OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

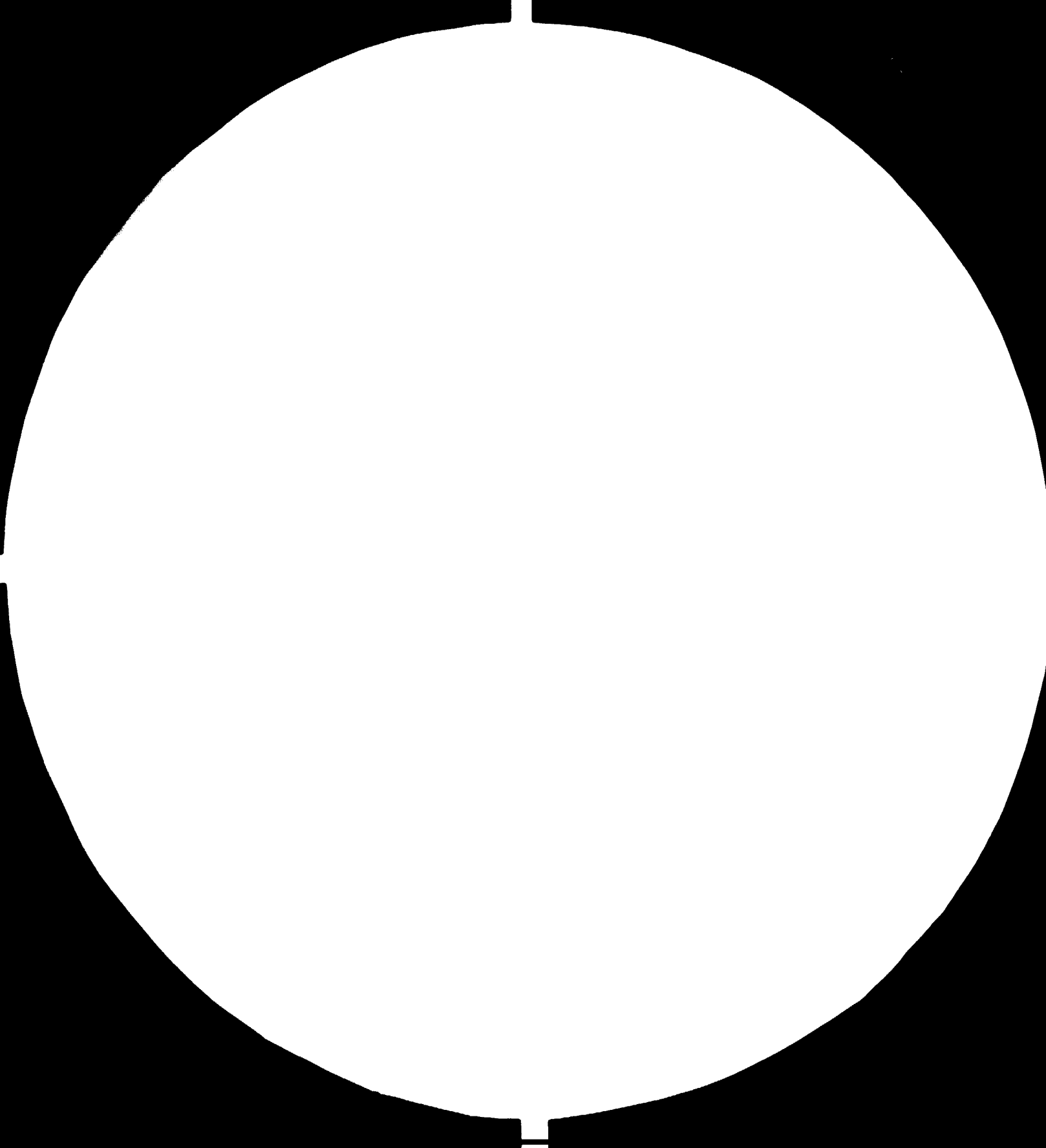
FAIR USE POLICY

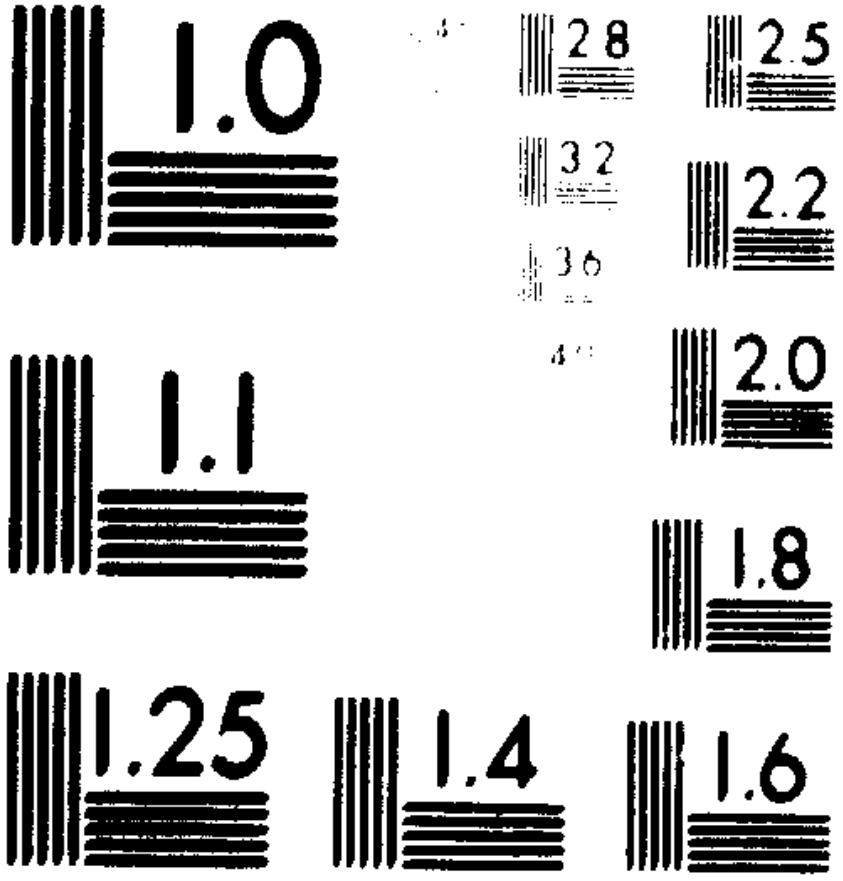
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





13008

Distr.
RESTRICTED

UNIDO/IO/R.90
20 October 1983

English

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Romania.

