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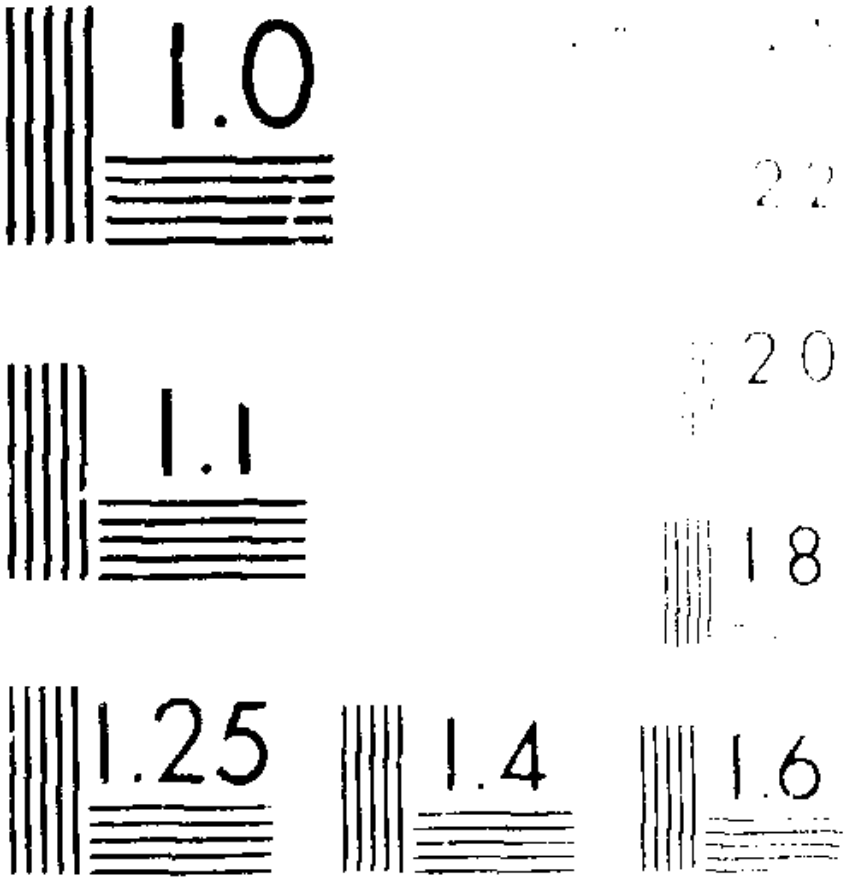
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UNITED NATIONS DEVELOPMENT PROGRAMME - ARGENTINE REPUBLIC

Executing Agency:
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION - UNIDO

Project:
COMISION NACIONAL DE ENERGIA ATOMICA - CNEA

Title of Post:
Expert in Dimensional Control of Advanced Metrology

Code of Post: DU/ARG/71/537/11-22/31.3.A

Mission Final Report from September,3 through September,28,1979

By:
Ernst J. G. Engelhard

November 1979

1. Introduction, Objective of the Mission

Since Argentina has decided to enter in an own nuclear energy program - under the patronage of the Comisión Nacional de Energía Atómica (CNEA) - with initial foreign technological assistance, but aiming towards final selfsuffiency, the necessity of quality control of nuclear plant components has become apparent.

Quality control in general implies metrology, in particular dimensional control as well as material testing. Non-destructive testing as a tool of material testing plays an important role in quality control not only in nuclear plants but also in industry. Development, study and application of the methods of non-destructive testing are under the responsibility of the Instituto Nacional de Ensayos No Destructivos (INEND) attached to the Centro Atómico Constituyentes in Buenos Aires.

The United Nations Development Program ARG/71/537 is assisting the INEND in establishing a National Institute for non-destructive testing and quality control.

The objective of the experts mission in the narrow sense of the job description was "Dimensional Control of Advanced Metrology" within the activities of the non-destructive testing institute. Actually it was extended to quality control in general.

2. Itinerary

The nominal duration of the mission was one month. Various institutes and industrial plants in Buenos Aires, Mendoza, Rosario and La Plata as listed below were visited during the period from September 3 through September 28, 1979.

