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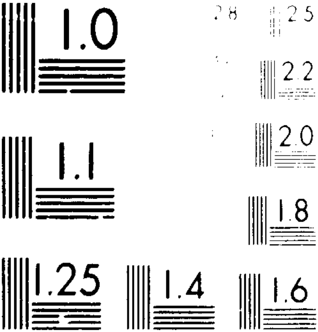
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UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

14 September 1981

# Mission to China

of

Frans J. Soede
Senior Industrial Development Officer
Institutional Infrastructure Branch
Division of Industrial Operations

17 - 27 August 1981

This report has not been cleared with the United Nations Industrial Development Organization (UNIDO) which does not therefore necessarily share the views presented.

The mission to the PR of China on Non-Destructive Testing (NDT) was carried out by two consultants (K. Beswick and J. Baez) from 3 to 28 August. The author of this report briefed the two consultants in Vienna on 3 August and joined the mission in Shanghai on 18 August 1981. He participated in the remaining visits to industry and institutions, took part in the discussions with the government officials in Shanghai and Beijing, contributed to the report writing and debriefed the consultants in Beijing.

The findings, conclusions and recommendations of the mission are covered in the report of the consultants of which a copy is attached (Annex I).

## STATUS OF DP/CPR/80/052

This project is in full implementation now. All equipment will be ordered before the end of this year (see Annexes II and III). The two-month five-men study tour will commence by the beginning of March 1982 and will visit the USA and Japan. For programmes see Annexes IV and V. Five persons have been selected for the study tour and four persons for the fellowships (Annex VI). Submission of their candidatures will take place soon. Two experts, one in NDT organization and one in NDT certification and training will be assigned to the project by the middle of next year.

## SECOND-PHASE OF THE NDT PROJECT

It has become apparent from the discussions and visits that in case the PRC would like to bring its NDT base up to the international level rapidly a number of external inputs (experts, study tours, fellowships, equipment) will be required to support the already impressive national efforts. On the government side (First Ministry of Machine building) there is a definite conviction that a second phase of the project will have to be implemented with UNDP support during the third country cycle from 1983 to 1986.

This was confirmed in a meeting with the Vice-Minister Tao Hengxian which took place in Beijing on 26 August 1981.

From our discussions with Mr. Allan Doss, UNDP Resident Representative a.i., we concluded that UNDP does not entirely share the above opinion of the Ministry but would like the PRC to select projects which are more in line with the major present objective of the government i.e. to reinforce.

light industries. It was explained to Mr. Loss that the establishment of a sound NDT base would help development of light industry because of the improvement in reliability and safety of machine tools and plant equipment produced by the capital goods industry.

Moreover it was mentioned to UNDP that NDT is not only significant to industry but also plays an important role in energy conservation and safety in public works, transportation, etc.

A preliminary draft project document (Annex VII) was designed by the mission and given to Mr. Wang Wutong the Head of the NDT Department of the Shanghai Research Institute for Materials which is the counterpart agency for the present project. The total cost of this second phase of the project will be about one million dollars. Our counterparts seem to be confident that they will receive a contribution of this magnitude from the third cycle "UNDP cake" notwithstanding the UNDP Resident Representative's reluctance.

TRIBOLOGY (FRICTION, WEAR AND LUBRICATION)

Mr. Tao Linghuan of the First Ministry of Machine Building, who is the keyperson in the creation of a regional tribology centre of excellence to be located in the PRC, asked me about the status of this project which has been submitted for UNIFSTD financing by ESCAP. I promised him that I would contact our office in NY and communicate the results to him. I pointed out that if UNIFSTD would be able to finance his project due to lack of funds, support from the UNDP Regional Programme could probably be obtained. A copy of the project document is available in my office.

EVALUATION OF IRSI'S

Mr. Tao Linghuan is responsible for a multi-branch R and D institution in his ministry. I talked to him about the joint UNDP/UNIDO evalutation study and promised him to sent two copies of all documents.

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

2 September 1981

# Assistance to The Shanghai Material Research Institute (SRIM) on Non-Destructive Testing.

DP/CPR/80/052

## Mission to China

of

Juan N. Baez*

Ken C. Beswick**

August 1981

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* Head, Training and Certification Division, INEND, Argentine Atomic Energy Commission.

** UNIDO Consultant and former Senior Technical Adviser to the UNDP project DU/ARG/71/537 on NDT in Argentina.

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## ANNEXES



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## A. INTRODUCTION AND OBJECTIVES OF THE MISSION

In accordance with Item E.a. of the Project Document DP/CPR/80/052, the two consultants were invited to China to carry out a preparatory assistance mission which covered:

(i) Technical consultancy on the choice of equipment and documentation and the design of the programmes for the study tour and fellowships covered by the subject project.

(ii) The evaluation of the present non-destructive testing (NDT) ability of China's engineering industry on the basis of visits to the Shanghai Material Research Institute (SRIM), the Research Institute of Mechanical and Electrical Technology (RIMET), Beijing, the Thermal-Power Engineering Research Institute, Xi'an, and some representative factories and institutions in the engineering branch.

(iii) Assistance to the First Ministry of Machine Building Industry of the People's Republic of China in establishing a national NDT base and to define the requirements for external technical assistance during the period 1983 - 1986.

The consultants arrived in Beijing on 6 August 1981 and after [illegible] gone through the usual administrative procedures and briefin[illegible] [illegible] UNDP office, started their activities on 7 August 1981 (see [illegible] for programme of visits).

[illegible] the afternoon of 18 August 1981, Mr Frans J. Soede, Senior [illegible] Development Officer of the Institutional Infrastructure [illegible] Division of Industrial Operations and backstopping officer of [illegible], UNIDO, Vienna, joined the two consultants and participated [illegible] [illegible] visits and discussions.

## [illegible] LECTURES

[illegible] 15 visits were made to institutes, Universities and [illegible] [illegible] details of these visits are given in Annex II.

In addition, three lectures were given:

(a) A three-hour lecture to about 80 people covering the development, methodology, present status and future trends of NDT in the MEERI.

(b) A similar four-hour lecture to about 120 persons in Shanghai.

(c) A specific lecture on training, qualification and certification to some 20 selected people in Shanghai.

Also, numerous informal discussions were held during the whole period of the mission.

## C. STATUS OF THE PROJECT

### 1. Mission of Two Consultants

This mission enabled a first joint evaluation of the status of NDT in China, both for the Government and UNIDO. The findings of the mission are summarized in Chapter D.

The opportunity to lecture to large audiences involved in NDT work enabled them to become familiar with the development and organization of NDT in more technologically developed countries. The interest shown by the audiences was a measure of the motivation, determination and enthusiasm to raise the level of NDT as soon as feasible to international standards.

During the technical visits, there was ample opportunity to give direct advice which was gratefully received.

This mission also provided the opportunity to discuss in detail the creation of a national NDT base (focal point with associated network) which will deal with all the aspects of NDT applications in the country such as equipment, proper use of the technology and systematic organized training and certification.

2. Equipment

The numerous quotations received from the suppliers were jointly evaluated and the selection made. It is considered that this equipment will expand the capabilities of SRIM and MEERI to support industry and other entities which require NDT assistance. Supplementary equipment is also required at this stage to overcome deficiencies in the application of some NDT methods such as radiography, magnetic particles and infrared thermography.

It is expected that all equipment will be ordered in 1981.

3. Study Tours

Based on the aforementioned evaluation of the present status of NDT in China, the future plans and the technical level of personnel engaged in NDT, it was agreed that a group of five senior engineers should visit both Japan and the USA for a period of two months to have first-hand contacts with manufacturers of NDT equipment, its industrial application and organization, and the existing institutional infrastructure, including NDT societies. The study tour should commence in March 1982.

4. Fellowships

The training programme for, and the location, of four fellowship candidates was discussed in detail. All the candidates appeared to be suitably qualified, the necessary forms have been completed for transmission to UNIDO through UNDP, and placement should be made as soon as possible.

5. Experts

Of the two man/months budgeted for 1982, one man/month will be used for advice in training and certification during May 1982. The second man/month will provide for an expert to give further assistance in the organization of the national NDT base.