DEVELOPMENT OF AIR POLLUTION MONITORING SYSTEMS IN INTENSELY CONTAMINATED INDUSTRIAL AND URBAN AREAS.

UC/ROM/82/110

ROMANIA

Terminal report*

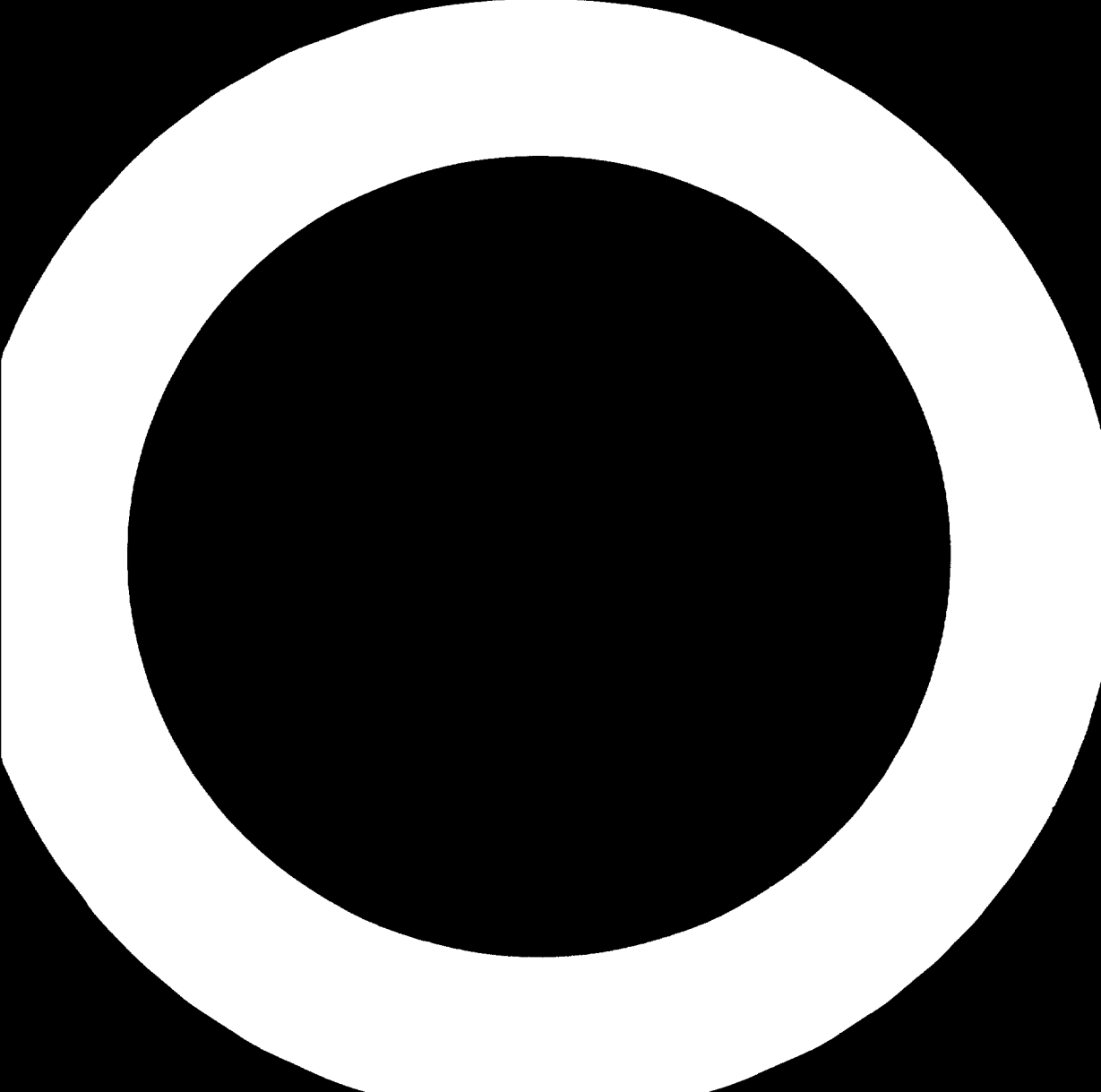
Prepared for the Government of Romania
by the United Nations Industrial Development Organization.

