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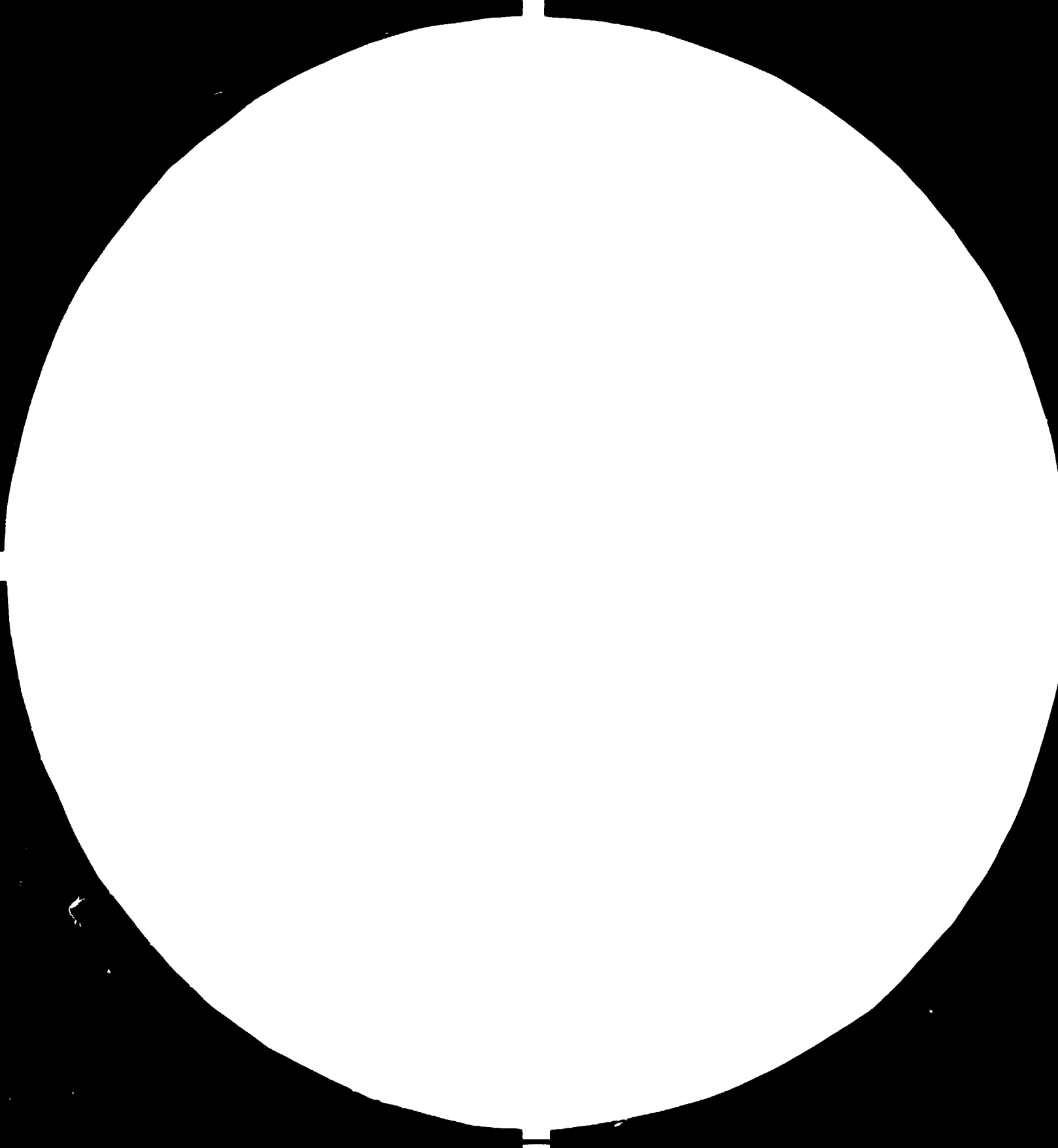
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

Report of Missions to China.
(non-destructive testing).

