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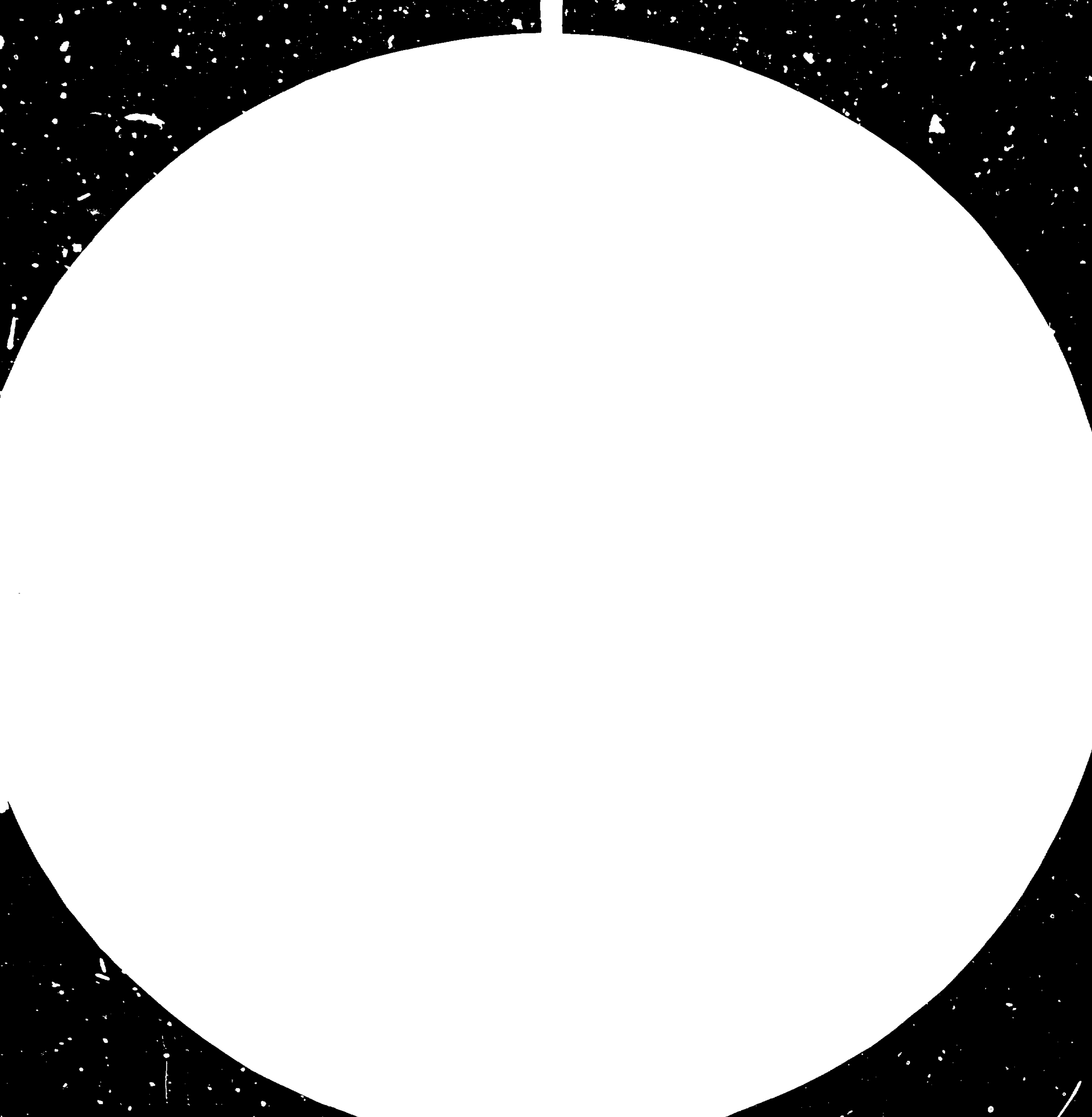

