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30 June 1987
English

INDUSTRIAL ENERGY MANAGEMENT CONSULTANCY AND TRAINING
DP/PHI/82/002
PHILIPPINES

Technical Report: Fuels and Appliance Testing Laboratory in the Republic of the Philippines

Prepared for the Government of the Philippiens
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations
Development Programme

Based on the work of Norval Jackson
Appliance Text Specialist

United Nations Industrial Development Organization

702

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30 June 1987
English

PROJECT	-	Fuels and Appliance Testing Laboratory in the Republic of the Philippines
REFERENCE	-	DP/PHI/82/002/11-05/31.4.Z
JOB DESCRIPTION	-	DP/PHI/82/002/11-05/REV. 4
SHORT TERM EXPERT	-	Norval Jackson
POST TITLE	-	Appliance Test Specialist
DURATION	-	3 Months
DUTY STATION	-	Manila, Philippines

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1. Purpose of Project

To establish the necessary services and capacities to achieve a better energy utilization in industry and improve the performance of the sector.

2. Duties of Expert

Expert was attached to the Ministry of Energy and worked under the supervision of the Chief Technical Adviser as part of a group of international experts assisting the Ministry of Energy in running of the Fuels and Appliance Testing Laboratory as part of the Energy Management Consultancy Centre. The expert was expected to:

2.1 Assist BEU in design, setting-up, operation and maintenance of appliance testing facility according to internationally accepted standards for various household appliances including refrigerators and other consumer durables commonly using electricity, gas or oil.

2.2 Assist BEU in the establishment, training, operation and maintenance of calibration testing facilities for commonly used energy monitoring instruments in energy field and prepare manual on these aspects.

2.3 Train BEU consultants and technicians in proper and correct method of testing these appliances according to international standards and in the operation and maintenance of fuels testing instruments.

2.4 Make an input to the preparation of manuals on procedures of testing, operation and maintenance of these appliances testing and calibration facilities.

2.5 Assist BEU in the installation of quality control procedures for various aspects of laboratory operation to ensure reliability, repeatability and accuracy of measurements in the laboratory.

2.6 Advise BEU in drafting standards for testing appliances wherever such standards do not exist in the Philippines.

2.7 Advise BEU on design and upgradation of existing infrastructural facilities for getting recognition from international agencies for the Fuels and Appliance Testing Laboratory.

3. Background Information

Research and development undertaken within the last decade in various countries produced many new technological and non-technological means for the conservation and better useage of energy in industry. Although information regarding such work is generally available, it has not yet benefited in an important degree, the developing countries, partly because it has not been adequately disseminated to them and partly because they generally lack sufficient expertise to make use of it. Technical assistance is therefore a valuable vehicle for bringing the new knowledge to the recipient countries and create both the expertise and the facilities where they are needed.

Energy conservation is relatively new area in the government's programme to reduce its dependence on imported oil. In addition to its aggresive development of its domestic energy resources, the government now wishes to embark on an energy-saving programme through the improvement of efficiency in the use of fuels in major industrial enterprises.

A practical way to achieving this goal is the creation of an institution which would gradually acquire the know-how of energy management conservation techniques and the skill to apply them to energy users. To this end it was proposed to establish in the Philippines with UNDP/UNIDO assistance an Energy Management Consultancy Services (EMCS).

The principal objective of the EMCS to implement energy saving measures among industrial and non-industrial users. It will work up towards that objective by developing a core of 15 specialists trained by a team of international experts to carry out with local staff, energy audits and consultancies. This will entail the elaboration of a general system for the development, application and implementation of energy saving measures and technologies and the preparation of working manuals with methodologies. Local specialists will be trained by the EMCS and in the factories. Furthermore a laboratory will be established for the purpose of testing the efficiency of fuel utilization by energy consuming equipment. Group training and fellowhips will be organized by the EMCS for officials and managers to observe how other countries and selected industries manage their energy problem.

4. Participation whilst in Manila

During the period of stay in Manila the following visits were made to establish background information and to further the programme.

4.1 Products Standards Agency (P.S.A.), Ministry of Trade and Industry - meeting with the Director to discuss the plans of PSA for the development of appliance testing and certification and to explore the PSA accreditation procedure for laboratories. Also discussed was the progress of the PSA technical committees in the preparation of Philippine National Standards (PNS) for energy using appliances and their priorities for 1987.

4.2 Attended a meeting of the PSA technical committee preparing the PNS for lamps and related equipment.

4.3 Attended a meeting of the PSA technical committee preparing the PNS for electric, L.P.G. and kerosine heated stoves.

4.4 Attended a meeting of the PSA technical committee preparing the PNS for refrigerators and freezers.

4.5 Visited the National Standards and Testing Centre (NSTC), part of the National Science and Technology Authority (NSTA) to see their reference standards rooms and the calibration and testing facilities. NSTC is a member of the Asean Pacific Standards Programme. A listing of the primary and secondary reference standards, comparators and measuring instruments held and maintained by NSTC is shown in Appendix I.

4.6 Visited Philippine Appliance Corporation (Philacor) to see their existing testing and development facility for refrigerators and freezers.

4.7 Many visits to the National Engineering Centre (NEC), University of the Philippines to advise on designs and control parameters for energy using appliance test facilities and also on the training requirements for BEU staff employed in the calibration and fuels testing laboratories.

4.8 Attended the lecture session at BEU offices and gave a lecture on the practical and economic aspects of waste heat recovery, at the request of the C.T.A.

5. Findings On Commencement of Duties

5.1 Staff

Just prior to arrival in Manila the last of the contract management staff of BEU (from the Philippine National Oil Company (PNOC) had left the BEU offices, and managers in acting positions had been appointed. During their period with BEU, the PNOC staff had become highly trained and their departure left BEU with a management team of much less experience.

The move to appointing permanent BEU staff to these management positions is to be welcomed since this will generate a more stable working arrangement.

5.2 Instrumentation and Equipment

5.2.1 Calibration Laboratory

The necessary instrumentation and equipment for this laboratory had not been listed and ordered except for a dead weight pressure gauge tester which was delivered incomplete and is an obsolete model.

5.2.2 Fuels Testing Laboratory

In reviewing the instrumentation and equipment available in this laboratory, several aspects emerged. It is understood that some of this detail is already known but for completeness the overall position is set out blow.

a) Centrifuge - not suitable for intended use.

b) Elemental Analyzer (Perkin Elmer) - the high purity oxygen and helium necessary for the operation of this equipment is not available in Philippines.

c) Dead Weight Pressure Gauge Tester - incomplete unit and a discontinued model.

d) Brookfield Viscometers (2 off) - ordered for 60 Hz but supplied for 50 Hz electricity supply.

e) Helium Leak Detectors - not suitable for intended use.

f) Saybolt Viscometer - does not meet the up to date ASTM requirements for Kinematic viscosity determination.

5.2.3 Servicing, Circuitry and Calibration Information.

The manufacturers information on servicing, circuitry and calibration had not been obtained for the portable instruments and equipment used for energy audit purposes and other laboratory equipment requiring calibration, servicing and repair.

5.3 Building Extensions to Laboratory

The work on the extension was at a standstill due to the non-availability of cement in the Philippines.

6. Work Programme

6.1 Calibration Laboratory

As reported earlier in Sections 5.2.1 and 5.2.3 of this report, necessary equipment and materials for instrument calibration had not been ordered. An exception to this was the dead weight pressure gauge tester. Also instrument and equipment manufacturers information on servicing, circuitry and calibration had not been obtained when the purchases were made. A calibration equipment and materials list was prepared and handed to the C.T.A. on May 7, 1987. A copy of this equipment and materials list is enclosed as Appendix II.