DP/CPR/80/052/11-02/313.J

and

DP/CPR/80/052/11-03/313.J

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Udo E. Steinhoff

August 1983

7479

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

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A. INTRODUCTION AND OBJECTIVES OF THE MISSION

In accordance with the Project Documents DP/CPR/80/052/11-02/313.J and DP/CPR/80/052/11-03/313.J the two experts were invited to China to help build up a Nondestructive Testing (NDT) research base for strengthening applications of NDT in industries, specially was expected to:

- (a) assist in the establishment of a system of personnel training (DP/CPR/80/052/11-02/313.J) and qualification (DP/CPR/80/052/11-03/313.J) in NDT which is suitable to China,
- (b) supply information about the latest text books of the training courses, NDT standards, questions and answers for examinations and other relevant information for personnel qualification.
- (c) The experts were also expected to prepare a final report, setting out the findings of the mission and recommendations to the government on further actions which might be taken.

The experts arrived at Beijing on 7 August 1983. They brought with them the latest text books for all training courses of the German Society for Non Destructive Testing (DGZfP) and examples of questions for all examinations of the DGZfP as well as the latest edition of recommended questions of the American Society for Non Destructive Testing (ASNT), and some papers concerning to the latest international situation in the field of training and qualification. The text books of the DGZfP are based on the minimum requirements for the qualification of NDT personnel which are defined by the International Committee of Non Destructive Testing (ICNT) on the last meeting in August 1982 in Moscow.

The papers were handed over to the Nondestructive Testing Institution of the Chinese Mechanical Engineering Society (CMES-NDTI).

B. VISITS AND LECTURES

The experts made visits in Beijing, Shenyang, Xian and Shanghai. At each place lectures were given in meetings with chinese experts involved in training and qualification of NDT personnel. Also, numerous discussions were held. Furthermore, visits were made to several factories, institutes and to one university.

In the middle of the mission there was a meeting with Mr. TAO HENGXIAN, Chief Engineer of the First Ministry of Machine Building and his staff. A final discussion took place with Mr. TAO HENGXIAN and Mr. LAI JEN, Vice President of the CMES-NDTI and their staff on Sunday, 29 August 1983.

Details of the visits are given in Annex I.

C. FINDINGS

1. Introduction

The survey carried out was the result of discussions with NDT experts from various industries and institutes in Beijing, Shenyang, Xian and Shanghai. Additional information was obtained from experts in the factories which were visited.

2. Qualification and Certification System (QCS)

A uniform system of qualification and certification is not yet implemented. Several ministries (about ten) are responsible for NDT application, this includes the qualification of the NDT personnel. Some Ministries have installed their own QCS, i.e. the First Ministry of Machine Building (together with CMES-NDTI), the Ministry of Electric Power, the Ministry of Labour and Personnel e.t.c.. As a result some individuals are to be certified in accordance with more than one QCS.

In conformity with international QCS all systems are based upon three levels of qualification: one level for engineers (1) and two levels for testers (2, the upper level and 3, the lower level). Remark: In most countries except Japan the sequence is reversed, i.e. level 3 is the highest one and level 1 the lowest one.

The QCS introduced by CMES-NDTI is described partially in four papers, published in the Chinese journal 'Non Destructive Testing':

- (a) Provisional Rules for Classification and Qualification of NDT Personnel
- (b) Provisional Regulations of Applying for Qualification and Certification of Level II personnel
- (c) Provisional Regulations for the Examination of Level II NDT Personnel
- (d) Provisional Regulations for the Certification of Level II Personnel

The papers (b), (c), (d) contain the recommendations for level 2 only. No concrete actions have been taken for levels 1 and 3. Three of the papers are translated to English but not yet published in international journals. It was stated that the differences between the QCS of the CMES-NDTI and that one of the Ministry of Labour and Personnel are to be found mainly in administrative regulations. The qualification requirements are very similar. It was further stated the QCS of CMES-NDTI is accepted by eight ministries.

All Chinese experts asked for information about the international situation in NDT personnel qualification. Some of them discussed the possibilities of a world conference on personnel qualification. At all places visited separate committees for personnel qualification are installed, attached either to CMES-NDTI or to one or more ministries. In some cases there exist separate committees for training and examination. It was stated an unsatisfactory communication between committees of the particular places on one hand and the committees of the various ministries on the other hand.