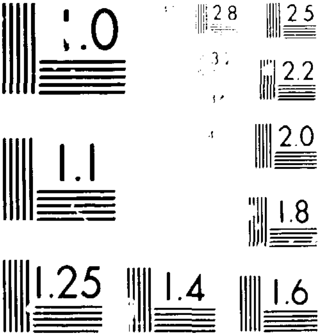

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UNIDO'S TECHNICAL ASSISTANCE TO THE NATIONAL METALLURGICAL LABORATORY JAMSHEDPUR *

by

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Amongst the International aid agencies participating in the development of the countries of the third world, the UNIDO discharges a unique role, as its participation is aimed to generate employment and raise the GNP of the countries simultaneously. It thus seeks to transplant through heterogeneous nucleation technical competence and to build the infrastructural facilities that may be required to sustain the growth of the alien technology on a different soil, yet most economists agree that the rapid industrialisation is the only method which could complete the task of centuries for bringing about social welfare in decades.

Industrialisation requires availability of motive power in the form of electricity. Since sources of hydro electricity are not available abundantly in all countries of the world and are in any case inadequate to meet the total demand, industrialisation has to depend on the availability of electrical energy generated through combustion of fossil fuels or through nuclear fission. Between these two, thermal electricity through coal is predominantly important and shall continue to occupy such a position.

In the history of industrialisation of India, the 1960s witnessed a rapid growth of thermal electricity generation. In order to meet the targets of electricity generation, the country had the alternatives either to depend on imported plant and machinery or to establish industrial units manufacturing the power generating machinery and necessarily the alloys and special steels. Almost simultaneously with the decision to establish steel production in India to meet the growing demands, a decision was also taken to make the power sector as indigenous as possible so as to reduce the drain on the scarce foreign exchange earnings of the country.

Creep is a special kind of high temperature deformation process and occurs insipidly when metals are exposed to high temperature and pressure simultaneously such as in high pressure boilers and heat transfer tubes in the various zones of a power plant, steam turbines etc. In order to reduce the risk to the human life in the operation of thermal plants, all the technologically advanced countries have established their own boiler codes and some of these establishments are now incorporated in relevant standards of International Standards Organisation. These regulations make prolong testing of steels for their creep resistance mandatory and no steel can be used for pressure applications unless it has satisfied the inspecting authorities with regard to its suitability for continued use at elevated temperatures under arduous conditions. In the technologically advanced countries, the development of steels took place simultaneously with developments in the power plants in terms of ever increasing high temperatures and pressures of operation.

In a developing country, however, the problem is different because the steel produced has got to pass the mandatory tests before its use in pressure part applications could be permitted. This could be a self-defeating situation.

Since the steels being made in India for high temperature applications, have been under collaborative arrangements with foreign steel producers and are the same as have been developed in the technologically advanced countries and their basic composition established after prolonged testing, the problem in a developing country was, therefore, to prove their suitability for continued use to the satisfaction of design engineers. The design engineers themselves often work in collaboration with foreign companies and therefore, would like to meticulously adhere to the design specifications and testing programme evolved in their associates from the technologically advanced countries.

The first task, therefore, in establishing indigenous production of steel for high temperature and high pressure applications in any developing country is to evolve a programme of accelerated tests aimed at providing confidence to the design engineers in the capability of steels of sophisticated composition and heat treatment in terms of their high temperature behaviour. As a result of considerable deliberation amongst the steel producers, the power plant design engineers and metallurgists and the physical metallurgists at the National Metallurgical Laboratory, a national programme of testing was evolved and was accepted by the Central Boilers Board. This test programme is given in Appendix I. A reference to this test programme shows that the establishment of a creep testing facility with a large number of points is a must for the acceptance of the steels. With the identification of self-reliance in the field of power generating equipment in its totality, as a national objective, the task before the national agencies became crystal clear. This pointed to the imperative necessity of establishing the creep testing facilities in India under an independent centre - not in any manner related either to the steel manufacturers or to the power plant manufacturers. The National Metallurgical Laboratory was, therefore, a natural choice.