As a consequence of the situation which obtained the amount of practical calibration training which could be given was limited. The basic elements of instruments and industrial measuring and transmitting equipment calibration and related topics were presented. Codes for temperature measurement by liquid in glass thermometers, thermocouples, radiation pyrometry, industrial resistance thermometry and temperature/time indicators were presented along with general procedures for calibration methods. These general procedures will require tailoring into a final form to suit the calibration equipment purchased. Procedures for pressure gauge calibration using the dead weight pressure gauge tester and comparator gauges were prepared.

The plan to hold and maintain primary reference standards at the BEU laboraotry is, in the writers opinion, somewhat misguided. Primary standards are expensive to hold and maintain and unnecessary refinement to what is required for an industrial interface which this calibration laboratory will provide. With the exception of Weston Cell, which is recommended should be held in the facility, all other primary standards should be held and maintained at the established government laboratory of NSTC. As can be seen in Appendix I, the primary standards held at NSTC have traceability back to international standards. NSTC also have membership of the Asean Pacific Standards Programme. During the visit made to NSTC it was very evident that improvement in the control of the environmental conditions in the primary and secondary standards rooms is very necessary to meet international standards for these rooms. Nevertheless it is unnecessary to duplicate an expensive resource.

Secondary and working standards will adequately meet the requirements for the services being offered by the BEU laboratory.

The building extension providing the accomodation for the standards and calibration rooms has been designed and built with a low load bearing capacity suspended type flooring carried on light weight steel reverse angle brackets. As a consequence the floor will be subject to vibration which in turn will affect the reference standards and calibration accuracy.

A possible solution to this problem could be to transfer the standards and calibration rooms to the ground floor into the area planned for the engineers/administration office and this office into the upper floor area planned for the standards and calibration rooms. These transfers will provide a suitably stable floor for the standards and calibration rooms and also permit a more energy efficient solution to the air conditioning requirements for these rooms; there being a lower solar heat gain in that part of the ground floor area. Other relatively small modifications to the building will be necessary, such as filling in the existing windows in the ground floor area and providing windows for the upper floor area. The air conditioning and air cleaning equipment required for the present plans will be suitable to meet the requirements for the suggested transfers.

6.2 Fuels Testing Laboratory

Due to the limited progress which was possible in the calibration laboratory, time was available to develop test procedures for the fuel testing laboratory. Procedures have been prepared for all planned testing work and assembled in the form of a Laboratory Procedures Manual. This will also form part of the Laboratory Quality Assurance Manual. The index of laboratory test procedures of the Procedures Manual are enclosed as Appendix III.

The procedure marked with a cross (x) have been demonstrated and proven in actual application. The disruption in the laboratory caused by the recommencement of the building extension work and the non-availability of sample preparation equipment prevented the proving of all the procedures and completion of the Laboratory Procedures Manual.

Some training was given on the interpretation of coal analysis results and safety in the laboratory. There are several safety matters which require attention preferably before the fuels testing laboratory commences operation.

a) Procedures should be developed for dealing with emergencies.

b) Fire and smoke alarms should be installed.

c) Fire extinguishers and fire blankets should be provided.

d) A cyanide first aid kit and general first aid kits should be provided.

e) In view of the reagents and solvents which are to be used a hands, eye and body douche should be installed.

f) The laboratory effluent tank installed is a two chamber system very similar to a domestic septic tank. This is not adequate for the intended purpose because the risk of fuel oils entering the system is high, chemicals of a very high toxicity (for example potassium cyanide) will be used in the laboratory and the system discharges into a nearby water course. Details of an outline design for a suitable effluent tank was left with the Head of the Laboratory. A procedure for effluent sampling, analysis, testing and disposal should be prepared.

NOTE: Potassium cyanide is extremely toxic and targets on the nervous system of the body. Disposal of this effluent should take place after reacting for 24 hours with a large excess of strongly alkaline calcium hyperchlorite solution and then with a large excess of water.

6.3 Appliance Testing Facilities

6.3.1 Calorimeter Room for Room Air Conditioner Testing.

This facility and the associated equipment are in a very poor state and require refurbishing and upgrading. During a programme of refurbishing and upgrading it is recommended that -

a) Automatic control of the "outdoor" chamber environmental conditions be introduced.

b) A data logger be provided for the automatic recording of test data.

c) A conditions monitoring system be included to provide automatic shut down of the test facility in the event of a plant item failure or a dangerous occurence.

Also d) Instruments used on this facility must be calibrated, certified and labelled annually and made available for inspection by clients. Any instruments not in calibration must be labelled to readily identify them as unsuitable for use.

Test methods and procedures follow American National Standard for air conditioners and are to hand.

6.3.2 Test Room for Refrigerators and Freezers

Design work on this facility commenced on 25 May 1987 when the National Engineering Centre (NEC) commenced their programme of work.

Design details have been given to provide for a test room to be built of a modular construction. The modules can be prefabricated off site and from locally available materials. The design also provides for an easily extendable test room, if this is required in the future. The design capacity of the test room (six upright fridge/freezers or four chest type freezers) was determined from information supplied by the Association of Home Appliance Manufacturers (AHAM).

The range of the test room environmental condition parameters and the permissible control tolerances have been identified along with the necessary test data recordings and their periodicities. The test room will have a capability to test refrigerators or freezers to international standards. In the short to medium term the test room could also be used for the testing of other electrical appliances such as stoves, flat irons, fans and blowers, water heaters, etc. until the demand exceeds the room capacity.

Test methods and procedures will follow the American National Standards for refrigerators and freezers and are to hand.

6.3.3 Test Facilities for Lamps and Ballasts

At the time of preparing this report there was little progress on the design of these facilities. A BEU policy on the range of tests to be made on lamps and ballasts has been requested. It has been recommended that, because the Philippine National Standard No. 12 for lamps and ballasts is mandatory and there is no other laboratory equipped to undertake the testing of these items for certification, the complete range of tests and procedures set out in the PNS should be undertaken.

6.4 Laboratory Building and Services

6.4.1 Laboratory Building

It is to be regretted that the layout of the laboratory building has not provided for the various laboratory and test facility areas to be on the ground floor level. In discussion with the architect who designed the building it became clear that a more desirable layout could have been achieved for a similar capital cost as that for the present building. A recommendation has been made under item 6.1 of this report to overcome one of the problems. The roof leaks in several places and must be made watertight to protect the expensive instruments and equipment. When the corrective action has been taken on the electrical wiring, six inches of fibreglass insulation should be placed above the ceilings to minimise solar heat gain to the rooms and help reduce the air conditioning costs.

6.4.2 Electrical Installation

The electrical installation in the building is positively dangerous, a fire hazard and does not conform to the Philippine electrical installation regulations. Much of the wiring is not enclosed in conduit and there are many joints in the wiring which are not properly made, are crudely wrapped in insulation tape and not enclosed in covered boxes. The electric mains cables into the building have taped joints which are exposed, below ground level and subject to flooding during periods of rainfall.

The electrical socket outlets should be of the 3 pin industrial type providing an earthed (ground) connection and suitable for 13 amperes capacity. Also the cabling of a cross sectional area suitable for 13 ampere will reduce the short term voltage reduction when a piece of equipment is switched on and so minimise the consequential effects on other test equipment being used at the time. All socket outlets in the laboratories should be on a circuit supplied from the automatic voltage regulator already installed.

6.4.3 Windows

Some of the windows have never been able to close since the original installation. The frames should be replaced with a better quality frame which will provide a good seal when closed. Thermal shielding of the window glass should also be provided.