3. Training

Participants of training courses and/or examinations shall have sufficient education and experience (on-the-job training). The experts constated different requirements as follows:

Education	Minimum years of experience		
	Level 1	Level 2	Level 3
University	1 to 4	1	no comments
Technical College	1 to 6	2	no comments
Secondary School			
upper level (12 y)	2(with level 2)	3 to 4	1
lower level (9 y)	4(with level 2)	7	3

Activities were started to establish training recommendations and requirements for qualification. The textbooks used in the courses are mostly written by the teachers themselves with regard to textbooks from foreign countries, but it was reported about difficulties in the interpretation of foreign standards described in the foreign textbooks. Comparable Chinese standards often were missing. The Chinese experts regret the lack of man-power to produce uniform textbooks. One impediment is the large distance between the experts in the various regions of China.

The training is carried out in the following main NDT methods:

Ultrasonic Testing	(UT)
Radiographic Testing	(RT)
Eddy Current Testing	(ET)
Magnetic Particle Testing	(MT)
Liquid Penetrant Testing	(PT)

Most of the courses carried out were Ultrasonic training courses for level 2 personnel. Courses for other seldom used NDT methods like Acoustic Emission Analysis, Infrared Technique, Stress Analysis are thought to be unnecessary.

The teachers in the courses are NDT experts from industries, institutes and universities. They have many years of experience in NDT application and research but only some of them are certified as level 1 individuals. The Chinese experts involved in training courses wished to be unburdened of administration duties. They recommended to engage full-time teachers. Furthermore they proposed to run a training course for teachers together with experts from foreign countries for international harmonisation.

NDT is not yet included in the syllabi of technical colleges and universities.

The training courses are carried out at factories, institutes and universities. It seems that no course has been run for level 1 personnel. The training of level 3 personnel is done on-the-job through learning-by-doing. The Chinese experts stated training courses are a burden for the factories. Therefore it is recommended to install additional training centres out of the factories. With respect to the large distances between the various industrial centres the Chinese experts proposed to build up main training centres, for example in Beijing, Chengdu or Chunching, Shanghai, Shenyang and Xian. They refused a single main training centre for the whole country. The use of video and moviefilm techniques are in the very beginning. The Chinese

experts asked for help in developing these techniques by UNIDO to support uniform training.

4. Running the Courses

Participants in courses for level 2 mostly have to pass an entrance examination. The duration of the courses varies. For example the ultrasonic course for level 2 runs four weeks at one place and eight weeks at another place. The ratio of theory to praxis in the ultrasonic courses for level 2 varies from 1:1 to 2:1. The theoretical part of the training courses seems to be overrated. The general knowledge on materials, production techniques and load of items take much time related to the duration of the course. The number of participants in the courses are 30 to 60 (in Germany 20 to 24).

5. Equipment

The quantity and partially the quality (not up to international standard) of the equipment is insufficient. In some ultrasonic courses participants have to bring with them their own equipment. In other courses the ratio of equipment to students is 1:3 or less. The experts had no opportunity to visit places for training in radiography, eddy current, magnetic particle and liquid penetrant testing. It was stated that training courses for radiographic testing had been run in factories where the radiographic method is in use. The x-ray equipment the experts found was, with some exceptions, not up to date. Special equipment to use for training only was not to be found. Necessary accessories (densitometer, film viewer) seem to be rare. At two places only radioactive sources were presented. The Chinese experts proposed the training centres should be equipped with instruments manufactured in China as well as in foreign countries. This balance is necessary to realize the status of application in the factories.

6. Estimated Number of Trainees

At the four places visited the experts asked for the number of certified testers and the NDT personnel in total. The figures given by the Chinese experts in their opinion should not be taken to make a prediction. All Chinese experts agreed however the number of trainees will increase strongly in future.

7. Examination and Certification

At present level 1 personnel is certified after passing an examination (but without training course) or appointed by the employer without examination (like in some foreign countries.) Up to now there was not enough man-power to describe uniform contents of training courses and regulations for qualification.

In the past the most efforts had been taken for establishing the level 2 qualification. CMES-NDTI prepared and published tentative regulations for qualification and certification of level 2 personnel. The candidate for certification has to pass both written and practical examination and if necessary an oral one. It is planned to have a national conference in order to discuss how to run the practical part of the examinations.

The level 3 qualification is not yet installed.

8. Examination and Certification according to Foreign Countries

NDT personnel in the Shipbuilding Industry had to be qualified due to the regulations of the Japanese QCS. One level 2 training course with examination was carried out in 1982. The insurance companies of 17 countries accepted these examinations.

