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TECHNICAL REPORT

Summary Report
Task 4: Air Pollution Reduction

by John Castleberry - July 1997
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Prepared by.
Regional Field Office, Moscow, Russia
Environmental Policy and Technology Project
A USAID Project Consortium Led by CH2M HILL

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EPT Regional Director

7 August 1997
Date

Executive Summary

The strategy of the air pollution task in Novokuznetsk was to (1) assist the City in establishing a visible emissions (VE) monitoring program; (2) design and implement a comprehensive air emissions inventory system, (3) provide the city with a refined air pollutant dispersion modeling capability, and (4) install new air quality monitoring stations throughout the city The aim of these tasks was to provide regulatory officials with better tools to develop a cost-effective air pollution control and enforcement strategy.

The EPT project assisted in the development of a VE program in Novokuznetsk. Local environmental managers were trained in the U.S. and Volgograd. A smoke generator for use in continued VE training in Novokuznetsk was acquired through the Commodity Import Program

A complete electronic emission inventory system was developed jointly by staff from Sibgipromez, the City of Novokuznetsk Environment and Nature Protection Committee, and EPT The inventory includes approximately 3,000 emission sources. The transfer of source and emissions data from the inventory to the dispersion model has been automated.

The EPT project provided a refined dispersion modeling package to Novokuznetsk. The package includes the ISCST3 model, a meteorological data preprocessor, and a graphics program Local and regional environmental managers were trained on the use of the model. A desktop computer, complete with all of the software and hardware necessary to use the modeling package, was provided to the City.

At the request of the City, a test case was run with the ISCST3 model to compare results with the Russian model Results suggest that the two models are roughly comparable near the source, where the maximum concentrations occur; but ISCST3 predicts concentrations greater than the Russian model away from the source, as concentrations begin to decline. However, these findings should be considered preliminary, as only a single test case was considered

Under the EPT project, three new air monitoring stations were installed and made operational The stations are equipped with PM10 sampling and meteorological monitoring equipment. The meteorological monitoring equipment are capable of recording data continuously Local environmental managers have been trained on installation and operation of the monitoring stations. A laptop computer was provided to Hydromet for use in downloading meteorological data from the stations. Replacement parts have been provided to keep the stations operating for a minimum of 3 more years.

In summary, the Air Pollution Task has provided the City of Novokuznetsk with several new tools and training to assist in the development of its air quality management program The visible emissions program will enable the city to monitor and inspect its numerous sources of particulate air pollution at a minimal cost. Three new monitoring

stations will characterize levels and trends of fine particulate matter (PM10) concentrations in and around Novokuznetsk. The stations will also record meteorological data on a continuous basis for use in refined dispersion modeling With the ISCST3 model, the City is now able to conduct a wide variety of refined modeling scenarios to assess air quality in Novokuznetsk and determine the most effective air pollution reduction measures The ISCST3 model is also linked to the City's extensive emission inventory to maximize versatility and accuracy.

Use of the tools developed through the air pollution task will ultimately lead to significant air pollution reductions in Novokuznetsk These reductions will result in numerous benefits to the City, including improved human health, less damage to property and the environment, lower medical costs, and a more productive labor force

With the emission inventory, monitoring stations, and air dispersion model, the City will be able to assess its air pollution at an unprecedented level of detail It will be possible to determine the areas within the City subject to the highest pollution levels, and the sources most responsible for those levels. With such information, the City can determine the optimum approach to its air pollution management program and predict the pollution reductions that will result

The introduction of new monitoring methods like Visible Emissions and stack testing (assisted by equipment and training provided by EPT) will produce immediate air pollution reductions and economic benefits. These methods will give the City the means for air pollution enforcement. Emission fees can now be assessed based on actual (as opposed to underreported) emissions; but more importantly, the City now has the capability to identify gross emitters and impose corrective actions.

Finally, the tools developed in the air pollution task will augment some of the programs under other tasks For example, the auditing program has already demonstrated 30 percent reductions in particulate matter emissions from 7 boiler houses from tune-ups and installation of automated equipment. The introduction of properly-prepared coal has also resulted in 30 to 90 percent reductions in particulate matter emissions The City now has the ability to prioritize the remaining boilerhouses by severity of pollution and expand the program city-wide in a logical order.