6.4.4 Services

a) The liquid petroleum gas cylinder connection to the gas distribution system is made by a flexible plastic tube. This tube material is subject to ultra violet degradation and must be replaced with a soft copper tube for safety.

b) All compressed gas cylinders should be on proper stands and secured with hold down brackets.

c) It is understood, from the electricity supply undertaking, Meralco, that the quality and reliability of the electricity supply will deteriorate further over the next 3 to 4 years. It follows that a standby electricity supply should be installed either from the existing diesel generator at the adjacent laboratories of the Philippines National Oil Corporation or from separately installed diesel generator to provide continuity and security of electricity supply to the standards and calibration rooms and also to the appliance test facilities.

d) The dry compressed air and vacuum systems are yet to be installed.

6.5 Laboratory Quality Assurance Manual

The documentation of quality assurance policy and procedures along with a description of the overall approach and philosophy to ensuring quality in the laboratories has been completed, in final draft from, to meet the requirements of PSA for accreditation purposes. The remaining sections of the manual to be completed relate to the organizational structure of the Ministry of Energy and the associated divisions and sections (undergoing change at present), the preparation of job descriptions for laboratory senior staff members and definitions of, and directives to, laboratory staff, setting out their responsibilities in technical and quality operations. Also, statements on general administration/management procedures controlling access to laboratory and testing areas, need to be prepared.

7. Recommendations

7.1 Training

a) As evidenced by the state of the portable instruments sent to the laboratory for repair and calibration, the BEU engineers engaged on energy audit and survey projects require refresher training on the handling and care of portable instruments.

b) The engineers engaged for calibration work require training and exposure to general instrument repair and digital instrument servicing, fault finding and the associated techniques of handling measuring instruments.

c) Technical personnel should participate in international seminars and conferences on standards and laboratory measurement techniques to keep up to date on methods and developments.

d) When the laboratory has achieved accreditation in Philippines it should participate in the Inter Laboratory Correlation Programme to gain confidence and credibility in the testing work and also to establish important contacts with other laboratories doing similar work.

e) When the laboratory has achieved accreditation in the Philippines, institutional membership of, and recognition by, international professional bodies should be established.

f) A working relationship should be established and maintained with other similar internationally known test and calibration institutions throughout the world.

g) For the first few years (3 years) of initial operation of the laboratory, the quality audit for conformance should be carried out under the supervision of an impartial expert.

h) Engineers attending courses or conferences should properly record and document their experience for the benefit of other BEU engineers.

7.2 General

a) The suppliers of the instruments and equipment for the energy audits and survey teams and the laboratory should be contacted and the manufacturers information on servicing, circuitry and calibration obtained.

b) The necessary calibration and sample preparation equipment and materials listed in Appendix II should be supplied.

c) The unsuitable equipment supplied should be replaced with equipment suitable for the intended use.

d) Monitor closely the training and other services to be provided by NEC to ensure the laboratory and staff are getting what is required.

e) Refurbish and upgrade the calorimeter room for room air conditioner testing.

7.3 Infrastructural Facilities

a) Interchange the use of the present accommodation planned for the standards and calibrations room with that planned for the engineers/administration office. Item 6.1 of the report refers.

b) Revise present plans to hold and maintain primary reference standards to holding and maintenance of secondary standards for calibration purposes.

c) Establish and maintain good communications coordination and a working relationship with NSTC and other national institutions.

d) Upgrade the NSTC primary and secondary reference standards rooms to acceptable international standards.

e) Upgrade the electrical installation in the laboratory at least to meet the Philippine electrical installation regulations.

f) Install a standby diesel generator to guarantee electricity supply to standards and test rooms.

g) All electrical socket outlets should be of the industrial 3 pin type providing an earthing (ground) connection and wired with cabling of a cross sectional area suitable for 13 amperes.

h) Replace existing window frames with units capable of providing a good seal and provide thermal shielding to glazing.

i) All compressed gas cylinders should be on prop stands equipped with hold down brackets.

j) Replace plastic tube on LPG cylinder connection with a soft copper pipe.

k) Install a dry compressed air and vacuum systems.

l) Develop procedures for dealing with emergencies.

m) Install fire and smoke alarms.

n) Provide fire extinguishers and fire blankets.

o) Provide cyanide and general first aid kits.

p) Install a hands, eye and body douche in the fuels testing laboratory.

q) Install a more suitable and safe laboratory effluent tank and develop procedures for control of effluent discharge.

r) Make the laboratory building roof water tight.

s) Insulate the upper floor ceiling with 6 inches of glass fibre insulation to minimize solar gain and air conditioning costs.

7.4 Future

a) The laboratories will require further assistance to become fully operational. When this has been achieved it should be planned that the laboratory becomes self financing to a point of at least break even, meeting costs from testing and calibration fees.

b) The energy audit and survey teams can be a good source of publicity for the laboratory facilities and make the services offered known to industry during visits and in seminar presentations.

c) It is unfortunate that the energy audit and survey teams are based some distance from the laboratories. Efforts will be necessary to establish good communications and working relationships.

d) In the future a measure of success in operation and staff efficiency should be monitored.

d.1 "Yardsticks" for success in operation cover four main aspects -

i) Do industry, commerce and government agencies use the testing and calibration facilities

ii) Do fees charged cover the costs of operation

iii) Do clients pay the fees willingly

iv) What have been the achievements and economic impact.

NOTE: Heavy financial support usually indicates poor efficiency.

d.2) "Yardsticks" for staff efficiency - usually cover four aspects and are based on a percentage of total staff time available.

i) percentage of man hours paid for by clients.

ii) percentage of man hours paid for on projects supported by Government or Government agencies.

iii) percentage of man hours on in-house projects

iv) percentage of non-productive man hours - sick leave, administration, leave, idling, etc.

8. Conclusions

These conclusions are based on the findings during the time spent at the laboratory. No appraisal was made of the future work load potential or sources of work.

1. It is quite apparent that good advice on the type and layout of a suitable laboratory building was either not sought or followed.

2. In the selection of some of the instruments and equipment for the fuels testing laboratory, uninformed selection was made in three cases and in two cases the equipment was not checked on receipt for conformance to specification.

3. The services of the expert were called upon too early for the training and procedure preparation elements for the calibration laboratory programme. The necessary equipment and instrument manufactures information was not available.

4. The three areas of the laboratory are developing well, but slowly with staff who are keen to make the operation a success. There is much attention to detail required to improve the status to be ready for a successful and credible operation.

5. The laboratory training and assistance programme contracted with National Engineering Centre is quite protracted and needs to be accelerated and monitored closely.

6. The next major step is to gain accreditation from the Product Standards Agency in order to establish credibility in the Philippines.

7. The laboratory asset has been under utilized for far too long and it is most important that it is put into service as quickly as possible to achieve the benefits.

8. The co-operation from the laboratory full time and contract staff was excellent and I wish to record may thanks to them and also to BEU and UNIDO for giving me the opportunity to be of assistance in this project.

