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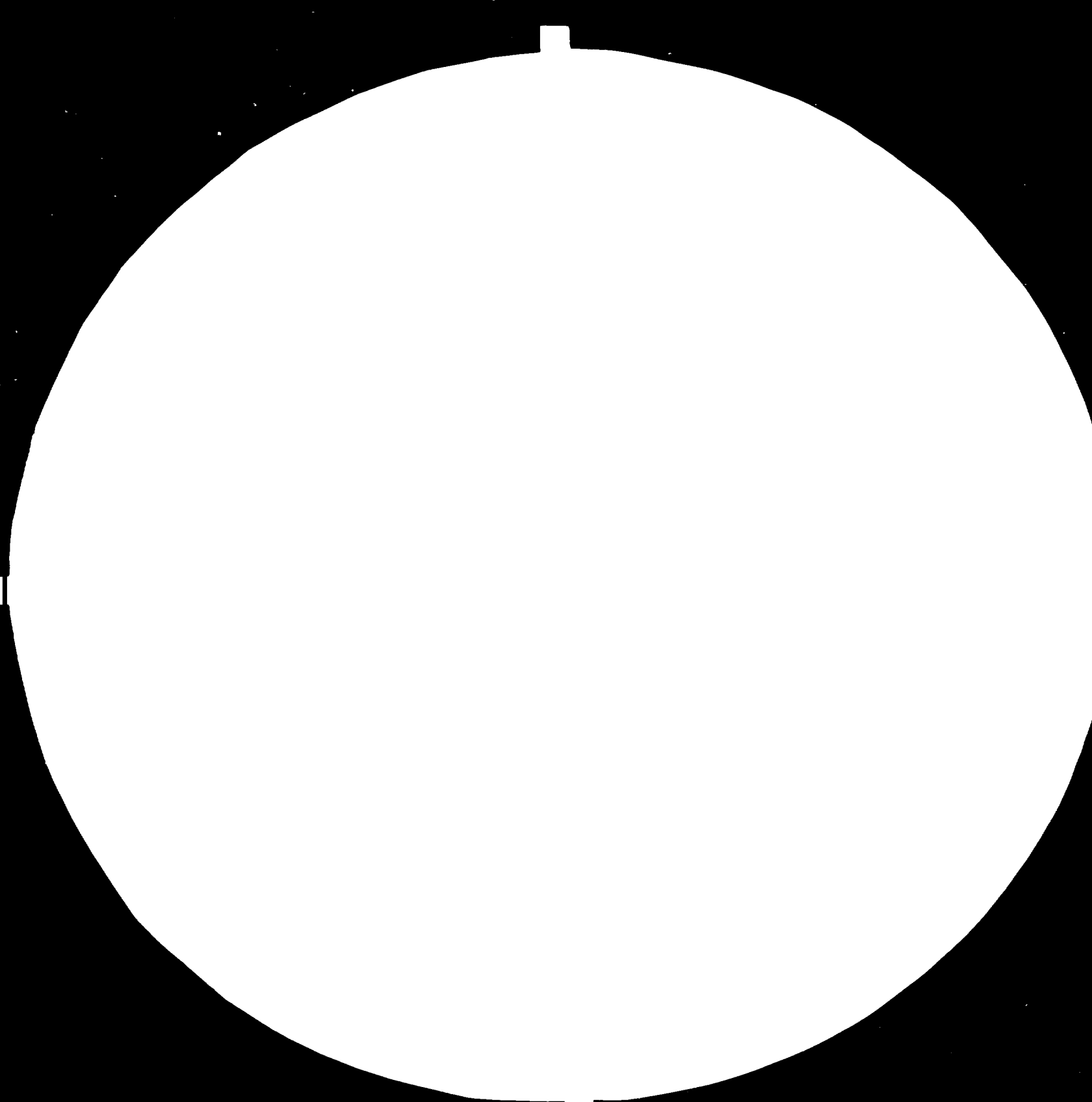
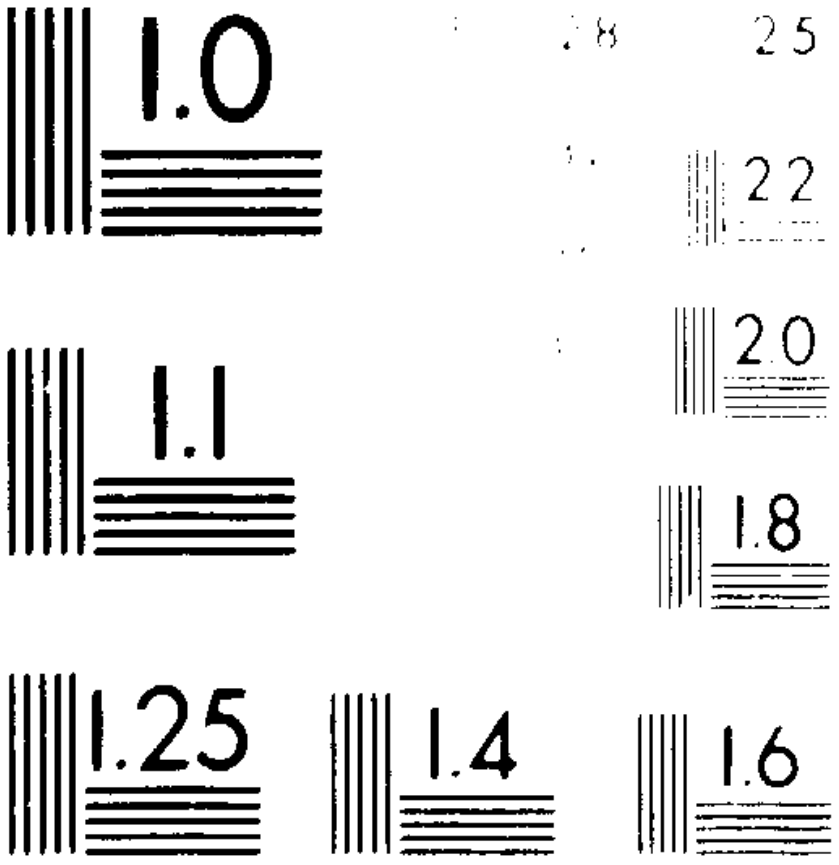
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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21 December 1983