Based on the work of P.K.Yennawar
Industrial air pollution expert

1181

* This document has been reproduced without formal editing.

V.83-63067



ABSTRACT

UNIDO was requested by the Romanian Government to assist it in its efforts to develop air pollution monitoring systems and equipment. The objectives of the project were to contribute to maintaining stable environmental conditions and to prevent air pollution in contaminated industrial and urban areas.

This assistance was provided by advising on the establishment of air pollution monitoring systems and equipment to control polluting sources and advising on measures required to remedy and prevent pollution from air effluents by industrial plants.

This assistance is particularly of importance as the project covers an arrangement whereby the Romanian Government will transfer its experience in this field for the benefit of the developing countries.

However, to further improve their research in the development of air pollution monitoring systems and equipment, it is recommended that some Romanian specialists in this field be sent for training to developed countries where air pollution monitoring equipment are being manufactured.

TABLE OF CONTENTS

LIST OF ANNEXES

1. INTRODUCTION:

The Government of Romania has been conscious of the environmental problems arising as a result of the rapid industrial growth taking place in the country. The Government is seeking solutions on such problems in close liaison with UNDP/UNIDO assistance. This report is an outcome of the findings of the expert (reporting) who worked with the staff of the Research Institute for the Electrotechnical Industry * ICPE, Bucharest, Romania - on his assignment with UNIDO during September 1983. The main task of the assignment was related to pollution monitoring (air) aspect and allied instrumentation.

2. PURPOSE:

In accordance with the immediate objectives of the UNIDO project UC/ROM/82/110, the job description duties for this mission were:

- to contribute to maintaining stable environmental conditions and to prevent industrial pollution in the country.

The expert was expected to:

2.1. Advise on air pollution monitoring equipment.

2.2. Assess the achievements in the construction of air monitoring devices.

2.3. Advise on setting up networks for air pollution measurements, and

2.4. Formulation and implementation of training programme.

3. BACKGROUND INFORMATION AND APPRECIATION OF THE CURRENT DEVELOPMENT

The Research Institute for the Electro-technical Industry, ICPE Burcharest, comes under the Ministry of Machine-Tools, Electrotechnics and Electronics (M.I.M.U.E.E.).

The Institute carried out a complex research dedicated to the development of new products and modern techniques and substitutes, etc. Amongst the numerous disciplines, designing and development of air monitoring equipment has been introduced during the last three years.

---

* Institute's name and address in Romanian:
Institutul de Cercetare stiintifica si Inginerie tehnologica pentru Industria electrotehnica,
Bd. Tudor Vladimirescu nr. 45-47,
sector 5
Bucuresti

Dr. Ing. Ionel RADU, Head of Research (Air) and his research associates formed a team engaged on developing automatic monitoring equipment for air pollution monitoring. The expert was associated with this team. Mr. George Galatchi, Personnel Relation Officer and UNDP Project Co-ordinator (UNDP Project ROM/82/002) coordinated programme assignment of the expert.