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6. General

The implementation of the project has obviously stimulated national activity in the NDT field such as the organization of more formal training courses in close co-operation with different institutions and industry, and an outline plan for certification.

In June 1981, a national NDT conference was held, with 300 participants and representatives of 15 Ministries. From the abstracts, the technical level of the conference was up to international standards.

## D. FINDINGS

1. Introduction

The survey carried out was limited to a small number of factories in the heavy engineering industry. No time was available to study NDT applications in public works, the manufacture of transportation equipment (road, water, air, rail), electric power generation, transmission and distribution, plant assembly and installation, etc.

2. Manpower in NDT

It is estimated that, at present, in China about 50,000 people are employed in NDT.

In Argentina, 2,000 people were employed in NDT in 1979, which is known to be insufficient. The ratio of population between China and Argentina is about forty. If this ratio is applied, it appears that China, at present, is employing about half of manpower in NDT in comparison with Argentina.

The consultants were impressed by the high level of motivation, innovative capability and curiosity of staff working in the NDT field.

3. NDT Equipment

The number of ultrasonic instruments used is estimated in the order of 5,000. The great majority of the equipment is manufactured locally. As well as ultrasonic instruments, x-ray machines, dye penetrants and magnetic particles are also made.

At a number of locations, remarkable innovative instrumentation development and application was found, such as large ultrasonic transducers to overcome surface roughness problems in the examination of large castings, microtransducers for in-service inspection of turbine blades, and high-precision thickness measurements ($\leq$1 mm).

There are energetic attempts to develop NDT equipment based on more sophisticated principles. For example, the consultants saw an infrared scanner designed and built by one engineer from scratch.

The quality of radiography film and lead screens is not sufficiently high and radiographic film viewers are very seldom used, notwithstanding the fact that this type of equipment is manufactured already in the country. Film densitometers were not seen in use. Radiography reference standards are not in use.

The Shanghai Ultrasonics Instrument Factory is interested to negotiate agreements for licensing or joint-ventures with foreign partners in order to manufacture for the export market. It was pointed out that UNIDO can give assistance in these negotiations by checking whether the terms of the agreements would provide a fair deal to the Chinese partners, and were in line with international practices.

There is also a need to manufacture more lightweight and portable ultrasonic instruments which we understand is an NDT problem, more related to the development of China's electronic industry.

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4. Residual Stress

It seems that a lot of emphasis is put on the research of resid̈ual service stress in fabricated steel components.

5. Radiation Protection

It seems that there is very little knowledge and application of radiological protection procedures and techniques.

6. NDT Techniques

Gamma (radioisotope) radiography is very rarely used.

Basic NDT techniques are widely used but in many cases not properly or incorrectly applied. There is over-use of ultrasonics techniques, for example, in the on-line inspection of steel billets where the magnetic particle technique would be more effective. In addition, there is a lack of use of fluorescent magnetic particle techniques.

7. Training

Most training of NDT technicians and operators is done on-the-job or through learning-by-doing, as in many other countries. Very few people active in NDT have received formal training in this field.

There is, however, an awareness of the need for training. The Chinese NDT Society has started some courses for technicians and operators. The consultants visited one ultrasonics course for 30 NDT technicians from the shipbuilding industry. This course was carried out at Jiaotong University in Shanghai, and was jointly organized by the SRIM, the Chinese NDT Society and the University (ratio of equipment to students - 1:3).

There are also plans to include NDT in the syllabi of technical schools and Universities.

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8. Certification

Although a lot of interest is shown in developing a nationwide NDT certification scheme for engineers, technicians and operators and the NDT Society has started to plan such a scheme, no concrete action has been taken up to the present.

9. NDT Information

Qualified NDT staff seem to be rather well-informed about worldwide developments in NDT. There does not seem, however, to be general and easy access to NDT information especially in technological applications.

The development of an NDT information system with access to foreign and local data banks, and dissemination to industry, is still in a rather preliminary stage.

10. Institutional Infrastructure

A large number of institutions and enterprises are involved in the application and research of NDT techniques and the manufacture of NDT equipment. It seems, however, that there is not enough co-ordination and communication. Therefore, the nationwide NDT institutional infrastructure is still in a preliminary stage of development.

E. CONCLUSIONS AND RECOMMENDATIONS

1. Notwithstanding the limited time, the mission was able to accomplish its objectives due mainly to the efficient organization and support given by the Chinese counterpart.

From the beginning of the mission, a frank and fluid exchange of information and opinions between the parties was established.

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2. The NDT base in China requires reinforcement which will necessitate considerable foreign inputs (experts, fellowships, study tours and equipment) for at least the next five years. Without these inputs and without exposure to the errors made by others working in this field, there is a great danger that wrong approaches to the use of NDT † hnology as a whole will continue to be made.

3. The national NDT base requires close co-ordination and intensive communication between all NDT specialists in the country, industry, Universities and technical schools, the National Committee for Science and Technology and all Ministries which are concerned with the application of NDT technology.

4. To help overcome the use of individual NDT methods rather than the use of NDT as an integrated technology, several actions are recommended:

(a) The use of well-equipped mobile laboratories which would supply complete training services to industry and other users.

(b) In addition to training in individual NDT methods, problem-orientated courses should be included in the training programmes.

(c) A national certification scheme should be designed, approved and implemented as soon as possible.

5. It is strongly recommended that urgent action be taken to enforce a national radiological protection scheme for the benefit and safety of operators of radiography equipment.

6. After the implementation of the above scheme, it is recommended that gamma radiography techniques should be introduced to improve the quality of inspection in the erection of industrial plants and civil works.

7. It is recommended that consideration be given to the use of more portable ul'rasonic instruments to allow their extended use in difficult work conditions.

8. The national NDT base must have a strong and up-to-date information centre for the collection, retrieval and dissemination of NDT information through its network down to the operator level.

9. To conform with international contractual requirements, it is recommended that factories make more formal use of written inspection procedures.

## F. FINAL DISCUSSIONS

At the end of the mission, the above-mentioned findings, conclusions and recommendations were orally communicated to the Director of the Shanghai Research Institute for Materials, Meng Zhi Laing, the Vice Minister of the First Ministry of Machine Building, Tao Hengxian, and Mr Alan Doss, UNDP Resident Representative a.i.

## Itinerary in Beijing, Xian and Shanghai

| | | | |
|---|---|---|---|
| 7.8.81 | Fri | 1000 | UNDP office |
| | | 1430 - 1530 | Meet the Director of Institute (MEERI) |
| | | 1530 - 1700 | Visit the MEERI |
| 8.8.81 | Sat | 0830 - 1000 | Visit the MEERI |
| | | 1000 - 1130 | Discussions |
| | | 1400 - 1530 | Visit Beijing Heavy Electric Machinery Plant |
| | | 1530 - 1700 | Visit Beijing Heavy Machinery Plant |
| 10.8.81 | Mon | 0830 - 1030 | Lecture (MEERI) |
| | | 1030 - 1130 | Discussions |
| | | 1400 - 1500 | Visit Beijing Metal Structure Plant |
| | | 1500 - 1700 | Visit Beijing Internal-Combustion Engine General Plant |
| 11.8.81 | Tues | 1245 | Flight to Xi'an |
| 12.8.81 | Wed | 0830 | Visit Xi'an Jiaotong University |
| | | 1400 | Visit Xi'an Research Institute of Heat Exchange Engineering |
| 14.8.81 | Fri | 0805 | Flight to Shanghai |

