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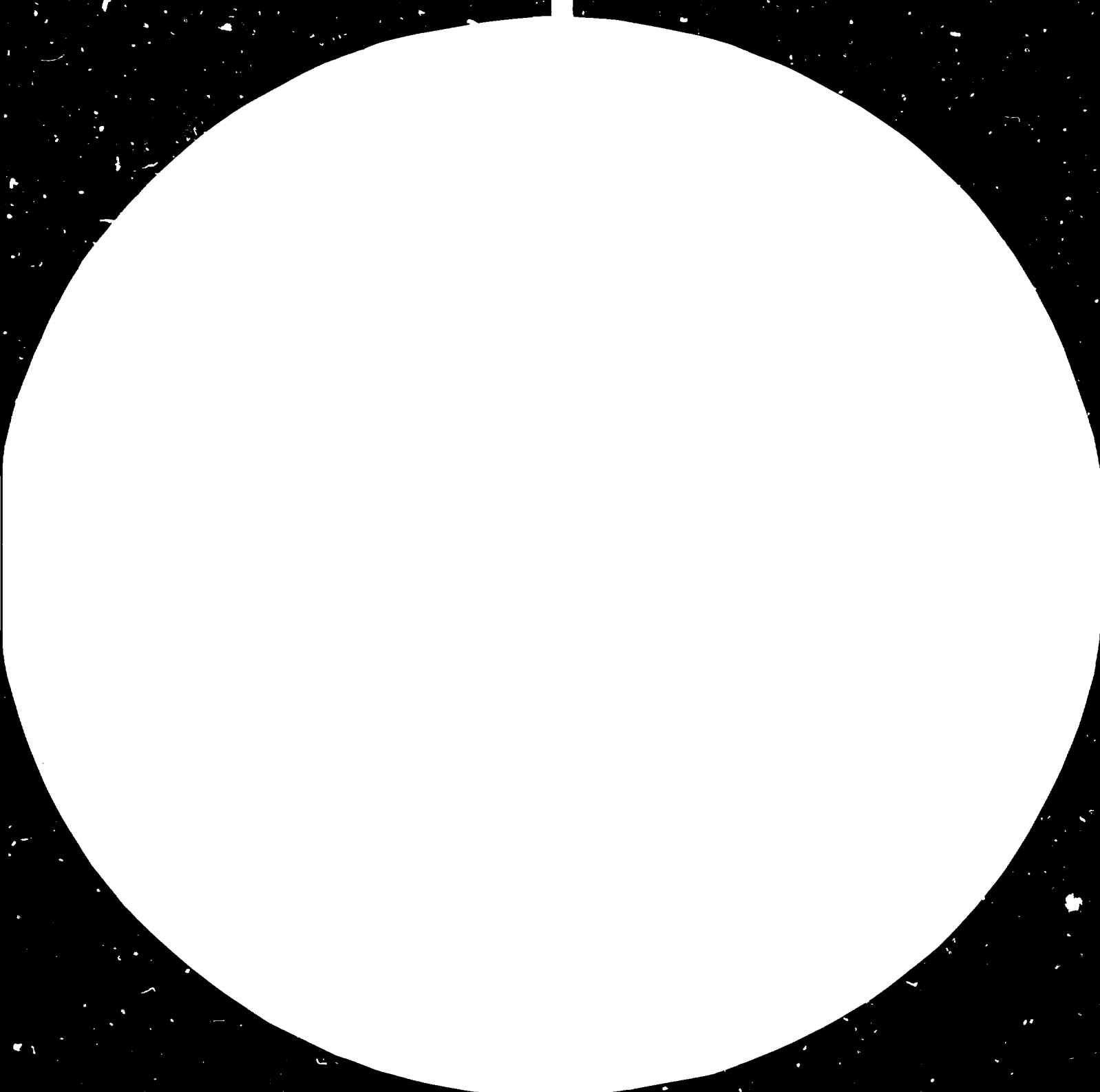

