or individual livestock raising expands, the pressures could simply become more diffuse if livestock management techniques are not improved.

---

9/ Agriculture in Ukraine adopted many facets of "chemical agriculture" as part of its conventional systems. This includes the use of synthetic herbicides and insecticides and perhaps others, e.g., fungicides, fumigants, etc. Because Ukraine is not self-sufficient in their production and does not have a chemical industry developing new and more targeted compounds, most of these have had to be imported and still are. Therefore, it may be some time before fully adequate supplies of superior compounds are routinely available.

10/ The use of slurry fluid systems is not unknown, however, especially for swine.

*A public information campaign to improve waste disposal and storage practices in rural areas, along with the permitting of larger sources and stronger fines, should help to prevent or reduce groundwater pollution.*

**Development of a New Farm Machinery Industry**

8.30 A large agricultural sector requires thousands of machines of all types. Agricultural machinery and equipment in Ukraine tend to be outdated and inefficient, creating significant losses. The country clearly has the capability to produce sophisticated machines--demonstrated in its military hardware and aviation industries. There is no reason then that, for example, a highly effective sprayer for herbicides or a superior seeder cannot be built. Much equipment in Ukraine is known to be significantly heavier and bulkier than similar equipment in the West. The quality of metal and other components to build lighter but stronger machines is not available to agriculture, even though it has been available to military, aviation and space industries. If this metal and fabrication skill were transferred to solve Ukraine's agricultural problems, significant progress could be made within a decade. One must keep in mind, though, that the number of units that will have to be produced is far greater than for more complicated aircraft, military or space vehicles.

**Other Issues in Agriculture**

8.31 **Water for Irrigation Use.** Presently about 2.6 million ha are under irrigation, constituting about 7 percent of arable land (75 percent of the water used comes from the Dnieper). The loss of fresh water to irrigation, though, may be causing serious changes in the ecological regime of the Dnieper estuary.[11] Another 3.2 million ha are under land amelioration projects, of which about 2.2 million ha are under drainage. Most of the irrigated land is in the Don'ts-Dnieper region, while the majority of land under drainage is in the southwestern part of the country. About 84 percent of irrigated land is used for production of grain (34 percent) and feed crops (50 percent). Irrigation is mainly by sprinklers and requires pumping; therefore it is energy intensive and will be affected by continuing increases in fuel prices. The cropping pattern may then change dramatically.

8.32 **Potential Heavy Metal Contamination From Industrial Activities.** The stack emissions of heavy industry are largely uncontrolled. Deposition of airborne particulate matter from these industries, particularly in the south and southeast, is high, and there is concern about heavy metals, such as Cd and Pb, contaminating the soils. Oblast laboratories have the responsibility to test food materials for heavy metals, but it is clear that sampling and testing cannot be very extensive. Heavy metal pollution of soil and water may have adverse effects on the wholesomeness of food produced in some regions, but this has not been verified by sufficient testing. Reported data are currently confusing and appear unreliable.

## B. Forestry

**Types and Characteristics of Ukrainian Forests**

8.33 The forests of Ukraine occupy almost 10 million ha of which 85 percent is considered commercial, primarily pine, beech, and oak. They occupy all five ecological zones in Ukraine:

---

11/ Before 1966, only 0.5 M ha were irrigated. Now over 2.6 M ha are under irrigation.

- Ukrainian Carpathians (45 percent)
- northern mixed forest (30 percent)
- southern Crimean mountains (25 percent)
- forest-steppe (12 percent)
- steppe (3 percent)

The forests were extensively damaged during World War II and, by the end of the war, represented only 11.7 percent of the land area. Due to aggressive replanting, they have recovered somewhat to comprise 14.3 percent of the country. Table 8.1 shows the composition and age of the forests only about 17 percent of the timber supply is in the "old" age class.

**Table 8.1: Forest Characterization**

| Forest Type | % Forest Area | % by Age Structure | | | |
|---|---|---|---|---|---|
| | | Young | Medium | Ripe | Old |
| **Pine/Fir** | 48 | 76 | 4 | 15 | 5 |
| **Broad-Leaved (Beech/Oak)** | 42 | 32 | 39 | 11 | 18 |
| **Broad-leaved (Alder/birch)** | 10 | NA | | | |

**Production**

8.34 The total growing stock of 1.24 bcm of forest has a mean annual growth of 24.4 million $m^3$ p.a., of which about 50 percent is logged. This represents a harvest ranging from 3.7 $m^3$ per ha p.a. in Polessya (representing 94 percent of mean annual growth) to 5.0 $m^3$ per ha p.a. in the Carpathians (representing 64 percent of mean annual growth).[12] The productivity of the Carpathian harvest would be considered average when compared to similar temperate forests, for example in Canada or Finland. The percentage of mean annual growth actually harvested in Polessya is very high; a wider margin between the annual growth increment and annual cut is desirable to assure sustainability. Forests are classified into two types: Type I where economic activities are restricted to sanitation cuts of about 1 $m^3$ per ha, totaling 600,000 $m^3$ p.a.; and Type II, representing commercial forests. Some of the sanitation cutting actually occurs in protected areas and represents a source of revenue for those areas.

8.35 While the survey of forestry operations in this study was limited, there is evidence that the sector suffers from poor planning and siting of harvest operations which may be damaging the growing stock and soil. Harvest operations witnessed during the study did not avoid watercourses and tended to compact the soil. They suffer from the disadvantage of 'whole log" extraction equipment designed for

12/ Higher annual increments are achievable on better quality soil.

low ground pressure and lack the ability to cut logs near harvest sites.[13] Still, with careful planning it should be possible to avoid soil disruption. US and Australia, for example, have strict controls on when (and under what weather conditions) harvesting can take place.

8.36 Pine is clear cut in 1-2 ha units in the mountains and no more than 10 ha cuts on the flats. Initial planting densities are quite high at 10,000 per ha, compared to Scandinavia and North American countries (5 -6,000 per ha). The density probably affects annual growth. Beech, the other major timber species, is harvested in two or three cuts of older trees (110 years and over) at 7-10 year intervals. The initial cut removes 60 percent of the "ripe" trees, the second cut 50 percent of the rest. This system apparently fosters the best natural regeneration. Not much attention is paid to harvesting systems tailored to detailed site indices based on soil type and potential rate of growth. The results of inventorying and research, or models to compare scenarios of growth and yield, do not seem to be incorporated in planning. In other words, the economics of different planting and harvesting scenarios are not carefully weighed to optimize production and conservation.

**The Forest Product Market**

8.37 The 12 million $m^3$ cut annually are not enough to meet domestic demand. Between 1985 and 1990, total consumption in Ukraine was 40 million $m^3$ p.a. The majority of wood was imported from Belarus and Russia, where many Ukrainians have gone to harvest Siberian spruce, generating significant remittances for some Carpathian villages. About 60 percent of finished wood products has been used internally, 30 percent has gone to other parts of the FSU, and 10 percent to foreign export. Beech products are used in furniture (particularly veneer facing) and for wood chemicals, charcoal and firewood. Oak is used for furniture and the softwoods for furniture, fuel and construction. The flow of imported wood has declined drastically over the past two years. National consumption fell to 33 million $m^3$ in 1991 and is expected to be around 24 million $m^3$ in 1993. In spite of the domestic shortfall, about 40,000 $m^3$ of premium logs are exported to Austria and Germany each year. Considerable licensed barter also occurs.

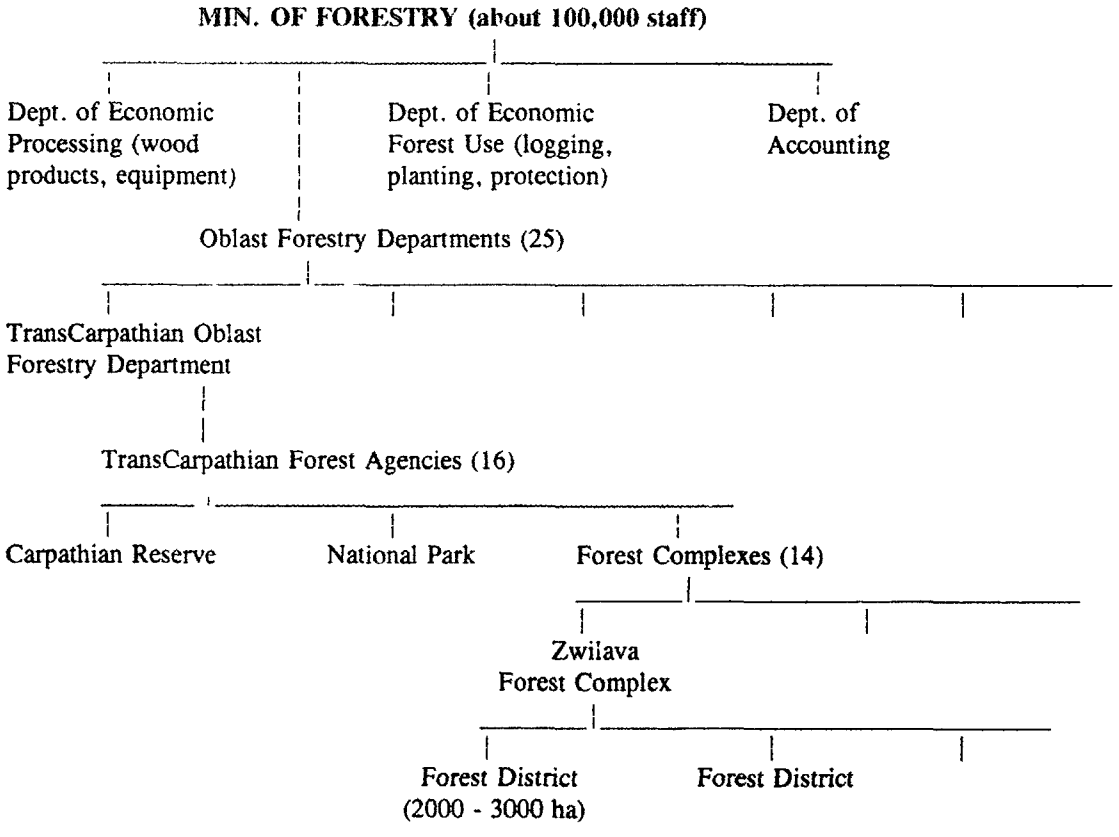
**Ownership and Administration**

8.38 Forests are state owned, with 72 percent managed by state forestry departments at the oblast level, 24 percent by state and collective farms, and 4 percent by the military and institutes of teaching and research. Actual operations are conducted by state forest enterprises. Fundamental changes in ownership and management are in progress. Formerly, forestry operations were under the Department of Agriculture, but split between a Department for Forest Facility, operating in the center and east of Ukraine, and a Department for Forest Economy, working the three most productive oblasts in the west. Historically, the small state enterprises responsible for most of the harvesting, transport and processing at the local level developed and cut as much as possible. The need to control this unsustainable "mining"

13/ Tractors and roading with fall-line skidding are the primary methods of extraction. Although foresters would like to employ more environmentally desirable cable logging, which is used roughly 30% of the time in the mountains, they do not have the equipment (which needs to be imported). Horse logging accounts for 10% of extraction on flat areas and may increase as aging machinery fails and replacements are unavailable.

of the forests led to the establishment of a single Ministry. The new Ministry of Forestry has a staff of about 100,000.[14] Box 8.5 provides a snapshot of its structure.

**Box 8.5: Structure of the Ministry of Forests**




8.39 A new land code permits private ownership of forest plots (cooperative and individual) of up to 5 ha in the context of a new government policy which reportedly emphasizes the environmental values of the forest as dictating its economic uses.

14/ The number of staff seems high compared to the Ministry of Forestry in Belarus which has 35,000 people, supervising an area of forest which is about 67% of the size of Ukraine's forested area.

**Planning and Management Approaches**

8.40 Ukrainian foresters appear capable and skilled in the topics and approaches of an older practice of forestry. They are trained at two national institutes in Kiev and Lviv; there are essentially two streams: forest officer (engineer) and ranger/technician. What seems to be lacking are the tools of site planning, inventorying, and economic analysis to plan harvesting operations. The foresters also manage areas of value to biological diversity, as watersheds for agriculture and human habitation, as tourist venues, and for grazing and fuel sources. Foresters, in fact, manage several of the country's nature reserves (see Table 8.2). However, they are not trained in multiple use approaches or other conservation practices which have developed outside the FSU over the past 15 years, such as:

- watershed management;
- land use planning, which includes the use of technologies such as geographic information systems;
- conservation biology (preservation of biological diversity through preservation of habitat);
- environmental impact assessments; and
- facilitation of public participation

8.41 All of these fields have their own approaches and technology, documented in relatively new literature and research. Professionals in forestry in Ukraine are aware of these approaches, but lack training or any practical experience with them. *Hence, development of short-term programs for working professionals is an early priority. Study tours for middle-level and senior managers to areas where commercial forestry has accommodated multiple uses will provide early and provocative exposure to new approaches.*[15] Over time, as resources permit, the forestry curriculum should be redesigned to include the abovementioned topics.