## Programme in Shanghai (14-26 August 1981)

| | | | |
|---|---|---|---|
| 14.8.81 | Fri | pm | Discussion of the activities in Shanghai |
| 15.8.81 | Sat | am | Reception by the Director of Shanghai Research Institute of Materials, briefing of the project implementation progress and visit to the laboratories of "new institute" |
| | | pm | Visit to the laboratories of "old institute" |
| 16.8.81 | Sun | am | Shanghai Industrial Exhibition |
| 17.8.81 | Mon | am | Lecture |
| | | pm | Technical discussion |
| 18.8.81 | Tues | am | Shanghai No. 5 Iron and Steel Works |
| | | pm | Shanghai Jiaotong University |

| | | | |
|---|---|---|---|
| 19.8.81 | Wed | am | Shanghai Boiler Plant |
| | | | Shanghai Heavy Machine Plant |
| | | pm | Shanghai Electrical Machinery Plant |
| | | | Shanghai Steam Turbine Factory |
| 20.8.81 | Thur | | Shanghai Ultrasonic Meters and Instrument Factory (SUIF) |
| 21.8.81 | Fri | | Preparation of report on study tour |
| 24.8.81 | Mon | am and pm | Discussion and advice on NDT base |
| | | Evening | Dinner given by Mr Meng, Director of Shanghai Research Institute of Materials |
| 25.8.81 | Tue | am | Travel to Beijing |
| 26.8.81 | Wed | am | Visit to UNDP office |
| | | pm | Discussion with Mr Meng Zhi Laing, Vice Minister, First Ministry of Machine Building |
| 27.8.81 | Thur | am | Preparation of report |
| | | | Lunch offered by First Ministry of Machine Building |
| | | pm | Discussions |
| 28.8.81 | Fri | am and pm | Preparation of report |
| 29.8.81 | Sat | am | Leave Beijing |

# DETAILS OF VISITS

## 1. Academy of Machinery Science and Technology, Beijing

The experts were received by the Director of the Academy, Zong Zang, two Deputy Directors, Tao Linghuan and Wang Xinmin, the Head of the Third Research Department, Zhu Sindi, and other staff members.

The Institute has eight centres in six cities, employing a total of 5,000 persons. The centres are:

(a) Shanghai Research Institute of Materials (NDT work performed)

(b) Harbin Research Institute of Welding (NDT work performed)

(c) Shengyan Research Institute of Foundry (NDT work performed)

(d) Whan Research Institute of Materials Protection

(e) Zhengchou Research Institute of Mechanical Engineering

(f) Research Institute of Automation for the Machine Building Industry, Beijing

(g) Research Institute of Standardization, Beijing

(h) Research Institute of Mechanical and Electrical Technology, Beijing (NDT work performed)

These Institutes are mainly devoted to the development and application of scientific knowledge within their special areas of interest.

During the visit to the Research Institute of Mechanical and Electrical Technology (RIMET), the main laboratories associated with NDT were:

(i) Metallography, where a non-destructive micro-probe analyser is used extensively and modern electronic systems for metallographical studies are employed.

(ii) Heat treatment, where a well-designed system for the non-destructive evaluation of the quenching properties of coolants used in heat treatment has been constructed and is now applied on a service basis in industry.

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(iii) Strain gauging, where studies are made of the stress developed in different structural parts of bicycles, for example, whilst in normal city circulation. Strain gauges are attached to the vehicle and the information is transmitted by radio to a central multiple channel recorder. This information is used to improve the design of bicycles.

(iv) Surface stress analysis, where x-ray diffraction principles are applied. During the last 10 years, a special instrument has been developed which employs a small x-ray source, a goniometer and proportional counters. Some 10 instruments of this type are applied in other institutes and industries for the investigation and evaluation of residual surface stress to improve the quality of fabricated steel components.

(v) Ultrasonics, where there is a range of locally manufactured instruments and transducers which are used to give service to industry. Special probes of 10 cm diameter with a single transducer have been designed to overcome surface roughness effects in the inspection of large castings.

## 2. Beijing Heavy Electrical Machinery Plant

The plant was started in 1958 and now has a staff of 6,800 with 600 technicians of which 400 are engineers. The main product is power station generators from 1,500 to 100,000 KW, 22 of the latter having been built to date. In recent years some 100 generators of 750 KW have been built and a design is being prepared for the first 200,000 KW generator to be built in 1982. Other products include alternators (160 to 3,200 KW), D.C. motors, oil tankers, internal combustion engines, 2,000 KW mobile generators using aircraft engines, and betatrons. In addition, domestic electrical appliances such as washing machines and driers are made. All the products are self-designed and manufactured in 20 workshops, and the product line is being changed because of lack of demand.

The NDT Group (13 staff) is a part of the Materials Testing Laboratory and works in both the laboratory and the plant. There is also a technical school for specialized training, including NDT.

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NDT observed in operation were manual inspection of flywheels using locally made ultrasonic equipment (pulse echo technique with normal transducers), x-ray radiography and magnetic particles. It was stated that dye penetrants are also commonly used. No written procedures were shown.

The visit was guided by Dian Zhen Meng, Deputy Director and Deputy Chief Engineer, Wang Lianshen, Director of Central Laboratory and Yun Quinhua, NDT Group Engineer.

3. Beijing Heavy Machinery Plant

The experts were received by Zhong Defa, Deputy Chief Engineer, Zhu Shubao, Director of the Testing Department, Zheng Zhong Xing, Head of the NDT Group, and other engineers.

The plant employs 7,500 people, including 500 technicians and the main products are presses, rolling mill cylinders, ball mills, cranes, wood cutting equipment, pumps with a cylinder diameter of 300 mm, iron and steel castings, forgings (40 tons), pump housings and generator housings. Their production of ship's components is approved by Lloyds. Crank arms and balance weights for oil pumps are also made.

A group of 14, of which two are engineers, is engaged in NDT, using mainly ultrasonic inspection with nine locally-made instruments, radiography using a 300 KV Scanray machine and magnetic particles. As the plant manufactures heavy sections, the use of gamma radiography was discussed. This technique is not used, the main reason being a lack of confidence in the safety of radioisotope use.

NDT training is done in the factory by plant staff and it was stated that systematic training throughout the country was required, a national certification scheme was essential and that the standardization of instruments was also necessary. Since the plant exports some of its products, the existence of such norms would be helpful.

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4. Beijing Metal Structure Plant

The experts were received by Yia Fenggi, Deputy Chief Engineer, Hu Zhonggi, Deputy Director, Testing Station, Yu Baohai, Deputy Director, Welding Research Institute, and Liu Weiguo, Deputy Director, Administration.

This plant is 30 years old and employs 1,900 people, its main products being for the oil and chemical industries. There are three plants with a total area of 150,000 square metres and the main products are pressure vessels and ball mills, using different kinds of steels and aluminium alloys. Annual production is roughly 7,000 tons.

The Testing Station has a staff of 100 of which 37 are involved in NDT (17 qualified operators and 20 technicians). There are four x-ray machines of 120, 200, 250 and 420 KV which are used to take 2,000 radiographs per month. Six locally made ultrasonic instruments are used for 3,000 tests per month. A mobile magnetic particle machine and dye penetrants are also routinely used. X-ray inspection has been performed for 20 years and ultrasonics for 13 years.

Concern was expressed about the quality of NDT in general and for this reason the plant has annual short-term training courses and examines the operators every month. Procedures are checked every six months. The main problems for which technical assistance is required are related to angle weld inspection, the positioning of probes in ultrasonic inspection and standards for aluminium welds.

5. Beijing Internal Combustion Engine General Plant

The experts were received by Pan Meifeng, Deputy Chief Engineer, Chen Jiansheng, Engineer, Central Laboratory, and other engineers.

Thirteen thousand people are employed in 15 sub-plants and more than 30 departments which are responsible for the complete mechanical process from design onwards.

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The main products are 75 H.P. gasoline engines for jeeps and two-ton trucks (42,000 units/year), and 55 H.P. diesel engines for tractors (20,000 units/year) which represent one-quarter of the total H.P. production of the country for these kinds of internal combustion engines.

The Central Laboratory is responsible for the management of NDT with three engineers, eight technicians and more than 20 operators.

The application of NDT techniques started because of the failure of crankshafts, valves and connecting rods. The forging plant is the largest user of NDT, applying ultrasonic and magnetic particle inspection. Engine block castings are also tested by ultrasonics, whilst magnetic particles are used for crankshafts. Magnetic particle techniques could be improved dramatically by the use of fluorescent particles.

6. Jiaotong University, Xi'an

The experts were received by Zhou Guangqi, Director of the Teaching Research Division of Welding Engineering, and other staff members.

