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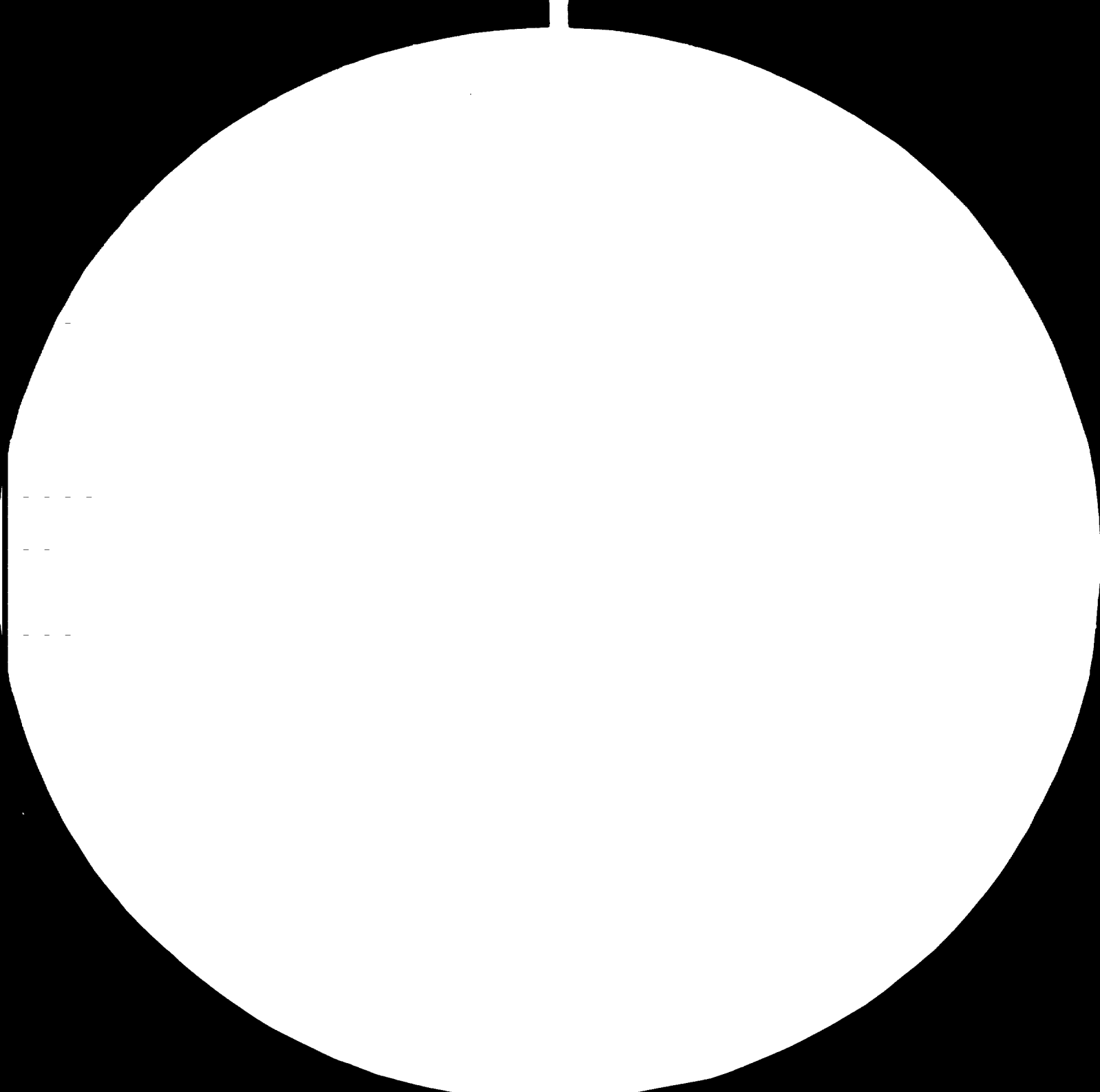
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MICROCOPY RESOLUTION TEST CHART

NATL BUREAU OF STANDARDS-1963-A

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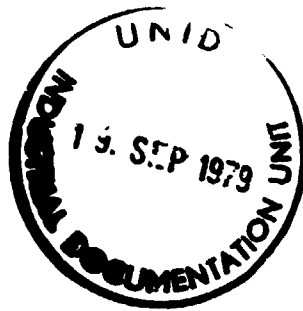
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IRAQI ORGANIZATION FOR STANDARDS

10166

**METROLOGY LABORATORIES
REPORT ON LAY-OUT AND EQUIPMENT**

BY

S. A. THULIN

Senior Metrology Adviser

001366

BAGHDAD, 10 September 1978

PROJECT No. TF / IRQ / 77 / 003

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Report on lay-out and equipment

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Note: This report has not yet been cleared
by UNIDO and therefore only reflects
the expert's personal opinion

SUMMARY

The expert was assigned as senior metrology adviser within the project "Assistance to the Iraqi Organization for Standards" (TF/IRQ/77/003/37) from 26 February 1978 to 25 September 1978 when he resigned to take up other duties.

The present final expert report contains technical recommendations for organizing and equipping the metrology department of the new compound of laboratories of the Iraqi Organization for Standards (IOS). These premises are expected to be taken into use before the end of September 1978.

The draft report was written in two parts: the chapters I to IV (p. 1 to 79) handed over to the counterpart on 25 May 1978 and chapter V (p. 80 to 118) handed over on 10 September 1978.

The copies of the draft report thus transmitted were accompanied by sets of technical documentation and annotated commercial quotations so as to enable equipment ordering for the activities of mass, dimensional, force, pressure and legal metrology as well as of all necessary laboratory furniture.

Though requested by the expert in June 1978, the equipment specified for the activities of electrical metrology, frequency metrology, photometry and thermometry has so far not been subject to commercial enquiries.

A plan for the improvement of the temperature stability in the laboratories for dimensional and electrical metrology was suggested by the expert and discussed with the engineers of the State Organization for Construction by the end of May 1978.

As a conclusion the expert considers that all necessary recommendations and specifications for the equipment procurements and the installations of the metrology premises have been made and that most urgent action must be taken to finalize equipment purchases and furnishing of the laboratories before other metrology experts are assigned. The original time schedule for experts (p.5) will have to be modified to take into account the delays already experienced in the equipment ordering procedures.

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1. INTRODUCTION

The original metrology scheme drawn up almost ten years ago has been updated and the distribution of the laboratories rearranged so as to include more calibration facilities for industrial, public services and scientific purposes.