Abbreviations/Acronyms

BaP	Benzo(a)pyrene
CIP	Commodity Import Program
CO	Carbon Monoxide
EPT	Environmental Policy and Technology
HF	Hydrogen Fluoride
Hydromet	Novokuznetsk Hydrometeorological Observatory
ISCST3	Industrial Source Complex - Short Term, Version 3
km	Kilometer
MPRM	Meteorological Processor for Regulatory Models
NOx	Nitrogen Oxides
PM	Particulate Matter
PM10	Particulate Matter less than 10 microns
SIC	Standard Industrial Classification
SO_2	Sulfur dioxide
UPS	Uninterruptable power supply
U.S EPA	United States Environmental Protection Agency

Section 1
Introduction

The City of Novokuznetsk contains a large number of industrial sources of air pollution, such as steel, aluminum, ferroalloy, coal mining, and cement plants. In addition, 160 coal-fired boilerhouses are scattered throughout the residential areas of the city These industrial sources generate large quantities of airborne particulate matter, nitrogen oxides, sulfur oxides, carbon monoxide, greenhouse gases, and toxic substances The high pollution levels in Novokuznetsk contribute to decreased life expectancy, increased illness, and damage to property and environment

The air pollution problem in Novokuznetsk is exacerbated by the unique geographical features of the area. Most of the population and industrial development of Novokuznetsk is situated within the meandering Tom River valley The hills that surround the city tend to trap air pollution within the valley where the population resides During periods of prolonged air stagnation, the buildup of air pollution can reach dangerous levels

USAID under the EPT project has been working in Novokuznetsk for over three years The thrust of the program under the air pollution task has been to introduce new methods and tools for assessing and predicting local air quality These tools will enable environmental managers in Novokuznetsk to make more informed decisions regarding the direction of their air pollution management program.

The air pollution task consisted of the following general approaches

- Assisting the City in establishing a visible emissions (VE) monitoring program
- Providing oversight and direction in developing an electronic air pollutant emission inventory for approximately 3,000 sources
- Installing a refined dispersion model and providing training to local and regional environmental managers
- Installing air pollution and meteorological monitoring stations and providing training to local environmental managers

This report summarizes the accomplishments made under the Air Pollution Task of the EPT Novokuznetsk project.

Section 2
Findings

2.1 Visible Emissions Program

A visible emissions (VE) monitoring program will provide Novokuznetsk with a new and inexpensive way to inspect and audit sources of particulate air pollution. A VE program is a more practical alternative to conventional source testing, which is relatively expensive and time consuming for a city-wide application. It will provide the City with a potential enforcement tool as well as a means for prioritizing sources for corrective measures.

The EPT project assisted in the development of a VE program in Novokuznetsk. Local environmental managers were trained in the U.S. and Volgograd. Additionally, a smoke generator was acquired through the Commodity Import Program. The smoke generator can be used for continued VE training in Novokuznetsk.

2.2 Air Emissions Inventory

A comprehensive inventory of air pollution sources and emissions is fundamental to air pollution tracking and reduction efforts The City of Novokuznetsk can use an emission inventory for the following purposes

- Providing source and emissions data for the ISCST3 and Russian dispersion models
- Supporting the City's request for an environmental designation of "extreme situation"
- Assessing emission fees
- Conducting health risk assessments
- Prioritizing emission reduction efforts
- Air pollution forecasting

2.2.1 Description of the Emission Inventory System.

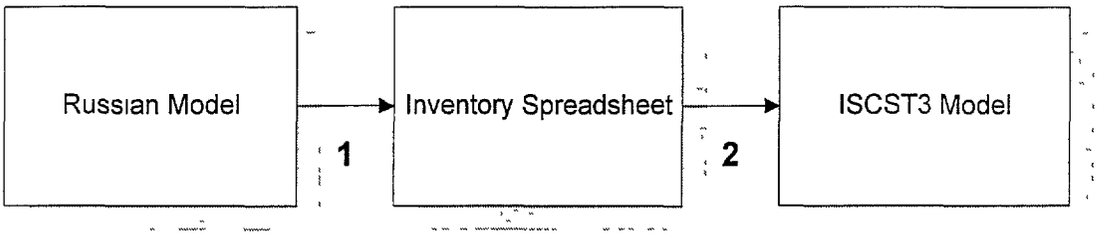
A complete electronic emission inventory system was developed jointly by staff from Sibgipromez, the City of Novokuznetsk Environment and Nature Protection Committee, and EPT The inventory contains more sources, more accurate emission estimates, and can now be updated more efficiently than previous inventories.