3.9. Arrival in Ezeiza airport Buenos Aires

4.9. Briefing in the UNIDO office in Buenos Aires

5. - 14.9. 2.1 Centro Atómico Constituyentes
Visit of the laboratories of INEND
Discussions with the director Eng. Espejo and the project manager Mr. Beswick as well as with members of the staff on the technologies of non-destructive testing, in particular on metrological problems in these technologies and in nuclear plants
Visit of the metrological laboratory and workshops of the combustibel elements division
Discussion on dimensional control of fuel elements

2.2 Instituto Nacional de Tecnologia Industrial (INTI)
Discussions with the director Professor Steinberg and members of the staff on the collaboration of the INTI with the INEND on the field of metrology
Visit of the non-destructive testing department of the INTI
Discussions with the head of this department, Eng. Kugel on relations between non-destructive testing and metrology

2.3 Centro Atómico Ezeiza
Visit of the zircalloy tube factory and of the material testing laboratory
Discussions on dimensional control in connection with the production of nuclear plant components

17. - 19.9. 2.4 Visit of the plants and laboratories of the "Industrias Metalurgicas Pescarmona" (IMPSA) in Mendoza
Discussions on dimensional control of big industrial parts and machines

2.5 Technological University of Mendoza
Lecture on the application of the present meter definition to industrial metrology (see annex 1)

20. - 21.9 2.5 Visit of the UNIDO project "Assistencia Tecnologica para el Mejoramiento y Desarrollo de la Pequena y Mediana Industria" in Rosario

Discussions on the metrological assistance of industry and on the implementation of a metrological laboratory
Visit of the metrological laboratory

2.6 Engineering Faculty of the National University of Mendoza
Visit of the metrological laboratory

2.7 Fabrica Militar in Rosario
Visit of the metrological laboratory

2.8 Glauco A. Vazquez, Establecimento Metalurgico in Rosario
Visit of the plants
Discussions on dimensional control of patterns and dies

24. - 25.9 2.9 Industrias Metalurgicas Pescarmona (IMPSA) in Mendoza
Second visit
Assistance in machine control
Examination of a laser interferometer in collaboration with metrologists of the INTI
Continuation of the discussions on dimensional control

26.9. INEND
Continuations of discussions

27.9. 2.10 Astillero Rio Santiago in La Plata (AFNE)
Visit of the plants
Discussions on the installation of a metrological laboratory

28.9. Return Buenos Aires - Rio de Janeiro

3. Findings

3.1 Interrelations between non-destructive testing and metrology

The missions objective was supposed to be dimensional control within the activities of the non-destructive testing institute (S1). Hence the first question suggesting itself is, in what manner and to what extent dimensional control and beyond this metrology in general is related to non-destructive testing. The relationship is not very close in consequence of the following reasons.

Metrology at the one hand is the quantitative comprehension of the state and of the conditions of matter and fields in space time.

Most of the methods of non-destructive testing at the other hand are purely qualitative. Typical examples are liquid-penetrant inspection, magnetic-particle inspection, Eddy-current inspection, radiographic inspection, acoustic-emission inspection et cetera.

Logically the quantitative metrology does not interfere on the field of qualitative testing.

However there are cases, not very many, where non-destructive testing is made in a quantitative manner, for instance thermography. This method is used for thermal inspection and consists in recording of the superficial distribution of the infrared radiation emitted by the object under examination, using a scanning process and transforming the chronological record into a spatial photographic picture, which indicates existing temperature differences as contrasts in colour or blackening. What interests is not only local temperature variation, but also the proper temperature in degrees. Hence the radiation recorded has to be related to the temperature scale, what is a purely metrological problem, rather difficult and going far beyond the competence of a material testing institute.

Another case, very similar, is the temperature control of welding, process very important in the fabrication of nuclear plant components.

As nearly always, when measurements are made, one encounters temperature. Other quantities, which may play a role in non-destructive testing are mass, force, pressure, mass flow, magnetic field strength in connection with hardness testing, pressure vessel inspection, leak testing and electromagnetic testing.