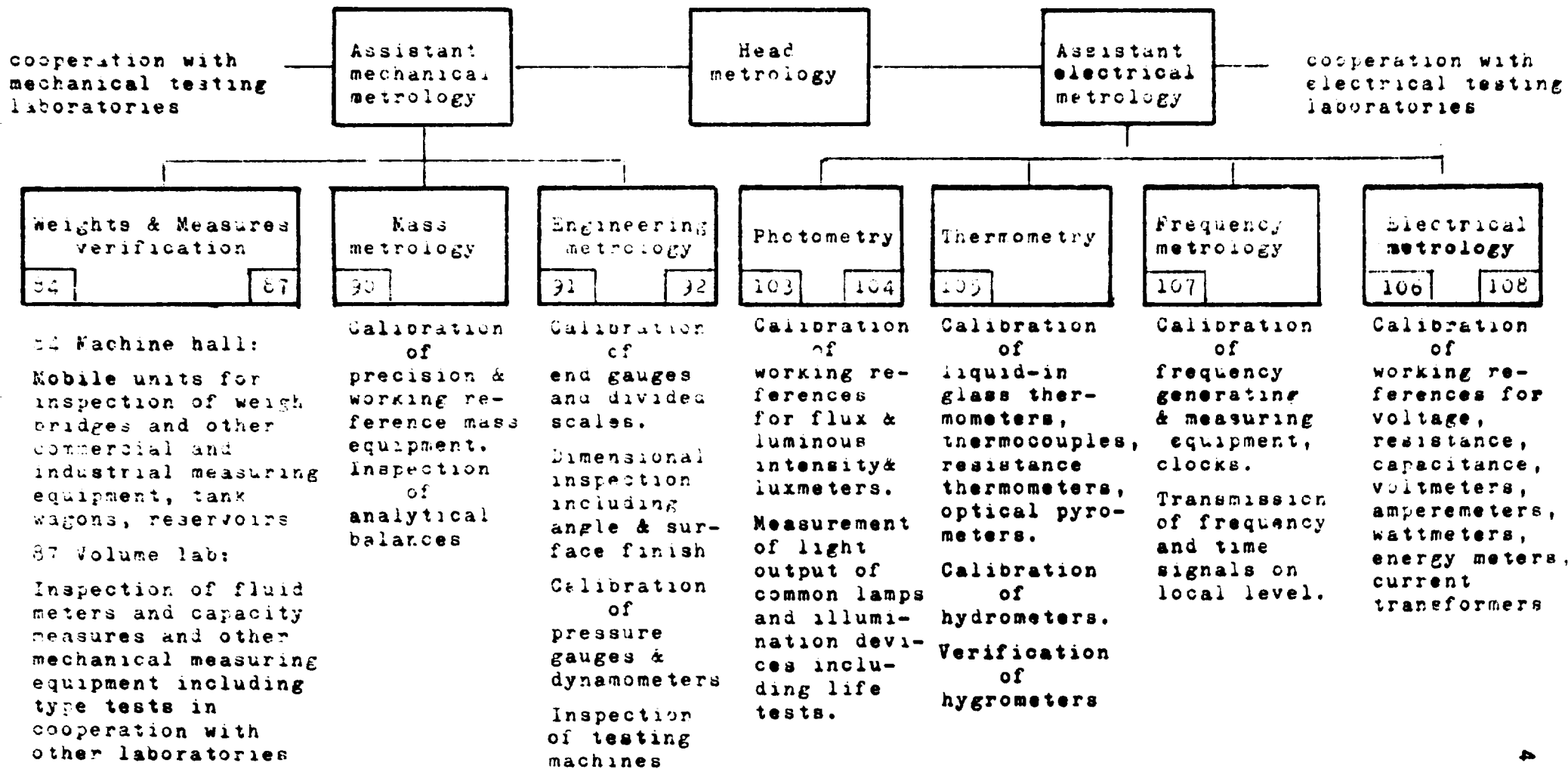
The extension of applied metrology for commercial and safety purposes to other quantities than the classical mass, length and volume quantities has also been taken into account.

There has also been included some metrology services for industry which include calibration or verification facilities for instruments used in process or product control. Such verifications have usually been considered to be made in the central laboratories through the use of suitable transfer instruments. Mobile facilities for such purposes have, however, been foreseen in several cases and they should be further extended according to the needs which will be shown by surveys conducted in industries.

The chart for the organisation of the laboratories included in the report is suggested on the basis of practical rather than theoretical facts and takes into account inter-relations of equipment and the lay-out of the premises as well as specialization and occupation of the staff.

Note: The English word "standard" often creates confusion when used simultaneously for the purpose of metrology or materials testing. For the metrologist it usually means a physical reference such as standard kilogramme. The French word in this case is "étalon" well distinguished from "norme" which means a written standard such as British Standard or an ISO standard. Though "étalon" has started to be used in English by some metrologists its use is not yet common and the author has preferred to employ "physical reference". In the specifications for equipment the word "standard" has by habit slipped in sometimes, it should then be interpreted with its metrology signification.