Role of UNIDO

In retrospect, it may be emphasised that the early seers of the NML were inspired by a broad vision as they had given considerable attention to the R&D activity in the broad area of physical metallurgy besides of course mineral beneficiation and extraction metallurgy. The National Metallurgical Laboratory also had a miniature 26 point creep laboratory. Since expansion of the creep testing facilities at the NML to meet the national objectives required considerable expansion and accelerated transplantation of the know-how of testing, the Government of India and the UNIDO entered into an agreement resulting in the UNIDO providing foreign exchange component for the procurement of equipment listed in Appendix II and provision of expert services and training fellowships to the staff of the National Metallurgical Laboratory. The names of the UNIDO experts and the training programmes of the counterpart Scientists and experts are given in Appendix III.

The creep testing and development of creep resistant steels simultaneously required the availability of good instrument engineers and physical metallurgists to understand and interpret the behaviour of the steel. This is achieved in the creep laboratory with an electronics engineer looking after the operation and maintenance of the laboratory and the metallurgists taking part in the development through study of micro structures etc.

Indian Creep Panel

In order to systematically plan, organise and coordinate the various activities concerning to research, development, testing and evaluation of creep resistant steels and alloys in the country, the Indian Creep Panel was set up in 1971 under the Chairmanship of the Director, NML and with its Technical Secretariat at Central Creep Testing Facility, NML and is presently represented by about 32 organisations in various concerned disciplines viz. steel/product manufacturers, user industries, designers, research and development institutions, standards/mandatory bodies and Government departments. The scope and functions of the Panel are as follows:

[a] To systematically plan, organise and coordinate the various activities concerning research, development, testing and evaluation of creep resistant steels and alloys in the country.

[b] To prepare perspective plans for the development and production of creep resistant steels and alloys, keeping in view the present and future requirements of such steels in the country.

[c] To sponsor long-term research and development projects on creep resistant steels and alloys.

[d] To assist the Indian Standard Institution and Central Boilers Board in formulation of national standards on relevant testing techniques, materials specifications, incorporating elevated temperature properties of Indian steels and alloys, and acceptance criteria for creep resistant materials.

[e] To organise technical seminars and symposia on relevant topics.

[f] To foster international cooperation by maintaining a close link with counterpart organisations in other advanced countries.

Realisation of the objective of the project

The project is broadly concerned with testing and evaluation of conventional high temperature creep quality steels and alloys produced indigenously to help establish their commercial production as well as efficient utilisation of such materials imported or indigenously produced in engineering situations.

Manufacturers

(1) Bharat Heavy Electricals Ltd.
(2) Reactor Research Centre.
(3) Steel Authority of India Ltd.
(4) Welding Electrode Manufacturers.

Services to the Thermal Power Plants

The Central Creep Testing Facility now called the High Temperature Materials Development Centre has been working under the overall guidance and supervision of Dr. Rajendra Kumar for the last eight years. Apart from taking direct part in the evaluation of indigenously produced creep resistant steels, the metallurgical knowledge of his group of metallurgists has been put to extensive use, and to the advantage of this country for a number of thermal power plants to understand the nature of their premature failures of boiler tubes and other components. The NML has been called to investigate metallurgically the causes of frequent outages at the number of thermal plants and it may not be out of place to mention here that in case of one thermal power station frequent outages on account of fuse failures were traced out to be due to inferior quality imported steel tubes themselves and not to any deficiency on the part of operational engineers.

Estimation of residual creep life of components

Metallic materials undergo structural damage under service conditions in thermal power stations. As a first approximation, the extent of the damage is determined by temperature and stress and this provides the basis for the anticipation of the design life of the component. Therefore, the service temperature and pressure are always specified for the fulfilment of the design life. In practice, however, the service conditions often undergo unintentional abuse on account of the several difficulties experienced in the control of operating parameters. Whereas services at less than designed temperature or pressures does not adversely affect the designed life of the component, any excursion of temperature or pressure, beyond the specified limits. cuts short the life. The creep damage caused by individual excursions is a cumulative process and the material could fail prematurely, when the accumulated damages become critical. The extent of damage depends upon the duration of the excursion as well as on the magnitude of the increase in temperature and/or pressure. A continuous increase of 20°C in the operating temperature could reduce the life to a third.