The measurements of these quantities are true metrological problems. Thus there cannot be denied, that direct relations between metrology and non-destructive testing exist, so far as quantitative testing is concerned.

3.2 Importance of the INTI

The metrological problems involved in material testing, in particular in non-destructive testing might be sometimes rather difficult and complex. As for instance to thermography the rather wide temperature range of application, going from ambient temperature up to appr. 2000°C, creates considerable complication. Different technologies and instruments must be used, liquid thermometers or resistance thermometers,

thermocouples for the lower and medium and pyrometry for the higher temperatures. In addition, since that, what is actually observed in thermography, is radiation, the emissivity of the object under examination, which in general is unknown, comes into play. In short temperature measurement requires much special knowledge and experience exceeding the capacity of a material testing institute.

However the crucial point is, that any reliable measurement must be related in some way to the concerned units of the internationally adopted SI-system. In other words the used instruments must be calibrated, what is beyond the competence of a material testing institute. In Argentina the competent authority for the maintenance of the standards in metrology is the Instituto Nacional de Tecnologia Industrial (INTI). The INTI, although still developing, has already a considerable capacity of metrological services on nearly every field of metrology and experienced experts, who can advise the INEND in metrologicl problems. Strenghtening of the ties between the INEND and the INTI is highly recommended.

3.3 Quality control

It has been mentioned(§3.1), that direct relations between non-destructive testing and metrology are reduced to the cases, where testing is made quantitatively.

However, since non-destructive testing on the one hand is quasi identical with quality control, to a certain extent, and since metrology at the other hand plays a dominant role in quality control, exists an indirect relationship between both technologies by way of quality control. Yet in consideration of, that the greater part of non-destructive testing is qualitative, it might be said, that non-destructive testing and metrology on the field of quality control are working more side by side rather than together.

3.3.1 Dimensional control in the atomic center

Dimensional control, in particular dimensional control of fuel elements is a major concern of the combustible elements department attached to the atomic center Constituyentes. The fuel elements are circular tubes made of zircalloy or assemblies of these. Qualities to be controlled are straightness, roundness, length, outer and inside diameter and angular positioning of welded spacers. Control of single

tubes is not problematic and is made with the usual equipment, as alignment telescopes, autocollimators,optical benches and mechanical comparators. A reasonably equipped metrological laboratory is providing the necessary facilities.

A precarious problem encountered was the dimensional control of a fuel bundle consisting of 37 tubes about 500 mm in length and of about 10 mm inside diameter, assembled in concentric circular groups In order to avoid local overheating in the reactor the mutual distances must not understep specified critical values. Measurement is practically impossible with the bundle assembled, since the specified test points are quasi inaccessible. The problem could be easily solved by control of the single bundle elements before assembling.

Possibly this case is an example of ill-conceived quality control and demonstrates, that quality control must begin with the design. It is extremely important, that the design be adapted to the quality control facilities. In general a designer has not enough knowledge of dimensional control. Hence he must consult the metrologist in order to modify his design in such a manner, that quality control, in particular dimensional control is facilitated.

The fabrication of the zircalloy tubes is in the Ezeiza atomic center. Calibration of the equipment used in the annealing process is a minor metrological problem easily to solve with the assistance of the INTI.

Wall thickness of the tubes and uniformity of this along the axis are controlled using a non-destructive method based on the attenuation of an ultrasonic wave travelling across the tube. This is one of the rare cases, where non-destructive testing and dimensional control intersect.

A more difficult problem encountered in Ezeiza is the dimensional control of odd-shaped tools. In general problems of this kind are solved by means of a three-coordinates measurement machine or of a profile projector. However evaluation is in general very time-consuming. A more convenient way to solve such a problem would be the application of one of thecomputerized measuring machines now on the market.

3.3.2 Dimensional control in the Industrias Metalurgicas Pescarmona(IMPSA) in Mendoza

This company produces big cranes, big parts for hydroelectric powerstations and for the chemical and in particular for the petrochemical industry. They are developing considerable activity in the civil construction engineering. Relations with the CNEA exist in connection with the construction of nuclear plants.