Sibgipromez and the City identified the emission sources, collected the various source parameters, and performed the emission calculations. The data were compiled into an existing database contained within the Russian air dispersion model. According to Sibgipromez, data for approximately 3,000 emission sources were collected.

To streamline the transfer of inventory data from the Russian model to the ISCST3 model, EPT staff developed a single inventory spreadsheet to serve as the bridge between the two models The inventory spreadsheet is essentially a duplicate of the inventory in

the Russian model, but in a format that can be readily transferred to ISCST3 Figure 1 illustrates the procedure by which inventory data are transferred to the ISCST3 model

Figure 1
Process for Importing Source and Emissions Data into ISCST3



The inventory spreadsheet contains the following data fields:

- General Site Information
- Site name
- Address
- Process Description
- Work time (hours per year)
- SIC Code
- Source Number
- Grid North Coordinate
- Grid East Coordinate
- Source Base Elevation
- Source Type (stack, volume, area, or open pit)
- Stack Height
- Stack Diameter
- Stack Exit Velocity
- Stack Exit Temperature
- Effective Release Height (volume, area, open pit sources)
- Lateral Dimension (volume sources)
- Vertical Dimension (area, volume sources)
- Length of X Side (area, open pit sources)
- Length of Y Side (area, open pit sources)
- Rotation Angle (area, open pit sources)
- Open Pit Volume
- Emission Rate[a]
- Control Technology Description[a]
- Tested Control Efficiency[a]
- Comments

[a]This field is repeated for each of 6 pollutants available for ISCST3 modeling nitrogen oxides (NOx), particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), hydrogen fluoride (HF), and benzo(a)pyrene (BaP)

From within the inventory spreadsheet, City staff can enter new source and emissions data, modify existing data, sort data, and export selected sources to ISCST3 The inventory spreadsheet comes equipped with a macro that automates the transfer of data to the ISCST3 model (shown as Step 2 in Figure 1) Currently, Step 1 (transfer of data from the Russian model to the inventory spreadsheet) is done manually

2.2.2 Summary of Training.

Local and regional environmental managers were trained on how to use the inventory spreadsheet and how to transfer data from the spreadsheet to the ISCST3 model A

complete set of instructions, translated into Russian, was distributed to the training attendees All software and electronic data developed by EPT staff and/or used in the training, including the inventory spreadsheet, were turned over to the City. The inventory spreadsheet and example files are resident on the City's desktop computer, which was provided by the EPT project

2.2.3 Suggested Tasks for City Staff to Continue Progress.

EPT recommends that the City conduct the following tasks in its effort to further the progress that has been made·

- To use ISCST3 with maximum flexibility, the City needs to finish transferring all inventory data from the Russian model to the inventory spreadsheet. Once this activity is complete, the City will have the capability to transfer data for any pollutant and any combination of sources to ISCST3 for modeling

- With each consecutive year, as the emission inventory is updated in the Russian model, City Staff will have to update the inventory spreadsheet simultaneously. At present, this step is manual Presumably, however, the City could develop a computer program that automatically transfers data from the Russian model to the inventory spreadsheet. Automating this process would save labor hours and reduce the possibility for errors being introduced to the inventory.