Thus the knowledge of the Residual creep life of the components already in service in a Thermal Power Plant is very useful to the management in:

[a] Replacement to be carried out at a most convenient stage

[b] Procurement of the material at a correct stage

[c] Decision with regard to rejection of quality steel

The facility has developed a technique for estimating the extent of accumulation of creep i.e. the remaining creep life. This technique has already been used to predict the residual creep life of the tube received from a number of thermal power plants and the results have been successfully utilised.

Expansion

Starting with 150 test points and taking into account the diversified use of the facility by the thermal power plants and others, steel plants and plant manufacturers, the NML expanded the facility to 200 test points through its own budget and another 12 test points just received from UNIDO are under installation. We are expecting another 12 points from a US manufacturer to arrive here any time now. There is sufficient pressure of work on the laboratory to justify its further expansion to 400 test points as envisaged in the original plan. In this context we are already in dialogue with the UNIDO and we are expecting their expert to visit and discuss with us shortly.

In a large country such as India, growth of petro-chemical industry is also a must in the process of increasing the GNP. The petro-chemical industries are also important consumers of the creep resistant materials but in their case the operating temperatures are higher than in the thermal power stations. Until recently most high temperature special alloys used in the petro-chemical industries were imported but their indigenous production is now being established in ever increasing measure to meet the growing indigenous demand. Generation of the high temperature priority data for such materials is also of national importance and we hope to enlarge our activity in this area. Already we have been in intimate touch with some leading industrial units of the sector to advise them on their metallurgical problems. We are currently having a project to determine the residual life of their high temperature components. High Temperature Materials Development Centre funded as it is partly by UNIDO, we, at the National Metallurgical Laboratory, with the support of the Government of India, are conscious of our responsibilities towards the other developing countries in the region and could, if asked, undertake investigations on metallurgical aspects of failures in power plants and fertiliser industries, estimation of residual life etc.

Conclusion

It is thus clear by the above account that the UNIDO played an important role in realising the aspirations of an important and critical sector of the industry to be self-reliant in the field of development, production and monitoring of high temperature materials specially for use of the thermal power plants, nuclear power plants, petro-chemical plants, etc. It was UNIDO's immediate interest and intense involvement that made it possible to prepare and execute a sizeable project for the establishment of Creep and High Temperature Testing Facilities at the National Metallurgical Laboratory to assist India in an important field of industrial activity.

In this connection, it would not be out of place to specially mention the name of Dr. B.R.Nijhawan, Senior Inter-regional Adviser, UNIDO and thank him for his keen and abiding interest in the project. I would also like to take this opportunity to thank the Ministry of Industry and the Ministry of Steel & Mines of the Government of India for their readily agreeing to financially participate and support in the recurring expenditure of the project. Thanks are also due to the Council of Scientific & Industrial Research for their sustained support of the project right from inception. I would also like to acknowledge collectively the contributions made by various members of the Creep Panel, comprising of several Government Departments, Ministries, educational and R&D institutions, steel producing units, fabricating engineering firms, thermal power plants and power plant manufacturers and suppliers, who are actively participating in the deliberations of the Creep Panel.

It may also be recorded that UNIDO have expressed keen interest in supporting the proposal to bring up the capacity of the present project to the earlier determined target of 400 test points supplemented with accessory equipment and instruments.

Appendix I

TEST PROGRAMME AS EVOLVED BY INDIAN CREEP PANEL

[1] To test a minimum of three casts from each steel manufacturer for each grade of steel at three temperatures and at three stress levels to give rupture lives of 1000, 3000 & 10,000 hours at each temperature and taking two specimens under each test condition.