Dimensional control in the IMPSA to a great extent is of a peculiar character in consequence of the bigness of the parts produced. Remote dimensional control is very much in use. The preferred instrument is the theodolite. The cathetometer apparently not applicated so far would be another useful tool.

Alignment problems are frequent, particularly in the straightness control of translational movements of machine parts. In consequence of the great distances in question and of the wide displacement range of machines to control-for instance 26 m in the case of a large mechanic center- the alignment telescopes and autocollimators should be more powerful than the present ones.

For the control of translational movement one uses also a laser-interferometer, a typical instrument for remote dimensional control. During the experts visit it was used for the displacement control of a big vertical lathe of several meters vertical movement capacity. The initial disagreement between the laser and the machines digital read-out could be later explicated by a misadjustment of the particular laser unit, which automatically compensates for the variation of the air conditions, temperature, pressure and humidity, on which the wavelength of the laser radiation travelling in air depends.

The examination of the laser interferometer was made in collaboration with metrologists of the INTI. It was suggested, that the laser compensation unit be recalibrated in the INTI. This case demonstrates once more the importance of the collaboration with the INTI in all problems of quality control, when metrology is concerned.

3.3.3 Dimensional control in Rosario

3.3.3.1 Fabrica Militar

This factory produces fire-arms under Belgian licence. The modest but well maintained metrological laboratory has adequate equipment enabling the most elemental techniques of dimensional control.It is note-

worthy, that measuring equipment, in particular gage blocks, the working standards of industry, are used without official certification.

3.3.3.2 Metrological laboratory of the Engineering Faculty of the National University

This laboratory is well equipped. Outstanding pieces of the present equipment are for instance the "Universal Measuring Machine" fabricated by Carl Zeiss, Jena and a three-coordinates measuring machine of the Societé Genevoise d'Instruments de Physique (SIP). The laboratory is capable, to carry out industrial measurements of many kinds, dimensional measurements, measurements of plugs, rings and threads, although limited in range. It is authorized by the Argentinian National Laboratory of Metrology, the INTI, to render metrological services to the industry of Santa Fé. However it seems, that the requirements in this regard are only very few.

3.3.3.3 The Metallurgical Factories Glauco A. Vazquez

This company is specialized in the manufacture of all kinds of patterns and dies for molding and forging. Since such parts are very often odd-shaped, dimensional control is difficult and very time-consuming, when made with elemental measuring equipment. A better way would be the application of one of the modern computerized measuring machines enabling many informations to be obtained in short time.

3.3.3.4 Direccion General de Asesoriamento Tecnico (D.A.T.)
UNIDO-Project ARG/78/004

The DAT is a governments institution attached to the Ministry of Finances and Economy of the Province of Santa Fé. Its aim is the promotion of the industry in Santa Fé by technical assistance.

The UNIDO-project ARG/78/004 is assisting the DAT in certain technologies. In particular the UNIDO is establishing a metrological laboratory for the requirements of the local industry. Doing so it is important, to analyze the situation and to know the real needs of the industry of Santa Fé.

So far as dimensional metrology is concerned, two facts have to be taken into account.

Firstly, a laboratory for dimensional metrology is already existing in the Engineering Faculty of the Rosario National University (3.3.3.2). Moreover this laboratory is a laboratory authorized by the INTI and reasonably equipped to carry out calibrations of industrial standards and gages. It seems to be doubtful, whether it would be justified or not, to establish a second laboratory of this particular field in the same place.

Secondly, reportedly and in accordance with the experts own, al-

though limited experiences precision industry having pronounced calibration needs is quasi non-existing in Santa-Fé.

Agricultural machinery was said to be an industrial branch of major importance in Santa Fé. Another example is the "Metallurgical Factories Glauco A. Vazquez" (c. f. 3.3.3.3).

One cannot help very much this kind of industry by gaging services, calibration and verification of industrial standards and gages although this kind of services are never completely to neglect. However, if the required precision is not high, gaging problems may be solved by the industry itself using the common elemental instruments.