2.3 Air Dispersion Model

As part of the EPT project, the Industrial Source Complex - Short Term (ISCST3) dispersion model and supplemental software were installed for the City's use. Dispersion models are capable of predicting pollutant concentrations under any hypothetical combination of sources and emissions The City of Novokuznetsk can use the ISCST3 model for the following purposes

- Predicting the effectiveness of planned emission reduction measures
- Determining the most appropriate sources to target for emission reduction measures
- Determining the most appropriate boiler houses to target for elimination or consolidation
- Determining the most appropriate boiler houses to temporarily shut down during emergency air pollution episodes
- Predicting the geographical areas with the highest pollution levels
- Forecasting air pollution levels based on expected meteorological conditions

In addition, if the Federation certifies the ISCST3 model for regulatory use, the City can use ISCST3 to determine maximum allowable emissions for sources. The City has not yet sought certification of ISCST3

2.3.1 Description of the Air Dispersion Model.

The ISCST3 dispersion modeling package was installed on the City's desktop computer by EPT staff Trinity Consultants' BREEZE software, version 1.05, was used as the basis of the modeling package. ISCST3 (version 96113) was developed by the U S EPA to predict concentrations or deposition of pollutants over all types of terrain from a wide variety of industrial sources ISCST3 can predict maximum concentrations or deposition for time periods ranging from 1 hour to 1 year. The model will allow up to 1,000 sources and 10,000 receptor points in a single run

In addition to ISCST3, the modeling package also includes the Meteorological Processor for Regulatory Models (MPRM), dated 96225, and Surfer for Windows, version 6 01 MPRM is used to process on-site meteorological data, such as the data that will be collected at the 3 EPT monitoring stations Surfer is a graphics package that can be used to present ISCST3 input and output effectively All components of the modeling package were tested to ensure that they were functioning properly.

Other electronic files intended to assist the City with its modeling were also created, tested, and placed on the City's computer. These files include

- Project-specific ISCST3, MPRM, and Surfer test cases
- A 33 km x 30 km receptor grid over Novokuznetsk and vicinity, with actual terrain elevations
- Receptors located at the 3 EPT and existing 8 existing Hydromet monitoring stations
- A complete screening meteorological data file (i.e., worst case hypothetical meteorological data)
- Files containing 5 years (1985-1989) of actual hourly meteorological data from the Novokuznetsk Airport (provided by Trinity Consultants)

Because of the complex geography of the Novokuznetsk area, local wind patterns can be quite variable depending on location Therefore, the City should be aware that the meteorological data from the Novokuznetsk Airport is not necessarily representative of the local conditions within the river valleys that run through Novokuznetsk Within the river valleys, the surface winds would have a tendency to align themselves with the valleys, particularly near the ground during stable atmospheric conditions The degree to which the valleys influence local wind patterns is not known

Despite the complexity of the local terrain, however, the airport data is still useful For example, airport data would be appropriate for modeling concentrations well downwind of Novokuznetsk, where the localized variations in wind patterns are relatively unimportant Because the values for stability, temperature, and mixing height would still be representative of the Novokuznetsk area at large, the airport data could be used to approximate maximum local concentrations from sources, although the predicted locations of the maximum impacts should be used cautiously The data would also be useful in comparing impacts from one source to another on a relative scale Finally, the airport

data serves as an excellent resource in practicing with ISCST3 until local data from the 3 EPT monitoring stations become available.

While no model can completely emulate the meteorology of Novokuznetsk, the three EPT monitoring stations will record conditions at different locations around Novokuznetsk. The City will then be able to select the most representative meteorological data for the source in question, based on the location of the source relative to the EPT stations. As an alternative, a screening meteorological data file was also provided to the City to estimate worst case 1-hour concentrations under hypothetical meteorological conditions.

2.3.2 Summary of Training.

After the ISCST3 model was installed and tested, training sessions were conducted for approximately 10 local and regional environmental managers. The training included the following components.

- Setting up and running ISCST3
- How to interpret ISCST3 output
- Calculating parameters for building downwash
- How to process and use meteorological data collected at the EPT monitoring stations
- How to create graphical plots of the model results and the local terrain elevations

A package of instructional materials, including step-by-step instructions, excerpts from manuals, and test cases, was translated into Russian and distributed to the trainees. All software manuals were left with the City The desktop computer containing the modeling software, and an accompanying laser printer, were also provided to the City.