APPENDIX I

NATIONAL STANDARDS AND TESTING CENTRE (NSTC)
STANDARDS & MEASURING INSTRUMENTS

1. PRIMARY STANDARDS

PARAMETER	STANDARD	NOMINAL VALUE	UNCERTAINTY ±	TRACEABILITY	YEAR OF LAST INTERNATIONAL CALIBRATION
MASS	1 kg stainless steel	1 kg	Ø.3 mg	Calibration at NML, Australia	1985
	set of weights 31 pcs.	1 mg-2Ø kg	Equivalent to OIML Class E2	Calibration at NRLM, Japan	1983
LENGTH	1 m line standard Nickel steel	1 m	Ø.3 um	Calibration at NRLM, Japan	1976
	set of gauge blocks	Ø.5 mm-1ØØ mm	Ø.Ø5 um to .1Ø um	Calibration at NML, Australia	1985
DENSITY	Silicon density standards	2.329Ø74 g/cm^3	Ø.ØØØØ19 g/cm^3	NBS standard reference materials	1982
VOLUME	Derived from mass & density standard	-	$1 \times 1Ø^{-4}$	Mass standard & density standard	-
FORCE	Deadweights	up to 4 tonf	$2 \times 1Ø^{-5}$ (1 g/5Ø kg)	Mass standard & gravitational acceleration	-
	Proving ring	9Ø tonf	Ø.Ø3 - Ø.25 tonf	Calibration at NML, Australia	1985

PRIMARY STANDARDS

PARAMETER	STANDARD	NOMINAL VALUE	UNCERTAINTY ±	TRACEABILITY	YEAR OF LAST INTERNATIONAL CALIBRATION
PRESSURE	Deadweights-Piston gage	up to 200 kgf/cm^2	0.1%	Mass & Length Standards & gravitational acceleration	-
	U-tube Mercury manometer	up to 760 mm Hg	0.1 mm Hg	-	-
DC VOLTAGE	Saturated Standard Cells in Oven Elmeasco 700A-04	1 V	0.4 ppm	Calibration at NML, Australia	1984
DC RESISTANCE	Thomas Type Standard Resistor, L&N 4210	1 Ohm	0.2 ppm	Calibration at NML, Australia	1985
AC-DC TRANSFER	Thermoelectric Comparator Fluke 540B	1:1 transfer, 0.5 to 1000 V	0.005% - 0.05%	Factory Calibration	1985
FREQUENCY	Time Base of Counter HP 5345A with high stability option	10 MHz (Time Base)	Aging rate: 3×10^{-9} per month 3×10^{-7} for 1 sec	VLF Comparison with NWC Transmission, Australia	Continuous
TEMPERATURE	Freezing Point of Water	0°C	IPTS 1968 Definition		
	Freezing Point of Tin	231.9681°C			
	Freezing Point of Zinc	419.58°C			

11. SECONDARY STANDARDS & COMPARATORS

PARAMETERS	EQUIPMENT	RANGE	UNCERTAINTY ±
MASS	Precision balances	Ø-2Ø g	(Ø.ØØ1 mg least reading)
		Ø-1ØØ g	(Ø.Ø1 mg least reading)
		Ø-3ØØØ g	(Ø.1 mg least reading)
		Ø-5Ø kg	(5Ø mg sensitivity)
		Ø-1ØØ kg	(2ØØ mg sensitivity)
LENGTH	Line comparator	Ø-1ØØØ mm	Ø.ØØ3 mm
	Gage block comparator	Ø-25Ø mm	Ø.Ø3 µm
	Universal Measuring Machine	Ø-5ØØ mm	1 um + 1Øppm of reading
	Electronic gaging micrometer	Ø-1.5 mm	Ø.3 µm
VOLUME	Proving tanks	up to 5ØØ L	Ø.Ø5%
FORCE	Universal Testing Machine	Ø-5Ø tonf	Ø.1%
HARDNESS	Vickers, Rockwell and Brinell measuring machines		
DC VOLTAGE	DC STANDARDS FACILITY:		
	a. Kelvin-Varley Voltage Divider Fluke 720A	Ø-1ØØØV	5 to 1Ø ppm
	b. Reference Voltage Divider Fluke 750A		
	c. Null Detector Fluke 845 AR	Ø-1, (1.1)	Ø.1 ppm linearity
	d. DC Voltage Source HP 740B		
	K-6 Potentiometer Facility L & N 7556-A32	Ø-16 mV-1.6V	Ø.ØØ25% to Ø.ØØØ5%

Appendix I
(continued)

SECONDARY STANDARDS & COMPARATORS

PARAMETER	EQUIPMENT	RANGE	UNCERTAINTY ±
AC VOLTAGE	AC Calibrator HP 745A	Ø-1 mV - 1ØØV	Ø.Ø2%
	AC/DC Meter Calibrator HP 692ØB	Ø-1Ø mV - 1ØØØV	Ø.2%
AC CURRENT	AC/DC Meter Calibrator HP 692ØB	Ø-1Ø µA - 1ØA	Ø.4%
RESISTANCE	L & N Reichsansalt & NBS Type Standard Resistors	Ø.ØØ1 ohm to 1 M ohm	Ø.ØØ1% - Ø.ØØ2%
	Six-Dial Wheatstone Bridge Facility L & N 4232-A31-B	Ø.1 ohm min. to 11 Gohm max.	Ø.ØØ5% to 2%
	Seven-Dial Double Ratio Set Facility L&N 4398-M-A-31	1:11 to 11:1 Ø.1 m ohm to 1ØØ k ohms	Ø.2 ppm
FREQUENCY	UNIVERSAL COUNTER HP 5345A + Automatic Frequency Converter HP 5354A	0-4 GHz	Time base stability $<3\times10^{-7}$ per month
	VLF/LF Receiver/Comparator Tracor 9ØØA Carrier: 9.9 kHz - 25.6 kHz 59.9 kHz - 75.6 kHz	1 MHz, 1Ø MHz	$1 \times 1Ø^{-11}$ typical for one day period
	Frequency Difference Meter Tracor 527 E	1ØØ kHz, 1 MHz, 2.5 MHz, 5 MHz	$1 \times 1Ø^{-11}$

SECONDARY STANDARDS & COMPARATORS

PARAMETERS	EQUIPMENT	RANGE	UNCERTAINTY ±
TEMPERATURE	Industrial Platinum Resistance Thermometer Shinadzu, SRB	Ø-63Ø°C	(CAlibrated with Freezing Point IPTS 1968)
	Type S Thermocouple	Ø-1ØØØ°C	1 µV + Ø.Ø7% Emf
	Type R Thermocouple	Ø-1ØØØ°C	1 µv
	Standard Mercury-in-glass Thermometers YAMATO Scientific Co, Inc. 56-1 H-3	Ø-3ØØ°C	Ø.1°C
	Digital Thermometer YEW 2572	CA Thermocouple -2ØØ to 137Ø°C	Ø.Ø5% + Ø.3°C
		PR Thermocouple Ø to 1ØØØ°C	
	mV Potentiometer L & N 8686	1Ø.1 mV-1ØØ.1 mV	Ø.Ø3%

APPENDIX II

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
1	DIGITAL PNEUMATIC-ELECTRONIC INSTRUMENT CALIBRATOR	1 Unit	-capable of both pneumatic and electronic calibration -fully digital display for pressure, mV, mA. -finely adjustable signals -DC voltage signal to transmitters -guaranteed 0.05% accuracy -220 vac/60 Hz power supply -complete with English manual -complete with servicing, circuitry and calibration information in English	Penwalt Corporation Wallace & Tierman Division 25 Main St., Belleville, NJ 07109 Model series 65-125

Appendix II

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
2	ICE POINT REFERENCE CELL	1 Unit	-constant 0 degree C reference temperature -+/- 0.025 degree C guaranteed temp. stability -0.05 degree C maximum instrument error -220 VAC/60 Hz power supply	FLUKE (DUETSCHLAND) GmBH Viertriebsurd - Dusseldorf Meineckestrasse 53, D-4000 Dusseldorf 30, West Germany Telex (841) 08585576 KAYE INSTRUMENTS, INC. Industrieregleg GmBH Postfach 82, Zieglergasse G 1072 Wein, Austria WAHL INSTRUMENTS INC. 5750 Hannum Avenue Culver City, CA 90231 USA Telex 66-4406 (Wahl Corp. LSA)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
3	PRECISION PRESSURE/ VACUUM GAGES Ranges: 0-50 psi 0-600 psi 0-200 in. WG 0-1080 mbar	 1 Unit 1 Unit 1 Unit 1 Unit	- 1/2" NPT - 6-8 inches dial - 0.05% FS accuracy - Laboratory calibration grade - certified - Complete with English maintenance manual	WIKA INSTRUMENT CORP. One Corporate Drive P.O. Box 11247 Hauppauge, NY 11788 DRESSER EUROPE SA Baesweiler Branch P.O.Box 1120 D-5112 Baesweiler WEST GERMANY 011-49-2401-4071