9. Continued Knowledge and Experience

The experts were asked to held a lecture about the present status of NDT application in Germany. In the following discussion it was pointed out that a continuous experience exchange (national and

international) is necessary. The number of such meetings should increase.

D. CONCLUSIONS

1. Introduction

The experts found that in most places the Chinese experts have done a good job in the training of NDT personnel, except that this training is not too well coordinated. As a result the same work was done at different places, and the differences of opinions mainly in the administrative part of the training system created difficulties for the application at other industries and prevents the international comparability. For instance CMES-NDTI, the Ministry of Labour and Personnel as well as the Shipbuilding Industry have developed their own QCS and training courses. There exists a lack of national harmonisation, whereas most western industrial countries have a national uniform QCS and are undertaking steps for international harmonisation.

At the last international conference for NDT in August 1982 in Moscow the INCT agreed with the following: A 3 level QCS for each NDT method and minimum qualification requirements for each level and each method. For ultrasonic and radiographic testing the qualification requirements for the three levels (1, 2 and 3) are already formulated in catchwords and released. The Peoples Republic of China, as a member of the ICNT, accepted these recommendations too. The two experts handed an English edition of this paper to the CMES-NDTI for publishing in the country.

2. Uniform QCS

The training and qualification can be conducted in an uniform manner world wide, because the objects, testing methods and equipment

are the same one. The qualification requirements for the NDT personnel are quite similar too. There are only differences in special knowledge concerning to the different objects and special standards or specifications.

To ease the cooperation between certain industries and on the international base it would be advantageous to develop a uniform QCS. The now more or less independently working boards should cooperate under one leadership and develop a mandatory QCS for all industries as well as uniform training and examination recommendations.

3. Training Committees

The developing of textbooks for training requires considerable detail work. To accomplish this it is essential to take into consideration the interests of all industries and have a sufficient number of experts for this task. In many other countries the national societies for NDT have assumed this task and established committees. In the German Society for NDT (DGZfP) for instance all industries, institutes and the government interested in the training of NDT personnel are represented. This training committee is responsible for basic problems whereas the detail work concerning textbooks and examination questions for all main test methods is the responsibility of one each sub-committee. In many other countries the responsibilities have been distributed in a similar manner to reach a common goal.

4. Training Centres

The training centres visited, or for which a report was received, were in an unsatisfactory condition, not only equipment and test pieces were inadequate but the training rooms too. A good training requires optimal equipment. The skills have to be trained and practiced. Equipment insufficient in number and quality or inadequate training rooms will have an adverse effect on the training of personnel. For the training of engineers which in basic training has to include all main used NDT methods the training centres must have the necessary variety

of equipment and test pieces.

The teachers at present are experts of the industry, institutes and universities, this is a part-time employment for them. Should the numbers of trainees increase then the capacity of trainers would become insufficient. Therefore it will probably be necessary to have a least part of the training be performed by full-time employed teachers. The increase in number of trainees can not be predicted. It is dependant on the industrial development of the country. The figures reported to the experts for in the NDT employed personnel are leading to the assumption that a heavy increase in the number of trainees will occur regardless of the further industrial development. Special consideration has to be given to the training of engineers in order to have sufficient personnel for training of lower level NDT personnel.

The training should be adjusted to international situations so that the qualification of the certified personnel meets international requirements. Therefore it is advisable to keep close contact with experts who have knowledge of and are well informed about the international status of qualification and certification.

E. RECOMMENDATIONS

1. Introduction

On the basis of the findings and conclusions the experts recommend to continue the NDT project.

2. Objective

The objective of the next phase of the NDT project should be the establishing of a uniform system of training and qualification for NDT personnel which is suitable to China.

3. Outputs

The following outputs are expected from the next phase of the project:

- (a) A uniform QCS equivalent to international recommendations,
- (b) A national committee responsible for uniform training, qualification and certification,
- (c) A well equipped training centre (i.e. in SRIM) as a model for further training centres in several regions of the country,
- (d) Trainers able to carry out training courses for all levels in accordance with the national QCS,
- (e) Uniform manuals for all training courses.