ORGANISATION AND ACTIVITIES OF ICS METROLOGY LABORATORIES



TIME SCHEDULE OF EQUIPMENTS
1978

Weights & Measures

Equipment ordering
delivery

Fellowship I

Fellowship II

Fellowship III

Expert

Mass metrology

Equipment ordering
delivery

Fellowship

Expert

Engineering metrology

Equipment ordering
delivery

Fellowship I

Fellowship II

Fellowship III

Expert

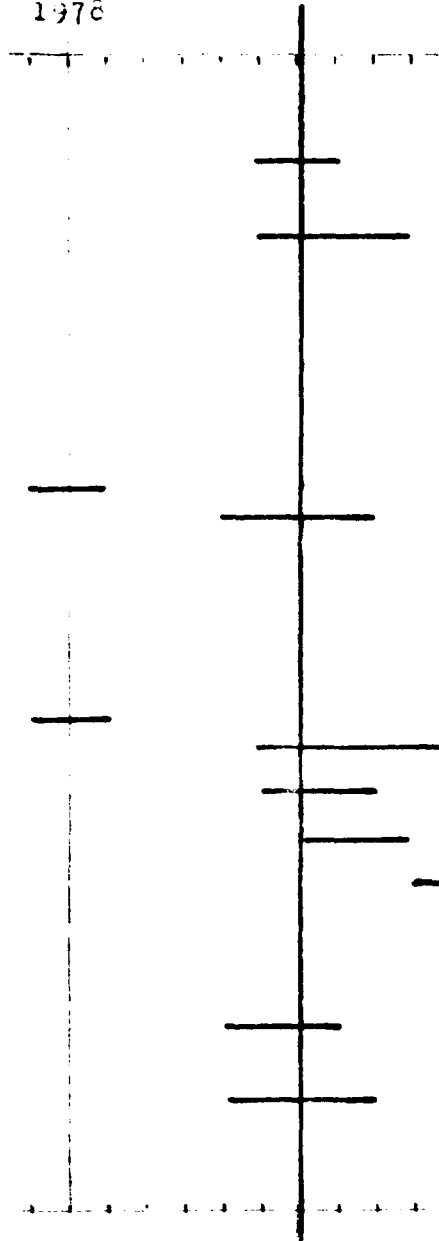
Electrical metrology

Equipment ordering
delivery

Fellowship I

Fellowship II

Expert



1 PROCUREMENTS, FELLOWSHIPS AND EXPERTS
 1979 1980

Budget
 or
 man-months

120 000 ID

4 mm

4 mm

4 mm

6 mm

30 000 ID

6 mm

-

100 000 ID

3 mm

3 mm

3 mm

3 mm

100 000 ID

4 mm

4 mm

6 mm

1978

Frequency & time

Equipment ordering
delivery

Fellowship

Expert

Thermometry

Equipment ordering
delivery

Fellowship

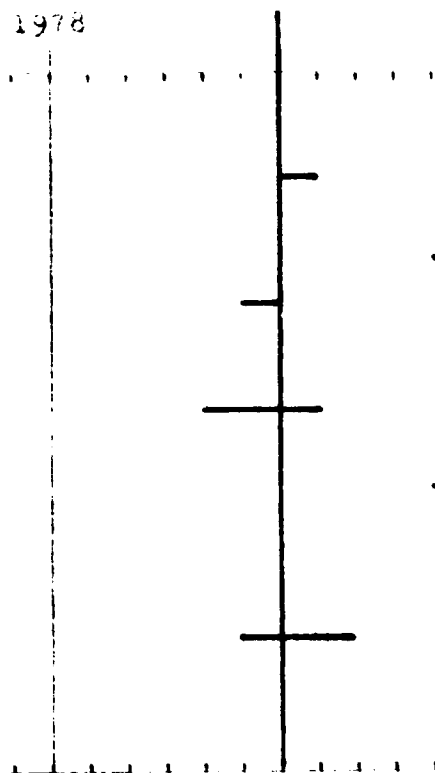
Expert

Photometry

Equipment ordering
delivery

Fellowship

Expert



Totals

Equipment

130 000 ID

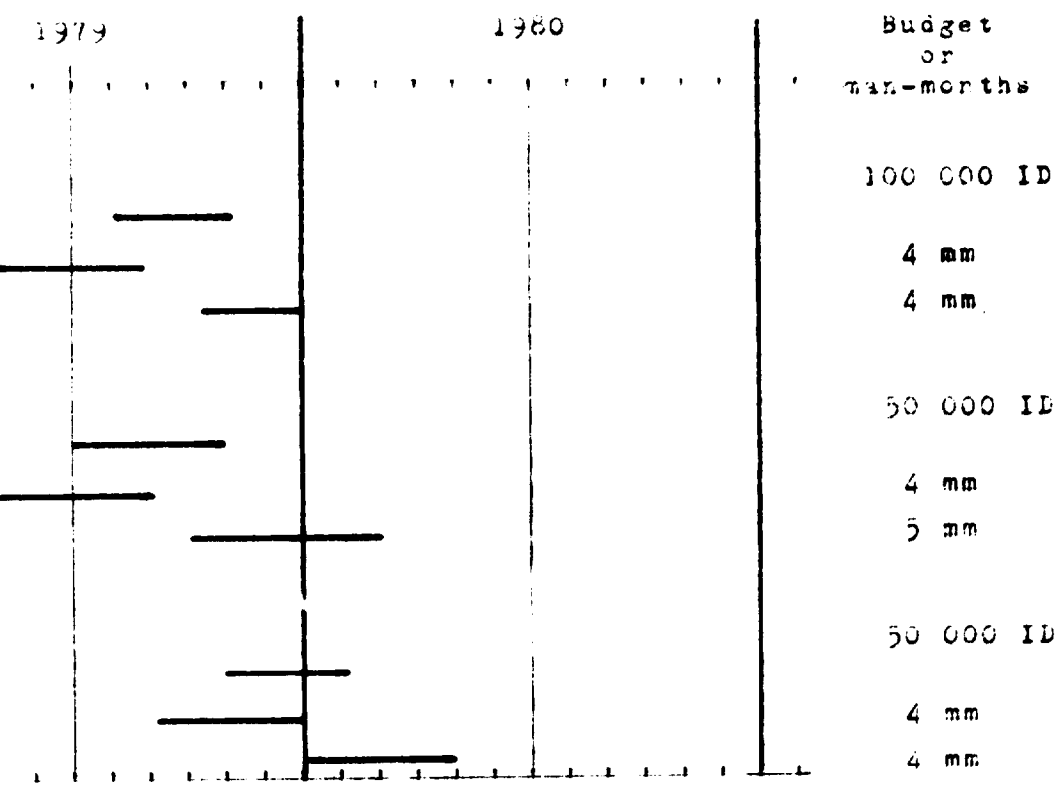
Fellowships

4 mm

Experts (short-term)

1 mm

Senior metrology
adviser



390 000 ID	(to be specified later)	520 000 ID
39 mm	4 mm	47 mm
12 mm	15 mm	28 mm
		24 mm

Expert in weights and measures verification (legal metrology)

Start: February 1980

Duration: 3 months February - April 1980
3 months October - December 1980

Duties: The expert will assist the Iraqi Organization for Standards in the technical implementation of facilities for
a) verification of road weigh bridges and industrial weighing equipment
b) verification of fluid meters and the capacity of tank trucks and reservoirs

Equipment for the above activities will have been procured during 1979 and be partly installed before the arrival of the expert.

The expert will during the first part of his assignment advise on the final arrangement of these facilities and their operation.

During the second part he will train counterparts in actual central laboratory and field verification.

Qualifications: Mechanical engineer with at least B. Sc. degree or equivalent and extensive experience in weigh bridge verification, fluid metering and tank gauging obtained in a national metrology service.

Note: If required for reasons of specialization, the duties may be divided in two different assignments.

Expert in engineering metrology

Start: October 1972

Duration: 3 months

Duties: To assist the Iraqi Organization for Standards in training counterparts in **engineering metrology** including

- a) calibration of end gauges and divided scales
- b) dimensional inspection including angle and surface finish
- c) calibration of pressure gauges and dynamometers
- d) inspection and calibration of mechanical testing machines for tensile, compression, impact or hardness tests.

Equipment for the above activities will have arrived and the expert will assist in their final stage of installation and start of operation.

Qualifications: Mechanical engineer with at least B.Sc. degree or equivalent and extensive experience in engineering metrology and tool room practice.

Expert in photometry

Start: January 1960

Duration: 4 months

Duties: To assist the Iraqi Organization for Standards in training counterparts in

- a) calibration of reference lamps for luminous flux and luminous intensity
- b) calibration of luxmeters
- c) measurement of light output of locally manufactured or imported incandescent or fluorescent lamps including life tests.