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
4	THERMOCOUPLE WIRES			
	1. Pt-pt-Rh Thermocouple assembly complete	2 each with ceramic protective sheath	- 18 inches length - 3/16 inch. O.D. - Pigtail leads - with 28 AWG compensating cable (20 meters) - special type	WAHL INSTRUMENTS, INC. 5750 Hannum Ave. Culver City, Ca. 90231 Telex 66-4406 (WahlCorp USA)
	2. TYPE T Cu-Cu-Ni thermocouple wire (-150 C to 350 C)	28 AWG - Two 100 ft roll 26 AWG - Two-100 ft roll	- Solid wire - duplex type - conform to ANSI, ISO, DIN, JIS Standards - Insulated Wire	KAYE INSTRUMENTS, INC. Industrieregler mBH Postfach 82, Zeiglergasse 6 1072 Wein, AUSTRIA
	3. TYPE J Fe-Cu-Ni thermocouple wire (-100 C to 890 C)	28 AWG - Two 100 ft roll 26 AWG - Two 100 ft roll	- Solid wire - duplex type - conform to ANSI, ISO, DIN, JIS Standards - Insulated Wire	OMEGA ENGINEERING INC. 1 Omega Drive P. O. Box 4047 Stanford, CT 06907 DELCO WIRE & CABLE CO. 257 Rittenhouse Circle Bristol, PA 19007 Telex 843-338

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
5	PRESSURE REDUCING VALVES	3 Units	- precision grade - size 1/2 NPT - capable to withstand up to 600 psi	BELLOFRAM, REXNORD COMPANY 30 Blanchard Rd., Burlington, MA 01803 INFRAMAT PROZESSLEIT & PREGESYSTEME Gesellschaft GmBH Turkenshazgasse 51 A-3400 Klosternneuburg Austria Telex 111059

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
6	DIGITAL TEMPERATURE INDICATOR WITH SWITCH BANK	1 Unit	-minimum of 20 points self indicating push button switches -with internal switching capability -self-indicating push button switches -0.1 degree C calibrated accuracy -gold plated switch contacts -4 decade LED display -4 readings update rate -0.1 degree C repeatability -flush mounted -220 VAC, 60 Hz supply voltage -accepts thermocouple signals, type T, J, K	TRANSMATION, INC. 977 Mt. Read Blvd. P.O. Box 7803, Rochester, NY 14606 Telex 97-8314 WAHL INSTRUMENTS, INC. 5750 Hannum Avenue Culver City, CA 90231 USA Telex 66-4406 (WahlCORP LSA)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
7	TEMPERATURE BATH	1 Unit	- for calibrating thermocouple and RTD - may use two heating medium (high temperature oil and glycol for low temperature) - -50 degrees C to 500 degrees C - 0.1 temperature stability - minimum of four wells - to include heating medium - 220 VAC, 60 hz power supply	WAHL INSTRUMENTS INC. 5750 Hannum ave. Culver City, CA 90231 Telex 66-4406 (WAHLCORP LSA) TECHNE, INC. 3700 Brunswick Pike Princeton, NJ 08540 Telex (609) 452-9275

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
8	BLACK BODY TEMPERATURE SOURCE	1 Unit	- for calibrating infrared thermometers - 200 to 1100 degrees C range - Automatic temperature control - +or- 2 degrees C temperature stability - 0.995 +or- 0.005 emissivity - temperature sensors traceable to NBS certified - complete with English manual - 220VAC, 60 hz power supply - complete with English maintenance manual	WAHL INSTRUMENTS, INC. 5750 Hannum ave. Culver City, CA 90231 Telex 66-4406 (Wahlcorp LSA)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
9	QUICK CONNECT FITTINGS	30 sets male and female	- for air operated industrial instruments - plug-in with shut off valve - accept male connector body for (polythylene) plastic tubing 1/4 in. O.D. - complete with KN tube fittings male connector body *Brass Knurled nut for 1/4 in. O.D. tube cat. B-402-1K *Brass front ferrule for 1/4 in. O.D. tube cat. B-403-1 *Complete with brass Kn tube fitting male connector body	CROWFORD FITTING CO. 29500 Solon Road Solon, Ohio 44139 VAUST VENTILE & FITTINGS GmBH Industriestrasse 816, A 2345 Brunn Am Gebirge, Austria Telex 847-79128 MANILA VALVE FITTINGS & CO. Room 302 Celta Building Casino St., Corner South Expressway Makati, Metro Manila Philippines

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
10	FLEXIBLE PLASTIC TUBING	100 meters	- ¼ inch O.D. - used for industrial instrument air supply like pneumatic controllers, I/P transducers, pneumatic transducers, etc.	NORTON PAMPUS GmBH Postfact 80, D-4 56 Willich 3 West Germany Telex 853 1924 TFED THERMON MFG. COMPANY Premaberg Industrainlagen Gessellschaft mBH Porszellangasse 19 A-1090 Vienna, Austria UNITECH ENGINEERING CORP. 605 Shaw Blvd., Mandaluyong Metro Manila Philippines

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
11	VERNIER MANOMETER	1 Unit	- 0 to 1080 mbar - certified to international standards	WIKA INSTRUMENT CORP. One Corporate Drive P.O. Box 11247 Hauppauge, NY 11788 DRESSER EUROPE SA Baesweiler Branch P.O.Box 1120 D-5112 Baesweiler West Germany 011-49-2401-4071

Appendix II (continued)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
12	WESTON CELL	2 Units	- unsaturated - 0.05% temperature coefficient/ degree C or better - certified to international standard	BURSTER Talstra Be 1-7, D-7562 Gernsbach, Germany

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
13	DEADWEIGHT TESTER & COMPARATOR	1 Unit	-0-1000 psi range -0.1 psi resolution -oil operated -include seal accessory for testing oxygen gauges -complete with English maintenance manual -complete with hydraulic oil to fill the oil reservoir plus 1 litre for spare	DRESSER EUROPE SA Baesweiler Branch P.O. Box 1120 D-5112 Baesweiler West Germany 011-49-2401-4071

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
14	IGNITION WIRE	500 centimeters	- for use with bomb calorimeter - No. 34B & S gage iron wire or Chromel C resistance wire - as per ASTM standard	FISHER SCIENTIFIC 52 Fadem Road Springfield, NJ 07081 (201) 379-1400

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
15	STANDARD REFERENCE COAL SAMPLES	One kg.	- standardized samples especially for calibration and representing grindability indexes of approximately 40, 60, 80, and 110 - to include certificate	NATIONAL BUREAU OF STANDARDS Route 1-270 Quince Orchard R Gathersburg, Maryland U.S.A.