4. Activities

To realize the above given outputs the following proposals are made:

Proposal No. 1: Establishment of a uniform qualification and certification system (QCS), including

- (a) common basic training accepted by all Ministries involved in NDT,
- (b) uniform examinations about basic training accepted by all Ministries involved in NDT,
- (c) uniform preconditions for education and experience gained in practical work,
- (d) uniform requirements concerning the physical ability of NDT personnel (i.e. visibility),
- (e) additional specific training related to special NDT applications in certain industries (Ministries),
- (f) uniform examinations about special training,

- (g) uniform regulations for the certification of NDT personnel including validity of certificates and responsibility of certified individuals.

Proposal No. 2: Installation of a National Committee for Qualification and Certification of NDT Personnel

- (a) In this committee all Ministries involved in NDT application and the CMES-NDT Institute should be represented.
- (b) The activities of this committee should be organized and prepared by a certain board, i.e. CMES-NDTI.
- (c) The regulations prepared by the committee are to be accepted by all Ministries.
- (d) The committee should install subcommittees responsible for qualifications in the following NDT methods:
 - Ultrasonic Testing (UT)
 - Radiographic Testing (RT)
 - Eddy Current Testing (ET)
 - Magnetic Particle Testing (MT)
 - Liquid Penetrant Testing (PT).

Additionally a subcommittee responsible for qualification of engineers (level 1) should be set up.

The activities of these subcommittees should be as follows:

- Describing the contents of all training courses and preparing textbooks for uniform training,
- Preparing recommendations for equipment and testpieces to be used in each training course,
- Preparing questions for basic and specific examinations,
- Selecting members of the examination boards.

Proposal No. 3: Description of the uniform Chinese QCS

The National Committee for Qualification and Certification (see proposal No. 2) should describe regulations for the uniform QCS. The contents of this QCS paper are recommended as:

- (a) NDT methods and levels of qualification,
- (b) Education background and practical experience,
- (c) Qualification requirements for each level,
- (d) Contents of basic training courses (see proposal No. 1) for each NDT method and each qualification level,
- (e) Regulations for the examinations of the basic part of qualifications. Model questions for each NDT method,
- (f) Contents of the specific training courses related to the necessities of the particular Ministries,
- (g) Regulations for the examinations of the specific part of qualifications,
- (h) Procedures for the certification of NDT personnel.

Proposal No. 4: Training Centres

Installation of training centres in some regions of the country (i.e. Beijing, Chendu oder Chunching, Shanghai, Shenyang, Xian).

More than one centre seems to be necessary because of the long distances and the great number of NDT personnel to be trained. It is useful to start with one well equipped centre, i.e. the SRIM.

Additional equipment should be purchased for training courses outside the training centres.

The training courses should be carried out uniformly at all training centres according to the QCS requirements (see proposal No.3).

Proposal No. 5: Training the Trainers

The training of the trainers should have priority. It should be an additional training of well-experienced trainers. It is recommended to run a seminar with Chinese experts and experts from foreign countries. They should discuss the contents of training courses and how to run them in detail. The output should be drafts of text books for all training courses (catchwords).

Proposal No. 6: Publishing the QCS

The QCS as described in proposal No. 3 should be published immediately in national and international journals. This is important for the international acceptance.

Proposal No. 7: Organization of Training and Qualification

The number of training courses and examinations will increase strongly. Therefore it is necessary to have a well-organized institution.

Proposal No. 8: Training in Radiation Protection

The training of NDT personnel in radiation protection should be included in the training courses for radiographic testing. Separate courses seem to be not necessary.

Programme in Beijing

- 7.8.83 Sun Preparing lectures about qualification
- 8.8.83 Mon Lectures covering the training, qualification and certification of NDT-personel. International recommendations with a view to worldwide harmonisation. Discussion about the lectures
- 9.8.83 Tues Visit two heavy machinery plants
Discussions
- 10.8.83 Wed UNDP/UNIDO Office
Flight to Shenyang

Programme in Shenyang (and Beijing)

- 11.8.83 Thur Preparing lectures about special NDT application and training in German plants
- 12.8.83 Fri Lectures in Shenyang Research Institute of Foundry.
Discussions
- 13.8.83 Sat Visit two heavy machinery plants.
Visit Shenyang Research Institute of Foundry.
Discussions
Lectures about special NDT application and training in Germany.
- 15.8.83 Mon Discussions
Visit heavy machinery plant
- 16.8.83 Tues Flight to Beijing
Meet the Vice Minister of the First Ministry of Machine Building, Tao Hengxian