Equipment for the above activities will have arrived and the expert will assist in their final stage of installation and start of operation.

Qualifications: Physicist or electrical engineer with at least B. Sc. degree and extensive experience in photometry and illumination engineering.

Expert in thermometry

Starts: October 1977

Duration: 5 months

Duties: To assist the Iraqi Organization for Standards in training counterparts in calibration of

- a) liquid-in-glass thermometers, thermocouples, resistance thermometers
- b) optical and radiation pyrometers
- c) hygrometers
- d) hydrometers

Equipment for the above activities will have arrived and the expert will assist in their final stage of installation and start of operation.

Qualifications: Physicist with at least B.Sc. degree or equivalent and extensive experience in thermal measurements and calibration of thermometers.

Expert in frequency and time metrology

- Start:** December 1978
- Duration:** 1 month Dec. 1978 for equipment planning
3 months October - December 1979 for training
- Duties:** The expert will assist the Iraqi Organization for Standards in establishing a frequency and time calibration laboratory. The assignment consists of two parts
- a) planning of equipment taking into account local requirements and including an investigation of the best means for local dissemination of time signals and standard frequencies for use by navigation, industries and public services, establishment of detailed specifications for purchasing of the equipment.
 - b) training of counterparts in the use of the equipment and generally in frequency and time metrology when the equipment has been delivered.
- Qualifications:** Physicist or electronic engineer with at least B. Sc. degree and extensive experience of frequency and time metrology including standard frequency and time signal transmissions.

Expert in electrical metrology

Start: October 1979

Duration: 6 months

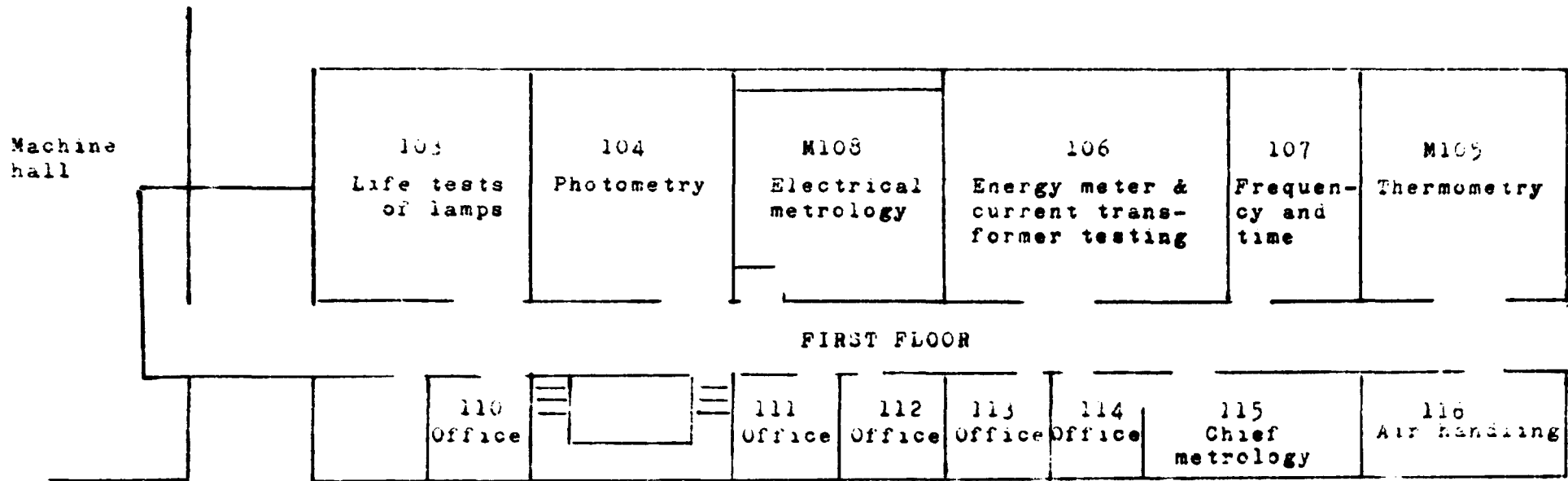
Duties: To assist the Iraqi Organization for Standards in training counterparts in calibration of electrical instruments including

- a) references(etalons) for voltage, resistance and capacitance
- b) direct current and alternating current, low frequency voltmeters, amperemeters, wattmeters
- c) energy meters
- d) current transformers

Equipment for the above activities will have arrived and the expert will assist in their final stage of installation and start of operation.

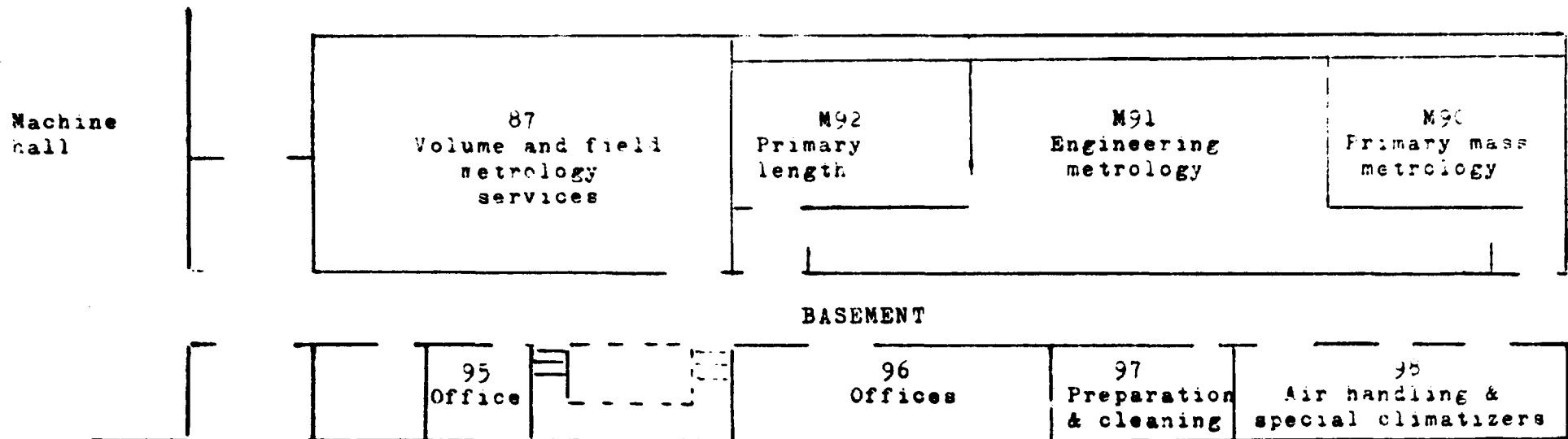
Qualifications: Electrical or electronic engineer with at least B.Sc. degree and extensive experience from calibration of electrical instruments for direct current and low frequency including maintenance of reference instrumentation(etalons).