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
16	VISCOMETER THERMOSTAT AND BATH	1 Unit	- kinematic viscosity bath - accomodates six suspended level viscometers - uniform to + or - 0.015 degree F - range 68 to 300 degrees F - for ASTM D 445 - 1/30 hp stirring motor - cover supports viscometers and heating coils - bath jar illuminated - with 2 in holes in lid/cover - 220 V, 60 Hz - complete with English manual	FISHER SCIENTIFIC Cleveland Building A 3355 Richmond Road Beachwood, OH 44122 (216) 292-7900

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
17	VISCOMETER HOLDERS	6 pieces	- suspends Ubbelhode viscometers in constant temperature bath with 2 in. hole in lid - with handle for lifting viscometer	FISHER SCIENTIFIC 113 Hartwell Avenue Lexington, MA 02173, USA Tel. (617) 861-0710 Telex: 92-3440 (200159, via RCA)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
18	VISCOMETER HOLDERS	6 pieces	- suspends Cannon-Fenske opaque type viscometers in bath with 2 in. hole in lid - with handle for lifting viscometers	WACO 94235-25 Wilkens-Anderson Co. 4525 W. Division St., Chicago, Illinois 60651 Tel. 384-4433 (In area code 312)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
19	UBBELOHDE VISCOMETERS ASTM size: 2C 2B 3B	 6 pcs. 6 pcs. 6 pcs.	- for transparent fluids - made of borosilicate glass - as per ASTM standard - to include certificate	FISHER SCIENTIFIC 113 Hartwell Avenue Lexington, MA 02173 USA Tel. (617) 861-0710 Telex: 92-3440 (200159, via RCA)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
20	CANNON-FENSKE VISCOMETERS		- opaque type	FISHER SCIENTIFIC 113 Hartwell Avenue Lexington, MA 02173, USA Tel. (617) 861-0710 Telex: 92-3440 (200159, via RCA)
			- made of borosilicate glass	
	ASTM size:			
	300	6 pcs.	- as per ASTM standard	
	350	6 pcs.		
	400	6 pcs.	- to include certificate	
				WACO Wilkens-Anderson Co. 4525 W. Division St., Chicago, Illinois 6051 Tel. 384-4433 (In are Code 312)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
21	ICE CRUSHER	1 Unit	- electricity operated - adjustable fragment size (flakes and nuggets) - portable - with container wherein crushed ice is deposited - 220V, 60 Hz, power supply	FISHER SCIENTIFIC 113 Hartwell Avenue Lexington, MA 02173 USA Tel. (617) 861-0710 Telex: 92-3440 (200159, via RCA)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
22	HARDGROVE GRINDABILITY MACHINE	1 Unit	- as specified in ASTM D409-71 - used to determine grindability of coal - equipped with a counter and an automatic device for stopping the machine after 60 + or -0.25 revs. - complete with English manual - 220V AC, 60 Hz power supply	WALLACE-FISHER INSTRUMENT CO. P.O. Box 451, Swansea, MA 02777 Tel. (617-673-4744)

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
23	SPRAY PATTERNATOR	1 Unit	- for investigations into oil burner atomising and sprayer patterns	LAIDLAW DREW LTD. Lighthill Industrial Estate Edinborough, Scotland

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
24	VISCOSITY STANDARDS		- for use in the calibration of Brookfield Viscometers Model LVTD - CP (Cone #42) and Model LVTD with thermosel system (spindle number 18, 31, 34)	BROOKFIELD ENGINEERING LABORATORIES, INC. 240 Cushing Street, Stoughton Massachusetts 02072 USA
	Viscosity Range:			
	10-2000 mPas	1 ltr		
	5-200,000 mPas	1 ltr		
			- certified at standard temperature	
			- to include certificate	

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
25	FURNACE/ASH FUSIBILITY DETERMINATOR	1 Unit	- for temperature range up to 1700 degrees C - automatically and electronically determines deformations of an ash cone - accurate to + or - 5 degrees C - heating rate of 1 degree C per minute to 100 degrees C per min - digital temperature display - oxidizing or reducing atmosphere may be selected before analysis - 3.5 KVA, 220V, /60 Hz - complete with English manual	LECO CORP. St. Joseph, Michigan, U.S.A.

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
26	COPPER CORROSION TEST APPARATUS	1 set	to include: 1. copper strip corrosion test bomb as per ASTM D-130 specifications 2. copper strips 3. silicon carbide grit paper 4. ASTM copper strip corrosion standards - certified	JEPPE TECHNICAL PHILS. 203 Fedman Suites Salcedo St. Makati, Metro-Manila

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
27	ASTM VISCOSITY OIL STANDARDS	1 pint each	ASTM S-200 with ASTM ASTM S-600 certificate ASTM S-2000	CANNON INSTRUMENT COMPANY P.O. Box 16, State College PA 16801

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
28	CRUSHERS OR GRINDER	1 Unit	- reduces sample to pass sieve numbers 4,8,20,60 (4.75 mm., 236 mm, 850 micro meters, 250 micro meters) - quiet, vibration free operation - portable unit - 220 V, /60 Hz	TECATOR POWDERTEC SAMPLE MILL FISHER SCIENTIFIC 50 Fadem Road Springfield, NJ 07081 Phone: (201) 379-1400 Cable Address: Fishersci, Springfield, NJ Telex No.: 4754246 or 138287

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
29	RIFFLE	1 Unit	- used as sample divider - splits coal stream into alternate elements - enclosed - slope of riffle must be at least 60 degrees - stainless steel	DRAWER RIFFLE SAMPLER FISHER SCIENTIFIC 52 Fadem Road Springfield, NJ 07081 (201) 379-1400

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
30	SET OF SIEVES	1 set	- dimensions should be in accordance with ASTM Specification E-11 of the following sizes: Number Size 4 4.75 mm 04-881-B 8 2.36 mm 04-881-F 20 850 microm 04-881-M 60 250 microm 04-881-U - to include certificate	FISHER SCIENTIFIC 52 Fadem Road Springfield, NJ 07081 (201) 379-1400

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
31	THERMOCOUPLE FUSION DEVICE	1 Unit	- 220 VAC, 60 Hz power supply - capable of fusing thermocouples up to gauge 14 AWG	OMEGA ENGINEERING, INC. 1 Omega Drive P.O. Box 4047 Standford, CT 06907

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
32	PID INDICATING CONTROLLER	2 Units	- dual output - accomodates thermocouple, RTD, mVdc, Vdc or mAdc - capabilities to include automatic tuning - automatic thermocouple and RTD linearization - digital displays, deviation bar graph and status display - IBM compatible (preferably IMB PC)	TAYLOR INSTRUMENT Combustion Engineering, Inc. Rochester NY FENWAL, INC. 400 Main Street Ashland 01721 RESEARCH, INC. Control Systems Box 24064 Minneapolis, MN 55424 USA Telex 29-05-02

Appendix II (continued)

ITEM NO.	ITEM	NO. REQUIRED	SPECIFICATIONS	RECOMMENDED SUPPLIER
33	2 IN MOTORIZED CONTROL VALVES	2 Units	- Control Supply 0 to 5 volts 4 to 20 mA - Motor Power 220 Volts 60 Hz	LOCAL PURCHASE PREFERRED

Appendix II (continued)

APPENDIX III

INDEX OF LABORATORY TEST PROCEDURES

1. Petroleum-Based Products

Procedure No FTL	Test	Test Method and/or Operating Reference	Scope
X 1.1	API Gravity, Density, Relative Density	Hydrometer Method ASTM D 1298-80	Applicable for crude petroleum, petroleum products or mixtures of petroleum and nonpetroleum products normally handled as liquids, and having a Reid vapor pressure (. . D 323) of 26 lb or less. Values are measured on a hydrometer at convinient temperatures, readings of density being reduced to 15°C, and readings of relative density (sp gravity) and API gravity to 60°F, by means of international standard tables.
1.2	Ash	ASTM D 482-80 Operating Manual For Muffle Furnace	Covers the determination of ash from distillate and residual fuels, gas turbine fuels, crudicals, lubricating oils, waxes, and other petroleum products, in which any ash-forming material present are normally considered to be undesirable impurities or contaminants. The method is limited to petroleum products which are free from added ash-forming additives, including certain phosphorous compounds.
1.3	Ash, Sulfated	ASTM D 874-82 Operating Manual For Muffle Furnace	Covers the determination of the sulfated ash from unused lubricating oils containing additives and from additive concentrates used in compounding. (usually contain one or more of the following metals: Ba, Ca, Mg, Zn, K, Na, Sn) The elements sulfur, phosphorous, and chlorine may also be present in combined form.