**Enforcement**

8.42 Division of responsibilities for enforcement of forestry and wildlife regulations has been in contention between the Ministry of Forestry and MEP for some time. New legislation addresses the wildlife issue by giving MEP responsibility. The responsibility for ensuring sound forestry practice is still unclear, however. MEP has a very small network of inspectors, who try to assure that good forestry practices are used, but its inspectors are understaffed and generally poorly equipped to be able to take a greater regulatory role. They need expanded financial resources and authority to undertake this role, which is not likely to be feasible in the near future. Changes really will have to come from within the forestry sector.

8.43 A positive step would be to establish a consultation process between forestry officials and MEP to address any potential impacts to threatened or endangered species as a consequence of forestry activities. Such consultation should be routine for each major forest area. Informed and useful consultation implies that MEP begins to develop a threatened species and ecosystems database, as well as impact assessment guidelines. Some of the information exists in the Red and Green Books (see Section D), but the level of precision required to influence forest works (e.g. to the level of siting a clear cut or access road) will require additional inventories for each oblast. Species requirements and the structure

15/ Such tours could, for example, examine the "Wildlife in Managed Forests" initiative of the US Forest Service and the on-farm/in-forest work of the Soil Conservation Service, etc.

**Box 8.6: Local Example--TransCarpathia**

The TransCarpathian oblast covers of 1.275 million ha, of which 672,500 ha are forest. State forests occupy 558,500 ha, forests managed by collective farms cover 94,000 ha, and forests held by the military 20,000 ha. The Carpathians house some of the finest beech stands in the world. The value of the resource is seen when the age structure of the Carpathian beech is compared to that of the entire country: the national beech forest has 29% ripe and mature trees and the Carpathians 50%.

**Harvest intensity of major forest types**

| Species | Forest Composition % | % In Harvest |
|---|---|---|
| Pine/Fir | 30 | 50 |
| Beech | 60 | 49 |
| Oak | 9 | 1 |
| Misc. | 1 | |

and distribution of ecosystems should be inventoried and recovery plans developed; the data could be entered into relational and spatial databases (GIS) accessible to those who plan forestry activities.

**Production of Minor Forest Products**

8.44 Medicinal plants, berries, mushrooms, honey, and nuts are "minor forest products," which are underrated economic assets of the forest. In 1990, one hectare of Ukrainian forest produced nearly US$1.00 worth of these products, although the potential export value is estimated to be closer to $25.00/ha. About 1400 tons of mushrooms (0.15 kg/ha) were harvested with 85 tons pickled for export to Western Europe. About 16,000 tons of nuts and berries were picked (1.5 kg/ha worth $2-$3/ha) with a potential value of nearly $30 million. Also of note is the "sok" or birch juice sold by the jar. The export potential for these products could be interesting, but there is no market knowledge or marketing expertise. Forest products are purchased by state industries from the general public who harvest them.

## C. The Protected Area Network[16]

**Ukraine's Natural Patrimony**

8.45 Ukraine possesses a variety of ecological communities: the European broadleafed forests, the northern taiga, the interior steppe, semi-arid sands and marshes near the Black and Azov Seas, estuaries of large rivers such as the Dnieper, and the sub-tropical pine and chaparral of Crimea. Regions of special note are here.

16/ See Annex 6 for descriptions of selected reserves and wetlands.

- The *Carpathians and the Crimea* are centers of high endemism and internationally significant. The Carpathians contain one quarter of the flora of Europe and many endemic and medicinal plants useful to mankind. The largest remaining stand of virgin beech forest (10,900 ha) occurs in the Carpathians and is a remarkable natural resource for the rest of Europe, which has lost such undisturbed areas. The Crimea is a center of contrast to the rest of the region, and many endemic and relict species are maintained by its unusual climate.

- Over *300,000 ha of wetlands* are of international importance as nesting sites of waterfowl. In the Danube Delta, 150,000 ha of which lie within Ukraine, the number of wetland birds is large, and several species there form a substantial proportion of the European or world populations. Sivash Bay (45,700 ha), Karkinitski Bay (37,300 ha) and the intertidal areas of Yagorlitski and Tendrovski (113,000 ha) are also wetlands of international importance.

- Most of the last virgin steppes of Europe are located in Ukraine's *Steppe Reserve* (comprising four separate areas) and in the *Askaniya-Nova Nature Reserve*, the country's oldest reserve.

8.46 Ukraine also has considerable recreational resources, concentrated mainly in the western forest region, the southern sea regions and along several rivers, particularly the Dnieper, southern Buh and Dniester. Resort resources (mineral waters and therapeutic muds) exist throughout the country. The south of Ukraine, specifically the Crimea, Mykolaiv, Odessa and Kherson oblasts, are the major centers for recreation and most developed in terms of recreational facilities, catering mainly to domestic tourism.

**Protected Areas**

8.47 The network of protected areas includes: 15 strict nature reserves (*Zapovedniki*), 4 national parks, 3 biosphere reserves and many other protected landscapes, zoological and botanic gardens and other locally significant reserves. The major categories are discussed below. The map on nature reserves indicates the areas reserved, as well as biogeographic regions. Annex 6 describes some of the reserves in more detail and provides ancillary information related to this chapter.

8.48 Only 2.1 percent of the country is under some form of protection. In some oblasts, less than 0.5 percent is reserved, which reflects the influence of agricultural and forestry activities over a long period of time. The government has indicated its interest in increasing the area of reserves to 3 percent in the future and has an ambitious target to include every plant species in two to three reserved areas. *However, the priority right now must be to concentrate on improving conditions at existing protected areas and encouraging ecosystem conservation more generally.*

8.49 **Nature Reserves.** The current economic situation threatens one of the most extensive and well tended systems of nature reserves in the world--the *Zapovedniki*--which house a vast range of biological diversity across the FSU. Nature reserves were strictly protected for scientific and educational purposes. Their use for recreation was typically not considered appropriate, and travel by unauthorized persons was prohibited. That status sometimes fostered resentment by local communities. Recent legislation and reclassification of some smaller, less rigorously protected areas have increased the number of reserves

**Box 8.7: Flora and Fauna of Ukraine**

About 32% of vegetation in the country is identifiable as part of the original natural vegetation. The flora comprise nearly 4,500 higher plant species. About 12 % of the entire flora are listed as threatened or endangered. Grasslands cover about 6.6 million ha, of which 380,000 ha are protected, although little of this can be described as natural. Ukraine's Red Book, which lists endangered or threatened species, has just been revised. It lists 631 species of flora and fungi, including 429 species of vascular plants. Many are relics of localized endemics; others include valuable drug and ornamental species.

The wildlife patrimony of the Ukraine is rich and varied, reflecting the diversity of the major ecological communities found in the country. Two major flyways traverse the area: a north-south and an east-west (coastal). Some of the breeding concentrations are significant. For example, 90% of the world's black-headed Mediterranean gulls breed on the spits and islands of Chernomorskyi (Black Sea) Reserve, south of Kherson. There are some 44,800 known species of animals which inhabit the country: 344 birds, 200 fish, 101 mammals, 37 herps (20 reptiles and 17 amphibians), and the remainder invertebrates. The Red Book lists some 381 species of fauna, including 101 mammals. Most wildlife management is focused on game species; little attention is given to the ecology and requirements of non-game species, particularly if they are not threatened. The main threat to the wildlife of Ukraine is not human encroachment as such, but destruction or contamination of the natural ecosystems on which they depend.

Recognizing the need to address the status of the flora and fauna at the community level, the Academy of Science has also recently published a Green Book, which provides a more systematic appreciation of the significant communities, habitats and ecosystems at risk.

in Ukraine to fifteen. In 1990, IUCN[17] classified eleven of the reserves in Ukraine as Category I reserves, the highest category of protection.

8.50 **National Parks**. The national parks were created to preserve valuable natural, historic, and cultural sites, provide tourism opportunities and recreation, conduct research, and support ecological education. Each national park has four zones: a reserved zone similar to nature reserves; a regulated recreation zone in which activities, such as hunting, fishing, and tourist camps, are permitted; a zone intended for accommodation; and an economic zone dedicated to commercial activity.

8.51 **Biosphere Reserves**. Created as part of the Man and Biosphere Program of UNESCO, the biosphere reserves are additions to the existing reserve system, usually as expanded areas including the strict reserves. Three zones are established within biosphere reserves: (i) a reserve zone which has the functions and objectives of a nature reserve, (ii) a buffer zone, and (iii) a transition zone which includes traditional land uses, settlement and recreation sites, and other limited economic activity. A central tenet of these reserves is to encourage integration of the interests of the surrounding community with sustainable use of natural resources in order to protect endangered resources.

---

17/ Protected Areas in Eastern and Central Europe and the USSR,(An Interim Review), The World Conservation Union (IUCN) 1990.

8.52 Two areas have been designated "biosphere reserves"--Askaniya-Nova and Chernomorskyi Reserves. The Carpathian mountains have recently been nominated; the biosphere reserve will comprise three discontinuous areas encompassing several individual massifs, each with core, buffer and transition zones. In this way, it captures a high percentage of endemic flora and fauna of the whole Carpathian system.[18]

8.53 **Regional Landscape Parks and Other Sites**. These areas are set aside to preserve typical and unique natural sites in a natural condition, as well as to provide conditions for "organized rest of people." They are usually set aside without withdrawing land from landowners or users. Provisions exist, should they be necessary, for zoning of activities and withdrawal of land. Other protected areas are generally managed at the oblast level but are less important in terms of biodiversity. Typically, they are less limited adjuncts to the strictly protected areas.

**Management of Protected Areas**

8.54 **Role of MEP.** New legislation in 1992 sets out the principles for management of the protected areas (see Box 8.8). MEP is responsible for protection of the country's natural heritage through its Department for Protected and Recreational Areas (DPRA). DPRA, up until February 1993, had two divisions: one for reserves and other protected areas; the other for protection of forests, flora and fauna. Total staffing in Kiev in mid-1992 was only 27 people. The two divisions have now been merged, with some personnel (13) and responsibilities transferred to other departments of the Ministry. In broad terms, DPRA is responsible for policy concerning the protected area network and supervision of various reporting functions, but it does not have a strong managerial or planning role. DPRA has an enthusiastic, dedicated staff, but resources are inadequate to coordinate the range of activities needed:

- planning (management, land use and financial);
- communications (media relations, community information and extension, interpretation, environmental education, publications);
- training (professional skills development, needs analysis, production of supporting materials and training aids); and
- enforcement.

Similarly, DPRA does not have the staff to tackle the emerging system-wide issues such as concessions, leasing and recreational management. The lack of a programmed approach to budgeting within the Ministry also hampers its effectiveness; it does not have a budget allocated to it which it can use to manage its activities.

18/ In this case, the biosphere reserve is distinct and separate from the nature reserve and the national park in the Carpathians, which carry the same name.