ENGLISH

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

India.

VACUUM STANDARDS

DP/IND/79/004

REPUBLIC OF INDIA

Final Report *

Prepared for the Republic of India

by the United Nations Industrial Development Organization,

executing agency for the United Nations Development Programme

Based on the Work of Dr. Vern E. BEAN,

Consultant to Pressure and Vacuum Section,

National Physical Laboratory (NPL)

* This document has been reproduced without formal editing.

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I. INTRODUCTION

The expert worked at the National Physical Laboratory (NPL) through 7 December 1983 inclusive except Saturdays and Sundays.

Arrived New Delhi 1:00 a.m. 14 November 1983

Departed New Delhi 4:00 a.m. 8 December 1983

The Pressure and Vacuum Section has recently moved into a newly renovated building where the pressure standards have been provided with appropriate and adequate laboratory space. Dr. K.K. Jain had put both the primary standard and transfer standard oil operated piston gages into operation before Mr. Vern Bean arrived. The characterization of the primary standard was not yet complete in that all of the necessary data had not been taken or processed. The data on hand appeared to be satisfactory and suggested that the gage was operating properly. NPL can now offer a pressure calibration service up to 280 MPa for oil operated gages using the transfer standard and the manufacturer's calibration. The expert would expect the characterization of the primary standard to be complete in a couple of months which will allow NPL to extend their oil operated gage calibration capacity to 700 MPa.

Dr. J.K.N. Sharma and his staff were most co-operative and eager to do all they could to gain the maximum benefit from Mr. Vern Bean's visit.

II. WORK ACCOMPLISHED

1. Set up and put into operation the gas operated transfer pressure standard piston gages (Ruska).
2. Trained Dr. A.K. Bandyopadhyya and Mr. K.K. Kushreshtha to operate the Ruska gages. NPL can now offer a calibration service based on the Ruska gages and the manufacturer's calibration using gas up to 4.2 MPa.
3. Set up the gas operated primary pressure standard piston gage (Harwood).

4. As Harwood failed to provide an operators manual, the expert wrote a brief cook-book on how to operate the gage and trained Dr. Bandyopadhyya and Mr. Kulshreshtha in how to:
   a) operate the gage, and
   b) make the measurements necessary to properly characterize the gage.

   The expert was not satisfied with the operational behaviour of this gage. The sink rate of the piston into the cylinder is fair too fast which indicates wither a gas leak in the plumbing or too much gas bypassing the piston.
   The team tested for leaks in the plumbing and found none. As this is a controlled-clearance gage, the gas flow past the piston is controlled by applying a pressure on the external wall of the cylinder. However, we they were not able to obtain an acceptable piston sink rate using that pressure which, in turn, implies that either the piston or the cylinder is not round enough. There were roundness measurements made on the piston and it appears to be acceptable. They need to have roundness measurements made on the cylinder inner diameter also. The expert is not sure whether or not NPL has the capability to make the needed inner diameter roundness measurements with the required sensitivity of a couple of microinches. The gage is not now operational and will not be operational until the proper piston sink rate is obtained.