1.4	Conradson Carbon Residue	ASTM D189-81	Covers the determination of the amount of carbon residue left after evaporation and pyrolysis of an oil, and intended to provide some indication of relative coke-forming propensities. The method is generally applicable to relatively nonvolatile petroleum products which partially decompose on distillation at atmospheric pressure.
1.5	Distillation of Petroleum Products	ASTM D 86-82 Operating Manual For Front View Distillation Apparatus	Covers the distillation of motor gasolines, aviation gasolines, special boiling point spirits, napthas, white spirit, kerosines, gas oils
1.6	Elemental Analysis	Perkin Elmer Elemental Analyzer Manual	Covers the determination of Carbon, Hydrogen, Nitrogen, and Oxygen content of liquid fuels
X 1.7	Flash Point	ASTM D 93-80	These methods cover the determination of the flash point by Pensky-Martens closed-cup tester of fuel oils, lube oils, suspensions of solids, liquids that tend to form a surface film under test conditions, and other liquids.
X 1.8	Flocculation Behaviour of Residues	(Source: Technical Division - BEU	applicable for residual fuel.
X 1.9	Heat of Combustion	Bomb Method ASTM D 240 Operating Manual for Calorimeter	ASTM 240 covers the procedures for determining heat of combustion of a variety of substances but particularly to liquid hydrocarbon fuels of both low and high volatility.
1.10	Insolubles in Used Lubricating Oils	ASTM D 893-80 Operating Manual for Centrifuge	Procedure A covers the determination of insolubles without the use of coagulant in the pentane. It provides an indication of the materials than can readily be separated from the oil-solvent mixtures by centrifuging.

Appendix III (continued)

			Procedure B covers the determination of insolubles in oils containing detergents and employs a coagulant for both the pentane and toluene insolubles. In addition to the materials separated by Procedure A, Procedure B separates some finely divided materials that may be suspended in the oil.
1.11	Neutralization Number	Potentiometric Titration ASTM D 664-81	This method covers procedures for the determination of acidic or basic constituents in petroleum products and lubricants. The method resolves these constituents into groups having weak-acids, strong acid, weak base, and strong base ionization properties, provided the dissociation constants of the more strongly acidic or basic compounds are at least 1000 times that of the next weaker groups.
1.12	Neutralization Number	Color Indicator Titration ASTM D 974-80	This method covers the determination of acidic or basic constituents in petroleum products and lubricants soluble or nearly soluble in mixtures of toluene. It is applicable for the determination of acids or bases whose dissociation constants in water are larger than 10^{-9} extremely weak acids or bases whose dissociation constants are smaller than 10^{-9} do not interfere. Salts react if their hydrolysis constants are larger than 10^{-9}. This method may be used to indicate relative charges that occur in an oil during use under oxidizing conditions. Although the titration is made under definite equilibrium conditions, the method does not measure an absolute acidic or basic property that can be used to predict performance of an oil under service conditions. No general relationship between bearing corrosion and acid or base number is known.

Appendix III (continued)

X 1.13	Pour Point	ASTM D 97 (Reapproved 1978)	This test is intended for use on any petroleum oil.
1.9 (Section 5.4)	Sulfur	General Bomb Method ASTM D 129-64 (Reapproved 1978)	Applicable for liquid hydrocarbon fuels.
1.14	Sulfur	-do-	Covers the determination of sulfur in petroleum products, including lubricating oils containing additives, additive concentrates, and lubricating greases, that cannot be burned completely in a wick lamp. The method is applicable to any petroleum product sufficiently low in volatility that it can be weighed accurately in an open sample boat and containing at least 0.1% sulfur.
1.15	Total Base Number	Potentiometric Perchloric Acid Titration ASTM D 2896-80	This method covers the determination of basic constituents in petroleum products by titration with perchloric acid in glacial acetic acid. For many materials the results obtained by this method D 664. With certain compounds such as strongly overbased oil additives and nitrogenous polymeric compounds, higher results may be obtained. The constituents may be considered to have basic characteristics include organic and inorganic bases, amino compounds, salts of weak acids (soaps) basic salts of poluacidic bases, and salts of heavy metals. This method is applicable to both fresh oils and used oils with total base numbers range of: Fresh oils - 5.5 - 13.5

Appendix III (continued)

				Application of this method to sulfated ash levels below 0.02% is restricted to oils containing ashless additives. The lower limit of the method is 0.005% sulfated ash. This method is not intended for the analysis used engine oils or oils containing lead. Neither is it recommended for the analysis of non-additive lubricating oils.
X	1.16	Viscosity, Saybolt Universal	ASTM D 88 (obsolete) Saybolt Viscometer Operating Manual	Covers the determination of the viscosity of lubricants and distillated materials with efflux times between 32 and 1000 seconds (using a Universal Orifice). Conversion to kinematic viscosity at 100°F and 210°F, see Table 1 and 2, ASTM D 2161 pp. 204-220.
X	1.17	Viscosity, Absolute	Brookfield Viscometer Operating Manual	Covers the determination of absolute viscosity (in centipoise) of fluids in small sample volumes (.5-1 mL). Viscosity range using Cone #CP-42 at speeds 0.5-100 rpm;6080 cps and above.
	1.18	Viscosity, Kinematic	ASTM D 445-83	Covers the determination of the kinematic viscosity of liquid petroleum products by measuring the time for a volume of liquid to flow under gravity through a calibrated glass capillary viscometer.
X	1.19	Water	Distillation Method ASTM D 95-83	Covers the determination of water in petroleum products, tars, and other bituminous materials.
	1.20	Water and Sediments	Centrifuge Method ASTM D 1796-83	Covers the laboratory test for the determination of water and sediments in fuel oils.

Appendix III (continued)

2. Non-Petroleum Based Fuels

Procedure No. FTL	TEST	Test Method and/or Operating Reference	SCOPE
2.1	Chlorine	Oxygen Bomb Method and Eschka Method Potentiometric and Volhard Titration ASTM D 2361-83 (Coal and Coke) Operating manual for JP calorimeter and Muffle furnace	Covers the determination of the total chlorine content of coal(Note: It is useful in the evaluation of slagging problems, corrosion in engineering processes and in the total analysis of coal and coke).
2.2	Elemental Analysis	Perkin Elmer Elemental Analyzer manual	Determination of the Carbon, Hydrogen, Nitrogen, Sulfur, Oxygen content of coal and coke.
2.3	Gross Calorific Value	Bomb Method ASTM D 2015	Covers the determination of the gross calorific value of solid fuel by the adiabatic bomb calorimeter.
2.4	Proximate Analysis	Perkin Elmer Coal Analyzer Manual	Covers the determination of moisture, volatile matter, fixed carbon, ash of coal and coke
2.5	Sulfur, Total	ASTM D 3177-84 JP Calorimeter manual Eschka Method Bomb Washing Method	Cover two alternative procedures for the determination of coal and coke.