The main metrological problem of the type of industry prevailin in Santa Fé is much more the inspection of the produced parts rather than gaging. Although the required precision is mostly low, the dimen sional inspection might be difficult because the parts to be controll are very often of complicated shape requiring many measurements to be made. Moreover economy demands, that the inspection be made in a reas ably short time.

To make many measurements in short time is hardly possible by use of the conventional measurement equipment disposable until a few years ago. Nowadays due to the combination of precision mechanics and modern electronics this is an easy task. However to the prejudice of the quality of industrial products the high acquisition costs prevent the broader application of equipment of this kind, particularly in the small and medium scale industry.

In consideration of this calamity a governmental institution like the DAT could contribute very much to improve the quality of the industrial production by acquisition of one of the recently designed computerized measuring machines and making it accessible to the local industry. Generally a laboratory specialized on the industrial inspection problems could probably render more effective technical assistance to the industry than a gaging laboratory.

3.3.4 Astillero y Fábrica de Naves Estatal (AFNE) in La Plata

The main activity of this state-owned enterprise is shipbuildi Relations to the Atomic Energy Center depend on the fabrication of pumps for nuclear power stations.

As to expect the production of AFNE is characterized by the pr dominance of big parts. Accordingly the situation is very similar to that of the Metallurgical Factories Pescarmona (IMPSA, 3.3.3.2).

The dimensional control of big parts requires special measurement methods and instruments. This fact should be taken into account at the selection of the equipment for the planned metrological laboratory. One must think not only of the common equipment for dimensional control but also of such typical instruments for remote measurement like for instance the theodolite and the cathetometer. Likewise the laser interferometer would be a useful tool highly to recommend in view of the necessity to control long translational movements of machine parts.

CONFERENCIA
Sobre Metrología Industrial en la Universidad Tecnológica Nacional.

POR: El Profesor Ernst Engelhardt, creador de la definición actual del metro patrón en base a la Radiación del Criptón.

FECHA: 18 de Setiembre de 1979 a las 19.00 hs.

LUGAR: Aula Magna Universidad Tecnológica Nacional Rodríguez 273 - Ciudad - Mendoza.

Temario:

- Reseña histórica del Metro Patrón y aplicación de la definición actual a la Metrología Industrial, con breve descripción de la técnica Interferométrica aplicada.
- Aplicación de sistemas de medición mediante Rayo Láser a Metrología Industrial. Sus posibilidades y limitaciones.

Antecedentes del Conferenciante:

El Dr. Engelhardt es graduado en Física en la Universidad de Erlangen, Alemania Federal y especializado en Metrología; ex-Director del Physikalische Technische Bundesanstalt (PTB Alemania Federal). Actualmente es consultor en metrología para UNESCO y ONUDI y experto del proyecto Arg./71-537 que creó el Instituto Nacional de Ensayos No-Destructivos (INEND) dentro del Programa de Naciones Unidas para el Desarrollo (PNUD), en el seno de la Comisión Nacional de Energía Atómica de Argentina.

Auspicia:

IMPSA

INDUSTRIAS METALURGICAS PESCARMONA S.A.

CERETTI 244 - GODOY CRUZ - MENDOZA

La Tribuna

ROSARIO, lunes 17 de septiembre de 1979

EXPERTOS EN METROLOGIA

El próximo jueves visitará la sede de la Direccion General de Asesoramiento Técnico (DAT), Salta 2752, el experto en metrología de la Organizacion de las Naciones Unidas para el Desarrollo Indus. (ONUDI) ingeniero D. Engelhard, de nacionalidad alemana.

La tarea del visitante consistirá en observar el equipamiento de los laboratorios metrológicos de ese organismo y efectuar las sugerencias correspondientes para su desarrollo y ampliación.

El experto vendra acompañado por personal de la Comisión Nacional de Energía Atómica donde actualmente cumple funciones, y a su vez visitará distintas industrias de nuestro medio y la Facultad de Ciencias Exactas e Ingenieria.