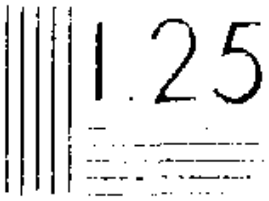

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13 May 1983
English

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CHINA: ASSISTANCE TO MACHINE BUILDING INDUSTRY

DP/CPR/78/021

CHINA

Terminal report*

Prepared for the Government of China
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of J. Barrie Graham,
expert in industrial ventilation and dust control

United Nations Industrial Development Organization
Vienna

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INTRODUCTION

Under a special services agreement with UNIDO I spent three months in the Peoples Republic of China working with the Institute of Engineering Design and Research which is a part of the Ministry of Machine Building Industry. The visit covered October, November, and December of 1982 and included work in Beijing, Louyang, and Zhengzhou. The following is a report of my work in China, some recommendations based on my experiences, and some comments on our living conditions in China.

My comments are given in a spirit of helpfulness to all my friends in China. These comments may seem to be critical of the situation in China but my purpose is not to find fault but to help them in their work and make it possible for them to make as much progress as possible as fast as possible. I hope these comments will be accepted in the spirit in which they are given.

China has over one billion people, has thousands of industrial plants, and has a land mass larger than the United States. I lectured to a relativly few Chinese people, worked in only two industrial plants, spent time in only three cities, and was in China for only three months. I do not speak one word of Chinese. My experience does not qualify me to be an expert on China, on Chinese engineers, or on Chinese industry. I can only express some opinions based on my own very limited experience.

ACKNOWLEDGMENT

I wish to express my gratitude and appreciation to Mr. Yin Jia He of the Central Institute who was my interpreter for the entire three month visit. Mr. Yin not only handled the translation of the technical lectures in a superior manner but made valuable suggestions on ways to improve the presentation. Much of the success of these lectures must be credited to Mr. Yin. In addition to the technical lectures he assisted my wife and me at all times during our visit so that our hotel accomodations were comfortable, restaurant

arrangements were very good, and all the many details that can be so strange to visitors in a foreign land were taken care of in a most efficient manner. This is a difficult task and throughout the entire three month period Mr. Yin was always pleasant and cooperative. As a result of this experience we consider Mr. Yin to be a true friend of ours.

LECTURE SERIES

I gave a series of lectures in Luoyang to a group of about 40 engineers from various parts of China. This series lasted about six weeks and covered the subject material listed in a separate part of this report under the heading "Course Outline for Industrial Ventilation." I shipped 40 copies of "INDUSTRIAL VENTILATION" to China and we used these as textbooks for the course. This book is published by the American Conference of Governmental Industrial Hygienists and is a standard reference for industrial ventilation work in the United States. The material seemed to be well received and seemed to be the type of material the students and advisors wanted to have presented. As a help for future work and as a continuing reference source, I have made arrangements for three sets of engineering handbooks to be sent to the Institute offices in Beijing, Luoyang and Zhengzhou. These handbooks are published by the American Society of Heating, Refrigerating & Air-Conditioning Engineers and will be very helpful to the engineers who are working in the industrial ventilation field.

The lectures were held in a classroom at the Technical College in Luoyang.

Although correspondence had been exchanged between Mr. Ding of the Institute and me on the subject of the curriculum, it was not possible to establish more than the broad outlines of the proposed material for the lecture series. It is virtually impossible to work out all the details of such a program without face to face discussions. Therefore an outline was worked out by Mr. Ding, of the Institute, and me prior to my leaving the United States but the program was left flexible enough to meet the requirements that developed when we had an opportunity to meet and plan the details of the

course.

At the beginning of the series and at intervals during the lectures, conferences were held with officials of the Institute, representatives of the engineers in the class, and me to establish the subject material to be discussed and the priority for the material. As a result of these conferences we were able to work out a program that covered the material of interest and importance to the engineers but still remained in my area of expertise. From my point of view this arrangement worked out very well and I believe it was very satisfactory from their point of view as well since they expressed approval with the progress as we proceeded through the lecture series.

Since there were 40 engineers in the class there was a wide range of interests represented even though all of them were from the general field of Industrial Ventilation. We tried as much as possible to arrange the material so each subject would be of interest to most of the engineers. The general recommendation given by the conference members was to cover as much material as possible in the time available. However questions from the class prompted more detailed discussion on certain subjects and resulted in more time being spent on certain parts of the curriculum than on others. This is probably a good result since this method reflects the true interests of the engineers in the class.