The University was founded in Shanghai in 1896 and in 1956 most of the departments and teaching staff were moved to Xi'an. It is a comprehensive University of science and engineering, directly under the Ministry of Education with eight departments, one of which is for Mechanical Engineering Technology and Materials Science, where the NDT work is performed. There are some 10,000 students and 3,500 staff, of whom 1,500 are in teaching.

Apart from metallography using modern electron microscope techniques, work is being done in fundamental applications of acoustic emission with equipment designed and constructed in the University. There is a laboratory for ultrasonics which is used for teaching and a welding laboratory in which investigations mainly directed to applications using, for example, plasma welding are carried out. There is a well-equipped general library for the whole University and the NDT section has up-to-date journals and books.

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7. <u>Thermal Power Engineering Research Institute, Xi'an</u>

The experts were received by Wang Jiu Zhu, Deputy Director of the General Office, Chen Chao Zhu, Deputy Director, Wei Zhongxia, Department Head, and engineers, He Qianyuan and Yu Xirong.

The Institute was founded in 1949, has a staff of 600 with more than 200 specialists, and belongs to the Ministry of Electricity. There are seven departments which are equipped to give support to coal-fired power stations, mainly for turbines, boilers, water treatment, metallurgy, environmental protection, electricity measurement and plant automation. It is still considered to be in the development stage, principally because of a lack of modern equipment.

The Metallurgical Laboratory has 65 staff, including 40 technicians and engineers and is divided into six groups, one of which is NDT. The others are physical metallurgy, high temperature stress, chemical analysis, friction and milling. The NDT Group has 17 persons, 12 of whom are engineers, and is considered to be the centre for NDT in electricity generation for the whole country with subsidiary laboratories in each province. They are specially prepared for the inspection of components for power stations during construction and installation and during service.

The main techniques employed are ultrasonics, radiography, magnetic particles and dye penetrants. In ultrasonics, there are many locally-made instruments which are regularly calibrated using a wide range of calibration blocks. A very small transducer has been developed for inspection of turbine blade inserts with disassembly. Apart from locally-made x-ray equipment, there is also a Caesium-137 gamma source (2 Curies) and Cobalt-60 thickness gauge. Magnetic particles and dye penetrants are used to inspect turbine blades, shafts and other components but fluorescent magnetic particles are not available. Crack depth is measured using the D.C. potential method with a locally-made instrument.

With very basic resources, an infra-red scanning device has been designed and built and is used, together with radiography, for the inspection of high-tension cable joints.

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8. Shanghai Research Institute of Materials (SRIM)

The experts were received by Gui Lifeng, Deputy Director, Wang Wutong, Department Chief and Director of the UNDP project, Zhang Chi Yao, Head of the Technology Development Office, Chen Chunien, Li Run Min, Chen Chu Nien and Xiang Xing Kong.

A description of the 12 departments of the Institute, which was founded in 1949 with 12 people, is attached (see Annex III). Of a total staff of 820, 400 are engaged in technical research (160 senior engineers included). The main work is for the mechanical industry, especially in iron and steel, non-ferrous metals and alloys, and non-metallic engineering plastics.

At the beginning of the 1950's, x-radiography and magnetic particle techniques were introduced in the Institute. This was followed in 1953 by ultrasonics, and 1954 training in magnetic particle, radiographic and ultrasonic techniques commenced. Up to 1962, more than 300 persons were trained and these people are now dispersed throughout the country.

In 1959, some ultrasonic inspection systems were produced for industry and in the same year Cobalt-60 gamma-ray inspection was started for flaw detection in 200 mm thick castings, using a scintillation counter as the detector. This latter technique has been transferred to industry. Also in 1959, eddy current work was started with the development of coils for the inspection of tubes of copper, stainless steel, zirconium and aluminium alloy. These techniques are now used in industry for on-line quality control. During the 1950's and 1960's, a lot of service work was done in industry because the scientific base was not sufficiently strong for intensive development effort. This service work continues.

The NDT Department was formally founded in 1963 and now occupies an area of 800 $m^2$ with 73 staff, including 37 engineers.

In ultrasonics, development efforts are mainly directed to automatic on-line inspection. For example, multiple transducer techniques for the examination of seamless boiler tubes, well casings, spiral welded tubes and steel bars. A C-scanning system was developed in 1972 for the inspection of graphite blocks. For sorting steel and the measurement of surface hardness, eddy current methods have been developed and applied. Sonic resonance and eddy current techniques have also been developed for measuring the pearlite content in nodular cast iron - now applied in the Chungchow factory for crankshaft examination. Recently, development work using the same techniques has been started for the inspection of steel rods.

Working closely with the NDT Department is the Radioisotope Applications Department which was founded in 1960 and now has 15 persons, including seven engineers. The main activities are:

(i) Wear studies in internal combustion engines

(ii) X-ray fluorescence and Mössbauer effects for non-destructive analysis, and

(iii) Temperature distribution in turbine blades using a Krypton-85 absorption and release technique.

A surprising aspect of the visit to this laboratory was the lack of radiation protection. For example, no radiation monitors or personal dosimeters were seen.

NDT training courses are given in co-operation with Universities, other Institutes and industry. There is a preoccupation to raise the level of training and to organize the systematic formation of personnel working in NDT. The courses appear not to be comprehensive but for individual techniques.

In 1978, the Chinese NDT Society was founded with the secretariat in the Shanghai Research Institute of Materials, and branches throughout the country. The main activities of the Society are to organize meetings and training courses to disseminate information. Two journals are published bi-monthly:

(i) An NDT journal (10,000 copies), and

(ii) NDT Abroad - translations (2,000 copies).

The Institute is separated in two locations, "old" and "new", with the NDT Department mainly in the "old" Institute. It was stated that this Department will take over the three-storey building which presently houses the "new" Institute when a further 10-storey building is constructed.

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During the visit it was confirmed that despite the general slowdown in new construction in the country, permission has been given to start building in January 1982 for completion in two years.

At the end of the visit to Shanghai, a special meeting was convened by the Director of the Institute, Meng Zhi Laing, with his staff to discuss in detail the findings of the mission.

9. Shanghai No. 5 Iron and Steel Works

The experts were received by Ming Zicheng, Assistant Chief Engineer, Zhu Renfa, Head of the Technical Inspection Section, and members of the NDT Group.

The works was set up to produce high alloy steels, stainless steel, ball bearing steel, spring steel and tool steel. It has a capacity of 500,000 tons/year of electric furnace steel, of which 400,000 tons/year is used to produce steel items. The main products are bars, tubes, plates and sheets and the biggest ingot produced is of two tons.

Some 80 persons work in NDT of which 10 are engineers, four are technicians and the rest operators. The actual inspection work is done only by operators. Photospectrometry is used for steel analysis. Most of the NDT inspection is carried out by ultrasonics and the well-equipped laboratories have a special section for the design and construction of ultrasonic transducers, which are in many cases of a novel design, using multiple crystals in one transducer. Normal probes are used for the continuous volumetric examination of billets and surface defects are detected using surface wave techniques. Special attention is given to the preparation of reference blocks for instrument calibration. Although there are automatic inspection systems, the speed of inspection is relatively slow and a large number of operators are used to feed the products to the systems.

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10. Shanghai Jiaotung University

The experts were received by Mr Chu, Deputy Director of the University, Wang Yi Zi, and other staff members.

This is the oldest University in China and was founded in 1896. It presently has 13 Departments of which one is the Materials Science Engineering Department (formerly the Metallurgical Department) with four specialities: materials science, forging, welding, and casting. There are six laboratories: metallic materials, composites, welding, casting, extrusion and compression, and NDT. In the Department there are 30 Professors, 100 Lecturers, 30 Assistant Lecturers, three Engineers, 20 Assistant Engineers, with 700 students. In addition, there are 35 post-graduate students of whom 33 are studying for M.Sc. degree and two for a Ph.D. degree.

NDT was started only in 1980 with three main activities: technical development, training of NDT personnel, and courses for students in the University. The Deputy Director of the University is also the Director of the Committee for Training and Certification of the NDT Society.