Notes: If required for reasons of leave of absence or specialization the assignment may be divided in two parts of 3 months each.



FIRST FLOOR

Scale: 1 cm = 1 m



BASEMENT

DISTRIBUTION OF IOS METROLOGY LABORATORIES

(Room numbers as per architect's drawings except for prefix M, modified lay-out)

INSTALLATIONS AND TYPES OF FURNITURE

Requirements for special air conditioning

The metrology laboratories will during a large part of the day be exposed to direct sunlight. In order to be able to reach any reasonable temperature stability, even with the best air-conditioning equipment, it will be necessary to provide for suitable thermal insulation of the windows of those rooms which are to be used for accurate measurements. These are mainly

Room	Activity	Required mean temperature	Acceptable variations
92	Primary length metrology	20 °C x)	± 0.3
91	Engineering metrology	20 °C x)	± 0.5
90	Mass metrology	not critical, stability only	± 1
108	Electrical metrology	23 °C	± 0.5

Note: x) also adjustable to 23 °C

The actual air-conditioning systems for these rooms may not be able to provide the necessary temperature stabilities even if the thermal insulation is improved. Furthermore they are connected to the central cooling and heating installations which may be inoperative during a part of the year. A careful study should be made by air-conditioning specialists to find out practical solutions both for thermal insulation and precise temperature control. The electrical laboratory will in any case require the installation of a special package-type air-conditioner with accurate temperature control.

Electrical sockets

In some laboratories such as for thermometry and electrical metrology the number of single-phase sockets will not be sufficient. This can easily be solved by installations whenever required of externally mounted BS 1363 sockets which are connected to the existing electrical channels through a short three-conductor cable. These sockets should have no switches but preferably be dual. Required numbers: 500 plus 1000 plugs.

Furniture design

The mass and length metrology activities will require some special stone benches supported by brick pillars. The length measuring machine to be ordered requires pillars made from concrete. Specifications for these items are given on the following pages room by room, see "Implementation of equipment and furniture". For the length measuring machine the manufacturer shall be consulted so as to obtain drawings of the required supports.

In other cases a form of standard laboratory furniture may be adopted. Some of this furniture will no doubt remain at fixed locations but some of it, let us say 30 %, should be easily movable according to needs and arrival of the equipment, the exact installation of which cannot always be foreseen in advance. Unlike the needs for chemical laboratories, most benches shall be provided for sitting work. In order to avoid the use of high type laboratory chairs which require a foot rest ring, the height of these tables should be set to 75 or 76 cm.

The benches shall for reasons of flexibility preferably be made by using individual very sturdy tables which are installed side by side without any other form of assembly. The experience from such tables with welded metal structure in other projects was extremely good. It is important, however that such unit tables are not too big and that they fit dimensionally to the modules of the rooms. The dimensions 1350 x 675 mm fit the actual window modules and allow 5 tables to be put side by side along the windows. Sketches of such tables were made on the assumption that they can be locally manufactured, see Fig. 1. Particular attention has to be paid to the quality of the table tops which preferably should be made from high-quality mat laminate-covered ply-wood or thick particle-board also covered on the other side so as to obtain dimensional stability. The borders must not be fragile and should preferably not be made of laminate unless very thick borders are used, nor should metal borders be used as many tables will carry electrical cables. Drawer unit inserts should be available on a large part of these tables but the experience has shown that low-locker type of inserts are not of much use as they are inconvenient for access to stored instruments.

The storage of instruments can preferably be done in metallic double-door lockers of similar type as used in offices but slightly deeper, furthermore the shelves should be reinforced as well as their fixtures. The preferred dimensions of such lockers is 50 cm deep, 100 cm in width and 185 to 190 cm high.

The rack-type of storage is also convenient especially for mechanical and electrical equipment and for in- or out-going test items. An attractive model which can easily be locally manufactured is shown in Fig. 2.

Rolling tables are also very useful in particular in the electrical and thermal laboratories but also for transporting weigh boxes or test items. A model harmonized to the laboratory bench of Fig 1 is shown in Fig. 3.

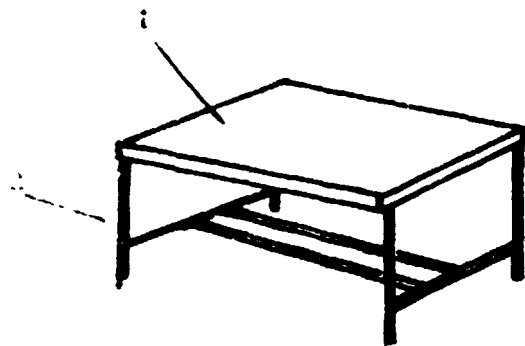
A local manufacturer of metallic furniture was consulted with the sketches of the required furniture. There seems to be no problem to have the racks manufactured locally nor workshop benches of metal. As regards the laboratory table of Fig 1 the main difficulty seems to be the requirements for the table tops which are essential.

It was later found that a British firm can supply benches of very similar design but based on assembly of the metal structures with a slight risk that the tables are less sturdy especially in free-standing position. This however, depends mainly on the quality of the type of assembly which from the available literature seemed to be acceptable. The standardized table tops of the supplier are 1000 mm or 1500 mm wide but only 500 mm deep. Experience has shown that for some equipment 650 mm is required and the manufacturer has been asked whether table tops with this dimension could be supplied and mounted on the normal size of bench frames. In case of ordering with this supplier 15 extra table tops should be ordered of 1500 mm width so as to allow construction of some special shelves for electronic instruments in the electrical laboratories or for use as low benches for climatic cabinets or other equipment.

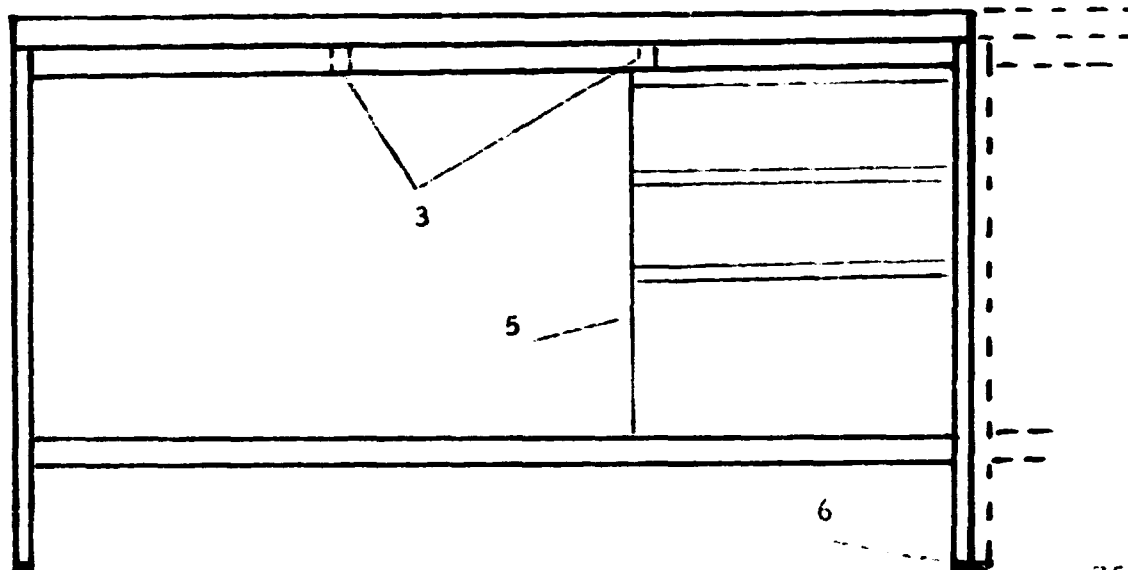
The estimated furniture requirements for metrology are:

Benches (Fig. 1 or similar)	100
Cupboards (lockers) 50x100x185 cm	40
Racks (Fig. 2)	40
Rolling tables (Fig. 3 or similar)	30
Laboratory chairs with back stud	60

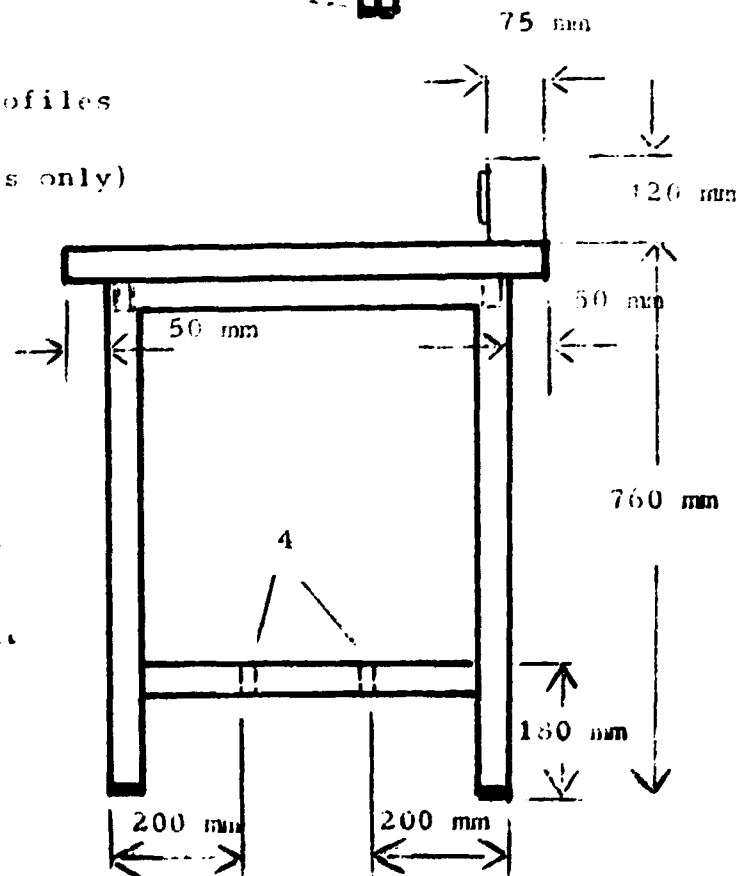
Fig 1 - LABORATORY TABLE



- 1 - Table top 1350 x 675 mm made from 25 to 40 mm thick chipboard covered both sides with formica (melamine), mat light grey colour without texture, borders covered with very resistant plastic material without protrusions as the tables are to be put side by side to form continuous benches when required. Hard linoleum with mat green colour and teak wood borders also acceptable.
- 2 - Welded structure made from 20x40 mm hollow iron profile painted black



- 3 - Reinforcements by welded profiles
- 4 - of same type as item 3
- 5 - drawer insert (on some tables only) width 450 mm (about)
 drawer modules: 2 x 125 mm and 1 x 250 mm (about)
 Insert to be fixed from bottom to reinforcements 4 by four screws to be supplied.
- 6 - hard rubber feet
- 7 - Energy ledge (on some tables only) made from formica covered wood or from metal to be fixed on tables by the customer and comprising four sockets 13 A three flat pin type to BS 1363 without switch