**Table 8.2: Reserves and Parks of Ukraine, January 1991**

| | Area (ha) | Agency Responsible | Species Protected | | |
|---|---|---|---|---|---|
| | | | Mammals | Birds | Plants |
| **RESERVES** | | | | | |
| 1. Askaniya Nova | 11,312 | Institute of Agricultural Research | 57 | 213 | 1,729 |
| 2. Dinsakiye plavni (Danube Delta) | 14,851 | Academy of Science | 22 | 212 | 563 |
| 3. Kanivskyi | 2,027 | Min. High Education | 49 | 240 | 832 |
| 4. Kardazsky | 2,874 | Academy Science | 42 | 200 | 1,100 |
| 5. Carpathians | 19,899 | Ministry of Forestry | 50 | 141 | 898 |
| 6. Lugansky | 1,608 | Academy of Science | 43 | 151 | 1,037 |
| 7. Mys Martyan | 240 | Academy of Agriculture | 288 | 146 | 500 |
| 8. Poiesskyi | 20,104 | Ministry of Forestry | 39 | 174 | 604 |
| 9. Medobari | 10,455 | Ministry of Forestry | | | |
| 10. Roztochchya | 2,085 | Min. High Education | 33 | 117 | 793 |
| 11. Ukraine Steppe | 2,755 | Academy of Science | 30 | 129 | 926 |
| 12. Chernomorskyi (Black Sea) | 57,048 | Academy of Science | 44 | 300 | 624 |
| 13. Yaltinskyi | 14,523 | Ministry of Forestry | 33 | 91 | 1,363 |
| 14. Dniprovsko-Orilsky | 3,766 | Ministry of Forestry | 16 | 15 | 11 |
| 15. Crimea | 44,175 | Ministry of Forestry | 37 | 250 | 1,180 |
| **NATIONAL PARKS** | | | | | |
| 1. Carpathians | 50,303 | Ministry of Forestry | 50 | 110 | 1,100 |
| 2. Sinevir | 40,400 | Ministry of Forestry | NA | NA | NA |
| 3. Shatskyi | 32,430 | Ministry of Forestry | 30 | 219 | 825 |
| **BIOSPHERE RESERVES** | | | | | |
| 1. Askaniya-Nova | 33,307 | Institute of Agricultural Research | NA | NA | NA |
| 2. Carpathians | 38,930 | MEP | NA | NA | NA |
| 3. Chernomorskyi (Black Sea) | 87,348 | Academy of Science of Ukraine | NA | NA | NA |

8.55 *Actual day to day management of the reserves is currently vested in a multitude of different agencies (see Table 8.2), and activities at individual reserves often reflect the orientation of the managing agency, rather than priorities of nature conservation.* For example, in the Carpathians National Park, the greatest proportion of the work force is involved in forestry activities, which reflects the fact that the Ministry of Forestry is responsible for actual management of the park. Management of protected forested areas has rarely been without considerable intervention, including timber production (so-called "sanitary cuts") from the less strictly protected buffer zones. In Askaniya Nova, which preserves some of the remaining steppe region, most activities center around animal science and genetics, reflecting the agricultural orientation of the agency in charge (the Institute of Agricultural Research).[19] Its research activities (eg. the breeding of wild horses and exotic animals) bear little relation to monitoring and conservation of the steppe region, which should be the principal objective of the reserve.

8.56 The individual managing agencies are responsible for financing the protected areas and are funded in turn by the government. Various reserves, though, rely on supplemental income, e.g. timber production in some reserves.[20] Some support has come from special but limited funds under the control of DPRA, directed at critical areas of the system, but there is no guarantee that such funding will be on-going. Right now the system is suffering critical financial problems. Inflation and a reduction in allocations are now dramatically affecting protection and management activities in each area. Maintenance of the infrastructure of the reserves tends to be poor and unsustainable given current allocations. Vehicles, communication systems and other essential management tools are failing. In most cases they were never at an optimal level anyway; only the longer established areas ever had adequate support.

8.57 Management planning, including land use planning, has reflected individual approaches of different managing agencies. An informal review of several plans show them to be narrow operational budgets established for a ten year period, dealing mainly with activities and resources required over the planning period. Actions related to reserve management objectives are not specified. Finally, these plans are not public documents.

8.58 Land use planning outside the reserves has rarely been attempted, although the concept is included in new legislation (see Box 8.8). At all of the protected areas surveyed during the study, conflicts with the local community were consistently noted by reserve managers. Enforcement has generally been the management response, although relatively few prosecutions have reached the courts. Neighbors can pose a long-term threat if they have been systematically excluded from reaping any of the benefits of reserved areas while possibly suffering cropping and grazing limitations, incursions of tourists, and a host of restrictions. *The participation of neighboring communities in future management planning and decisionmaking for the reserves is essential.* Given the changes in the country, it would be desirable to direct more attention to better communication and other efforts to build local community support for the reserves. This can pay large dividends in terms of future cooperation.

---

19/ For example, in Askaniya Nova there has been cooperation with researchers from the San Diego zoo regarding the endangered Przwolski horse. Over time, genetic information has been collected as a basis for a possible long term reintroduction program. This program has not been developed, although it is a priority if research on this animal is to address biodiversity protection and the long term maintenance of the species. Unfortunately there is little experience with such an approach and the horse has been seen primarily as a valuable and saleable item.

20/ See Annex 6, Section D, for information on sources of income for individual reserves.

8.59 **Suggested Changes in Management.** The protected areas are not identifiably part of a system. Policy development and any form of structured management are frustrated by the current structure. An expanded role for the Department of Protected and Recreational Areas would be desirable to coordinate monitoring, conservation activities and training associated with the protected areas. To date, financial constraints have hampered this further development. While it may not be possible to change day to day responsibility at the present time, in view if the precarious financial situation of the protected area network, *a greater role should be authorized for the Ministry for Environmental Protection through the Department of Protected and Recreational Areas, with some transfer of resources from other agencies. This would allow DPRA to take a more active coordinating and planning role.*

8.60 Several other steps are also recommended. One would be a rapid emergency assessment of major reserves to ascertain what basic resources are needed to keep the reserves going. This assessment could then serve to attract other donors from abroad. Second, installation of some computerization and information systems is badly needed to assist with assessment, planning and enforcement activities (eg. related to forestry operations) and also for financial management and staff development. Gradually, over time staffing should be expanded to assist in coordination of planning, recreation and visitor management, communications, concessions and leasing, training and policy.

8.61 Over the medium term, individual plans for every reserve should be developed as a priority and linked with land use planning provisions outside the reserves. More broadly, again over time, policy and planning procedures should be worked out for the whole system of reserves. There is a reference manual on protected area management, published in 1988. It has references to relevant legislation, requirements for planning (operational), procedures for the establishment of protected areas, annual reporting requirements, and guidelines on enforcement, protection of fauna and research for different categories of reservation. Although overtaken by recent legislation and never fully adopted by each reserve, the approach is significant and provides a mechanism for the communication of consistent management objectives throughout the system. It could be expanded and updated to provide field management guidelines for the major activities of the reserve system (wildlife management, research, visitor management, etc) and be clearly related to the current legislative responsibilities and approaches. Preferably, it should be a public document.

8.62 **Funding Mechanisms.** The policy framework necessary to earmark certain earnings to the protected areas needs to be developed further and possibly expanded to cover recreational equipment and fees for use. There is a need to investigate the possibilities of visitor fees and the sale of publications targeted at foreign visitors as mechanisms for recurrent funding of the protected reserve system. The tourism sector, both local and international, can also have significant benefits for biodiversity. It needs to be developed within acceptable limits and carefully designed and managed to remain within the ecological and social carrying capacity of a particular area if the potential benefits are to be optimized without undue affects on the resource itself. In natural areas, appropriate tourism can not only inform the public of the need for the protection of biodiversity, but it can also encourage active support for wider conservation objectives. At the same time, it can also support the financial viability of protected areas through fees for use and by payment for the provision of services, particularly for recreation. Policy, administrative and enforcement arrangements need to be developed for the establishment of appropriate concessions and leasing activities. A necessary precursor to these activities targeting international tourism will be market research and analysis of the recreational opportunities of the existing system. Technical assistance for this research will need to be sought internationally.

**Box 8.8: Legislation Related to Protected Areas**

The Law on The Protected Areas or Territories of Ukraine was passed on June 16, 1992. It states that nature reserves, the protected zones of biosphere reserves, and lands granted to national parks are national property, but areas outside the strictly protected zones can be any form of property allowed by Ukrainian legislation. It declares the Ministry for Environmental Protection the responsible body for organization, protection and utilization of the country's natural heritage. Notwithstanding this, a number of individual organizations from different ministries have on-the-ground responsibilities for management of specific reserves. The legislation permits public organizations to participate in management of the reserves and territories fund to protect them or to participate in research.

The legislation provides for regulations to determine the regime of activities (commercial and industrial) which can occur in areas adjacent to those formally reserved. Regulations are formulated by the actual management authority of each protected area. Assessment of ecological impacts are required in restricted areas, and those activities which have a negative impact are prohibited. The actual size of a restricted area is determined by a special landscape analysis.

Financing of "natural heritage" sites is also considered. All income earned by a reserve is earmarked for retention by the reserve administration. "Ecology funds" are options authorized as a source of revenue; funds can come from penalties and fines, sales of confiscated equipment, pollution penalties imposed on industry and other enterprises, and voluntary donations. MEP is responsible for regulation of the funds.

The legislation also establishes mechanisms for the expansion of the network of protected areas, including an examination of the natural and cultural features of each area, an analysis of the economic impact of the expansion, and consultation with local authorities. Importantly, the legislation provides a mechanism in which the Minister can resolve land use conflicts related to a proposal. It also establishes a "security service" or enforcement organization under the control of each protected area administration.

A general provision indicates that Ukraine will enter into international agreements for nature protection, and the conditions (rules) of these agreements will have priority. Ukraine is not presently a signatory of the RAMSAR Agreement. but it does participate in the UNESCO Man and the Biosphere Reserve Program.

Legislation has recently been passed on wildlife protection, and further legislation on non-forest vegetation is currently under consideration. The former deals with changes in ownership of wildlife, administration of hunting, and changes in limits and licenses. It also indicates that the primary principle of the reserve system should be protection of habitat rather than wildlife *per se*. Both legislative initiatives call for specific measures to link strictly protected areas with corridors or areas of modified land use. This is an exciting concept with a very significant benefit for protection of biodiversity. It is a mechanism which could avoid remnant islands of protection which alone are unlikely to sustain a representative sample of flora or fauna. Associated with this approach is the possibility of providing an incentive to individual landholders, via tax relief, for setting aside small areas of their land for conservation purposes. These are innovative ideas for biodiversity preservation, even globally, given the limited experience with such practices throughout the world.

8.63 Studies elsewhere indicate that appropriate tourism is not a complete solution for conservation financing. Other sources of funding will remain necessary to maintain many of the protected areas which do not have a tourism capability. Moreover, tourism will provide little support if the benefits it generates are not channeled back into the protected area and the surrounding communities. One way of ensuring channeling is by earmarking revenues for park maintenance and community development. The earmarking provided for in the recent legislation is a significant step forward in this regard.

8.64 The recent legislation provides for the mechanism of establishing an "ecology fund", as a way to help finance activities in special areas. A fund has been established at Askaniya Nova. Initial funding came from a donation by a private individual from overseas, which was matched by funding from MEP. An international trust, is being set up to support activities in the International Carpathian Biosphere Reserve, which includes areas in Ukraine, Poland and Slovakia. Initial funding for the trust was recently granted by the MacArthur Foundation in the US, and supplemented further by the Global Environment Facility (GEF). Such international funding opportunities will offer a basis for initial financial support for selective areas.

8.65 **GEF Support.** Two areas of international ecological value in Ukraine are being supported by the GEF; both have been developed in cooperation with neighboring countries. The Transcarpathian Biodiversity Protection Project, which became effective in late 1993, provides US$0.5 million to support management and conservation activities in the Carpathian reserve and to create linkages with neighboring parts of the International Carpathian Biosphere Reserve. The Danube Delta Biodiversity Project, which becomes effective mid to late 1994, will assist the governments of Romania and Ukraine to implement a management plan for the Danube Delta, an area containing significant bird populations under threat. Funding of $1.5 million will be used for management activities in Ukraine's part of the delta.

**Training and Professional Development**

8.66 Most of the existing reserve managers and their staff have had some form of initial training as foresters. It is important now to introduce new aspects of wildlife sciences and conservation biology not only to the forestry curricula, but to other institutions of higher learning which emphasize, for example, zoology or environmental sciences. The curriculum for wildlife managers should be broader and inclusive of fundamental concepts and techniques in ecology, which are not currently addressed. Some of the most basic techniques of wildlife management are: harvest calculation; the inventory of forage composition; analysis of productivity, utilization and digestibility; and preference. There is no knowledge of emerging concepts of population founder effects, minimum viable population size, protected area architecture, and the facilitation of public participation.

8.67 **Training**. The priority for training should be on professionals already in the field to acquaint them with the following approaches:

- conservation biology and restoration ecology courses
- concessions and leasing and visitor management training programs
- management planning
- technical skills such as computerization
- project management and procurement
- communications and media development
- enforcement technology and policy
- methods to assure public participation

One approach to early introduction of these concepts, in a practical way, would be to try to arrange, with international assistance, a "sister forest program" matching forest types in Ukraine with those in Europe or the US and creating opportunities for field foresters to share their experiences. This could cover some of the very operational activities. Similar programs might be possible for other types of reserves and parks or for wetlands conservation. A concerted effort should be made to secure funds for overseas study tours for motivated individuals. Through international help again, a series of seminars could be organized in Ukraine to introduce staff to many of the current concepts of conservation biology and related ares of ecological management.

8.68 Ongoing training programs are essential if personnel are to remain current in their specialty and to ensure that skills are developed to meet emerging issues; such a system for managers and staff with specific courses for each management level should be a longer term aim. Local training in management and various skills could be developed from a needs analysis, with an emphasis on "training the trainer" in the initial stages. To develop this needs analysis and to implement training strategies, a training unit should be established in DPRA as a priority.