The NDT Laboratory has a good range of ultrasonic equipment, x-ray machines and facilities for magnetic particle and dye penetrant testing. An ultrasonics training course was in progress for 30 technicians from the shipbuilding industry. A practical session of this course was visited and it was observed that there was a ratio of 1:3 between instruments and students, which is considered satisfactory. The experts were impressed by the interest and enthusiasm of the students. This course, which is for 56 days, is organized jointly by the University, SRIM, and the NDT Society.

11. Shanghai Boiler Plant

The experts were received by Senior Engineer Ma Minggang, Chief of the NDT Department, and staff of the NDT Laboratory.

The factory employs 3,700 persons, principally in the production of boilers for power stations up to 300 MW (2 or 3 per year), pressure vessels for the chemical industry and small industrial boilers. Tubes, plates and forgings are the main raw materials used, while welding is the main production process.

Eddy current and ultrasonic methods (mainly manual) are employed for the inspection of incoming materials. An ultrasonic system is under development to tube inspection, whilst at the same time an eddy current system has been ordered from West Germany for the same purpose. Heavy plates and forgings are inspected manually by ultrasonics whilst magnetic particles and dye penetrants are used for weld inspection together with radiography for thicknesses less than 20 mm and ultrasonics for thicknesses greater than 50 mm. Gamma radiography is rarely used because of the short half-life of Iridium 192 and misunderstandings about the safety of radioisotopes.

Some 45 persons are presently engaged in NDT and 10 more will be recruited shortly. They are divided into three groups:

(a) Pressure Vessel Shop, where 20 persons mainly inspect welds but also give assistance to the Steel Structure Shop in the examination of plates and forgings.

(b) Tube Shop, where 19 persons carry out 100 per cent inspection of welds in small diameter tubes for power station boilers using x-ray and ultrasonic equipment. Some 5-6,000 radiographs are made each month.

(c) General Test Work, where six persons are involved in the design of ultrasonic transducers and writing procedures. These procedures are used informally however.

The NDT Group is in the Quality Control Department, which is directly under the Director of the factory.

12. <u>Shanghai Heavy Machine Plant</u>

The experts were received by the Director of the Testing Department, Zhou Mei Chin, and other staff members.

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The plant has an area of 830,000 $m^2$ and employs 9,100 persons of whom 250 are engineers and 550 technicians. The main products are: complete steel rollings mills, hydraulic presses, sluice gates, cement kilns, heaving castings and forgings, generator rotors for steam turbines, high pressure vessels and different kinds of rollers up to 1.6 metres diameter. The capacity for castings is up to 20 tons and ingots of 80 tons can be produced. For forging, there is a 12,000 ton hydraulic press and in the steel plant, high temperature resistant steel can be made.

The NDT Group has 11 persons and depends on the central laboratory. The main technique used is ultrasonics with locally-made equipment with x-ray inspection for thicknesses up to 40 mm. Magnetic particles and dye penetrants are also used. Some people have received training in the Shanghai Jiaotong University and the rest in the factory.

18. Shanghai Steam Turbine Factory

The experts were received by Zheng Jia Xun, and other engineers.

Some 8,000 persons are employed in the factory which produces turbines up to 300 MW and heavy generators. The NDT Group has 15 persons equipped with five x-ray machines (one up to 400 KV), 10 locally-made and two imported ultrasonic instruments, four magnetic particle benches and dye penetrants. Ultrasonics and magnetic particles are used for turbine blades and rotors and micro-transducers are used for the inspection of turbine blade inserts. Magnetic particles and dye penetrants are used for surface inspection of castings and preparations are now being made to inspect the inside of castings using ultrasonics. A 2 Curie Caesium 137 radiographic source has been ordered.

It was stated that there was a need for more standardization and calibration work and for more training and information. The factory is strongly supported by SRIM and is very interested in the development of a system for the in-service inspection of turbines.

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14. Shanghai Electrical Machinery Works

The experts were received by the Deputy Chief Engineer and members of the NDT Group.

Some 8,400 persons are employed in the manufacture of motors, turbo-generators, electrical silicon rectifiers and condensers. The manufacture of generators was started in 1954 and are used in one in three power stations in the country.

The Metallic Materials Department is concerned with chemical analysis, the measurement of electrical properties and NDT. The NDT Group consists of eight persons, comprising two engineers, two assistant engineers and four technical workers, some of whom have more than 20 years experience. NDT is used in the inspection of forgings, generator parts and shafts and turbine rotors, blades and end-rings. The Group has five ultrasonic instruments including one US1P 11, three x-ray machines (two of 150 KV and one of 200 KV), and one magnetic particle bench locally-made.

It was stated that there is a need for more formal training to raise the technical level and that a certification scheme is essential.

15. Shanghai Ultrasonic Meters and Instruments Factory (SUIF)

The experts were received by Chen Chifan, Chang Tsechi and Yang Piehong.

The factory was founded in 1970 and employs 480 persons in the design and assembly of ultrasonic equipment for cleaning, welding and bonding (transistors), cutting ceramics, medical diagnosis, echo sounding and NDT. The main NDT instruments are:

(a) A portable ultrasonic digital thickness gauge, range 1.5 - 100 mm (± 0.1 mm).

(b) A digital precision thickness meter, range 0.25 - 200 mm (± 0.02 mm).

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(c) A portable ultrasonic flaw detector with standard features.

(d) A mobile ultrasonic railway line flaw detector which uses three transducers and has a water coupling system and is battery-operated. It is light and compact and can be operated by one person.

About 700 flaw detectors and more than 1,000 thickness gauges are produced annually. In addition, the factory makes transducers for all of their instruments using lead-zirconium carbonate crystals.

A special mention should be made of the digital precision thickness gauge which, employing a single crystal probe, accurately measures thicknesses below 1.0 mm down to a minimum of 0.25 mm. The instrument was checked and showed an extremely good repeatability.

ANNEX III

# A Brief Introduction of Shanghai Materials Research Institute

## Department 1 - Material Strength

In order to optimize the selection and application of materials, Department 1 investigates strength, fatigue and creep at high temperature; fatigue and brittle fracture at low temperature; and fatigue at ambient temperature. It also studies the mechanism of various modes of failure by macro- and micro-methods, and develops appropriate new alloys for certain special purposes.

## Department 2 - Nondestructive Testing

Department 2 investigates and develops the principles, methods and techniques of nondestructive testing, as well as some special instruments and equipments concerned. The testing methods adopted include those by ultrasonics, eddy current, radiography, magnetic powder and liquid penetration.

## Department 3 - Physical Testing

This department devotes itself to testing various physical properties of materials, developing new testing methods, investigating various modes of failure by means of micro- methods and placing emphasis on fracture analysis. The area of its activity involves optical metallography, electron microscopy, X-ray diffraction analysis, etc.

Department 4 - Chemical Analysis

Department 4 is engaged in the chemical analysis of materials, including ordinary, micro- and automatic analysis, as well as in the research of new analytical methods. Its activities include wet chemical analysis, emission spectrography, atomic absorption spectrography, polarography, X-ray fluorescence analysis, etc.

Department 5 - Nonmetallic Materials

Department 5 investigates technology and testing methods of fibre-reinforced composites with high module and high strength, and the related mechanism. At the same time, it studies the techniques of composing the non-metallic or metallic fibers or grains with high polymers, and works on the common problems with respect to the application of engineering plastics in the areas of anti-friction, sealing, self-lubrication and water-lubrication.

Department 6 - Technology of Metallic Materials

Concerning the processes of smelting, casting, forging and welding, Department 6 further improves the properties of the existing materials, specifies the manufacturing processes of new materials, and tests the technological properties of metallic materials.

components in order to exploit the potential availability of materials, and optimizes the selection and application of materials, especially for wear-resistant use.

Department 11 - Technical Information

Department 11 masters and analyzes the developing trends both at home and abroad, publishes periodicals, manages technical reference materials and translates the foreign literatures. It also attempts to further develop the techniques for selecting materials and accumulating the data concerning the material properties by electronic computer.