Appendix III (continued)

3. Boiler Feedwater

Procedure No FTL	Test	Test Method and/or Operating Reference	Scope
3.1	Acidity	Titration Method Spectrophotometer Manual	Applicable for determining the phenolpthalein in water, wastewater, and sea water samples.
3.2	Alkalinity	-do-	Applicable for determining the alkalinity (P or T) in water, wastewater, and sea water samples. The P alkalinity is determined by titration to a pH of 8.3 (the phenolpthalein end point) and registers the total hydroxide and one half the carbonate present. The T alkalinity includes all carbonate, bicarbonate and hydroxide alkalinity (determined by titration to a pH of 5.1, 4.8, 4.5 or 3.7 depending on the type of sample).
3.3	Acidity or Alkalinity	Electrometric Titration ASTM D 1067-82	Covers the determination of acidity or alkalinity of all types of water.
3.4	Chlorides	Silver Nitrate Titration ASTM D 512-81	Covers the determination of chloride ion in water, wastewater and brines.
3.5	Chlorine, Free	DPD Method Spectrophotometer Manual	Applicable for determining free chlorine (hypochlorous acid and/or hypochlorite ion) in drinking water, wastewater and sea water. Range: 0-1.70 mg/L.
X 3.6	Chlorine, Total	DPD Method Spectrophotometer Manual	Applicable for water samples containing combine chlorine (monochloramine, dichloramine, nitrogen trichloride and other chloro derivatives) and free chlorine within the range of 0-1.70 mg/L.

Appendix III (continued)

X	3.7	Conductivity	Conductivity/Salinity Manual (LF 191)	Covers determination of the ability of an aqueous solution to carry an electric current and is therefore dependent on the pressure of ions, their total concentration, mobility, volume and relative concentrations and or the temperature of measurement. Unit of measurement: is ms/cm, mho/cm. Range: 0.0-1999 m/s/cm.
	3.8	Copper	Bicinchroninate Method Spectrophotometer Manual	Applicable for determining copper in water, wastewater and sea water. This method has high sensitivity and freedom of interference from those materials normally found in water and wastewater. Range: 0-5.00 mg/L.
	3.9	Copper	Porphyrin Method Spectrophotometer Manual	Applicable for determining trace amounts of free copper in water, wastewater, and sea water. Range: 0-250.0 mg/L.
X	3.10	Dissolved Oxygen	OXI 191 Manual	Covers the determination of dissolved oxygen in natural and wastewater. The analysis of dissolved oxygen is a key test in water pollution and waste treatment process control.
	3.11	Hardness	Titration Method ASTM D 1126-80	Applicable to raw waters, treated waters, and boiler waters that are clear in appearance and free of complexing treatment chemicals. Low detection limit - approximately 0.5 mg/L. Upper detection limit - can be extended to all concentrations by sample dilution. It is possible to differentiate between hardness due to calcium ions and due to magnesium ions by this method.

Appendix III
(continued)

3.12	Hardness	Titration Method Using UniVer 1 Hardness Reagent Spectrophotometer Manual	Applicable for determining total hardness (total concentration of Ca and Mg expressed as their $CaCO_3$ equivalent and other polyvalent metal ions). This method is advantageous when large amounts of Cu, Co, Zn, Ni and other metals are known to be present in the water sample.
3.13	Hardness	Titration Method Using ManVer 2 Hardness Reagent Spectrophotometer Manual	This method is applicable for the determination of total hardness in water, wastewater and sea water.
3.14	Hydrazine	Dimethylaminobenzaldehyde Method Spectrophotometer Manual	Applicable for the determination of small amounts of hydrazine in boiler feedwater. This method can also be used for determining hydrazine in fresh water, boiler water, and sea water.
3.15	Iron, Ferrous	Phenanthroline Method Spectrophotometer Manual	Applicable for the determination of Ferrous Iron in water.
X 3.16	Iron, Total	Ferrozine Method Spectrophotometer Manual	Applicable for determining trace levels of iron in drinking water and sea water. It can be used to determine iron contamination in chemical reagents and glycols and can be used to analyze samples containing magnetite (black iron oxide) or ferrites. This method is more than twice as sensitive as 1,10 phenanthroline method.

Appendix III
(continued)

3.17	Iron, Total	1,10 Phenanthroline Method Spectrophotometer Manual	Applicable for determining iron (including precipitated or suspended iron such as rust) in drinking water, wastewater, and sea water. Range: 0-3.000 mg/L.
3.18	Lead	Dithizone Method Spectrophotometer Manual	Applicable for determining lead in water and wastewater (This method is very sensitive to lead).
	Organic Constituents		
3.19	Oil	Extraction Method - Calorimetric Spectrophotometer Manual	Applicable for determining oils in water. Colorless oils will not register using this method.
3.20	Oil and Grease	Extraction Method-Gravimetric	Applicable to wastewater and sea water samples.
3.21	Volatile Acids	Distillation Method Standard Methods for the Examination of Water and Wastewater; 16th ed., 505 (1985)	This technique recovers acids containing up to 6 carbon atoms. Fractional recovery of each acid increase with increasing molecular weight. This method is empirical and gives incomplete and somewhat variable recovery. Factors such as heating rate, and proportion of sample recovered as distillate affect the result, requiring the determination of a recovery factor for each apparatus and a set of operating conditions. However, it is suitable for routine control purposes.
3.22	Volatile Acids	Esterification Method Spectrophotometer Manual	Applicable for the determination of volatile organic acids in digestor sludge. All volatile organic acids present are reported as their equivalent mg/L acetic acid. Materials commonly present in digestor sludge do not interfere with the test. Range: 0-2800 mg/L.

Appendix III (continued)

X	3.23	pH	LF 191 Manual	Covers the determination of pH by electrometric measurement using the glass electrode as the sensor.
	3.24	Phosphates(ortho) High Range	Amino Acid Method Spectrophotometer Manual	Applicable to fresh water, sea water and wastewater samples. Range: 0-20.00 mg/L.
	3.25	Salinity	Conductivity/ Salinity Manual	Covers the determination of the total solids in water after all carbonates have been converted to oxides, all bromine and iodide have been replaced by chloride, and all organic matter has been oxidized.
	3.26	Silica Low Range	Heteropoly Blue Method Spectrophotometer Manual	Applicable to fresh water and sea water . Interferences are discussed in the procedural notes. Range: 0-2.0 mg/L.
X	3.27	Silica, High Range	Silicomolybdate Method Spectrophotometer Manual	Applicable to fresh water and sea water. Range: 0-30 mg/L.
	3.28	Silica, Total	Gravimetric Method (acid dehydration) ASTM D 859-80	Covers the determination of silica in water and wastewater. It is dependent of interferences and is a primary measure of total silica in water.
	3.29	Sulfide	Methylene Blue Method Spectrophotometer Manual	Applicable for determining sulfide in fresh water, wastewater and sea water. High concentrations of sulfide in oil field waters may be determined after proper dilution. Range: 0-0.800 mg/L
	3.30	Sulfate Ion	Gravimetric Method ASTM D 516-82	Applicable to all types of water and and wastewater. It is directly applicable to samples containing approximately 20 to 100 mg/L(ppm) of sulfate ion.

Appendix III (continued)

3.31	Sulfite Ion	Iodometric (Titration) Spectrophotometer Manual	Covers the determination of sulfite ions in boiler, fresh waters treated with sulfite for dissolved oxygen control, in natural waters or wastewaters as a result of industrial pollution and in treatment plant effluents dechlorinated with sulfur dioxide.
3.32	Total Solids	Gravimetric Method Standard Methods for the Examination of Water and Wastewater, 16th ed. (1985)	Covers the determination of total solids (total dissolved solids and total suspended solids) in water at 103-105°C.
3.33	Total Dissolved Solids	Gravimetric Method -------do----------	Covers the determination of the portion of total solids retained by a filter (Drying temperature: 180°C).
3.34	Total Suspended Solids	Gravimetric Method Spectrophotometer Manual	Covers the determination of the portion of total solids retained by a filter (drying temperature: 103-105°C)
3.35	Total Suspended Solids	Photometric Method Spectrophotometer Manual	Covers the determination of suspended solids in a simple direct measurement.. This method is often use for checking in-plant. Range: 0-1000 mg/L.

Appendix III
(continued)