2.3.3 Comparison of American and Russian Dispersion Models.

The City currently uses a federally-approved Russian dispersion model; however, the ISCST3 model has several clear advantages over the Russian model, including:

- The ability to account for actual terrain elevations (as opposed to a single terrain category assigned to an entire geographical area in the Russian model)
- The ability to model actual hourly meteorological data (as opposed to built-in worst case hypothetical meteorological data for the Russian model)
- The ability to predict pollutant concentrations for a variety of different averaging times (as opposed to a single 20-minute averaging time for the Russian model)

In addition, the two models are based on fundamentally different dispersion formulas. Specifically, ISCST3 uses the Gaussian dispersion formula while the Russian model uses the Berlyand formula

At the request of the City, a test case was run with the ISCST3 model to compare results with the Russian model Results of the test could be used by the Federation in evaluating ISCST3 for certification The results suggest that the two models are roughly comparable

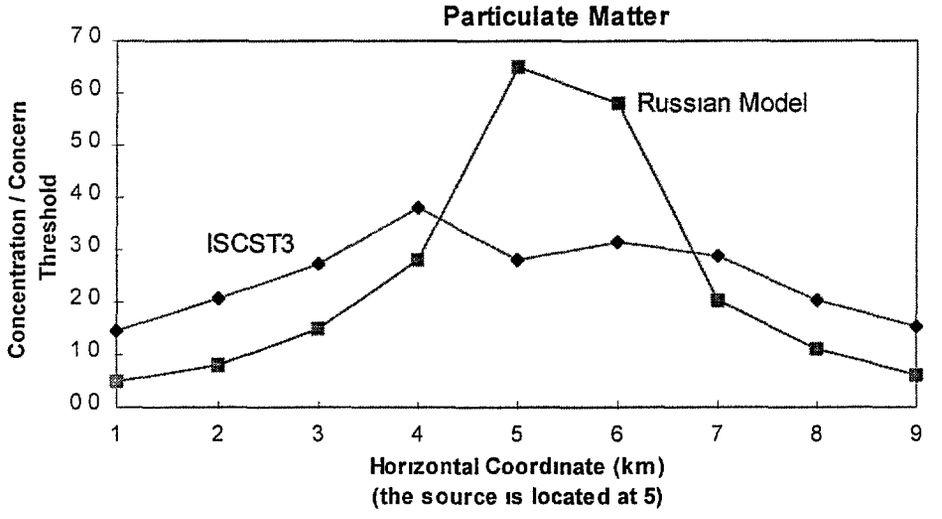
near the source, where the maximum concentrations occur; but ISCST3 predicts concentrations greater than the Russian model away from the source, as concentrations begin to decline. However, these findings should be considered preliminary, as only a single test case was considered.