8.69 Obviously, it is also important to begin training new professionals or young people just seeking training to assure new approaches in the future. Over time, MEP might want to take the initiative to foster such curricular and vocational diversity, where such issues will not be an add-on activity in the shadow of commercial forestry and other agendas. The forestry curricula should be revised and entry level employment opportunities expanded to include a wider range of graduate specialties, eg. degrees in wildlife, appropriate aspects of forestry, veterinary wildlife, tourism management, recreation, business, etc. One initiative would be to enter into memoranda of understanding with foreign universities to simplify the exchange of scholars and students, mutual use of facilities and equipment, etc.

8.70 Entry-level employment in the future should go beyond the reserve and forestry systems to new fields which require environmental (including wildlife) scientists such as the conduct of environmental impact assessments, managing the marine environment, steppe management, the management of agricultural environments for biodiversity, coordination of waterfowl management with other flyway countries, marketing wildlife products, veterinary wildlife, the special enforcement needs of rare and threatened species, etc.

**Interpretation, Public Education and Visitor Facilities**

8.71 Many of the protected areas have established educational or museum centers which cater mainly to school groups. The facilities usually make extensive use of dioramas, which can be substantial installations. Most of them lack audio-visual equipment, although they usually have a pamphlet describing the reserve features. Only in some specific sites are the more passive interpretative approaches (including walking trails) developed. As most of the areas are still managed as strictly protected areas, opportunities to change visitor attitudes through recreation in the reserve are not developed. The number of visitors is low compared to neighboring reserved areas in the Carpathians and similar areas in Europe; these numbers have dramatically decreased in the last eighteen months reflecting the state of the economy. Visitor facilities are minimal, which also reflects the meager operating budgets of the reserve system. Visitor management and interpretative facilities will be of increasing importance with the expected increase in both local and international tourists. To gain full advantage, visitor and interpretive facilities, thematically based and interactive in nature, will need to be provided.

8.72 The Carpathian National Park is an exception. The visiting public, including alpine skiers, enjoys a number of opportunities to learn about the park through a well developed visitor center and free standing information boards. The park offers a considerable range of facilities, and the park director is well aware of the concession and leasing opportunities. Nonetheless, there is little experience with such arrangements, and the necessary checks and balances would need to be developed.

8.73 A system wide communications program to provide local and national support for the system of reserves is needed. It would include media relations, community information and extension, interpretation, environmental education and publications. It could be coordinated by DPRA, with implementation assigned to individual reserve managers In addition, field staff should eventually be trained in information/education techniques and media preparation. The objectives would be to promote public awareness, understanding and appreciation of the natural and cultural heritage; and to promote concern for its conservation.

**Research**

8.74 Successful conservation of natural resources stems from a sound knowledge and understanding of flora and fauna, their relationship in ecosystems and responses to externalities such as visitor use and pollution. Research, therefore, needs to include: surveys of the distribution of plants and animals; continuous inventory assessment; collection of data on visitation and assessment of the impact of such visitation on natural resources; methods of restoring affected areas; and the conservation biology of particular species. Given the paucity of resources, research must have the aim of providing data that will be of potential value in making management decisions. A guideline for research in protected areas should be that projects should only be undertaken where the scientific value of the project can be demonstrated and where the work is consistent with the management of the reserve.

8.75 Coordination of research and development of a strategic rationale is the responsibility of the DPRA, assisted by a small group from the Academy of Science. This group of ten people, consists of four specialists (botany/wetlands, zoology, geobotany and forestry), which are now trying to develop a scientific policy for the reserve system. Such a policy would form the basis for a more focused program of research. For example, it would be possible to develop individual research projects to determine minimum critical areas for the maintenance of individual populations. This could then be used in the revision and design of reserve boundaries.

**International Cooperation and Agreements**

8.76 Ukraine is not presently a signatory to the RAMSAR (Wetlands) Convention which requires each country to nominate wetlands of international importance and support their protection. Four sites were previously designated by the USSR as RAMSAR sites in Ukraine. These sites are still of international importance, and management of them has not changed. Ukraine is a signatory to the Biodiversity Treaty ratified at the UNCED conference (see Annex 6, Section F). Its ability, though, to meet the requirements of international agreements is constrained by the lack of resources. This is the reason it has not joined the RAMSAR agreement, and also affects its ability to meet the monitoring requirements required as part of the UNESCO Man and the Biosphere Program.

8.77 MEP has shown interest in signing the CITES Agreement[21] which regulates trade of endangered species, but to date the funds (about $10,000) to make an initial contribution and establish membership are not available. In Askaniya Nova, the rare Przwolski horse has reached numbers beyond the carrying capacity of the reserve. As Ukraine has not signed CITES, distribution of animals to other research and conservation institutions of CITES member countries in the original range of the animals cannot occur. This creates a dilemma for the reserve administration. CITES membership at this time is important as it would solve a number of developing problems with animals bred in captivity.

**GIS, Computerization and Information Systems**

8.78 The need for computerization of information and management systems is clear. Geographic Information Systems (GIS) are required to assist with the complex land use planning decisions which will be inevitable with the privatization of boundary areas (see description of GIS systems in Annex 6, Section F). Before equipment is purchased, it makes sense to design a system which has common data sets, can be used by field managers and has the capability to address priority problems in biodiversity conservation. It is recommended that DPRA prepare a computerization plan for the system of protected areas, addressing organizational needs and directed at the development of GIS, enforcement, licensing, concessionaire management, research and communication activities as well as administration and financial management.

## D. Game Management[22]

8.79 Formal hunting areas of the country total about 5 million ha, or between 8 and 9 percent of the country. About 550,000 hunters participate in hunting through four main organizations. The Ukrainian Society of Hunters and Fisherman (USHF) is by far the largest with over 87 percent of the hunted area, largely on collective farms. The Forestry, Military and the Police Hunting Clubs account for much of the remaining areas. These groups have significant social functions beyond hunting, and management is largely voluntary. The size of the hunting facility is somewhat dependent on the region, but they tend to run between 10,000 ha and 50,000 ha. With the confusion attending the distribution of private property, the areas are to be reorganized to smaller parcels. The Clubs employ a "Jaeger," or wildlife and hunting specialist to guard and inventory about 6000 ha in forest environments and about 10,000 ha in farmlands. MEP also employs Jaegers as wildlife inspectors. They check hunting club compliance, assist in animal damage control, and check on the effects of pesticides.

8.80 Damage by animals to forest regeneration and to field crops is significant. Animal damage control is loose and generally informal, although some compensation is agreed upon by the collective farms and the society who actually arranges killing the offending animal. This system is designed to prevent poaching and poisoning, and to avoid a compensation program administrated by the State. As with violations, courts are avoided.

8.81 The Protection and Use of Fauna Act of March 1994 introduces some fundamental changes in wildlife administration. Hunting facilities formally reported to the Ministry of Forestry, which had a

---

21/ The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) establishes lists of endangered species for which international commercial trade is either prohibited or regulated to combat over-exploitation.

22/ For information on game populations, see Annex 6, Section D, Table 4.

Department for Hunting Facilities. The new legislation is designed to account for new land ownership patterns, to transfer regulation of hunting from Ministry of Forestry to MEP, to change limits and licenses, and to reorient the entire approach away from solely management of species to managing habitats. Many of the administrative changes in the new legislation are yet to be implemented, though.

**National Issues**

8.82 Three major issues confront wildlife management in the Ukraine: (i) the nearly complete reliance on foresters for staffing field and management positions; (ii) the limited curriculum in this field available at only two forestry schools; and, (iii) the inability of the wildlife resource to pay its own way, even partially. The first two issues are common to wildlife managers, foresters and protected area managers, and specific recommendations have addressed the need to expand the forestry curricula. Some rigor and standardization in the requirements for a license would be an important step toward better management of the hunting facilities. For example, membership in a hunting society could reflect successful completion of a study syllabus, some written (as well as oral) graded questions, and a field practicum. Finally, carefully managed trophy hunting for profit (in foreign currency) and an innovative animal damage control research and development program will go part of the way toward enfranchising the sector and therefore addressing the last of the three issues. It is important to earmark the receipts for wildlife management or the funds will disappear into the general treasury: funding could come from local taxes on arms, ammunition, hunting paraphernalia, boats and fishing equipment.

# IX. MEETING INTERNATIONAL OBLIGATIONS



## A. Overview of Recent Agreements

9.0 Ukraine is a signatory to various international conventions, on its own right and as the legal successor to the Ukrainian Socialist Republic (UkrSSR).[1] Altogether, Ukraine has signed some 25 international agreements relating to the environment and natural resources. Box 9.1 lists some of the most recent.

**Box 9.1: Recent Agreements (Dates of Signature)**

Geneva Convention on Long Range, Transboundary Air Pollution (1979)
- Related EMEP Protocol (Monitoring and Evaluation) (1984)
- Related Protocol on Sulfur, the "Helsinki Protocol" (1985)
- Related Protocol on NOx (1988)
- Related Protocol on VOCs (1991)

Vienna Convention for Protection of the Ozone Layer (1986)
Montreal Protocol on Substances that Deplete the Ozone Layer (1988)
Convention on Biological Diversity, UNCED (1992)
Framework Convention on Climate Change, UNCED (1992)
Bucharest Convention on the Black Sea (1992)
Odessa Declaration on the Black Sea (1993)

Note: Not all have been ratified.

9.1 Ukraine has not signed and has no early plans to sign the Basel Convention on Transboundary Movement of Hazardous Waste. It is also not a member of the RAMSAR Convention or Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) because of lack of funds to pay the membership fees.

9.2 Right now, there is no clear legal authority in Ukraine for implementation of the agreements signed prior to independence. Moreover, MEP does not have the staff or institutional capacity to implement or monitor all existing agreements. It is most actively involved in GEF-supported activities related to the Black Sea agreements (see Chapter II). In addition, the new Law on Protected Areas or Territories of Ukraine appears to incorporate many of the provisions of the Convention on Biological Diversity (see Chapter VIII, Box 8.8 and Annex 6, Section F).

---

1/ Historically, the UkrSSR signed each agreement signed by the central government of the FSU.

9.3 With so many priorities domestically, it is difficult for Ukrainian authorities to focus on international obligations. Still, the government cannot ignore or remain unprepared in regard to transboundary and international issues. In this regard, it would worthwhile for MEP, along with the Ministry of Foreign Affairs and Ministry of Finance, to review and formulate positions on major regional and international environmental agreements. The commitments under three international agreements are discussed below, considering Ukraine's economic situation and environmental priorities and hence its ability to respond to the commitments entailed.

## B. European Protocols on Transboundary Pollution

9.4 Because of growing concern over damage from acid rain, the foremost transboundary air pollution issue in Europe is reduction of $SO_2$ and NOx emissions coming from power plants, industry, households and other small scale users of fuels, and motor vehicles. Ukraine is a signatory to European protocols in regard to transboundary $SO_2$ and NOx emissions.[2] According to Ukraine's National Report for UNCED, $SO_2$ emissions have been reduced by 36 percent and NOx emissions by five percent over the period 1980-1991. The $SO_2$ reductions were reportedly achieved through more use of natural gas in power stations. Such substitution makes sense because use of natural gas reduces particulates and other pollutants which are more serious contributors to local ambient pollution, as well as $SO_2$; it therefore represents a "win-win" measure. NOx emissions have reportedly come down as a result of technical improvements (some use of low NOx burners) in the electric power industry. Indeed, both $SO_2$ and NOx emissions may have fallen further as a result of the economic downswing and lower industrial production over the last two years, a situation which may continue over the medium term.

9.5 It is in the electric power sector where the pressure to reduce sulfur emissions is usually strongest.[3] Investments in flue gas desulfurization (FGD), considered the "best available control technology" (BACT), are very expensive and, in most cases, would probably not be part of a least cost strategy to meet local pollution abatement targets in a country such as Ukraine. Power plants in Ukraine have very high stacks, probably reducing the local impact, although, as noted in Chapter VI, better evaluatory procedures are needed to characterize the extent of local ambient pollution caused by emissions from power plants. In determining how to meet international obligations, authorities need to look at the range of options and their costs in a variety of industries and sectors to determine a cost effective way to respond to those commitments. Identifying further "win-win" measures, rather than installing expensive FGD units, is the practical approach. Such measures include: energy conservation, attention to improved coal quality, and perhaps removal of sulfur from oil products as part of refinery restructuring and modernization (see Chapter VI). In addition, over the next 10-20 years, progress in implementing economic reform could lead to structural changes in the economy, modernization and further energy conservation, all of which would lead to reduced $SO_2$ and other emissions in industry and other sectors. Reductions in NOx emissions would not be as great as those for $SO_2$ because of expected growth in automobile traffic over the longer term.