The team has already developed following equipment in the field of air pollution:

- Automatic Monitoring Equipment for air pollution with SO_2, NO_2, and H_2S.
- Portable counter for the ambient dust concentration monitoring.
- Automated equipment, for measurement of dust concentration stack monitoring.
- Particle-size analyser (Impaction) 1-40 microns).
- Ozone generator for water treatment (800 gm/hr).

The expert was taken round and shown the installations of some equipment which was impressive. Printed leaflets describing the equipment are already in circulation and were presented to the expert which give the technical specifications and applications of the equipment. However, the expert was informed that the units are at a stage of approval.

Dr. Radu being an electronic engineer is mostly responsible in designing of the equipment He has developed the electronic circuitry components (please refer to appendix 1), which, in general, could be used for automation of any component concerning monitoring of air pollutants at source as well as in ambient air. All electric and electronic circuitry necessary for the assembly of automatic instrumentation is available. Dr. Radu is now looking forward to seek expertise in the choice of detectors for individual pollutants. Currently, a detector using spectrophotometric principles and optical circuitry has been designed, developed. The same is under test with the chemical counterpart from Meteorological Institute.

4. ASSIGNMENT PROGRAMME:

During the initial meeting with Dr. Radu and Mr. George Galatchi, the expert had identified the following expected programme during assignment:-

- Approach to develop detector/sensors;

- Discussion on use of automatic monitors in the field and their limitations - alternatives.
- Programme for exchange of technical know how from developing countries and approach in assembling the equipment to the requirements of respective countries.
- Programme for air quality monitoring network in Bucharest.

The above programme was also discussed with Dr. Florin Tanasescu, Director General of the Institute.

5. APPROACH TO DEVELOPMENT OF DETECTORS

A detector based on coulumetric principles is now developed in collaboration with Central Chemical Research Institute (ICECHIM). This detector is to be used for source monitoring of SO_2. It is encouraging to note that such developments are taking place within the country without any specific model to follow - the originality of the design pattern is indigenous and efforts need to be further strengthened and accelerated. Models on chemiluminescence technique and other recent advances are necessary. A study tour of a scientist, responsible for these developments at places where such instruments are manufactured will accelerate the programme. The policy of the government to procure these equipments within the country seem to be the requirement of situation taking into account the feasibility aspect and secondly the restrictions on imports.

During the course of discussions with the Director General of the Institute, interest in collaborative programme amongst the developing countries on this issue was noted. Exchange of know-how on air monitoring system from different developing countries to get mutual benefit was identified. Such a programme can be materialised through the international agencies' assistance or on bilateral co-operation programmes.

6. MEETING WITH INDUSTRIALISTS

Bistrita city is an industrial one having varieties of factories. Lead battery, glass, manufacture of thermal insulating material for cars, bag filters and manufactures of certain components required for electrostatic precipitator and many others. Some of them were visited

by the expert. Next day Trade Union Bureau held a meeting in which all the factories were represented by their chief engineers.

Fugitive and stack emissions of the toxic substances seem to be worrying them. Instrumentation for continuous recording is their prime need. Industries identifying their problems are as follows: (See also Appendix II).

INDUSTRY	POLLUTANTS
Lead battery	Lead vapours
Glass factory	Lead, acid fumes
Wood processing	Wood powder and formaldehyde vapors
Netex Insulating Board mfg.	Textile fibres phenolic resins, cellulosic material
Machine Tool and esp. components	Foundry emissions and furanic resins
Pulp and paper	Mercaptanes, H_2S, alkaline vapours
Industrial affluent treatment	Colour
Aluminium industry	Fluorine

The members also expressed their anxiety over the lack of information on the effects and the limits of safe level. Necessary literature and documentation is in great demand. It was worth noting that the expert was given free access in the industries he visited and free and frank exposure on their problems.

7. AIR POLLUTION MONITORING IN BUCHAREST

This programme seems to be handled by the Meteorology department. Unfortunately, the expert had no opportunity to visit this network. However, the following model is prepared as per the term of assignment.

Object: To establish air quality base line data and its support to pollution abatement measures.

Background information: Bucharest is developing fast and certain inventories are to be made. These are:-

- meteorological pattern;
- emission inventory and abatement measures in industries;
- autovehicular activity and
- central and domestic heating during winter.