At the beginning of the lectures the engineers did not participate in the classroom activities but simply seemed to accept what I presented. After about two weeks and with some encouragement on my part the class members began to ask specific questions and to initiate discussions on material of interest to them. This is a better atmosphere for both the students and the lecturer and we were able to improve this as time went on and for the last half of the lecture series the cooperation and discussions between the students and me were very satisfying to me and I hope to the students.

Several times during this period I gave two and three day lectures to different groups numbering as high as 200 engineers.

It is my belief that the lecture series was

successful and that a lot of good, useful engineering information was given to the Chinese engineers. Obviously, all of us gained experience during the six weeks of classroom work and if we were to do it again we would make some improvements. I have made some recommendations in a later section of this report.

TRACTOR FACTORY

At the conclusion of the lecture series I worked for about two weeks at the Tractor Factory in Luoyang. I worked with the plant engineers on industrial ventilation problems, air cleaning problems, and noise control problems. This was a valuable experience for all of us and I recommend that this type of work be made an integral part of any industrial development visit to China. It gave me a first hand look at a Chinese industrial plant and helped me to set up discussions that had direct application to real problems in the plant. Some of the Tractor Factory engineers had attended the lecture series and I was able to demonstrate many of the principles we had covered in the lectures by using these principles to propose solutions to actual problems in the plant. I think the combination of lectures and actual plant work was quite valuable to the engineers who participated in both sessions since they had the opportunity to see at first hand how to apply the principles to actual problems.

ABRASIVE WHEEL FACTORY

After the two weeks at the Tractor Factory I spent about two weeks at the Second Abrasive Wheel Factory in Zhengzhou. The work here was similar to that at the Tractor Factory in that we covered industrial ventilation, air cleaning, and noise control. However the specific problems at this plant were quite different and created many new and interesting problems for us. Some of the Abrasive Plant engineers had also attended the lecture series and we were able to demonstrate the connector between the principles and actual application to real problems.

Only a few of the engineers had the opportunity to

attend both lecture sessions and the sessions at the factories and in future sessions it might be possible to give all the engineers this opportunity by dividing the class into several teams and assigning each team a real problem in some local factory. They would spend part of their time in lecture courses and part of their time working on the real problem. The visiting lecturer would be available to guide the work on the problem and to answer questions as the work progressed. In addition this procedure produces some needed design work for the plant that may not get done otherwise.

A possible problem may arise as a result of the work in both plants. During these visits we discussed and made preliminary plans for some projects that are to be carried out in the future. Some of these projects will be expensive and it is important that they be done right. We did not have time to get into the details of the designs and only the general ideas were put on paper. If there was any misunderstanding during these initial discussions it might result in some major errors by the time the final designs are worked out. There is no way for me to know if my recommendations were fully understood during our preliminary discussions. As these designs are being developed I recommend that they be reviewed by some Chinese engineer who has had experience in this work and can assist in the design. By all means the final designs should be carefully reviewed before construction work begins to make sure that the recomendations were fully understood by the engineers who carried out the detailed design.

BEIJING LECTURES

After two weeks at the Abrasives Factory we went to Beijing where I gave a series of lectures for about one week. The engineers came from some local industry for one series of lectures and another lecture series was given at the offices of the Central Institute. Both lectures covered some of the material that had been given during the lectures at Luoyang.

RECOMMENDATIONS FOR FUTURE LECTURE SERIES

It should be understood that these recommendations are not a criticism of the lecture series held in China last October, November, and December. As I have stated above, I believe these lectures went very well and I am very grateful for the cooperation and assistance given me by the people at the Institute and by the engineers who attended the classes.

However this series of lectures was a valuable experience and we can take advantage of this experience to improve the lecture series for future lecturers and students.

1. My strongest recommendation is that the lectures should not be scheduled for six days a week. The schedule is too difficult for both the lecturer and the students. Everyone is so tired by the end of the week that the rate of learning falls off very rapidly. I believe that more can be learned in five days of classes than in six days because the people involved are able to maintain their attention better.