---

2/ Protocols to the Geneva Convention on Long Range, Transboundary Air Pollution (1979) commit signatory European countries to reduce emissions of $SO_2$ by 30 percent by 1994 and to stabilize NOx emissions by 1995.

3/ Not only is there pressure from international agreements, but also because of the desire of many CEE countries to align their policies with those of the EC. The EC's Large Combustion Plant Directive has very strict targets for $SO_2$ and NOx reductions and encourages EC members to adopt "best available control technology" (BACT) for all new and many existing large power plants (>300 MW).

9.6 The first effective period of the Helsinki Protocol ends in 1994, and a second sulfur protocol is expected to be drafted in the interim. Western European nations are likely to seek further reductions in "acidifying substances," although this second protocol is expected to consider internationally differentiated reduction targets, based on differences in costs of reductions and varying damage at different locations. Ukraine, along with other CEE countries, will want to participate in and influence the dialogue with the rest of Europe. If Western Europeans seek controls over and above what CEE countries can afford or seek to accelerate reductions which may be achievable over time through expected economic transitions, then creative arrangements--bringing additional aid to the resource-constrained CEE countries--should be considered.

**Possible Supporting International Arrangements**

9.7 In the context of bilateral aid, some direct compensatory arrangements for reductions in SOx and NOx may be negotiated (e.g. subsidized financing of specific investments). Because these arrangements still involve significant costs to the host country, though, the recipient government needs to make sure that the underlying investments make sense in terms of national priorities.

9.8 Various ideas have been discussed in international fora by which additional incentives could be provided to CEE countries to meet transboundary obligations. Most interesting is the possibility of negotiating offsetting arrangements or marketable permit programs, whereby Western European countries would buy allowances or permits from CEE countries because of the potential opportunities to reduce $SO_2$ and NOx emissions in the CEE at lower cost than in their own countries. The most forthright approach would be simply to allow Western European countries to meet their own national emission targets by funding emission reductions in CEE countries. A more sophisticated approach would be a formal permit trading program, with each country issued a specified level of permits but with the option of buying or selling them to meet target emission levels Allowing a market for the permits would encourage purchases of permits by those countries facing high cost emission reductions and sales by those countries with opportunities for lower cost emissions. A potential model for such a program is the recently initiated US $SO_2$ marketable permit program (see Chapter IV, Box 4.4).

9.9 A complicating factor in implementing such programs is that they would not address the problem of non-uniform impacts of emission reductions in different locations (due to varying loads and susceptibility to acid rain damage).[4] It may be possible, though, to devise adjustments in such programs to address such concerns.

## C. Commitments Under the Montreal Protocol

9.10 While part of the FSU, Ukraine signed the Vienna Convention and the Montreal Protocol, which set schedules for phase out of halons and CFCs. Along with Russia, however, it did not sign the two most recent amendments, those signed in London (1990) and Copenhagen (1992), which tightened the deadline for phase out, committing signatory countries to total phase out of halons by January 1, 1994

4/ EMEP and IASA have ongoing programs which try to analyze the differential impacts of acidifying emissions from and on different European countries. See Annex 2, Table 4 for the results for Ukraine.

and CFCs by 1 January 1996. Those amendments are regarded as adjustments which automatically apply to all original signatories.[5]

**Box 9.2: Concerns About Global Warming**

The last two years have witnessed a dramatic increase in worldwide concern over global climate change. Increases in atmospheric temperatures are expected to take place as a result of accumulation of "greenhouse gases" which deplete the stratospheric ozone layer, the earth's natural sunscreen, which filters the sun's ultraviolet rays. The magnitude of temperature increases and the environmental and economic costs are uncertain and are likely to differ substantially across regions. The main greenhouse gases are carbon dioxide ($CO_2$), methane, chlorofluorocarbons (CFCs) and nitrogen oxides. CFCs are the most common and widely used ozone-depleting substance (ODS). Both CFCs and halons (another family of ozone depleting substances) are expected to be phased out under the Montreal Protocol. $CO_2$ emissions are covered under the Framework Convention on Climate Change.

9.11 As long as Ukraine does not sign the abovementioned amendments, the country is not required to limit its consumption of HCFC and methyl bromide. However, it is *not* freed from its obligations to phase out the ozone-depleting substances regulated under the original Montreal Protocol (CFC-11, CFC-12, CFC-113, CFC-114, CRC-115, Halon-1211, Halon-1301 and Halon 2402) according to the accelerated schedule cited at para. 9.10.

9.12 Because of the economic crisis in Ukraine, very little has been done to implement the treaty, and actual progress towards substitution of ozone-depleting substances (ODS) is extremely limited. Ukraine is not a producer of the substances regulated by the Montreal Protocol; they are supplied mainly by Russian factories.[6] ODS are used, though, in several industrial sectors, the most important being the aerosol and refrigeration (domestic and commercial) industries, representing 22 percent and 68 percent respectively of total use; another 10% is used mainly in the solvents industry. ODS consumption in the foam sector is reportedly small to non-existent; this implies, however, that production within the refrigeration sector is based totally on import of prefoamed cabinets. The single most commonly used ODS is CFC-12, of which over 4000 tons p.a. was consumed in 1989-1991 (in aerosols and refrigeration primarily).

9.13 Total ODS consumption has been dropping since 1986 (when estimated usage was 9500 tons), largely due to economic factors and some limited conversion to non-ODS technologies in the aerosol

5/ In Copenhagen, the Russia Federation specifically asked for a postponement of the deadlines unless substantial foreign assistance could be provided to help the countries meet them, but this was not agreed.

6/ All production in the FSU comes from eight manufacturing sites in Russia. Present production of regulated ODS is about 90,000 tpa, down from 110,000 tpa three years ago.

sector.[7] Estimated 1991 consumption of ODS was in excess of 7000 tons, but consumption was almost halved in 1992 (3,878 metric tons), mainly as a result of the economic crisis.

**Constraints and Opportunities in Individual Sectors**

9.14 The constraints and opportunities in each of category of ODS use are somewhat different (see Box 9.3). As Ukraine moves to a market-based economy, there will be additional incentives to use non-ODS technologies because they are generally less expensive, and conversion usually offers a good return on investment.[8] This also presents opportunities for stimulating new business. *Typically, most conversion projects in the aerosol sector would be cost effective, while some projects in the foam, solvent and fire protection industries also offer interesting opportunities.* Local market distortions (such as price subsidies) will affect the potential financial gains from introduction of non-ODS technologies and can render them less attractive.

9.15 *In the aerosol sector, there are few if any technical constraints, and substantial phase-out has been achieved worldwide at low or negative costs.* Also, the alternative technologies are proven and available in the FSU. But efforts to introduce substitutes in the FSU, such as the common propane/butane hydrocarbon aerosol propellant (HAP), have so far met with mixed results, although Ukraine's National Report for UNCED (1992) comments that specifications for the use of hydrocarbon propellants have been worked out and approved, and the work in organizing production is underway. The aerosol industry in Ukraine comprises two factories, of which the Donetsk factory (domestic chemistry products) is reported to have recently converted to propane and butane. Other replacement technologies, such as mechanical pumps, have been considered and are being introduced in some manufacturing plants. Based on the experience of other CEE countries, the scarcity of capital may be the single most important constraint to full conversion to non-ODS technologies in the aerosol industry.

9.16 *In the refrigeration sector, the key issue is a technical one.* Substitution of ODS with non-ODS technologies remains in the early stages because of the need to redesign refrigeration appliances and adapt manufacturing facilities for eventual production of HFC-134a compressors, the new international standard. This requires substantially more engineering development work and thus substantial up-front costs. The shortage of financial resources in Ukraine has delayed the applied R&D needed to effect a shift in technology. Also, the availability of HFC-134a is a constraint, because it is not yet produced in the FSU. The Scientific and Technical Association of Household Refrigerating Engineering Manufacturers, comprising all the enterprises in the refrigeration industry in Ukraine has prepared various ODS replacement projects in collaboration with the Odessa Institute of Low Temperature Engineering and Energetics, the principal research institute in this field. Due to lack of finance, however, it has not been possible to implement even one single ODS replacement project at manufacturing enterprises.

---

7/ ODS consumption in the Ukrainian army and military-industrial complex under the Ministry of Defense is not included, since these units and enterprises are "closed."

8/ Safety concerns in the manufacturing environment cannot be neglected, though, as these substances are flammable.

**Box 9.3: Potential for Phase-Out of ODS in Individual Sectors**

**Refrigeration, Air Conditioning and Heat Pumps.** CFCs are used widely in refrigeration, air conditioning and heat pump applications. The refrigeration industry is the most capital intensive of ODS-using industries, as the value of refrigeration equipment within each country is valued at several billion dollars. CFC-12 is the most widely used refrigerant in domestic refrigeration, freezing applications (CFC-502 also common), cold storage and food processing. Central air conditioning systems for commercial and industrial buildings typically use CFC-11 as the working fluid. *Applied engineering work is required to adapt refrigerator and freezer manufacturing to production of the new HFC-134a compressor. Implementation of a recovery and recycling program for CFC refrigerants is urgently needed in order to satisfy the demand for CFC refrigerants in existing refrigeration applications and air conditioning.* This includes the introduction of improved servicing and maintenance procedures in order to recover substantial amounts of CFCs.

**Aerosol, Sterilants and Miscellaneous Uses.** CFCs have been used extensively in aerosol products, mainly as a propellant but also as a solvent or active ingredient. A wide variety of alternatives is available to substitute CFCs in virtually all aerosol applications: propane/butane mixtures (dependent on the availability of LPG), dimethyl ether, carbon dioxide, nitrogen, mechanical pumps and not-in-kind substitution (sticks, roll-ons, etc). *The availability of capital is really the only constraint to substitution.*

**Foam products.** Consumption of ODS by the foam plastics manufacturing industry is extremely varied. About 80% are used in building and appliance insulation. The various types of foam plastics have their own physico-chemical composition and foaming properties. In the flexible foam sector, the introduction of water-blown foam to produce soft foam products should be encouraged, possibly through a ban on the production of very soft foams. The use of HCFC or other chemical-based blowing agents is not recommended, given the cost and production-related health considerations. In the rigid foam sector, a 50% reduction can be achieved by introducing the widely-used reduced CFC foam formulations. *The final transition to non-ODS will depend on the results of experience with HFC and HCFC blends and complete water-blown rigid foams.*

**Solvents, Coatings and Adhesives.** CFC-113 and methyl chloroform (MCF) are widely used in the electronics industry and metal degreasing applications. MCF is also used in the production of adhesives, coatings, some aerosols and other non-specific applications. This industry is characterized by numerous small users. *Dissemination of technical information is the first step*, followed by demonstration projects and perhaps a technical clearing house, sponsored by an industry association.

**Fire Extinguishing Agents (Halons).** Halon 1211 and 1301 are widely used as effective fire extinguishing agents in protection of computer rooms and electronics, and also in transportation. Halon 1301 is also used in fire protection systems for cultural heritage, record, hydrocarbon transport and other miscellaneous applications. As these substances contain Bremine, they are aggressive in affecting the ozone layer. Halon 1301, for instance, has 10 times the ozone-depleting power of CFC-11. *Measures must be introduced to recover and recycle or destroy the large stock of halons which have been accumulated over the last few years. Participation in the planned international halon bank is an option worth considering.*

9.17 Ukraine's refrigeration industry is dominated by four factories manufacturing refrigerators and freezers (an estimated 2 million in 1993) and compressors (an estimated 1 million in 1993). None of them has been converted to ODS-free technologies. The domestic refrigeration industry is the largest segment within the industry. In 1993, the four factories exported 30-50 percent of their output, largely commercial refrigerators, of which 5-20 percent was exported to countries outside the FSU. Ukraine could lose all export business in the next few years if it cannot successfully convert to substitutes in the refrigeration sector. *Hence, there are strong commercial reasons for initiating the process of substitution as soon as possible.*

9.18 The country also needs to consider the problems of refrigeration servicing after 1996, when it is likely that Russia will no longer export CFCs, as called for in the Montreal Protocol. When refrigerators break down, the chemicals for continued operation will not be available.[9] The capital stock in refrigeration equipment is substantial; therefore, appropriate measures are needed to ensure continued operation of this equipment after 1996. At the present time, servicing and maintenance procedures, as well as refrigerant recovery, recycling and reclamation in Ukraine is reported to be unsatisfactory. *A comprehensive recovery, reclamation and recycling program is needed to ensure a supply of CFCs for those applications which cannot be adapted to the new non-ODS refrigerants.* Planning for such a program should get started soon. Also, retrofit technologies for large-scale refrigeration applications will also be required in order to minimize the scrapping of equipment with remaining lifetimes.