If based on the inventory it will be possible to fix the pollutants for monitoring. Viewing the general activities in the city, however, the common pollutants could be identified as:

Oxides of nitrogen (NO_x)
Sulphur dioxide (SO_2)
Carbon monoxide (CO)
Hydrocarbons (HC)
and total suspended particulates (TSP)

Monitoring equipment: Initially, the programme could be set through manual procedure and later on, the equipment (automatic) as developed at the ICPE can be introduced on few strategic points as and when these are made available. Continuous monitoring gives time variation of pollutants at a given station. Much data can be obtained in this manner and if the stations telemetered to a control station, this could be possible under the developments that are taking place in ICPE.

Manual sampling also should be on a 24 hour basis and evaluated using different averaging times (4 hourly, dayly, and yearly). Sampling should be carried out 5-6 times a month.

Initially the number of monitoring stations will depend on available man-power and the amount of equipment and increased further on a grid pattern basis.

Among the pollutants, SO_2, NO_x and suspended particulate matter should be monitored at the elevation of 10m to 15m height from ground level. Sampling should be the ultimate goal of the programme.

Carbon-monoxide and hydrocarbons from auto exhaust are to be monitored in traffic active areas at ground level on a discontinuous basis only to have background information.

8. REPRESENTATIVENESS OF SAMPLING STATION

Sampling station should be truely represented for the area in which it is placed. Following are the conditions one must take into account.

- Exclude the place where there is direct influence of nearby emittants. Emitting source should be away from monitoring station 100m; if not possible 50meters. This will however depend on the magniture of emissions.

- the height of the sampling station should be 10meters and 15 meters;
- exposure of the inlet of the sampler should not be obstructed by a wall, a tree and a tall structure;
- there should be a security of the equipment and which should be free from vandal activity;

Duration of sampling and flow rate

In manual sampling the flow rates are as follows:-

Duration of sampling:	Flow rate
24 hr. integrated sampling (without change of bubbler)	150 ml/min
4 hourly sampling	500 ml/min
1 hour sampling	1 lit/min

In automatic recorders the flow rates are designed as per the requirement of situation.

Sampling and analysis procedures

Pollutant	Method	
	Preference	Alternate
Sulfur dioxide	flame ionization or pararosaniline method	-
NO_x	chemiluminescence	Saltzmann modified method
CO	Infrared gas analysis	
HC	Flame ionisation	
TSP	High vol. sampler	Optical device principle using paper tape sampler

Meteorological measurements

Following meteorological parameters should be measured at one central location at least and if possible, at more than one as to obtain a better idea of the micro-climate of different parts of the city.

Wind speed

Wind direction

Humidity

Temperature

Data reporting:

Reporting of results and their evaluation can be done more systematically following WHO report "Selected Methods of Measuring Air Pollutants", WHO offset, Pub. No.24, 1976.

9. RECOMMENDATIONS:

1. The expert had a series of discussions with Dr. Ionel Radu, Mr. George Galatchi and the team of workers on the issue of design - pattern of air monitoring instruments and the sepcific requirements in their application in the field. Having made remarkable progress in the direction of electronic circuitry, this development needs to be further encouraged in the development of sensible detectors and allied components.

2. The scientist developing the monitors should be sent on a study tour to get himself acquainted with newly developed and commercialized equipment in certain other countries which shall enable him to make the assessment on his home product and if necessary improve the design with respect to proper choice of detectors and other modifications, if any.

3. It is a known fact that commercially available equipment in advanced countries cannot be set directly to work in developing countries on the ground of certain limitations and local conditions. ICPE has sought a midway to achieve the objective of self development programme which is highly impressive and encouraging. The expert realises the eagerness and anxiety on the part of the ICPE authority for exchange of information and know-how among the scientists from developing countries. It is also understood that ICPE is willing to arrive at a common programme of mutual interest in the development of air pollution monitors for air pollution monitoring at source as well as in the ambient air by sharing the knowledge from one another and solving the difficulties in the progress of building up instrumentation on indigenous origin. This purpose could be realized through an arrangement of a workshop bringing scientists together.

4. Air quality monitoring programmes have to be taken very seriously at evert decisional level counting the industrialization is on the progressive direction. The air monitoring network in the city of Bucharest needs to be intensified and developed as a model for following the same in industrial areas and other cities in the country.
   Necessary input through locally developed instruments is available for this purpose and should be tested and utilized. If this is followed, it will have a dual benefit; firstly, of establishing the base line air quality data for the city, and secondly improving the mechanics of the instrumentation for its accuracy and versatile application, and ultimately for mass production.