Programme in Xian

- 17.8.83 Wed Flight to Xian
- Visit Thermal Power Engineering Research Institute and discussions about the UNIDO programme

- 18.8.83 Thur Visit the Laboratories of the Research Institute
Lectures as described (see 8.8.83)
Discussions
Videofilm about the Institute.
- 19.8.83 Fri Final discussions about the findings of the
experts up to this day.
- 20.8.83 Sat Flight to Shanghai

Programme in Shanghai

- 22.8.83 Mon Reception by the Deputy Director of Shanghai
Research Institute of Materials (SRIM)
Lecture and first discussion about the findings
and proposals of the experts.
Introduction to the CMES-NDTI
- 23.8.83 Tues Discussions about the proposals of the experts.
- 24.8.83 Wed Visit Shanghai Jiaotong University
Reception by the Vice President Prof.
Lin Tung-Liang
Visit Shanghai Boiler Plant
- 25.8.83 Thur Preparing the final report
Final discussions with SRIM and NDT Society
- 26.8.83 Fri Flight to Beijing

Programme in Beijing

- 27.8.83 Sat Meet Mr. Lei Wei Zong at Research Institute of
Mechanical and Electrical Technology FMME.
Discussion of the findings and proposals of the
experts.
- 28.8.83 Sun Reception by Lai Jen (Economic Committee) and
Tao Hengxian (FMME).
Final discussions.
- 29.8.83 Mon Flight to Frankfurt

INTERNATIONAL ASPECTS IN TRAINING AND QUALIFICATION OF NDT PERSONNEL

The increase of the importance of NDT in the industries has led to more importance of the qualification of NDT personnel as well because exact test results are to be expected from qualified NDT personnel only.

The general qualification requirements for a certain NDT method and a certain qualification level are the same in all industries, the only differences are specific knowledge of the objects to be tested and specific regulations and standards. A rough definition of 'qualification' is to point out as follows:

- Personnel, choosing the NDT method, giving adequate instructions and is supervising the performance of the tests,
- Personnel, performing the tests.

On this basis a three-level qualification system has been developed in most of the industrial countries, one level for engineers and two levels for testers. The qualification requirements for the testers are to be defined as follows:

- higher level: personnel should be able to perform the test independently,
- lower level: personnel should be able to perform the test according to written or verbal instructions.

The three-level QCS has existed since 1969 in the USA and since 1970 in Germany. The systems have been developed independently in the various countries. As a result the regulations are different. The differences concern mainly the administrative regulations, like requirements for education and time of experience, duration of training, training centres, rules for examinations etc., whereas the qualification requirements are nearly the same.

The existence of various QCS creates problems in international commerce if the goods are to be tested by qualified NDT personnel. It can happen that such personnel has to be certified for more than one QCS.

These problems have resulted in the desire for international harmonisation. First steps were the establishment of the ISO Subcommittee TC 135, SC 7 (Personnel Qualification) at the end of the sixties and the first attempt of the International Committee for NDT (ICNT) in 1973 to harmonize the existing QCS. These efforts remained unsuccessful because the national structures in commerce varied strongly. Therefore the German Society for NDT (DGZfP) made a new proposal at the meeting of the ICNT in 1979 in Melbourne. The DGZfP proposed to restrict the international harmonisation to the following main points:

- (a) Three level QCS according to each main NDT method (at present: UT,RT,ET,MT,PT),
- (b) Uniform qualification requirements for each level and each NDT method,
- (c) Examination carried out by an independent board.

These proposals were accepted. In the meantime a group of European NDT societies have been formulating the qualification requirements for UT and RT in catchwords. These drafts have been sent to all ICNT members for a critical review. The answers were considered in final papers which were accepted at the last meeting of the ICNT in August 1982 in Moscow.

If all countries will consider these minimum qualification requirements in their own systems, a first step in the direction towards international harmonisation has been achieved. But further steps have to follow. At present it is still necessary to qualify the NDT personnel to the QCS of that country to which the items to be tested were exported. But it is possible that essential parts of the

qualification were accepted if both parties will accept the ICNT qualification recommendations. The DGZfP, the Austrian and the Polish NDT Societies agreed to a mutual recognition of the national qualification. The DGZfP and the American NDT Society (ASNT) agreed to mutual recognition of the engineers qualification. With these agreements the countries have achieved a further step towards international harmonisation.