**Responsibility for Implementing the Montreal Protocol and Supporting International Arrangements**

9.19 MEP is responsible for implementing the Protocol. In December 1993, it issued an intra-ministerial order on the development of an ODS National Program for Ukraine. This was the first government initiative in support of the Montreal Protocol. The order establishes a working group, headed by MEP, to assist MEP in developing a national program.

9.20 The Interim Multilateral Fund (IMLF) has been established as a mechanism for funding ODS phase-out projects in developing countries which are parties to the Montreal Protocol. Eligibility for the program are based on UN income criteria, however, and most countries of the FSU, including Ukraine, presently do not qualify. Funds are available under GEF for assistance in preparing a phase-out strategy (what is called a "country program") and also for follow up projects to phase out ODS. Development of country programs for Russia, Belarus and Ukraine, supported by GEF, is commencing in 1994, and hopefully this effort will lead to identification of projects which can be funded under the facility.

## D. Reduction of $CO_2$ and Methane Emissions

9.21 Total carbon emissions from fossil fuel consumption in Ukraine are about 190 million tons (almost 700 million tons of $CO_2$) with more than 50 percent from the industrial sector. Thus, Ukraine is among the ten largest carbon emitters in the world, and only Russia and Germany emit more carbon in the CEE. This, of course, is related to the fact that the economy is so energy intensive (discussed in Chapter I and in Chapter V, the latter in regard to the steel industry). Carbon emissions per capita in

9/ Not surprisingly, the lifetime of a domestic refrigerator is increasing--from an estimated 15 years to an estimated 20 years.

Ukraine are as high as 3.6 tons, even with a relatively high share of natural gas in energy consumption, only exceeded by Luxembourg, Russia, Kazakhstan, and Czechoslovakia in the CEE (see Annex 2, Table 3).

9.22 Non-OECD countries are reluctant to take specific measures to reduce $CO_2$ emissions on global environmental considerations because of more urgent development objectives and the fact that the current stock of atmospheric emissions is considered a "responsibility" of the OECD countries.[10] Nevertheless, non-OECD countries, and particularly the states of the FSU and Eastern Europe, will probably achieve substantial reductions over the next 10 to 20 years by policies that make economic and local environmental sense. *Such policies include: (i) removal of subsidies on fossil fuels and fossil fuel generated electricity; (ii) removal of non-price barriers to energy efficiency; and (iii) changes in macroeconomic policy and steps towards economic reform, which will bring structural changes and create greater accountability among energy users.* A recent estimate[11] suggests that the FSU as a whole could reduce carbon emissions by one third by removing fossil fuel subsidies, given that 1991/92 energy prices were as low as 10-15 percent of world prices.[12] Another estimate suggests reductions of over 40 percent would occur as a result of macroeconomic adjustments, energy subsidy removal, and imposition of energy taxes.[13]

**Possible Supporting International Arrangements**

9.23 To achieve greenhouse gas emission reductions above and beyond what can be realized by policies that make economic and local environmental sense, some form of compensation from OECD countries would be expected, perhaps determined in a broader international treaty on greenhouse gas reductions. The problem of compensation might be solved by programs such as tradeable carbon (and methane) emission permits (similar to concepts suggested for reducing transboundary $SO_2$/NOx emissions). Tradeable permits offer the potential of cost efficient carbon emission reductions. OECD countries would find such an arrangement desirable if the cost of emission reductions in non-OECD countries are lower than in their own countries. Non-OECD countries would benefit if the value of financial transfers exceeds the cost of emission reductions; these countries could also target reductions on the basis of various considerations (local environment, energy security etc.) in addition to the market value of the tradeable permits. A permit trading program for $CO_2$ emissions is easier to design than that for $SO_2$ and NOx emissions because there are no complicating site-specific concerns.

---

10/ The contribution to increases in atmospheric $CO_2$ concentration over the period 1800-1988 from fossil fuel combustion in OECD countries is 65% of the world total; their contribution to current annual emissions (1988) represents 45%. A. Grubler and N. Nakicenovic, "International Burden Sharing in Greenhouse Gas Reduction," Draft, World Bank, 1992.

11/ B. Larsen and A. Shah, "World Fossil Fuel Subsidies and Global Carbon Emissions," World Bank Policy Research Working Paper Series, No. 1002, 1992.

12/ This analysis assumed a long-run constant price elasticity of energy demand of -0.15. Such a reduction would imply a reduction in the energy intensity in Ukraine from 2.63 koe/US $ to 1.8 4 koe/US $, still about three times higher than that for the average upper middle-income country.

13/ G. Hughes, "Cleaning up Eastern Europe," Finance and Development, September 1992.

**Box 9.4: United Nations Framework Convention on Climate Change**

The main provisions of the Convention call for the following actions:

- development of national inventories of emissions of greenhouse gases by sources and removals by sources;
- institution of measures to mitigate climate change and to facilitate adoption;
- application of processes to control emissions in all relevant sectors;
- sustainable management and conservation of sinks and reservoirs of greenhouse gases;
- inclusion of climate change considerations in social, economic and environmental policies;
- cooperation in the adaption to climate change;
- cooperation in research, exchange of information, education, training and raising public awareness.

It is expected that the Convention will enter into force in 1994.

Source of Box: "Environmental Action Program for Central and Eastern Europe," Chapter VI-XIX, Lucerne, Switzerland, 1993.

9.24 An international treaty on tradeable $CO_2$ permits is unlikely in the next few years, however. Perhaps a more promising strategy in the short term is a proposal initially suggested by Norway that would allow OECD countries to meet their own national emission targets (at least in part) by financing emission reductions outside their own national territory. Countries would then bilaterally agree on the terms, with expectations that the net benefits are positive for both parties.

# X. SHORT TO MEDIUM TERM PRIORITIES

1. Policy Changes and Reform Efforts
2. Regulatory Policy and Infrastructure
3. Needs of the Ministry for Environmental Protection
4. Modern Epidemiology and Environmental Health
5. Pilot Regulatory Programs in Selected Cities
6. Short Term Action Plans in Industry and Energy Plants
7. Short to Medium Term Steps for Water & Wastewater Treatment
8. Short Term Actions for Hazardous and Solid Waste Management
9. Dnieper River Management
10. Management of Other Key Waterbodies
11. Priorities for Investment in Municipal Water & Wastewater Treatment
12. Priorities for Investments in Industry
13. Environmental Considerations in Privatization
14. Priorities for Pollution Abatement in the Thermal Power Industry
15. Nuclear Safety
16. Actions Concerning Chernobyl
17. Agriculture
18. Forestry
19. Protected Areas
20. International Obligations

## 1. Policy Changes and Reform Efforts

Efforts to reform the economy will have an important impact in easing environmental pressures. It is extremely important therefore to move ahead with economic reform, in particular the following:

- Take steps towards macroeconomic stabilization and development of financial markets.
- Encourage privatization in order to introduce greater accountability in enterprises and to spur creation of new economic activities and new investment.
- Encourage prompt adjustment to higher energy prices and allow adjustments to economic prices for water and other material inputs to encourage operating discipline and more attention to conservation.
- Create an appropriate safety net, restricted to the truly needy.

## 2. Regulatory Policy and Related Infrastructure

This transition period, especially the next five years, provides an opportunity to strengthen regulatory infrastructure necessary for practical and effective environmental management. Areas where changes are recommended are the following:

- **Environmental Legislation**

  - Consider restricting the volume of proposed environmental legislation, in favor of drafting implementing rules and procedures to make legislation more specific, incorporating some of the recommendations mentioned below in regard to standards and regulatory policy.

  - Introduce legislation regarding hazardous waste management and prioritization of clean up; also clarify the liability of new investors regarding contaminated sites due to past pollution.

  - Seek external support for a part-time legal advisor or a working group of external advisers to provide comments on proposed legislation or legal aspects and to offer comparative approaches.

  - Limit the overly ambitious scope of EIA obligations in draft legislation. A more practical approach would be to require complete expert assessments of major projects and only a simple public statement of expected impacts for minor projects. The permitting process, rather than a full blown EIA, would take care of ongoing regulation.

- **Standards**

  - Revise and limit the number of ambient standards to those which are most critical, and which can be realistically monitored and enforced, thus making the regulatory program more effective.

  - Draw from the health-based standards of the EC or the US, or selectively from both, adapting them to Ukraine's particular needs and establishing a suitable phase-in period. Avoid trying to enforce strict standards during the transition period.

  - Augment the present system by selectively setting technology-based standards for: (i) industries emitting persistent toxics, and (ii) different categories of wastewater dischargers (minimum technology standards would be appropriate, rather than trying to achieve advanced forms of treatment).

- **Improvements in Monitoring and Regulatory Techniques**

  - Make more effective use of current resources and facilities for ambient monitoring, by integrating existing monitoring and analytical activities scattered in various agencies and redirecting them to address regulatory objectives, while at the same time preserving the

current strengths of individual agencies (e.g. Hydromet). In the process, introduce improved quality control and siting practices as well as reporting procedures. Selectively upgrade monitoring and testing equipment.

- Develop better air emission and discharge inventories at the plant level, perhaps using techniques used in other countries.

- Experiment with a combination of analytical techniques for improved site characterization and development of short and long term plans for pollution abatement at priority sites.

- Establish one national laboratory, equipped with modern instrumentation and staffed by trained technicians, to ensure quality control in testing for water and air media particularly, and to provide training.

- **Specific Recommendations Concerning Air Quality Regulation**

  - Reconsider existing 20-minute standards, which have no relation to health impact. Develop a small set of ambient standards for general air pollutants. Develop technology based standards for key hazardous emissions.

  - Eliminate reliance on sanitary protection zones. Emission limits should be developed such that ambient air quality standards are attained on all land not under ownership of the polluting enterprise.

  - As an immediate priority, try to upgrade particulate monitors, moving to high volume particulate samplers typically used in the EC or US.[1] The siting of monitors also should be reexamined; some are too low or are situated close to roadways. MEP branches would also benefit from selective use of mobile emissions monitoring vans.

  - Improve quality control procedures for samples.

- **Specific Recommendations Concerning Water Monitoring**

  - Integrate water quality monitoring systems, building on the strengths of existing systems but tailoring their activities more to pollution control and environmental planning. A revised system--defining the network of sampling stations, sampling frequency, parameters monitored at each point, level of automation, etc.--needs to be designed with a view to cost effectiveness. Monitoring and laboratory equipment should be upgraded after a revised monitoring system and its objectives are defined.

  - Expand water quality monitoring to include biological indicators. Biological material and sediment samples should be collected on a regular basis for analysis of inorganic and

---

1/ Over time, as resources permit, MEP will want to install real time automatic monitoring equipment for gaseous pollutants in major industrial complexes. For the present time, continued use of wet chemistry methods is satisfactory, albeit with improved quality control of samples.

organic micropollutants. Testing for synthetic organic chemicals, especially solvents and pesticides, should be expanded.

- In monitoring for inspection purposes, include other locations besides official discharge points in order to track deliberate permit violations or discover previously unknown discharges. Control monitoring should be done closer to the processes themselves.

- Include some non-fixed station monitoring activities for special surveys of waterbodies of particular interest, from time to time.

- **Specific Recommendations Concerning Hazardous Waste Management**

  - Begin to develop a legal and regulatory framework for hazardous waste management, including guidelines for clean up (eg. setting practical "low cost containment" targets).

  - Begin to develop an inventory of hazardous waste sites, focusing on those that are suspected to be immediately dangerous to health through an initial screening exercise; prioritize the sites by further evaluation of the health risks. This too could start with some pilot programs.

- **Permitting and Compliance**

  - Seek authority to place conditions on individual permits, violations of which can be sanctioned independently of overall emission or discharge limits.

  - Work with industries to develop detailed, realistic compliance schedules, preferably based on revised standards and, where possible, improved site characterization. Include in these schedules short term action plans which can be taken immediately. In the permits, allow for incremental stages at which to monitor progress and apply sanctions.

  - Support opportunities to make small or intermediate technical investments.

  - Require investments in modern pollution control (although not necessarily the most advanced technology) when major capital investments at a plant are undertaken.

  - Make permitting requirements public.

  - Seek authority for multiple factor penalty calculations which allow fines and other penalties to be adjusted upward or downward in appropriate cases.

- **Pollution Fee System**

  - Direct a larger percentage of fee revenue to MEP oblast and local branches to finance regulatory programs.

  - Reduce the number of pollutants in the program but raise fees on those remaining and adjust periodically for inflation.

- Increase fines under the fee system.
- Reduce exemptions under the program.

- **Market Based Instruments**
  - Explore opportunities to introduce permit trading or offset programs for air quality regulation over the medium to longer term through some pilot programs, after the basic regulatory infrastructure has been strengthened.