5. Exchange of information on literature should be made available specially on procedures and methods for sampling and analysis on toxic substances and their safe levels.

10. ACKNOWLEDGEMENTS

The expert wishes to express his gratitude to many representatives in the Government Agencies for their cooperation and goodwill. He is much indebted to Dr. Eng. Ionel Radu, Head of Research Laboratory for his intensive exchange of experience with the expert in reviewing and understanding the problems to be solved.

The cordial thanks are also due to Prof. Dr. Eng. Florin Teodor Tanasescu, General Director, ICPE, who took keen interest in the expert's assignment. Special thanks are due to Mr. R. Rabenold, Resident Representative of UNDP, and the staff, Mr. George Galatchi, for their cordial and helpful assistance.

The expert would also like to thank Miss Daniela Moga, interpreter, for her hard task she put in during the complete assignment. Thanks are also conveyed to Mrs. Victoria Radu, economist of the same laboratory, who assisted in looking after the welfare of the expert.

APPENDIX 1

COMPONENTS STRUCTURE OF AIR POLLUTION MONITORING EQUIPMENT

DETECTOR

- detector cell
- optical systems: light source
  photoelement
  geometry correction elements

AIR CIRCUITS

- valves
- pumps
- flow meters

DETECTOR ELECTRONICS

All electric and electronic circuitry necessary in order to have a Gas Analyser Apparatus as laboratory instrument, from the detector cell itself to the current or digital output for an automatic equipment or a processing system.

PRE-AMPLIFICATION

Special designed circuitry to obtain a good sensitivity with an efficient noise protection and a good stability.

CORRECTION AMPLIFIERS

To obtain a good linearity for the output signal counting all non-linearities of the phototransistor and the exponential dependence of the reagent transparence of the gas concentration.

A/D, D/A CONVERTERS

Analogous to digital converter.
Digital to analogous converter.

INTERFACING SYSTEMS

To provide both a complete control from the panel and an automatic control and calibration from the computer system.

CONTROL AND OPERATION CIRCUITS

Between the TTL circuits and power components like as: electric motors, power transistors, etc.

POWER CIRCUITS

Power supply units with constant output voltage for a line a/c voltage 220 v, + 10% - 15%. Thermostatic circuitry.

PROCESSING ELECTRONIC SYSTEM

Developed with Romanian integrated circuits only and allowing to extend the counting capabilities. A modular strucutre. Programmes for average concentration for 30 minutes and for 24 hours, for a permanent registration or at definite programmed hours, for zero adjustment and for calibration.