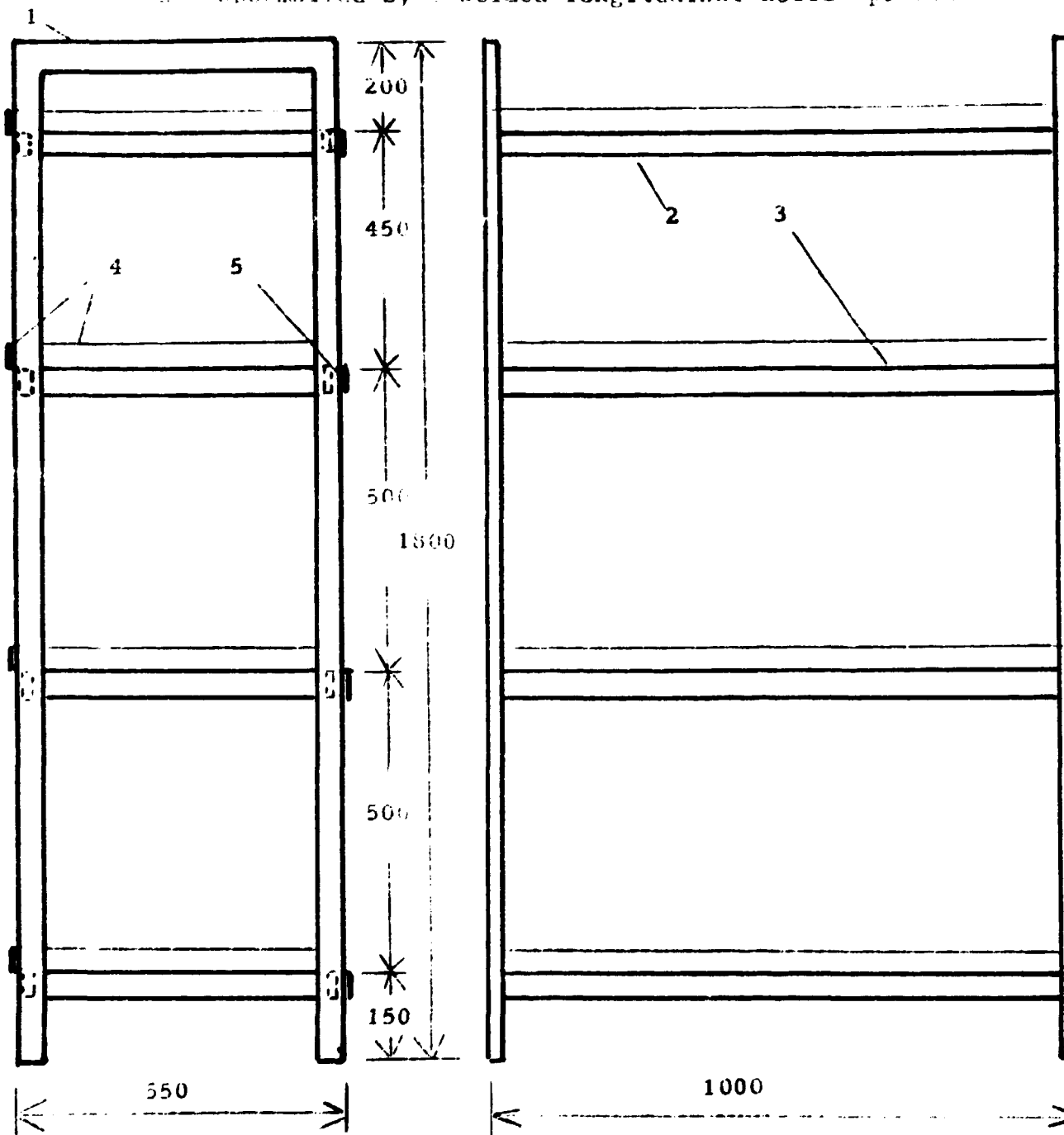


FURNITURE BY IRANI STANDARD LABOURATORY

FIG 2 - RACKS WITH OPEN SHELVING Colour: light grey painted

1 - Racks made from hollow profile iron 20 x 40 mm consisting of two welded ladder structures

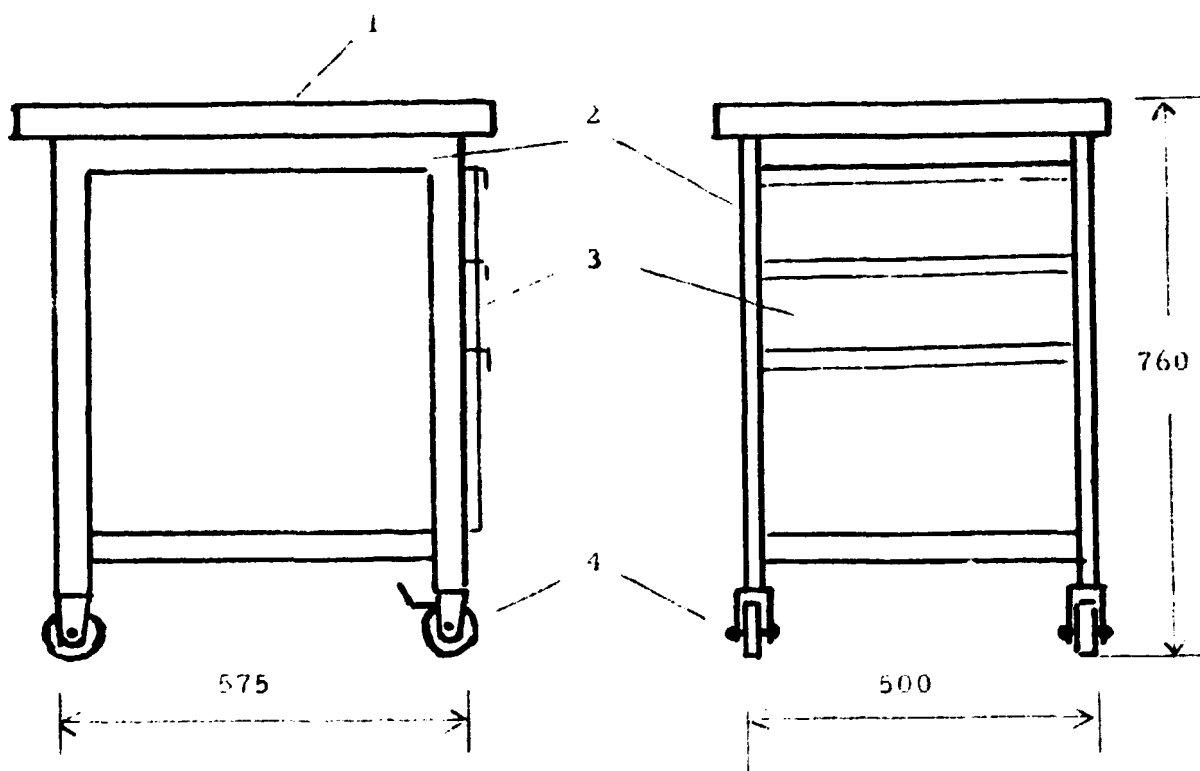
2 - assembled by 3 welded longitudinal hollow profile irons



3 - Four shelves of 1 mm steel sheet reinforced longitudinally in the middle, with 4 cm borders at the rear on the sides and in front

4 - Borders 4 cm bent upwards

5 - Borders 4 cm bent downwards to cover structural profile

Fig 3 - ROLLING TABLE

- 1 - Table top, specifications as for table in Fig 1 but dimensions 675 x 550 mm
- 2 - Hollow profile iron 20 x 40 mm or approaching
- 3 - Drawer insert same as for table in Fig 1 (to be installed on some tables only)
- 4 - Rubbercasted casters, diameter min 50 mm maximum 60 mm, rotating around their axis of fixation. It should be possible to block two of the casters

Note: Some tables of the same type as above and same height but without casters.

IMPLEMENTATION OF EQUIPMENT AND FURNITURE

Short descriptions of the rooms and the necessary furniture are given below room by room. The suggestions are in several cases only tentative as they will have to be confirmed according to the dimensions and other requirements of the equipment to be ordered.

Laboratory benches which are supposed to have a fixed location are drawn in the sketches with plain lines whereas movable benches are generally drawn with dotted lines.

Room 84 - Machine hall

Activities: Calibration of heavy weights and storage of mobile units and equipment such as weigh-bridge and volume calibrating trucks and measuring vans. Also tests of industrial and commercial weighing equipment.

Equipment: - One lorry or trailer van equipped with crane and carrying 500 kg weights for calibration of road weigh bridges (see Annex A item 1)

- one (or two) measuring busses for field calibrations (see Annex A item 2)

- precision balance for calibrating 500 kg weights (Annex A item 3)

Note: quotation already received from BIW, PIG

- Workbenches for routine work on weights, commercial and industrial weighing equipment, etc along with suitable tools.

Installations: definite plans will have to be made when more detailed information is available, the following should however be noted.