- **Ecology Funds and Ecological Bank**
  - Set specific criteria for use of resources from local ecology funds, focusing on support for small investments which are quickly achievable (e.g. supporting short term action plans in plants or small environmental investments to improve a plant's privatization prospects).
  - Instead of a narrow ecological bank, consider establishing a regional or municipal development bank, with a broader mandate and opportunity for risk diversification. Lend only to commercial entities, likely to repay the loan, at commercial rates.

- **Public Participation**
  - Develop specific mechanisms for public information and participation in the regulatory process.

## 3. Needs of the Ministry for Environmental Protection

- **Division of Responsibilities Between Center and Local Branches**
  - Give responsibility for actual implementation and enforcement to MEP's oblast and municipal branches, as pollution abatement activities must be planned and undertaken at local levels. The central office retains oversight responsibilities and responsibility for legislation, rulemaking and other policy considerations.
  - In order to strengthen inspection capabilities at the local level, work towards the following targets:

    (i) Increasing staffing at oblast and municipal levels so that no single inspector handles more than 20-40 sources depending on the size and complexity of the sources.

    (ii) Providing training for all inspectors in modern regulatory techniques and on the features and operation of control equipment and the industrial processes they are expected to regulate. This training should be an

ongoing process to update and refresh their skills on an annual or biennial basis.

- Consider giving local governments the ability to adopt more stringent standards over time. They should not have the power to weaken national norms, however.

- **Basic Administration and Training**

  - Begin to decentralize authority within the Ministry and improve the budgeting system so that managers know what resources they have to implement tasks and responsibilities assigned to them.

  - In parallel with making improvements in evaluatory techniques, improve information management systems (with acquisition of more computers over time) so that data on emissions and discharges and on permits can be accessed and exchanged between the oblasts and the center.

  - Perhaps through the new Environmental Education Center, develop training modules for staff which: (i) acquaint managers and staff with environmental management approaches in other countries; (ii) provide basic training in regulatory tools and techniques; (iii) build expertise, particularly among inspectors working with industry, in environmental auditing techniques, in process and control technologies for different industries, and on cross media issues in specific industries; and (iv) provide training in natural resource management techniques for staff working on protected areas and agricultural/forestry issues. Supplement this training with carefully designed study tours abroad to demonstrate new approaches or technical opportunities.

- **International Programs and Assistance**

  - In seeking international assistance most effectively, establish a working group within the Ministry, perhaps under a Deputy Minister, which would include representatives of various functional departments and participants from oblast and municipal branches. This would be a means of assuring that proposals for international assistance reflect the true needs of "on the ground" regulatory authorities and that assistance programs are well integrated with primary activities within the Ministry. Such an arrangement could also help to coordinate better various bilateral and international aid programs.

  - Assure that functional experts and representatives of MEP branches in cities affected participate actively in international programs (e.g. representatives of coastal cities for the Black Sea program).

## 4. Modern Epidemiology and Environmental Health

- Introduce controlled studies, collaboratively with external colleagues, to test the results of some of the studies and data developed by Ukrainian health experts, using modern statistical and risk assessment techniques. The results of such studies should be released to the public.

- Introduce academic training in modern epidemiological methods.

## 5. Pilot Regulatory Programs in Selected Cities

(combining activities mentioned under other headings)
It is not going to be possible to tackle all problems at once. It is strongly recommended that MEP:

- Select one or two priority cities to experiment with improved air quality, water quality and waste management programs, to include: (i) agreement on short-term action plans in industry and municipal water & wastewater treatment plants; (ii) introduction, selectively, of improved monitoring and analytical equipment and modeling techniques to characterize pollution problems more accurately; (iii) evaluation and prioritization of pollution investments, considering health impact and cost effectiveness, and (iv) preparation of pollution abatement plans over medium to long term.

- Industrial cities, which are priorities, include: Zaporizhzhia, Donetsk and communities nearby, Mariiupil, Kryvyi Rih, Dnipropetrovsk/Kamiansk, Odessa.

## 6. Opportunities for Short-Term Action Plans in Industry and Energy Sectors

- Put in place a process to encourage or require short-term action plans in major industrial and energy related plants or operations,[2] encompassing a series of low-cost measures to improve safety, reduce pollution in the workplace, and achieve energy & water savings. Consider requiring these plans in current environmental permits.

  - Create incentives for such programs, e.g. provide some counterpart funding from local ecology funds. Seek matching funds from international donors for technical assistance and small equipment needs.

  - Conduct environmental/operational audits of participating plants.

- At Kostiantynivka, conduct blood lead testing in workers and children in the community and soil sampling to determine the health impact from lead and other emissions from longstanding operations of the secondary lead/zinc smelter there. International assistance is also needed for a detailed environmental audit and evaluation of the economic viability of the smelter with a view to determine whether or not to continue operations.

- Take steps to improve safety in the coal mining industry.

- Conduct a hazard and risk assessment of the pressurized ammonia pipeline which crosses the country. The study should include an evaluation of the following: design, construction and installation of the pipeline (and provisions for land subsidence along the route); safety features

---

2/ Particularly in metallurgical (non-ferrous and ferrous) and chemical industries or plants where hazardous substances are used.

of the system; corrosion prevention and detection of leaks or ruptures; and emergency shutdown systems and evacuation procedures.

## 7. Short to Medium Term Steps in Municipal Water Management

- Begin the process of strengthening and commercializing municipal utilities (Vodokanals) and phasing in modern tariff structures to achieve cost recovery and internal generation of funds which can be used for capital investment.

- Identify and implement low cost operating and technical improvements in the following areas:

**Water Treatment**
- water conservation and attention to low cost ways to achieve leakage control[3]
- improvements in filtration and sludge control/disposal
- better instrumentation and controls

**Wastewater and Sewerage Treatment**
- improvements in anaerobic sludge digestion (including aeration efficiency)
- mechanical dewatering of sludge
- utilization of methane gas for power generation in plants

**Pretreatment of Industrial Wastewater**

- Early opportunities for cost effective pre-treatment of wastewater at industrial plants (large and small) discharging into municipal sewage plants or directly into rivers should be considered.

Priority cities include: Zaporizhzhia, Odessa, Mariiupil, Dnipropetrovsk, Kryvyi Rih.

## 8. Short Term Actions for Hazardous and Solid Waste Management

- Introduce programs at the municipal level to separate wastes in order to manage them more cost effectively.

- As far as possible, identify low-cost containment measures to avoid health risks from hazardous waste sites, leaving more expensive clean up to the longer term.

- Introduce some pilot recycling programs (and related incentives) for hazardous chemicals or materials, as a way to reduce careless, haphazard disposal, funded by deposit-refund schemes or taxes on such products.

---

3/ Recognizing that a program of leakage control can be very expensive.

## 9. Dnieper River Management

- As an immediate priority, with an external donor as partner, conduct a joint sampling and analysis mission along the southern reaches of the Dnieper River to make a baseline assessment of water quality and to introduce modern equipment and sampling techniques.

- Concentrate on identifying problems and taking short term actions in a sub-basin of the river, the industrial south where the most serious problems appear to lie.

- Develop over the medium term a basin-wide plan for Dnieper River management, including strengthening the river management authority, emphasizing greater coordination of water use and water quality management.

## 10. Management of Other Key Waterbodies

- Over the medium term, develop action plans for water pollution and water shortage issues for the catchment or subcatchment areas of the Inhulets River in Dnipropetrvsk Oblast and the Siverskodonets River in Kharkiv and Luhansk Oblasts. The study of the Inhulets should be done in conjunction with evaluation of the iron ore mining and metallurgical industries of Kryvi Rih.

- Perhaps as a regional effort under the Black Sea Program, undertake a study to identify opportunities to address the problem of fishery declines in the Azov Sea, thus to revise the economic potential of this waterbody.

## 11. Priorities for Investment in Municipal Water and Wastewater Treatment

Water and wastewater treatment is very expensive, and it will take time for utilities to build up a self-financing capability to afford major investments. Regulatory standards should not be pushing plants to invest in high cost advanced treatment facilities, but rather to put basic facilities in place. Priority cities for modest water or wastewater treatment investments (based on what is most cost effective) include:

| | |
|---|---|
| Top priority: | Zaporizhzhia, Odessa, Mariiupil, Dnipropetrovsk/Kamiansk, Sevastopil, Kryvyi Rih, Lysychansk-Rubizhne area (Luhansk Oblast) |
| Second tier priority: | Kharkiv, Kiev, Yalta (because of its high touristic value). |

## 12. Priorities for Investments in Industry

- Emphasize *first* improved particulate control in plants.

- Establish a policy of requiring investments in modern pollution control ("best practical" technology) in parallel with new capital investments at plants. Older plants, not contemplating new investments, should be held to their respective compliance schedules.

- Because of the health impact, give attention right away to known sources of hazardous emissions: lead and aluminum smelters, coke ovens, some chemical plants, and various workshops in steel plants emitting heavy metals or trace hydrocarbons. These plants are priority candidates for short term action plans. They are also candidates for early review of their business prospects and long term viability. If a plant is likely to continue for many years, despite its lack of economic viability, larger investments to reduce the hazardous emissions may need to be considered in order to reduce health risks further (eg. installation of improved dust filters which also act as a barrier for lead, mercury and other heavy metals should be considered first).

- Steps are needed to address underlying structural and technological problems in key industries which also contribute to serious pollution problems. This will take a long time and environmental compliance schedules for major investments will need to be realistic. Key industries in this regard are:

  - Steel and coking industries
  - Coal industry
  - Iron ore industry
  - Segments of the chemical industry

- In regard to conversion of military industries and related manufacturing facilities, identify opportunities to encourage development of manufacturing capabilities for a variety of environmentally friendly equipment: meters and control equipment for energy and water savings; improved monitoring and analytical equipment; modern pollution control equipment; and lighter, more efficient farm and forestry equipment.

## 13. Environmental Considerations in Privatization

- Reconsider elements proposed under April 1992 proposed foreign investment rules.

- In a limited number of industries, where the most hazardous pollution problems may exist, consider partial indemnification of investors (domestic and foreign) for state-mandated clean up of contaminated sites resulting from past pollution and for any third party liability which may arise, based on an application by the investor within a specified time frame. The intent would be to negotiate an arrangement whereby the investor agrees to take relatively low cost measures to contain dangerous contamination on site and to relieve the worker environment, while avoiding being saddled with the cost of an expensive full clean up program. This would

balance the interests of the state to address immediate pollution problems having an impact on health with its desire to create certainty for investors and maximize the proceeds from privatization. Baseline surveys through environmental audits would need to be undertaken, although screening procedures could be used to dictate the extent of the audit necessary in each transaction. This approach demands close cooperation between privatization and environmental authorities.

- As part of this program, consider the following additional steps: (i) requiring environmental information in the privatization plans of medium size and large scale enterprises; (ii) establishing an environmental unit within the privatization agency (the Polish approach); and (iii) dedicating a small percentage of privatization proceeds to a general clean up fund, to be used at priority sites.

- Issues concerning ongoing pollution would be addressed through the normal permitting process.

## 14. Priorities for Air Pollution Abatement in the Thermal Power Industry

- Emphasize *first* improved particulate control at electric power stations (including options other than "end of pipe" controls; see below).

- Encourage development of a coal market and greater coal blending and washing to reduce ash and sulfur content of the coal used, consistent with the requirements of the boilers and control equipment.

- Emphasize better furnace operation to reduce emissions, using tools such as combustion analyzers.

- Improve system operation as far as possible (consistent with overall system planning), to avoid extensive diurnal cycling of coal fired plants to reduce emissions.

- Improve monitoring and site characterization at individual plants to understand better the impact of emissions, as part of necessary planning before making major control investments, e.g. in regard to SOx and NOx control.

- Experiment with lower cost technology options for $SO_2$ and NOx control[4], which would achieve significant emission reductions, but at lower cost than the highest performing technologies.

- Train power station staff and regulatory authorities in fuel blending strategies, improved operating techniques and stack opacity inspection.

---

4/ Especially low NOx burners, as the technology exists in Ukraine.

## 15. Nuclear Safety

- Close remaining units at Chernobyl by end-1993.
- Improve the safety procedures in remaining plants, with stricter supervision by regulatory authorities and heavy penalties for non-compliance.
- Develop and publicize a plan for phase-in of investments in safety upgrades.
- Undertake a study of solutions for management of low, medium and high-level nuclear wastes, including spent fuel, in the event that disposal in the Russian Federation is no longer an option.