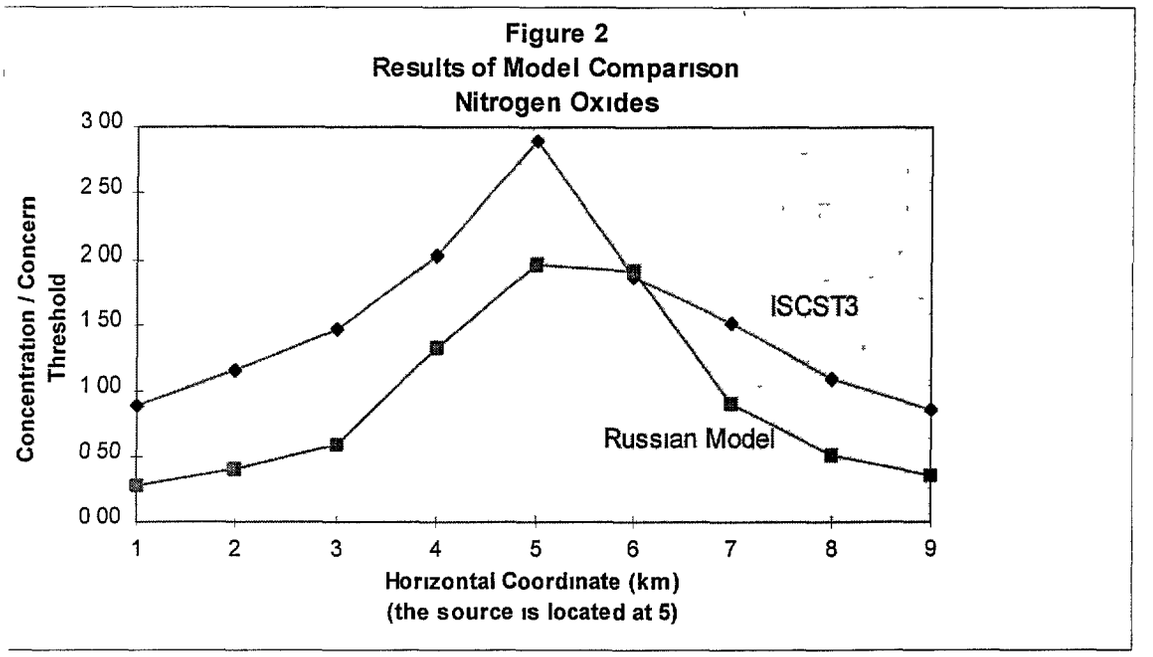
The Kuznetsk Ferro-Alloy Plant was selected by the City as the test case This plant contains numerous point (stack) and line (roof vent) emission sources Particulate matter and nitrogen oxide emissions were modeled. All source parameters and emission rates were provided by the City via the emission inventory. City staff conducted the test run with the Russian model, and EPT staff conducted the test run with the ISCST3 model.

Concentrations of PM and NOx were predicted by each model at pre-determined receptor locations arranged in a grid, centered on the facility The grid extended 4 km in each direction from the facility The distance between grid points was 1 km For comparative purposes, ISCST3 was run with worst case hypothetical meteorological data, similar to that used by the Russian model Maximum 1-hour ground-level concentrations were calculated with ISCST3 (1 hour is the shortest averaging time available in ISCST3) Maximum 20-minute ground-level concentrations were calculated with the Russian model

Figures 1 and 2 summarize the results of the comparative tests for PM and NOx, respectively. In each figure, the results are expressed as concentration divided by concern threshold for that particular pollutant. The higher the result, the higher the predicted concentration.

Figure 1
Results of Model Comparison
Particulate Matter





As shown in the figures, both models predict maximum concentrations near the facility, with concentrations declining as the distance from the facility increases. And both figures show that ISCST3 consistently predicts higher concentrations than the Russian model 2 km and greater from plant Within 2 km of the plant, however, the results are mixed. For PM, the Russian model predicts concentrations significantly higher than ISCST3 For NOx, however, ISCST3 generally predicts higher concentrations than the Russian model.

2.3.4 Suggested Tasks for City Staff to Continue Progress.

EPT recommends that the City conduct the following tasks in its effort to further the progress that has been made

- Begin using ISCST3 on a regular basis to gain familiarity and expertise, and to reinforce the training For example, sort the inventory spreadsheet by magnitude of emissions and model the maximum emitters. Or model individual facilities, or groups of facilities in close proximity to each other.

- Receive from Hydromet the meteorological data collected from the three EPT monitoring stations Use MPRM to create meteorological data files compatible with ISCST3 Try using the meteorological data files in ISCST3.

2.4 Air Monitoring Stations

As part of the air pollution task, three new monitoring stations were installed in and around Novokuznetsk The purpose of the stations is to conduct sampling for ambient concentrations of fine particulate matter (PM10) and to continuously record local

meteorological data Data collected from monitoring stations can be used for the following purposes·

- Assessing the severity of air pollution in Novokuznetsk
- Determining the spatial and temporal variations in air pollution levels
- Tracking long-term trends in air pollution
- Determining background concentrations (i e., the portion of ambient concentrations not attributable to the emission sources being studied)
- Validating dispersion model predictions
- Providing local meteorological data for use in dispersion modeling
- Evaluating the transport of pollutants into and away from Novokuznetsk

The three EPT stations are complimented by 8 existing Russian stations, scattered throughout the Novokuznetsk area The 8 Russian stations are used to conduct sampling for a number of different pollutants and to record meteorological data However, the meteorological data are only recorded approximately 3 times per day, based on an instantaneous observation. Therefore, the meteorological data from the 8 Russian stations are not suitable for use in a dispersion model.