5. Repaired a faulty high pressure generator.

6. Installed the high pressure viscometer. While visiting Mr. V. Bean's laboratory, Dr. Sharma saw the high pressure viscometer he had designed and built. They agreed such a device would be a valuable asset to the NPL pressure lab for it is a fast and easy way to determine the freezing pressure of pressure transmitting fluids which is particularly important for a pressure lab that is just getting started. The sample containment and sensin system and the associated electronics were built at NBS. NPL provided the needed pressure equipment and the general purpose electronics. Mounts for the pressure vessel were fabricated at NPL in their general machine shop.

The viscometer is operational and Dr. Jain has been trained to operate it.

7. With Dr. Jain, the expert designed a new high pressure electrical lead-through and various adapters to connect high pressure plumbing systems that are otherwise incompatable.

8. The expert consulted at great length on a variety of gas and oil pressure measurement problems and techniques with NPL staff.

III. GENERAL OBSERVATIONS OF THE NATIONAL PHYSICAL LABORATORY (NPL)

NPL scientists work under some difficult handicaps:

1. The general machine shop is inadequate. On the plus side, there are some co-operative and skilled personnel. They have several quality, domestically-build, lathes in the 10-12 inch size range. On the negative side, there is some hesitancy to try things they have never done before. There is a dire need for quality milling machines. The machines they have are too few in number and too small. Jobs that should have been done in an end-milling machine using a fly-cutter were done by hand with hammer, chisel and files. They need a metal-cutting band saw. They need to provide a clean environment for precision machining work by placing the machine tools in a separate room form the welding, foundary, and carpentry operations currently all housed together, by reparing the broken windows to keep the pidgons and dust out, and by cleaning out the mess created by pidgons roosting over head.

2. There is a lack of standard hardware such as bearings, tube fittings, screws, bolts, pins, shafts, gears, etc. all the little mechanical bits and pieces that are taken for granted elsewhere and are routinely incorporated into scientific apparatus by the mechanical designer.

3. India is a metric country meaning that bolts and pipes have metric threads. India has a lot of American equipment which features

American threadings on bolts and pipes. India has also a lot of British bolts and pipes from that era of her history which have British threading. None of these three threading systems is compatible with any other.

4. Mr. Vern Bean senses some lack of experience in solving mechanical design problems. That is not too surprising. If one cannot get the little bits and pieces one needs and/or one does not think ones shop can build it, one would not get much practice in mechanical design.

5. Scientists in India are isolated by distance. Travel is expensive and it is a long way to other countries where scientific work is being done.

IV. RECOMMENDATIONS

The expert, Mr. Vern Bean is very much in favor of the UNIDO pressure project at the National Physical Laboratory (NPL). He thinks that there is potential for great benefit to India resulting from this project. It should be continued so that the NPL personnel can be fully trained to use their equipment to the best advantage and to provide contact and co-operation with scientists outside India.

The expert specifically recommends the following:

1. NPL needs to obtain a variety of tubing and pipe fittings to mount units to be calibrated to their pressure/vacuum standards. Such fittings must include adapters from one coupling system to another, such as swagelok to flare, swagelok to national pipe thread, swagelok to hose barb, flare to national pipe thread, flare to hose barb, etc., in a range of sizes.

2. Because of the three thread system in India, NPL will have to make adapters for some of the pressure units to be calibrated. To do so, they need to obtain tap and die sets for both bolts and pipe for metric threads up to 20 mm diameter, tap and die sets for both bolts and pipes for American threads up to 3/4 inch diameter.

3. The NPL personnel who are to operate the pressure calibration service need to have the opportunity of working in a lab for several weeks where an active pressure calibration program is now underway. They need hands-on experience in calibrating a diverse variety of pressure measurement devices.

4. After the calibration rersonnel have had the additional training mentioned in 3 above, and after they have the NPL pressure calibration service operating, an expert in pressure calibration should visit NPL to consult on problems and to help de-bug the service.

5. Scientists of the NPL pressure group need continued contact with others working in pressure metrology. They should be able to attend conferences such as the Gordon Conference on Physics and Chemistry at High Pressure and the conference of the International Association for the Advancement of High Pressure Science and Technology.

6. There should be exchanges between scientists of NPL and the other national metrology laboratories.

7. When the calibration services are functioning properly, then NPL scientists need to have the opportunity to pursue research on some of the problems of metrology such as new techniques and/or materials for pressure transducers, pressure fixed-points, properties of pressure transmitting media, etc. Such research not only improves the science of metrology but will increase the skill and the experience of NPL personnel.