2. Future planning should consider two possible directions for the subject material of the course and for the method of teaching. These two general classifications are:

A. Lectures of broad interest.
B. Lectures of specific interest.

A. Broad interest.

This is the general type of lecture series that we conducted during this past visit. In this type of lecture a great many subjects are covered and the purpose is to provide the students with a background on these various subjects so that they can recognize the type of problem to be solved and have a general knowledge of how to proceed to a satisfactory solution of the problem. Another objective is to give the students a general knowledge of the equipment and instrumentation available for solving problems. This method gives a broad, general background that is valuable for working on a great variety of problems but it requires that the engineer do further study on

his own in order to develop the knowledge necessary to solve specific problems.

In this lecture series I believe we may have tried to cover too many different subjects. As a result some subjects were covered rather well while other subjects were covered rather quickly and we did not give the engineers much information for future work. The Chinese want to learn as much as possible about as many subjects as possible and I understand the logic of this attitude. However, this series showed us that it would be better to put a limit on the number of subjects and make sure that each subject is covered adequately so as to give the engineer a good basis for further study of each subject.

B. Specific interest lectures.

Specific interest lectures cover only one or a few subjects but cover them in great detail. These lectures would be only two or three weeks in duration and the classes would probably be smaller since only those engineers who are working most of their time in those particular fields would attend. The objective of this type of lecture would be to give the engineer a good working knowledge of the subject so that he can start to work effectively on the type of problem covered in the lecture series. Some examples of subjects in this area are:

A. Noise control
B. Duct system and hood design
C. Air pollution control systems
D. Instrumentation

There are many other such subjects that could be covered in specific interest lectures.

GENERAL COMMENTS

The following comments are not concerned directly with future lectures but are based on my observations during the lectures and during the visits to the factories. I hope these comments may be of some help to the Chinese in future planning.

INITIATIVE

A number of the students and some of the engineers in the plants resisted new ideas or suggestions for change on the basis that the change would slow down production, would be an inconvience to the workers, would cost too much money (without knowing what the cost would be), would not work, etc. While this attitude did not occur in most cases, it did occur in enough cases to prompt me to make some comment about it. This attitude is not one that is limited to Chinese engineers. We find the same attitudes here in the United States and I suspect that it is the same throughout the world. However it is an attitude that should be discouraged. The engineers should be trained to approach the problems with complete confidence that the problem CAN be solved and solved within the requirements of cost, production, workers conditions, etc.

If a more open mind toward new ideas and a more positive attitude can be developed, more problems will be solved and they will be solved in a manner that will be of maximum benefit to the operation of the plant.

As a part of this attitude I believe that the Chinese engineers may think that the engineers in the United States (and some other countries) have all the answers to these industrial problems. This is not true and we are working on the solution to many of the same problems that are facing the Chinese engineers. The Chinese engineers have the skills and abilities to solve these problems and must develop more confidence in their own ability. The Chinese engineers can learn much from engineers in the United States and some other countries and they should take advantage of every opportunity to learn from others but the Chinese should not underestimate their own engineering capability. A combination of help from the outside and good use of

Chinese engineering skills will allow China to progress at the maximum rate.

TRANSFER OF INFORMATION

It appeared to me that more progress could be made if a system of information exchange could be worked out within China. During the lecture series it was apparent that some of the engineers had a good working knowledge of some engineering design procedures while other engineers in the class did not seem to know that this knowledge was available. Engineers from one part of China had solved problems in a very satisfactory manner and their systems were operating very well. Engineers from other parts of China were working on similiar problems and were starting from the beginning rather than taking advantage of the knowledge and experience that was available to them from other engineers. Development of a system of engineering information exchange is not easy but the need is great and the results are very advantageous.

In the United States much of the information exchange is accomplished through the activities of the engineering societies such as ASHRAE, ASME, AMCA, and similar organizations. I described the operation of these organizations in my lectures and the Chinese should consider some similar type of organization for technical information exchange.