FRONT PANEL AND CONTROL ELEMENTS ON IT

MECHANICAL SUB ASSEMBLIES

- frame
- box
- gripping sub-assemblies

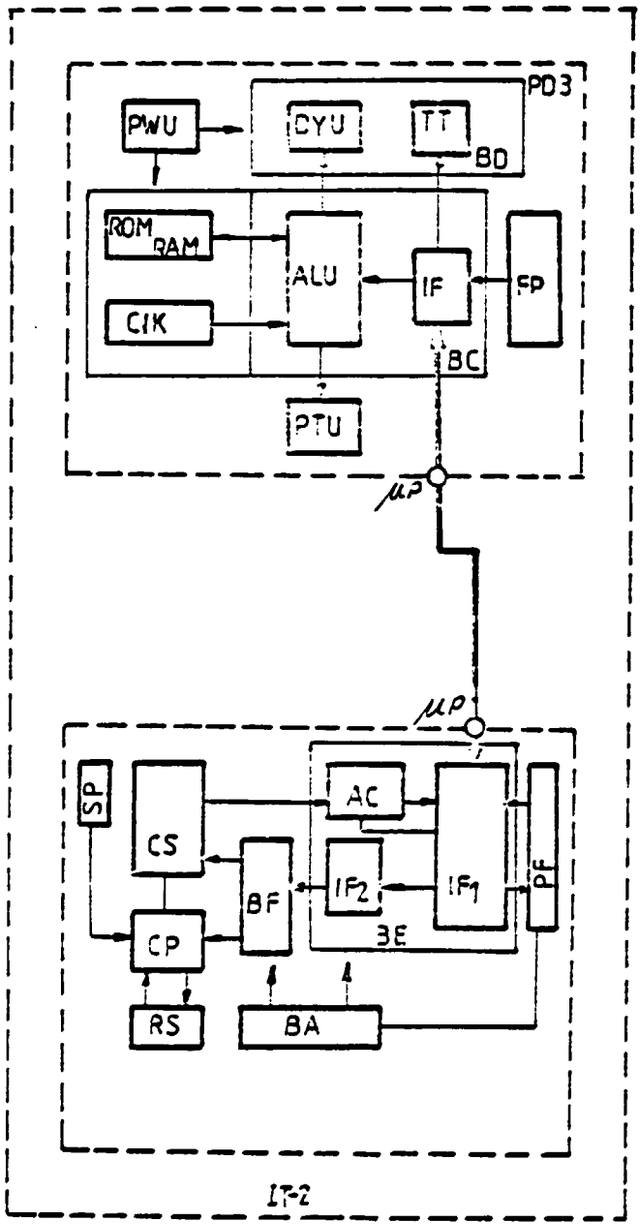
PROCESSING ELECTRONIC SYSTEM

- computation system structure
- programming

PERIPHERIAL SUB-ASSEMBLIES

- printing
- analogic registering on paper or magnetic tape
- displays
- testers

TRANSMISSION and TELECOMMAND SYSTEMS



Processing unit BP-3

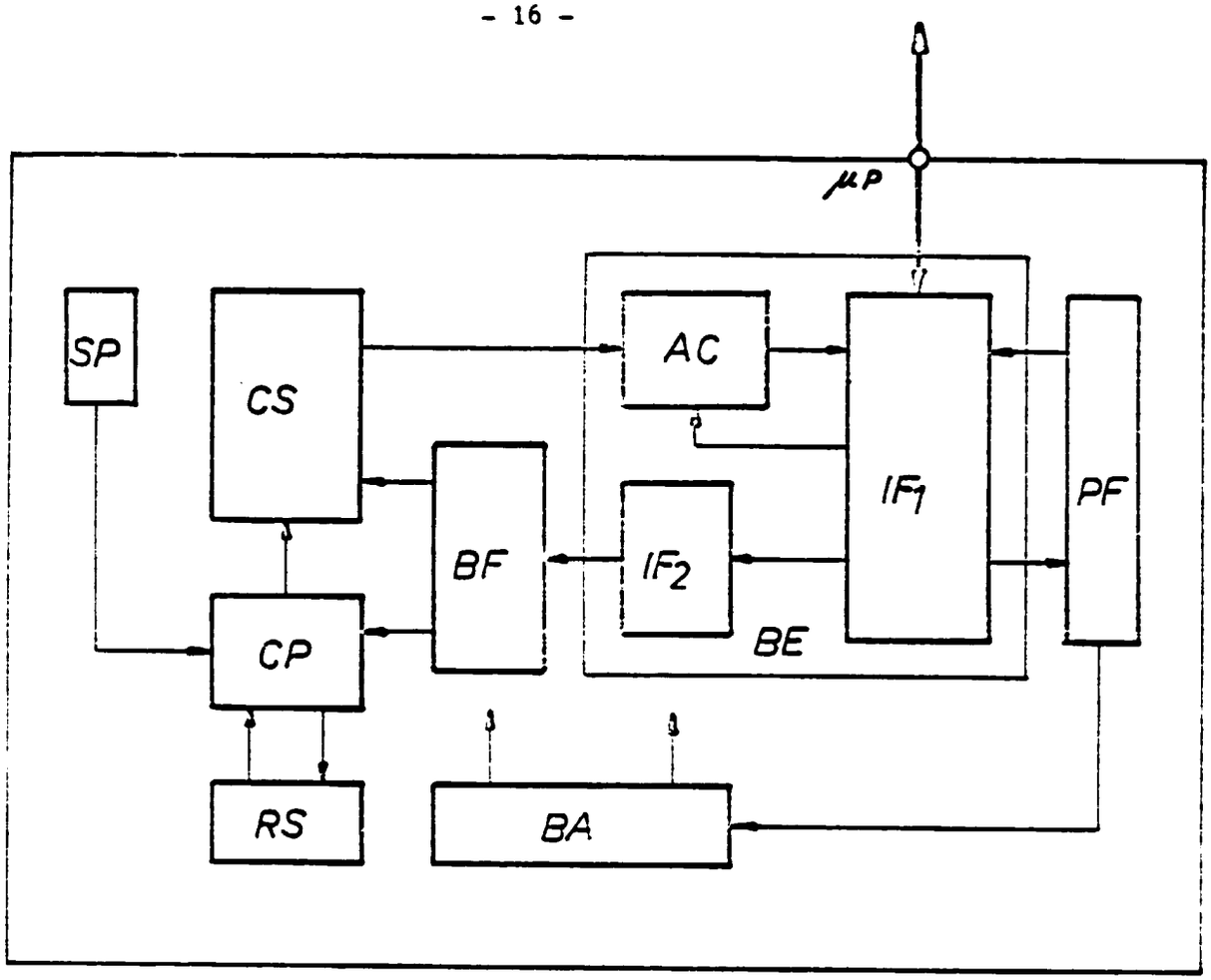
PWU - power
ALU - control
DYU - display
IF - interface
FP - front panel
TT - remote control
PTU - printer
CIK - clock