Department 12 - Comprehensive Workshop

The Comprehensive Workshop is engaged in making samples, designing and manufacturing special equipments, and undertaking maintenance routine.

# The draft proposal standard for the qualification and certification of NDT personnel by The NDT Society of China

## 1. General Principles

1. The people who engaged in the field of NDT in production and are responsible to the inspection of products must be qualified on their technical level according to this standard. The people will be classified into certain grades of technical level after passing examinations of fundamental (theoretical) knowledge and practical operation.

2. People who gained the specific grade in certain type of NDT techniques will only be involved in the specific NDT works and have the responsibility appropriate to his technical level.

3. People who engaged in research and development, education and other feild of NDT will gain certain grade of technical level through the qualification program.

4. People who passed the qualification program will be certified and have the certification.

5. This proposal standard will be applied to people engaged in radiography, ultrasonics, magnetic particle, eddy current and penetrant inspection methods.

## 2. Classification of technical levels

6. The classification of technical levels of personnel is divided into three grades, that is the grade I, grade II,

grade III. grade III is the lowest grade.

7. The classification of grades in the five inspection methods are as follows:

The radiographic method (RT) with grades I, II and III.
The ultrasonic method (UT) with grades I, II and III.
The magnetic particle method (MT) with grades I, II and III.
The eddy current method (ET) with grades I, and II.
The penetrant methods (PT) with grades II, and III.

### 3. The fundamental requirements to various grades of personnel

Requirements in detail are as follows:

8. The requirements for the grade III personnel: They should have general knowledge of NDT, and perform the practical operation under the direction of grade I and grade II personnel.

   8.1 They can adjust instruments and equipment and correctly perform the test according to the defined procedure.
   8.2 Record the inspection results.
   8.3 Report and make primary judgement for simple inspection items.
   8.4 Understand and perform the measure for safty protection.

9. The requirements for the grade II personnel:

   9.1 They can adjust and operate instruments and equipment proficiently according to the specifications, perform testing independently, and evaluate the inspection results, as well as come to the conclusion.
   9.2 Familiar with relevant standards and technical specifications.
   9.3 Responsible to the testing results, sign and dispatch

the test report.

9.4 Direct the work of grade III personnel and also train them.

9.5 Familiar with the requirements of safty precautions.

10. The requirments for grade I personnel:

10.1 Define the method to be used and design the test procedure.

10.2 Explain the reasons for selecting the method and the requirements of relevant standards and specifications.

10.3 Design the testing procedures according to relevant standards and specifications. Evaluate the test results, sign the test reports and is responsible to the whole NDT procedures.

10.4 Direct the work of grade II and grade III personnel, inspect the test report and data.

10.5 Work on the training and examining program of grade II and grade III personnel.

10.6 Have ability for improvement of NDT methods.

10.7 Design the required safty precaution procedures and supervise their performance.

10.8 Assist the product designer to set up proposed specifications when their is no proper standards.

## 4. The organization and supervision for qualification and certification of personnel

11. Their are three steps for administration of the qualification of NDT personnel. Grade I personnel is qualified by the National Qualification and Certification Organization of Personnel (NQCCP). Grade II personnel is qualified by the local or industrial

department qualification organizations which are admitted by the NQCOP. Grade III personnel is qualified by factories and enterprises themselves.

12. The NQCOP is composed of experts, engineers and representatives who come from the NDT society, ministries of the State Council ( now the Chairman and vise-chairman of Training and qualification committe of the NDT society is responsible to the work of organization ) The local or industrial departments qualification organizations of personnel are composed of specialists and representatiyes who are selected from these departments, and they should be proved by the NQCOP.

13. Among the members of each step of the qualification organization the sum of technical personnel must not be less than 2/3 of the total stuffs. The Chairman of the qualification organization must be a specialist of NDT, the vise chairman should be the representative of the administration department.

14. The tasks of the qualification organization are: checking the necessary conditions of candidates, designing the content of the examination, assessing the results of examination, issuring the certification, checking routinely the effectiveness of certification and carrying out examination for renewing the certification.

15. The qualification organization for grade II and grade III, the content of their qualification scheme and procedures should be reported to the above step of qualification organization, and then can be carried out, after being proved. The higher step of qualification organization has the right to check and supervise the examination carried out by the lower step. The NQCOP is supervised by the members of the standing committee of NDT society ( or the NDT Base ).

5. The necessary conditions of candidates applying for qualification

16. Candidates of each grade for qualification should have the following conditions

16.1 grade I

a. Graduates who majored in speciality of NDT in college or university have been working in the field of NDT continuously for more than one year.

b. Graduates who majored in science in college or university have been working in the field of NDT continuously for more than two years.

c. Graduates from NDT technical school have been working in the field of NDT continuously for three years.

d. Graduates from technical school or the persons educated to the same level have been working in the field of NDT continuously more than four years.

e. Persons have certification of grade II for three years.

16.2 Grade II

a. Graduates from technical school, college or university have been working coutinuously in the field of NDT for more than one year.

b. Graduates from senior middle school have had the certification of grade III for two years.

c. Graduates from senior middle school, or persons educated to the same level have been working in the field of NDT for more than three years.

16.3 Grade III

a. Graduates from school for skilled workers have been working continuously in the field of NDT for one year.

b. Graduates from junior middle school or persons educated to the same level have been working continuously in the field of NDT for one and a half years.

c. Persons educated to or above the sinior middle school have been working continuously in the field of NDT for six months.

* The necessary conditions of the specific candidate will be determined by the qualification committee.

17. Candidates must fill in an application form attached with medical examination report, they can't attend the examination until they are proved by the qualification committee. The date and place for examination will be announced previously and informed to the candidates, the relative enterprises and departments.

6. Methods and contents of examination

18. All of the candidates for qualification must take part in the examination, which consists of the theoretical part and the part for practical operation, the oral test may be conducted if it is necessary. The content in detail of examination will be determined by the qualification committee acording to the basic requirements of this standard. The examination will be implemented by a group nominated by the qualification committee.

19. The candidates will be allowed to attend the practical operation examination so long as they passed the theorcetical examination.

20. Candidates who took part in a NDT training class, which was held according to the requirements of training program of NDT society, can apply for free-

charge from theoretical examination if their records of final examination in the training class were good that means the mark was over 80 in a full range of 100.

21. The extent of examination is as follows:

21.1 grade I

Outline of NDT techniques; basic principles of the technique involved; equipment and instruments and their calibration methods; the interpretations and determination of flaw signals and images; the relevant standards and specifications; the safty precautions and radiation protection rules; the knowledge of materials, flaws, metallurgy and technology.

21.2 grade II

Outline of NDT techniques; basic principles of the techniques involved; equipment and instruments and their calibration methods; the relevant standards and specifications; the safty precautions and radiation protection rules; the knowledge of material, flaw, metallurgy and technology.

21.3 grade III

the operation and calibration of testing instruments and equipment.

7. certification and its effectiveness

22. The candidates passing the qualification program of grade I and grade II will be certified by the N.C.P. The formal certification will be issured to the unit that the candidate joint with, the copy of the certi-

fication will be issured to the candidate. The name of candidates passing the qualification program of grade III should be submit to the N [illegible]. The certification is valid to each industrial system and enterprise in its duration.

23. The certification must be listed with the methods involved, the technical grade, the main objects to be examined, and the industrial system the candidate belongs to. For example: grade II of ultrasonic testing, railway and its welds, the railway system.

24. The duration of the certification is temporarily designated to be three years, the duration may be prolonged once more by inquirement, but the longest effective duration of the certification will not exceed six years. By the end of that duration the re-examination must be carried out.

25. The validity of certification will be lost in the following cases:

25.1 By the end of the first duration of the certification, the keeper does not submit the inquirement for extending the duration.

25.2 The candidate can't pass the re-examination.

25.3 The keeper of the certification is not suitable to NDT work for his illness.

25.3 The keeper of the certification made serious mistakes.

26. The procedure and content of the re-examination will be carried out according to chapter six.

KCB/dt

2 September 1981

Subject: DP/CPR/80/052 - Evaluation of Equipment

Item 1: X-ray apparatus

Recommend SCANRAY DOF-225 (8mA). Meets specifications and is lowest price ($8,750).