MAINTENANCE

During my work at the tractor factory and at the abrasives plant I examined industrial exhaust systems, air cleaning systems, and fan installations which had been described to me as not operating properly. In some of these cases the problem was not in the system design but was due to a lack of proper maintenance of the equipment. Many of the problems could be solved by a planned program of preventive maintenance. This type of program is intended to keep all equipment in good running order at all times and not wait until equipment breaks down before making repairs. The equipment is checked at regular intervals and parts are repaired or replaced if they show any significant signs of wear so that the machines are always in good oerating condition.

This type of program appears to be expensive but experience has shown that it is really less expensive to conduct a well run preventive maintenance program than to run a program that is based on repairing equipment only when it breaks down. The proper operation of a preventive maintenance program is a complex problem and must be done with a great deal of thought and planning. If there is interest in such a program it would be advisable to study some background material on this subject. I would be glad to get some material on preventive maintenance and send it to the Institute or to the plants if they desire.

I strongly recommend that maintenance work be given a much higher priority in the plants.

WORK RULES

I do not claim expertise on the subject of adequate working conditions but even with my limited experience I could see that working conditions could be improved in many parts of the plants. There were many instances where the workers were being exposed to high noise levels, to very hot conditions, or to very dusty conditions. The long range solution to these problems is to build sound reduction enclosures, to provide radiation and heat shields, or to install dust removal systems but there are ways to solve these problems immediately. The workers should be required to wear ear protectors or to wear respirators for their own protection. Workers working around furnaces should be required to wear eye protection and face shields. Excuses such as "They do not want to wear ear [illegible] because they are not [illegible]" are simply unacceptable. They must wear them or their health will be affected. Plant work rules should be established to require the use of protective equipment.

In other cases the workers are working too close to operating machinery and are subject to personal injury. More protective shields and guards should be added to the machinery to protect the workers

AUTOMATION

During my lectures there was great interest in automation and computer control for industrial ventilation systems. These subjects should be carefully studied by the Chinese engineers but I want to add a word of caution. We have found here in the United States that it is very easy to use automation and computers in ways that are not economical. It is very tempting to use computers as much as possible and to use automatic instruments as much as possible but it will soon be found that much of the equipment is not doing a significant part of the job. The objective is to use just enough instrumentation and computer capability to do the job and not to use any more than that. The Chinese engineers should be warned to progress very carefully in this area and to make sure that the instrumentation and computers will be justified economically. They must use this type of equipment but they must plan their development program well.

ENERGY CONSERVATION

We discussed the subject of energy conservation on many occasions but I want to add some further comments on this subject because there is an important difference between energy conservation in the United States and in China. In the United States we have not designed energy efficient systems in the past and we are now redesigning those systems so that they are energy efficient and are designing new systems to be efficient. In existing buildings and plants it is quite possible that the total energy requirments will less than they were previously. In China the situation is different.

In China many of the existing systems do not have adequate ventilation and air cleaning facilities and it will be necessary to add these to the plant facilities. This will mean an INCREASE in the power requirements for the plant. Therefore China must expect increased power requirements and must add these essential facilities but must do very good engineering design work so that the increase is as small as possible.

GENERAL LIVING CONDITIONS

The three month visit I made to China sponsored by UNIDO was a very rewarding experience in many ways. My wife accompanied me and for both of us it was our first time in China. We now feel very sympathetic to the Chinese people and will follow their development and history with great interest always. We feel very close to the people with whom we worked, all of whom were without exception extremely cordial and helpful. Mr. Yin, who acted as interpreter during our whole stay, of the lectures as well as in other situations, was everything one could wish for. He was always a pleasant, helpful companion, besides doing excellent work with the technical lectures.

Mrs. Graham conducted a series of conversational English classes, arranged by the Institute in Luoyang. We both feel that the benefit was mutual and that we are far richer in our personal lives because of our close contact with the members of our classes.

Everything possible was done to make us comfortable in our quarters in Luoyang. A suite was provided so that I had a place to work other than in the bedroom.

Each Sunday we were taken to the special cultural and historic sights within driving distance of Luoyang. Banquets with delicious and beautifully presented foods were given for us in all three cities. We had been asked what we were interested in and had replied, "Everything!" Hence we were taken to Provincial operas, Chinese films, libraries, schools, and anything else that could be arranged.