LA CAPITAL - Rosario, lunes 17 de septiembre de 1979

Técnicos del IRAM cumplen tareas en nuestra ciudad

Desde hoy y hasta el miércoles próximo visitarán nuestra ciudad funcionarios del IRAM, Instituto Argentino de Racionalización de Materiales, organismo cuyo objetivo es propender al conocimiento y difusión de la normalización, reconocido por el gobierno nacional como ente centralizador para el estudio técnico - científico de normas, a los efectos de mantener la uniformidad de sistemas y criterios en su confección. La presencia en nuestro medio responde a una actividad de divulgación entre industrias interesadas en el sistema IRAM de Conformidad y Certificación de Calidad, destinado a proteger tanto al productor como al consumidor. Para ello establecerá su sede en la Dirección General de Asesoramiento Técnico (DAT), calle Salta 2752, dependiente de la Subsecretaría de Industrias de la provincia, donde se puede efectuar también consultas sobre esa visita a el teléfono 38-6666.

Igualmente, la actividad de los funcionarios de IRAM está destinada a verificar el funcionamiento del Banco de Normas de la citada Dirección General de Asesoramiento Técnico (DAT), integrado con un juego completo de normas IRAM, las Normas SAE 1979, y el cual se completará a la brevedad con los 48 tomos de las Normas ASTM adquiridas por el Proyecto ONUDI.

Asimismo existen otras normas específicas de la British Standard, UNI y equivalencias con otros países.

Experto en metrología

El 20 del actual visitará la sede de la Dirección General de Asesoramiento Técnico (DAT) el experto en metrología de la Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI), ingeniero Engelhard, de nacionalidad alemana.

La tarea del visitante consistirá en observar el equipamiento de los laboratorios metrológicos de ese organismo, y efectuar las sugerencias correspondientes para su desarrollo y ampliación.

El experto vendrá acompañado por personal de la Comisión Nacional de Energía Atómica, donde actualmente cumple funciones, y a su vez visitará distintas industrias de nuestro medio y la Facultad de Ciencias Exactas e Ingeniería.

La Tribuna

FUNDADO EL 29 DE MARZO DE 1950
Director: Raúl N. Gardelli

Rosario, miércoles 19 de septiembre de 1979

Experto en metrología

Mañana, visitará la sede de la Dirección General de Asesoramiento Técnico (DAT), el experto en metrología de la Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI), ingeniero Engelhard, de nacionalidad alemana. La tarea del visitante consistirá en observar el equipamiento de los laboratorios metrológicos de ese organismo, y efectuar las sugerencias correspondientes para su desarrollo y ampliación.

La Tribuna
ROSARIO, miércoles 19 de septiembre de 1979

UN EXPERTO EN METEOROLOGIA VISITARA ROSARIO

Mañana visitará la sede de la Dirección General de Asesoramiento Técnico (DAT), el experto en Meteorologia, ingeniero D. Engelhard, de nacionalidad alemana.

El ingeniero Engelhard desarrolla tareas de investigación en la Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI).

Durante su visita al DAT observará el equipamiento de los laboratorios meteorológicos del organismo y efectuará las sugerencias correspondientes para su desarrollo y ampliación.

El experto arribará a la ciudad de Rosario acompañado por personal de la Comisión Nacional de Energía Atómica, donde actualmente cumple funciones. Además de la mencionada repartición, visitará distintas industrias ubicadas en la zona de influencia de la ciudad del sur y la Facultad de Ciencias Exactas e Ingeniería.

EL CORREO DE FIRMAT

SEMANARIO

Noticioso, Comercial, Cultural, Social y Deportivo

FUNDADO EL 11 DE OCTUBRE DE 1914

Expertos de Metrología en Rosario

El próximo jueves 20 visitará la sede de la Dirección General de Asesoramiento Técnico (DAT), de calle Salta 2752, Rosario, el experto en Metrología de la Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI) Ing. D. Engelhard, de nacionalidad alemana.

La tarea del visitante consistirá en observar el equipamiento de los laboratorios metrológicos de ese organismo, y efectuar las sugerencias correspondientes para su desarrollo y ampliación.

El experto vendrá acompañado por personal de la Comisión Nacional de Energía Atómica, donde actualmente cumple funciones, y a su vez visitará distintas industrias de esa ciudad y la Facultad de Ciencias Exactas e Ingeniería.