Item 2: Ultrasonic Stress Measurement Apparatus

Recommend ULTRASONIC ANALYSIS INC., but with two each transducers offered.
Only offer to meet specifications.
(Price $15,800).

Item 3: Ultrasonic Flaw Detector

Recommend:

(a) Laboratory instrument; KRAUTKRAMER USlP 11.
Only offer to meet requirements.

(b) Portable instrument; KRAUTKRAMER USL 32.
Lowest offer to meet requirements.
Offer by CNS Electronics is for examination of concrete and ceramics and not for steel, and therefore does not meet specifications.

Accept KRAUTKRAMER offer in total for both USlP 11 and USL 32 with all accessories less UL 342 and UL 346 (battery pack and battery charger), but with UL 345 (combined power pack and charger unit).
(Price $19,859).

Item 4: Ultrasonic Thickness Gauge

Recommend KRAUTKRAMER DM2.
Little price difference in offers and compatible with other equipment in Item 3.
CNS Electronics instrument not reliable in our experience.

Accept KRAUTKRAMER offer in total less DA 242 (set of 5 dry cells), but with DA 241 and DA 245 (set of 5 NiCd cells and charger).
(Price $3,083).

Item 5: Magnetic Particle Crack Detector

Recommend MAGNAFLUX P-920.
After discussions with the counterpart, a transportable instrument is required. The offer by Balteau is for an instrument which is either AC or DC, not both and is therefore unacceptable.

Accept MAGNAFLUX offer in total, including all accessories with black light (220/50/1). (Price $4,464).

Item 6: Eddy Current Apparatus

Recommend AUTOMATION INDUSTRIES EM 3300.
This instrument is well-known, widely used and reliable. It is the most complete instrument, offering the possibility to expand with more sophisticated accessories. Magnaflux offer is restricted in this sense.

Accept offer for EM 3300 with following accessories:

Parts Nos.
43D051,
435052,
43B044-1 (with scraper),
43B044-3,
44A078,
Bolt-hole probe,
Differential encircling coils for O.D.2,
44B022-2,
44B022-3.

(Price $11,210).

Item 7: Acoustic Emission Equipment

Recommend BRÜEL AND KJAER after discussions with counterpart.
Offer by CNS Electronics does not correspond to requirements.
Other offers too expensive and complex at this stage.

Accept BRÜEL AND KJAER offer in total. (Price $16,192).

Item 8: <u>Gammaray Container</u>

Recommend <u>AUTOMATION INDUSTRIES INC</u>.
Model 520 Iriditron with 100 Curies
Iridium source.
Lowest offer.
Because of short half-life of Iridium 192,
a replacement 100 Curies Iridium source
should be included in the order for
delivery one year after the supply of the
first unit.
(Price $6,060).

For the operation of this equipment,
beamers are essential and therefore
parts Nos. 200-520-004 and 300-520-060
should be purchased although not quoted.
Estimated price $500.
(Price $6,560).

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ANNEX III

KCP/dt
1 September 1981

ADDITIONAL EQUIPMENT TO BE PURCHASED DURING 1981

Infrared

Radiation Area Survey Metre

6x Personal Dosimeters

Densitometer

Film Viewer

Lead Screens

Radiography Reference Standards (ASTM, 11WU)

Magnetic Particle References (ASTM)

ASME Standards

ASTM Standards

Photocopier (RICOH)

Training Literature (USA)

Training Films (Materials Evaluation)

KCB/dt
1 September 1981

PROGRAMME OF STUDY TOUR IN THE UNITED STATES FOR PROJECT DP/CPR/80/052

| Days | Place | Unit | Content of Study Tour |
|---|---|---|---|
| 25 working days (5 weeks) | California, Stanford | Stanford University | Ultrasonic flaw inspection |
| | California, Palo Alto | Electric Power Research Institute | Ultrasonic stress measurement<br>Ultrasonics<br>Eddy currents<br>X-ray stress measurement |
| | California, Palo Alto | Lockheed-California Co. | Tomography technique |
| | California, Palo Alto | Varian Radiation | Linear electron accelerator |
| | California, San Juan, Capistrano | Dunegan-Endevco | Acoustic emission equipment |
| | California, Chatsworth | Automation Industries Inc. | Ultrasonic flaw detection equipment |
| | Colorado, Denver | Denver University | X-ray stress measurement |
| 2 days | Texas, San Antonio | Southwest Research Institute | Automatic ultrasonic flaw detection<br>Magnetic stress measurement<br>In-service inspection |
| | Michigan | Ford Automobile Co.<br>or<br>General Motors | Application of NDT to the automobile industry<br>Ultrasonics |
| | Illinois | Northwestern University | Residual stress measurement |
| | Ohio, Cleveland | Lewis Research Center | Acoustic emission<br>Ultrasonics |
| | Ohio | Republic Steel Co. Research Center | Ultrasonic flaw detection for the automatic testing of tubes |
| | Ohio, Columbus | Battelle Laboratory | Multiple frequency eddy current<br>Multiple parameter eddy current |
| | Ohio, Columbus | ASNT | Personnel training, qualification and certification<br>Actuities for NDT |
| | New Jersey | Physical Acoustic Emission | Acoustic emission |

| Days | Place |
|---|---|
| | New Jersey, Trenton |
| | New Jersey, Hillsdale |
| | Connecticut, Stanford |
| | Connecticut, Stratford |

| Unit | Content of Study Tour |
|---|---|
| Sonic Instruments Inc. | Ultrasonic inspection equipment |
| Schumag Machinery Inc. | Automatic eddy current detector |
| Panametrics Co. | Gamma radiography<br>Analyser of ultrasonic inspection |
| Ultrasonic Stress Analysis Co. | Ultrasonic stress analyser |
| General Dynamics Co. | NDT technology for large structure (rotors of generator and turbine) |
| Westinghouse | Technology of in-service inspection for nuclear power station |

ANNEX V

PROGRAMME OF STUDY TOUR IN JAPAN FO

| Days | Place |
|---|---|
| 15 working days (3 weeks) | TOKYO-TO MEGURO-KU |
| | TOKYO-TO MITAKA-SHI |
| | TOKYO-TO MEGURO-KU |
| | TOKYO-TO MINATO-KU |
| | TOKYO-TO CHIYOUFU-SHI |
| | TOKOHAMA-SHI KANAGAWA-KU |
| | KAWASAKI-SHI |
| | OSAKA-FU SUITA-SHI |
| | OSAKA-SHI TOHOKU-KU |
| | OSAKA-SHI |

KCB/dt
1 September 1981

R THE PROJECT DP/CPR/80/052

| Unit | Content of Study Tour |
| --- | --- |
| National Research Institute for Metals | Ultrasonics<br>Eddy current<br>Magnetic particle<br>X-ray |
| Ship Research Institute Ministry of Transport | Acoustic emission<br>Radiation<br>Ultrasonics |
| Institute of Space and Aeronautical Science, University of Tokyo | Ultrasonics<br>Electromagnetics<br>Acoustic emission<br>Personnel training |
| Japan Atomic Energy Research Institute | Ultrasonics<br>Electromagnetics |
| National Aerospace Laboratory | Ultrasonics<br>Electromagnetics<br>Inspection for composite |
| Kana gawa University, Faculty of Engineering | Inspection of insulating materials |
| Tokyo Shibaura Electric Co. Ltd | Ultrasonics |
| Osaka University, Faculty of Engineering | Ultrasonics<br>Radiation |
| Journal of N.D.I. Ltd | Ultrasonics<br>Electromagnetics |
| Sumitomo Metal Industries Ltd | Ultrasonics<br>Radiography |

| Days | Place |
| --- | --- |
| | NAGOYA |
| | TOKYO-TO |
| | TOKYO-TO |
| | TOKYO-TO |

| Unit | Content of Study Tour |
| --- | --- |
| Toyota Central Research and Development Laboratories Inc. | Application of NDT to the automobile industry |
| Toyota Motors Ltd | X-ray stress measurement |
| Nippon Steel Corporation | Ultrasonics<br>Radiation<br>Acoustic emission<br>Electromagnetics |
| Rigaku-Denki | Manufacture of NDT equipment |