## 16. Actions Concerning Chernobyl

- Undertake a pre-feasibility study to analyze potential problems concerning the sarcophagus over unit 4 to evaluate carefully the extent of problems, consider options for their solution, and select the most cost effective solution.
- In the 30 km. zone, take only low-cost containment measures, as needed, as the cost of full clean up would be prohibitively expensive at this time.
- In other areas, with varying degrees of contamination, increase attention to good controls over food production. Check quality assurance procedures in food control regularly, perhaps with external assistance periodically.
- Introduce modern epidemiological studies and techniques through collaboration between the Ukrainian and foreign health experts in order to establish more clearly what the health impacts from Chernobyl are and what are the ongoing health risks. Publish those results as part of a public information campaign.
- In selected communities, collaborate with external experts to confirm current levels of surface contamination, improve estimates of internal doses, and thus assess better the overall expected human dosage of people living in areas categorized as contaminated. These studies should be conducted using modern monitoring equipment and selectively employing whole body monitoring and body dosimeters (TLDs).
- In parallel with reconfirmation of data, consolidate existing monitoring and health data into a consistent and comprehensive database, so that all information concerning Chernobyl effects is readily accessible.
- With information from the epidemiological and contamination/dose studies, re-examine the existing compensation program to make it more cost effective and affordable.

- Be selective in taking remediation measures in areas outside the 30 km zone, choosing those which are low cost, cost effective and sensible in reducing health risks, based on internationally accepted measures, or which offer opportunities to utilize the land productively. Classify hazardous nuclear wastes using international standards as a first step in distinguishing how to contain or dispose of wastes of varying danger.

## 17. Agriculture

- In parallel with changes in ownership of farms, establish new forms of extension services or other means to reach the farmer and introduce new approaches, including developing close ties with both government and university research institutes on a more practical basis.

- Design and introduce a pilot program (at a selected cooperative farm, which is also incorporating some privatization measures) to demonstrate the potential for transitions to reduced tillage systems and low input agriculture.

- Introduce procedures for better land management practices in conjunction with privatization legislation, including putting marginal lands into forest areas, shrubs or grassland and protecting reserved areas and associated buffer zones.

- Create incentives for planting of shelterbelts and land retirement programs for high-potential habitat.

- Devise a strategy for creating a domestic capability to produce tools and equipment needed for reduced tillage and low input agriculture, as demand for such equipment emerges over the medium term.

## 18. Forestry

- Encourage professional development and training programs which introduce new forestry management techniques, particularly restoration forestry and multiple use concepts (forestry management for many uses). Foresters are the largest managers of natural resources, and conservation therefore should be practiced on managed as well as protected areas.

- Introduce improved planning and economic valuation techniques to guide forestry operations.

- Introduce modern harvesting techniques and related modern equipment (but not necessarily the most advanced equipment).

- Strengthen the inspectorates within MEP to enforce forestry regulations and penalties to protect nature reserves and parks.

- Encourage commercialization and marketing of minor forest products.

## 19. Protected Areas

- Undertake a review of emergency needs in the protected areas and wetlands during the transition period to avoid irrecoverable damage or neglect in these areas.

- Seek greater authority by MEP's Department of Protected and Recreational Areas over the protected area network, while maintaining the current decentralized "on the ground" management of the reserves. With some transfer of resources and increases in staff, enable MEP to take a greater role in management and planning to assure that the objectives of the reserves and biodiversity protection are met.

- Develop greater cooperation between protected areas experts and forestry experts, starting with joint training.

- Identify financing mechanisms for protected areas (ecotourism, visitor fees, concessions and leasing).

- Develop communications programs and avenues for community input, to create a more sustainable balance between nature reserves and nearby communities and their economic activities.

- As soon as resources permit, become a member of the RAMSAR Convention and CITES.

## 20. International Obligations

Ukraine is a signatory to various international obligations. In view of severe resource constraints, it needs to find a strategy vis-a-vis these obligations which coincides with domestic priorities.

- **Geneva Convention on Long Range Transboundary Air Pollution**

  - Work more closely with EMEP and IASA to understand better transboundary pollution coming into or exported from Ukraine.

  - Identify "win-win" measures to reduce $SO_2$ and NOx emissions: e.g. energy conservation, improvements in coal quality, and reduction of S in oil products.

  - Investigate opportunities for multilateral permit trading or offset programs to reduce transboundary pollution.

- **Montreal Protocol**

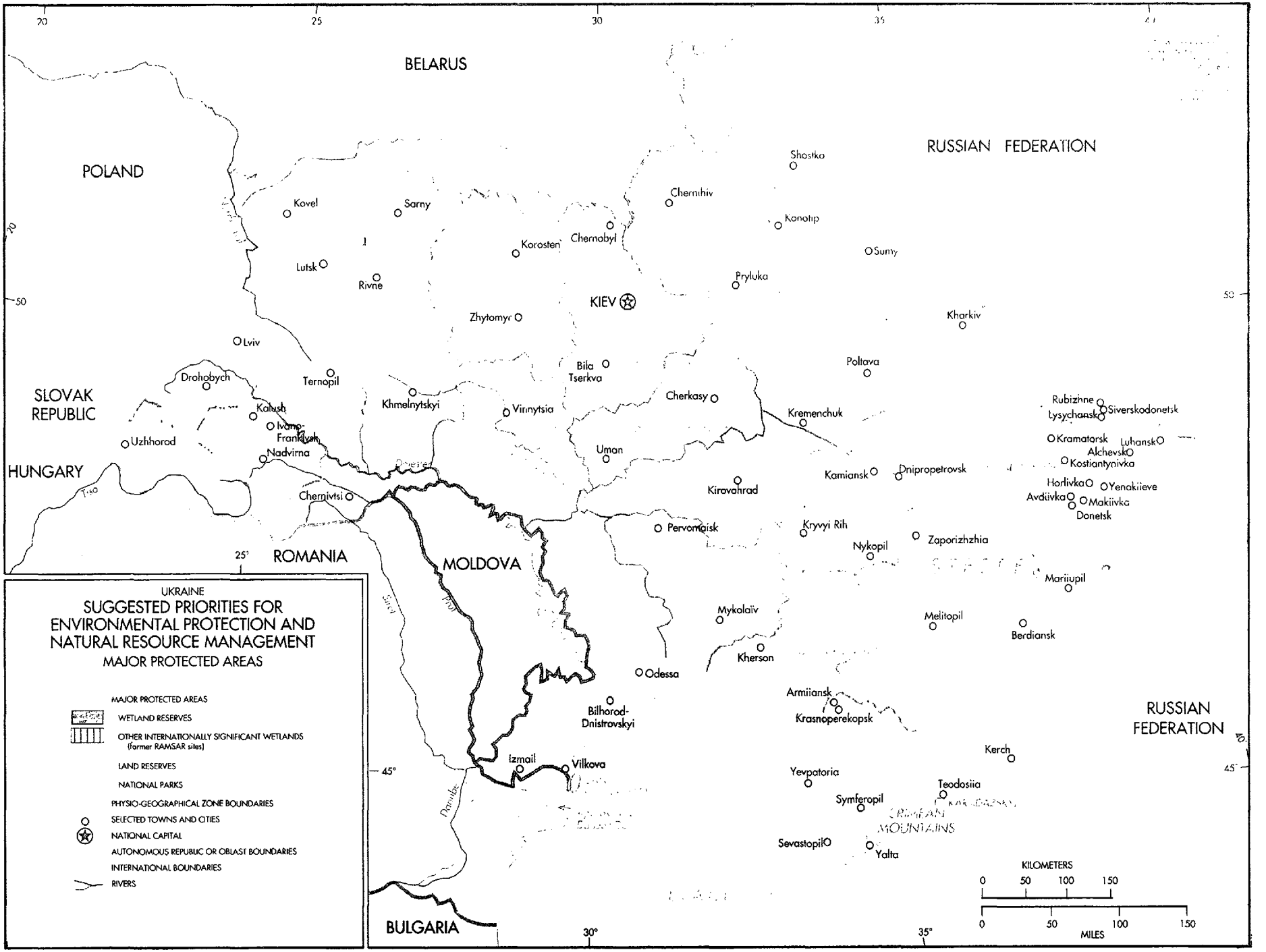
  With GEF funding available, develop a country strategy in regard to ODS phase-out over a realistic time frame and identify small phase-out projects which could be beneficiaries of GEF projects. In devising a country program, the following should be considered:

  - Profitable opportunities for ODS phase-out in the aerosol sector.

- Technical constraints and financial costs of switching to production of HFC-134a compressors in the refrigeration sector.
- Steps needed in developing a recovery and recycling program for CFCs for refrigeration servicing after 1996.
- Opportunities for phase out in other sectors.

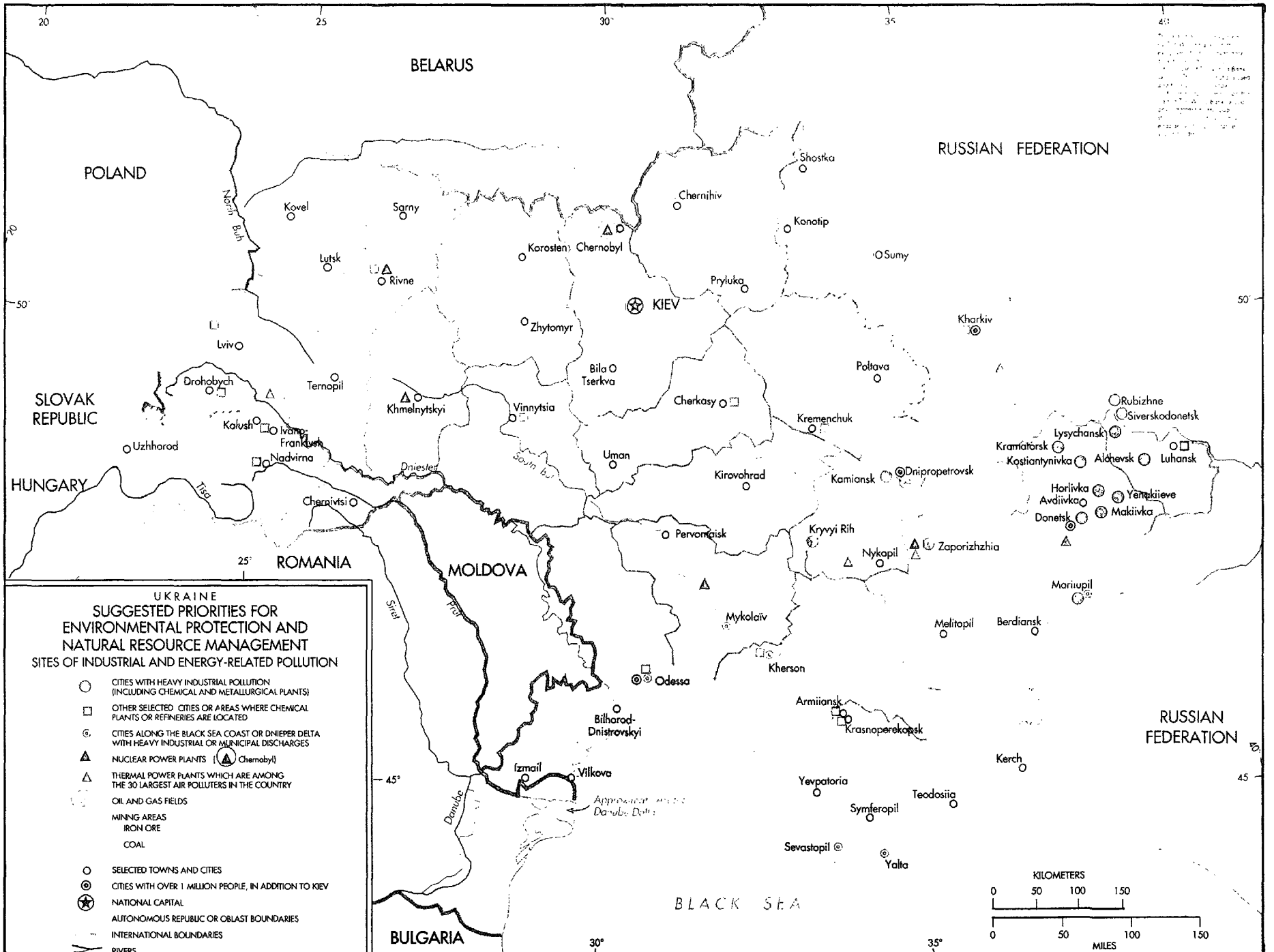
- **Framework Convention on Climate Change**
  - Concentrate on energy conservation and structural changes which will reduce energy intensity and consequent carbon emissions.
  - In international fora, investigate opportunities for multilateral permit trading or offset programs to reduce carbon emissions.

IBRD 24250




JUNE 1993

IBRD 24249




JUNE 1993