2.4.1 Description of the Monitoring Stations.

The three EPT monitoring stations are located (1) downtown, just west of the City Administration building; (2) 22 km east-northeast of the City Administration building, along the north edge of the Tom River Valley, and (3) in the hills, 7 km south of the City Administration building, adjacent to the highway police station Depending on the wind direction, the two outlying stations could serve as upwind (background) and downwind monitoring stations.

Each monitoring station is equipped with a control shelter (approximately 3 meters tall) and a 10-meter tower Affixed to the tower are a PM10 sampler and meteorological equipment to record the following data· wind speed, wind direction, temperature, solar radiation, relative humidity, and precipitation Inside the control building is a Campbell Scientific 21X datalogger to record the meteorological data The datalogger also calculates and records the standard deviation of wind direction, which is used to determine atmospheric stability All meteorological parameters are recorded at 15-minute intervals

EPT supplied Hydromet with a laptop computer complete with the software necessary to download meteorological data from the dataloggers on a regular schedule EPT also provided the City with replacement parts (500 glass fiber filters and replacement brushes and bearings) to keep the PM10 samplers operating for a minimum of 3 years

2.4.2 Summary of Training.

Hydromet staff have been trained on installation and operation of the monitoring stations On-site training was also provided for data logger programming and collection of

meteorological data. Key excerpts from the software and hardware manuals were translated into Russian The training instructions are included in Appendix A.

2.4.3 Suggested Tasks for City Staff to Continue Progress.

EPT recommends that the City conduct the following tasks in its effort to further the progress that has been made:

- Establish a PM10 sampling schedule based on the EPT recommendation, and begin sampling.
- Establish a regular schedule to download meteorological data from the dataloggers to the laptop (e.g., every six days, to match the PM10 sampling schedule).
- Provide the meteorological data to the City for use in dispersion modeling.

Section 3
Conclusions

The Air Pollution Task has provided the City of Novokuznetsk with several new tools and training to assist in the development of its air quality management program The visible emissions program will enable the city to monitor and inspect its numerous sources of particulate air pollution at a minimal cost. Three new monitoring stations will characterize levels and trends of fine particulate matter (PM10) concentrations in and around Novokuznetsk. The stations will also record meteorological data on a continuous basis for use in refined dispersion modeling. With the ISCST3 model, the City is now able to conduct a wide variety of refined modeling scenarios to assess air quality in Novokuznetsk and determine the most effective air pollution reduction measures. The ISCST3 model is also linked to the City's extensive emission inventory to maximize versatility and accuracy. Because these tools provide valuable information at a relatively low cost, the City should be able to continue their use indefinitely.

Use of the tools developed through the air pollution task will ultimately lead to significant air pollution reductions in Novokuznetsk. These reductions will result in numerous benefits to the City, including improved human health, less damage to property and the environment, lower medical costs, and a more productive labor force.

With the emission inventory, monitoring stations, and air dispersion model, the City will be able to assess its air pollution at an unprecedented level of detail. It will be possible to determine the areas within the City subject to the highest pollution levels, and the sources most responsible for those levels. With such information, the City can determine the optimum approach to its air pollution management program and predict the pollution reductions that will result.

The introduction of new monitoring methods like Visible Emissions and stack testing (assisted by equipment and training provided by EPT) will produce immediate air pollution reductions and economic benefits. These methods will give the City the means for air pollution enforcement Emission fees can now be assessed based on actual (as opposed to underreported) emissions; but more importantly, the City now has the capability to identify gross emitters and impose corrective actions

Finally, the tools developed in the air pollution task will augment some of the programs under other tasks. For example, the auditing program has already demonstrated 30 percent reductions in particulate matter emissions from 7 boiler houses from tune-ups and installation of automated equipment The introduction of properly-prepared coal has also resulted in 30 to 90 percent reductions in particulate matter emissions The City now has the ability to prioritize the remaining boilerhouses by severity of pollution and expand the program city-wide in a logical order