ANNEX VI

KCB/dt
1 September 1981

## STUDY TOUR AND FELLOWSHIPS

The following candidates to participate in study tours to Japan and USA for Non-Destructive Testing (NDT):

Wang Wu-Tong
Zhang Gi-Yao
Zhu Sen-Di
Li Run-Min
Plus one other candidate

The following candidates to participate in fellowships for Non-Destructive Testing (NDT):

| | |
|---|---|
| Shi Ji-Hua | - to Germany |
| Li Run-Min | - to USA |
| Huang Yun-Bo | - to England |

Plus one other candidate

oOo

UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Government of the People's Republic of China

# PROJECT DESIGN
## FOR SECOND PHASE OF PROJECT

| | |
|---|---|
| Title: | Assistance to Material Research Institute on Non-Destructive Testing (NDT) |
| Project Number: | |
| Duration: | |
| Primary Function: | Institution Building |
| Secondary Function: | Experiment and Research |
| Sub-sector: | Industrial Development Support Service (0510) |
| Government Implementing Agency: | The First Ministry of Machine Building Industry (FMMBI) |
| Executing Agency: | United Nations Industrial Development Organization (UNIDO) |
| Project Proposal Date: | |
| Estimated Starting Date: | |
| Government Inputs: | |
| UNDP Inputs: | |

Signed: ______________________ Date: ____________
(On behalf of the Government)

Signed: ______________________ Date: ____________
(On behalf of the Executing Agency)

Signed: ______________________ Date: ____________
(On behalf of UNIDO)

PART II. PROJECT

A. DEVELOPMENT OBJECTIVE

Improvement of quality and safety of industrial installations and products.

B. IMMEDIATE OBJECTIVES

(i) Assistance in the establishment of a national NDT base (focal point - associated network).

(ii) Improvement of quality and reliability of capital goods.

(iii) Improvement of the efficiency of power generation/transmission.

(iv) Improvement of safety and operational efficiency in chemical plants, transportation (rail, water, air and land), and civil works installations (bridges, cranes, silos, etc).

D. OUTPUTS

1. Well-organized NDT base with an efficient network throughout the whole country.

2. A national certification scheme up to international levels will be in operation by the end of 1984.

3. A radiological protection scheme for radiographic equipment operators will be put into operation by the end of 1984.

4. Establishment of a uniform level of training in basic NDT techniques throughout the country. By 1986, X engineers, Y technicians and Z operators will have been trained to this level.

5. Considerable improvement in the reliability of power generation equipment and decrease of losses in the transmission systems.

6. Through the establishment of well-defined in-service inspection procedures, the number of accidents in chemical plants, transportation systems and civil works installations will be reduced. This will also result in a significant improvement in operational efficiency.

7. Increase in the quality and efficiency of capital goods will produce corresponding benefits in the quality and economic production in light industry.

## F. INPUTS

### a. Government Inputs

| | | |
|---|---|---|
| Buildings | ) | |
| Staff | ) | Expand |
| Equipment | ) | |
| Transportation | ) | |

### b. UNDP Inputs

| | | |
|---|---|---|
| Experts and consultants | 58 m/m | |
| Two study tours | | $75,000 |
| Fellowships | 120 m/m | |
| Equipment | | $250,000 |
| Miscellaneous | | $15,000 |

UNIDO

# PROJECT BUDGET/REVISION



| 3. COUNTRY | 4. PROJECT NUMBER AND AMEND. | 5. SPECIFIC ACTIVITY |
|---|---|---|
| CHINA | | |

10. PROJECT TITLE

PROJECT DESIGN FOR SECOND PHASE OF PROJECT DP/CPR/80/052

| 15. 10. 11 | PROJECT PERSONNEL EXPERTS / Post title | 16. TOTAL m/m | 16. TOTAL $ | 17. 1983 m/m | 17. 1983 $ | 18. 1984 m/m | 18. 1984 $ | 19. 1985 m/m | 19. 1985 $ | 20. 1986 m/m | 20. 1986 $ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11-01 | NDT organization | 4 | | 1 | | 1 | | 1 | | 1 | |
| 02 | Ultrasonics | 4 | | - | | 2 | | - | | 2 | |
| 03 | Radiography | 5 | | 3 | | - | | 2 | | - | |
| 04 | Magn. Part + Optical + Penetrants | 2 | | 2 | | - | | - | | - | |
| 05 | Eddy current | 4 | | - | | 3 | | - | | 1 | |
| 06 | Leak testing | 2 | | - | | - | | 2 | | - | |
| 07 | Certification | 5 | | 3 | | - | | - | | 2 | |
| 08 | NDT Information | 1 | | 1 | | - | | - | | - | |
| 09 | NDT Standardization | 3 | | - | | - | | 3 | | - | |
| 10 | Radiological protection | 6 | | 3 | | - | | 3 | | - | |
| 11 | Technology Agreements | 3 | | - | | 1 | | 1 | | 1 | |
| 12 | High-energy radiography | 2 | | - | | - | | - | | 2 | |
| 13 | Welding inspection | 2 | | - | | 2 | | - | | - | |
| 14 | Infrared | 2 | | - | | 2 | | - | | - | |
| 11-99 | SUBTOTAL: | | | | | | | | | | |

21. REMARKS

UNIDO

# PROJECT BUDGET/REVISION



| 3. COUNTRY | 4. PROJECT NUMBER AND AMEND. | 5. SPECIFIC ACTIVITY |
|---|---|---|
| CHINA | | |

10. PROJECT TITLE

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|---|---|---|---|---|---|---|---|---|---|---|
| 11-15 Acoustic Emission | 3 | | – | | – | | – | | 3 | |
| 16 Surface stress | 2 | | 2 | | – | | – | | – | |
| | | | | | | | | | | |
| 50 Consultants | 8 | | 2 | | 2 | | 2 | | 2 | |
| 11-99 SUBTOTAL: | 58 | | | | | | | | | |

21. REMARKS

| | | | TOTAL |
|---|---|---|---|
| 16.00 | HQ staff travel | | 10,000 |
| 31.00 | Fellowships | | |
| | Acoustic emission | 1 x 6 m/m | |
| | Data Processing | 1 x 6 m/m | |
| | Composite examination | 1 x 6 m/m | |
| | Infrared | 1 x 6 m/m | |
| | X-ray imagery | 1 x 6 m/m | |
| | NDT civil works | 3 x 6 m/m | |
| | NDT aviation | 2 x 6 m/m | |
| | NDT pressure vessels | 3 x 6 m/m | |
| | Welding inspection | 3 x 6 m/m | |
| | NDT power stations | 2 x 6 m/m | |
| | NDT chemical plant | 2 x 6 m/m | |
| | Total | 120 m/m | |
| 32.00 | Study Tours | | |
| | FRG, France, UK, Denmark, Netherlands | | 40,000 |
| | USA, Japan | | 35,000 |
| 49.01 | Equipment (non consumable) | | 250,000 |
| 49.02 | Equipment (consumable) | | 10,000 |
| 59.00 | Miscellaneous | | 15,000 |
| | TOTAL | US$ | 1,000,000 |

| 1 9 8 3 | 1 9 8 4 | 1 9 8 5 | 1 9 8 6 |
|---|---|---|---|
| ------- | 5,000 | ------- | 5,000 |
| | 6 m/m | | |
| | | 6 m/m | |
| | 6 m/m | | |
| 6 m/m | | | |
| | | 6 m/m | |
| | 6 m/m | 12 m/m | |
| | | 12 m/m | |
| 18 m/m | | | |
| 18 m/m | | | |
| | 12 m/m | | |
| | 12 m/m | | |
| 40,000 | | | |
| | | 35,000 | |
| 100,000 | 50,000 | 50,000 | 50,000 |
| 2,500 | 2,500 | 2,500 | 2,500 |
| 3,000 | 3,000 | 3,000 | 6,000 |