[2] Until 33,000 hours tests are carried out by NML/Steel Plants for collecting elevated temperature data of alloy steel produced indigenously against ASME or BS grades, these grades of steel may be accepted and long time elevated temperature properties/maximum allowable stress values given in ASME Code or BS as the case may be, may be used for the purpose of design provided:

i_/ A certificate is furnished by the producer of the steel to the effect that the steel has been manufactured strictly in accordance with the technical requirements of the ASME Code or B.S. to assure that the creep rupture requirements are complied with.

ii_/ The Steelmaker furnishes the necessary certificate that the steel conforms to the chemical analysis, room and elevated temperature mechanical properties given in ASME Code or BS as the case may be.

iii_/ The short-term stress-rupture tests for 10,000 hours as described below are carried out by NML/Steel Plants for the purpose of checking whether the steel is upto the specification and also to ensure that the steel is capable of meeting the long-time rupture stress values/maximum allowable stress values given in ASME Code or BS as the case may be and a certificate is given by NML/Steel Plant to this effect.

iv_/ A minimum of three casts are tested from each steel manufacturer for each grade of steel.

v_/ Each grade of steel is tested at three temperatures and at three stress levels to give rupture lives of 1000, 3000, 10000 hours at each temperature and taking two specimens under each test condition, in conformity with the Code/Specification to which the steel is made.

vi_/ Concurrently the stress-rupture tests for 33,000 hours duration are taken up on the same three casts from each steel manufacturer for each grade of steel at three test temperatures and taking two specimens at each temperature.

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/ Appendix II

LIST OF EQUIPMENT PROVIDED BY UNDP/UNIDO

Sl.No.	Equipment	Quantity
(1)	Single specimen creep testing machines	55 Nos.
(2)	Multi-specimen creep testing machines with 12 test points each	6 Nos.
(3)	Instron high temperature tensile testing machine	1 No.
(4)	'Solarton' central measuring and recording console	1 No.
(5)	Extensometer calibrating device, Null-balance type	1 No.
(6)	Thermo-couples' secondary calibrating device	1 No.
(7)	Thermo-counples' Primary calibrating device	1 No.
(8)	Preportional weights for single and multi specimens creep testing machines	34 Nos.

Appendix III

UNIDO EXPERT SERVICES AND THE TRAINING PROGRAMMES OF THE COUNTER PART SCIENTISTS AND EXPERTS

UNIDO Experts

(1)	Mr. D.J. Armstrong, Planning Consultant	.	One month August 1971
(2)	Mr. I J. Armstrong, Chief Technical Adviser	..	November 1971 to October 1972
(3)	Mr. D.C.F. Dunn Chief Technical Adviser	..	August 1974 to July 1975 and November 1975 to July 1976
(4)	Mr. G.W. Russel Equipment Installation Engr.	..	July 1974 to June 1975
(5)	Dr. T.B. Gibbons High Temperature Materials Consultant	..	October 1974 to September 1975

Fellowships

(1)	Mr. R. Choubey, Scientist	..	June 1971 to July 1971
(2)	Mr. K.M.Chowdary, Scientist	..	3 months - 1974 3 months - 1976
(3)	Mr. Raghubir Singh, Scientist	..	4 months - 1974
(4)	Mr. M.R.Das, Scientific Asstt.	..	4 months - 1974
(5)	Mr. H. Sirgh, Scientist	..	3 months - 1974
(6)	Mr. L.N.Das, Scientist	..	3 months - 1976
(7)	Mr. Arjun Dev, Scientist	..	3 months - 1975-76
(8)	Mr. K.Prasad, Scientist	..	3 months - 1976

In addition to the above Dr. Rajendra Kumar, Scientist (Director) & Project Co-Director also visited on a Senior Study Tour Fellowship to study the working of full-fledged creep laboratories, National Creep Committees, and power plant equipment manufacturing organisations in Europe.