Sensor unit US-2

AC - corection amplifier
BA - power suply
BE - electronics
BF - power controls
CP - air and reagent circuitry.
CS - sensor cell.
IF1 - interface (to front panel and μP)
IF2 - interface (to internal controls).
PF - front panel
RS - reagent tanks
SP - samplying circuitry.

Termostatic syst IT-2

SMP
Block diagram



AC_ corection amplifier
BA_ power suply
BE_ electronics
BF_ power controls
CP_ air and reagent circuitry
CS_ sensor cell
IF1_ interface (to front panel and μP)
IF2_ interface (to internal controls)
PF_ front panel
RS_ reagent tanks
SP_ samplyng circuitry

SMP-US2

Fotometric Gas Analyser SD2

Dear Mr. YEMMAR

ICPE REQUESTS FOR DOCUMENTATION

According to those discussed and agreed during your visit in Bistrita, we send you the list of the participants at the round-table and in the same time, we take the liberty to remind you that we are interested in receive the informations and documentations concerning the following fields :

1. Ozone - detection
2. Ozone - uses
3. Ozone - biological studies
4. Industrial powder - (from : textile industry, lead - battery ind., wood ind.and foundry) - detection and means of depollution
5. Toxic vapours - (Formic aldehide (CH_2O), Phenol (C_6H_5OH), Lead (Pb), Carbon sulfide (CS_2)) - detections and means of decrease of the emanations (means of depollution)
6. The struggle agains pollution in the cellulose and paper industry.

The first three points belong to our preccupations and, for this reasom, our interest is major; the last three fields concern the problems rising by the factories from our district.

We ask you to send all the informations and documentations concerning these six points on our address in Bistrita, and we shall transmit those are interested in our district.

Our address is :

RUSU GHEORGHE - INSTITUTUL DE CERCETARE STIINTIFICA SI INGINERIE TEHNOLOGICA PENTRU INDUSTRIA ELECTROTEHNICA -
I.C.P.E. - FILIALA BISTRITA
BISTRITA, Str.Parcului nr.7, Cod.4400
Judetul BISTRITA-NASAUD
ROMANIA

./.

that means : Scientific Research Institute for Electrotechnical Industry - Branch Bistrita.).

We thank you for cooperation and we hope to meet again in Bistrita during the next your visit in Roumania.

Your sincerely,

Gheorghe Rusu

LIST OF PARTICIPANTS AT THE ROUND - TABLE

BISTRITA, 23 SEPT.1983

1. Chiș Viorel - Chief Eng. - I.P.E. - Bistrița, Acumulatorul (Factory of lead batteries).
2. Suciu Zoltan - Chief Eng. - Fabrica de sticlă-menaj - Bistrița (Factory of glass).
3. Centea Petre - Chief Eng. - I.U.T. - Bistrița (Factory of technologic equipment).
4. Singel Vasile - Chief Eng. - Metex - Bistrița (Factory of nonweaved fibers).
5. Blaga Dorin - Chief Eng. - Fabrica de Hîrtie - Prundu Bîrgăului (Factory of paper).
6. Rubinger Mihai - Chief Eng. - C.P.L. - Bistrița (Factory of wood processing).
7. Radu Ionel - I.C.P.E. - București (Dr. eng.-Chief of research lab)
8. Rusu Gheorghe - Bistrița Branch's Manager of I.C.P.E.
9. Vermeșan Vasile - Dipl.eng. (chemist) - I.C.P.E. - Bistrița
10. Moldovan Vasile - Dipl.eng. - I.C.P.E. - Bistrița
11. Corneanu Cornel - Dipl.eng. - I.C.P.E. - Bistrița
12. Turdeanu Alexandru - Dipl.eng. (chemist) - I.C.P.E. - Bistrița
13. Nagy Zoltan - Dipl.eng. (chemist) - I.C.P.E. - Bistrița
14. Tigăuan Iacob - Dipl.eng. (chemist) - I.C.P.E. - Bistrița.

B-286