Our only travel request was to go to Xian to see the Qin tomb excavations. A four day trip between the end of the lectures and the beginning of my work in the Tractor Factory was approved. Mr. Yin and Mr. Xue accompanied us by train, all arrangements were made for us, and we paid our own expenses only. Through the good help of the Chinese we were able to see one of the great cultural wonders of their country.

The Tractor Factory staff continued the good

treatment we had become used to. When we left Luoyang for Zhengzhou we were driven by van in order to be taken to a commune and to One Hundred Springs on the way.

In Zhengzhou Mr. Hao and others at the No. 2 Abrasives Factory were equally cordial and hospitable. We were given dinners, taken to the cinema, and a Sunday trip to Kaifeng was most enjoyable. We left Zhengzhou with regret as we had Luoyang. Our stays in both cities were memorable.

In Beijing we were given a room at the Beijing Hotel, the best accommodations we had had: very comfortable and of course convenient to the Central Institute.

We will be happy to help the friends we made in China in any way possible. I have sent some product catalogs at their request, and my wife is sending pictures which she took. We will also be happy if we can advise others going to China at your behest.

COURSE OUTLINE
FOR
INDUSTRIAL VENTILATION

1 - FLUID FLOW

PRESSURE VARIATIONS
TOTAL PRESSURE
VELOCITY PRESSURE
STATIC PRESSURE
ROUGHNESS
COEFFICIENT OF FRICTION
TURBULENT FLOW
WALL FRICTION EFFECTS
DUCT SECTION CHANGES
FLOW SEPARATION

2 - FAN SELECTION AND APPLICATION

CENTRIFUGAL FANS
AXIAL FANS
FAN DESIGN
FAN PERFORMANCE CURVE
FAN LAWS
FAN PROPORTIONS
SELECTION CHARTS
SELECTION BASED ON TOTAL PRESSURE
TOTAL PRESSURE = STATIC PRESSURE + VELOCITY PRESSURE
FAN PRESSURE RELATIONSHIP
FAN CONTROL METHODS
FAN CURVE EVALUATION
SYSTEM EFFECT FACTORS
STABILITY

3 - DUCT DESIGN

VELOCITY PROFILE
SYSTEM ANALYSIS
FRICTION FACTORS
ROUND DUCTS
RECTANGULAR DUCTS
ENTRANCE CONDITIONS
CHANGING CROSS-SECTION

FUASE
DYNAMIC LOSSES
INLETS
OUTLETS
DIFFUSERS
NOZZLES
ELBOWS
TEES
ORIFICES
OBSTRUCTIONS

4 - DUCT DESIGN METHODS

EQUAL FRICTION
VELOCITY REDUCTION
STATIC REGAIN
CONSTANT VELOCITY

5 - MATCHING THE FAN TO THE SYSTEM
FAN PERFORMANCE CHARACTERISTICS
DUCT SYSTEM CHARACTERISTICS
DESIGN VS. MEASURED PERFORMANCE
DAMPER ADJUSTMENT
SPEED ADJUSTMENT
OPERATING TECHNIQUES

6 - HOOD DESIGNS

ENTRANCE FLOW PATTERN
CAPTURE VELOCITIES
HOOD SHAPE
HOOD POSITION
ENCLOSURES OR BOOTHS
EXTERIOR HOODS
    PLAIN OPENINGS
    FLANGED OPENINGS
    SLOTS
    CANOPY
RECEIVING HOODS
PUSH-PULL HOODS
DOWN DRAFT HOODS
WORKER PROTECTION
ECONOMY OF AIR FLOW
SEPARATE AIR SUPPLY
RECIRCULATION OF AIR

7 - HOOD APPLICATIONS

FOUNDRIES
GRINDING
MATERIALS HANDLING
PAINTING
WELDING
ELECTRIC FURNACE
ENGINE TESTING
CONVEYOR BELTS
OVENS

8 - PRINCIPLES OF DUST COLLECTION

STATISTICAL CONSIDERATIONS
IMPINGMENT
IMPACTION
INTERCEPTION
STRAINING
DIFFUSIONAL EFFECTS
ELECTROSTATIC EFFECTS
PARTICLE SIZE
CONCENTRATION
CHARACTERISTICS OF AIR OR GAS STREAM
CHARACTERISTICS OF CONTAMINANT
GAS ABSORBTION
ADSORBTION
DILUTION
GENERAL VENTILATION

9 - DUST AND FUME COLLECTORS

PRINCIPLES OF OPERATION. OPERATING CHARACTERISTICS AND TYPICAL APPLICATIONS FOR:

IMPINGMENT FILTERS
  THROW AWAY
  WASHABLE
  ROLL TYPE
  HEPA
ELECTROSTATIC FILTERS
FABRIC
  MATERIALS
  BAG TYPES

INTERMITTENT OPERATION
MULTIPLE SECTION
REVERSE JET CONTINUOUS DUTY
REVERSE FLOW = COLLAPSE
PULSE TYPE
SHAKER TUBE
WET COLLECTORS
CENTRIFUGAL
DYNAMIC
VENTURI
SCRUBBERS
SPRAY TOWERS
PACKED TOWERS
MIST COLLECTORS
ABSORBERS
ADSORBERS
DRY COLLECTORS
CYCLONES
DYNAMIC
SETTLING CHAMBERS
UNIT COLLECTORS
COMBUSTION

10 - SELECTION FACTORS

EFFICIENCY
LOADING
PARTICLE SIZE
COST
CORROSION
PRESSURE DROP
TEMPERATURE
MAINTENANCE

11 - INSTRUMENTS - FLOW MEASUREMENT

PITOT TUBES
MANOMETERS
MICRO INCLINES
U-TUBE
THERMOMETERS
PRESSSURE INDICATORS
PRESSURE TRANSDUCERS
SPEED INDICATORS
RECORDERS
ANEMOMETERS

HOT WIRE
VANE
FLOWMETERS
VENTURI
ORIFICE
NOZZLE
TURBINE
PSYCHROMETER
TACHOMETER

12 - SYSTEM TESTING - FLOW

HOOD FACE VELOCITIES
FACE VELOCITY DISTRIBUTION
DUCT PRESSURE LOSSES
BRANCH FLOW RATES
TOTAL FLOW RATES
FAN TOTAL PRESSURE
FAN SPEED
PRESSURE DROP ACROSS COLLECTOR
COLLECTOR EFFICIENCY
TRAVERSE PLANE LOCATIONS
ACCEPTABLE VELOCITY PROFILES
NUMBER OF TRAVERSE POINTS

13 - DUST COLLECTION EVALUATION
REQUIRED PERFORMANCE
SAMPLING METHOD
INSTRUMENTATION
ANALYSIS
WEIGHT
PARTICLE SIZE
PARTICLE COUNT
OPACITY
EQUIPMENT OPERATING CONDITION

14 - NOISE CONTROL - FUNDAMENTALS

DECIBELS
SOUND POWER LEVELS
SOUND PRESSURE LEVELS
"A" WEIGHTED LEVELS
COMBINING LEVELS
FREQUENCY RANGE
FREE FIELD RADIATION

SEMI-REVERBERANT ROOM RADIATION
ROOM CHARACTERISTICS

15 - NOISE CONTROL - FAN NOISE

FAN NOISE MEASUREMENT
SIZE AND SPEED CHANGE
FAN DESIGN NOISE CHARACTERISTICS
FAN NOISE DATA

16 - NOISE CONTROL - SYSTEM

ALLOWABLE NOISE LEVELS
METHODS OF NOISE REDUCTION

17 - NOISE CONTROL - VIBRATION

FAN UNBALANCE
  BALANCING PROCEDURE
RESONANCE
ISOLATORS

18 - MAKE-UP AIR
RECIRCULATION
OUTSIDE AIR
DISTRIBUTION METHOD
TEMPERATURE DIFFERENCE
HEATING MAKE-UP AIR
SPECIAL DIFFUSERS
HEAT RECOVERY METHODS
DILUTION VENTILATION
STRATIFIED AIR
AIR CONDITIONING