- a) It is likely that the weigh-bridge of 50 tons originally foreseen will not be needed nor the travelling crane if the weigh bridge calibration lorry has its own easily movable crane. The floor will however most probably have to be further reinforced to support the lorry and an opening made for the 500 kg balance.
- b) Ventilation will have to be foreseen for the room located under the air handling equipment.
- c) The machine hall will at least partly have to be provided with a clean floor covering such as vinyl-asbestos tiles or similar.
- d) Dust protection has to be provided so as to prevent dust from outside which can come in through the slits in the sliding entrance doors. (Double-door system or similar)
- e) A lift device may have to be installed for transporting heavy or voluminous equipment from the machine hall to the first floor balcony.

Room 87 - Liquid volume and flow metrology

Activities: Testing of industrial liquid flow meters mainly water meters, calibration of secondary volume standards for liquid up to 100 litres. Other activities in the future include routine checking of pressure gauges using suitable test media. Occasional and accurate calibration of pressure gauges using dead-weight piston and mercury column equipment will take place in room 91)

Equipment: - Tentative specifications for the water meter and volume measuring equipment are given in Annex A, items 5 to 8.

Installations: - The definite requirements will be formulated when drawings have been obtained from the suppliers of the equipment.

Room 90 - Mass metrology

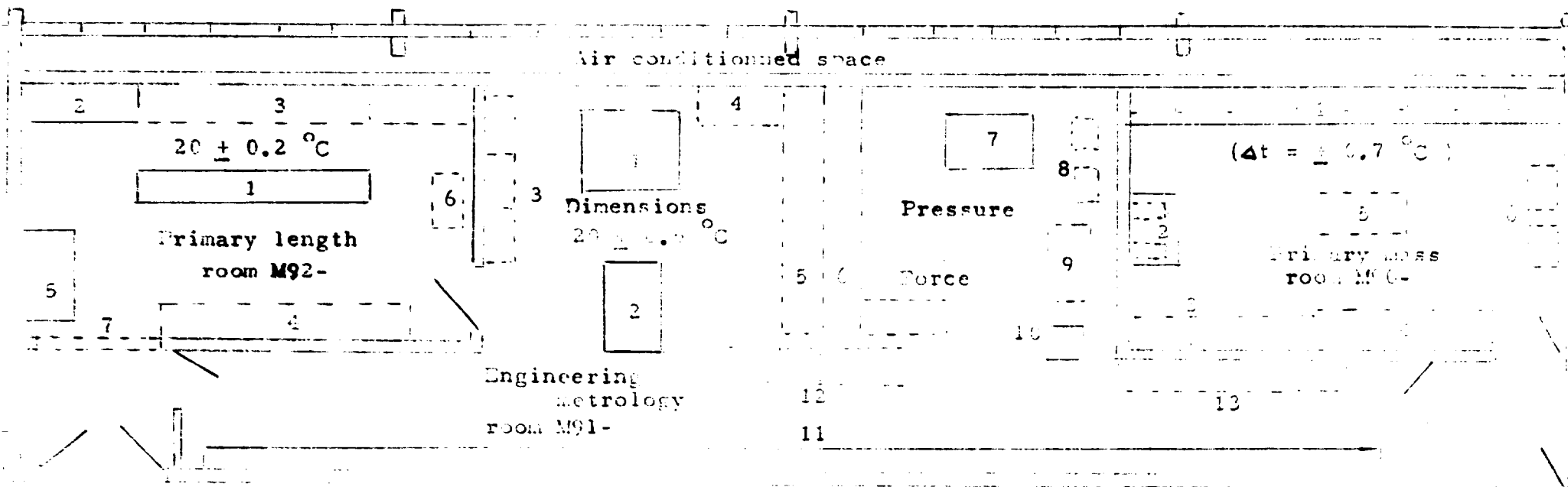
Activities: Calibration of secondary weights to primary national reference standards as well as regular calibration and/or adjustment of working standards used for field calibrations or in the machine hall. Calibration of analytical weights and precision grade commercial weights, examinations of precision balances.

Equipment: Primary and secondary sets of weights (to be kept in the cupboards), one set of direct reading analytical type of substitution balances ranging to 200 g, two balances 5 kg and 20 kg capacity to be placed on separate heavy support, one set of electronic balances with printer for readability of small standard weights and also several weights consisting of balances with capacities of 0.1, 1.2 and 15 kg located on a special bench.

The specifications for the mass metrology equipment are given in more detail in Annex B.

Installations: - Thermal insulation of the windows will have to be provided, see "special air-conditioning", page 4.

The furniture shall consist of at least two heavy supported stone benches for the primary balances. Two other fixed benches are needed, one for the electronic balances and the other for use as supports for balances to be tested. A more detailed description is given on the following sketch.



Lay-out of equipment and furniture in primary length and mass laboratories and engineering metrology, pressure and force metrology room after modification of the systems for special air-conditioning of these rooms including special thermal insulation

After modification of a local air-conditioning system,
Room M90 - mass metrology, installations:

- | Item | Description |
|---------|---|
| M90 - 1 | Work bench for the primary 5 kg to 5 kg balances with polished marble top or similar covering material, length of bench 3 meter, height 75 cm, depth 65 cm supported by brick pillars 35 cm wide and 55 cm deep covered with concrete and painted.
electrical sockets, dual type every 2 meter at 90 cm from floor all along this bench. |
| M90 - 2 | Support for 50 kg balance similar to item M90-1 but 130 cm wide and 75 cm deep, height 75 cm consisting of thin marble plate supported by two brick pillars 35 cm wide and 55 cm in depth. |
| M90 - 3 | Metallic cupboards 50 x 100 cm with reinforced shelves for weights. |
| M90 - 4 | Bench for electronic balances and similar (can if desired also be located at position 6), provide for two dual electrical sockets at 1 m height (in case high, standard benches are used instead of the low sitting benches) |
| M90 - 5 | Office desk (Laboratory table type) |
| M90 - 6 | Two rolling tables for sets of weights |

Room M92 - primary length metrology, after modification
of walls and air-conditioning:

Activities: Calibration of end gauges and precision line standards up to 3 meter. Highly accurate dimensional inspection work including screw threads.

Installations:

- | | |
|---------|--|
| M92 - 1 | Primary length comparator for end gauges and scales up to 3 m, Zeiss Jena model ULMM |
| M92 - 2 | Cupboard for ULM accessories, furnished by Zeiss Jena. |
| M92 - 3 | Laboratory bench, preferably 90 cm high, maximum 65 cm deep for disposal of test items, possibly completed with metallic cupboard in the corner. |
| M92 - 4 | Low bench 75 cm high maximum 65 cm in depth for small gauges, end gauges and gauge comparator. |

Item	Description
M92 - 5	Tridimensional measuring machine with its necessary table, 1970 tel. 88 - 314
M92 - 6	Rolling table
M92 - 7	Double-door, usually closed but used for the intake of heavy equipment.

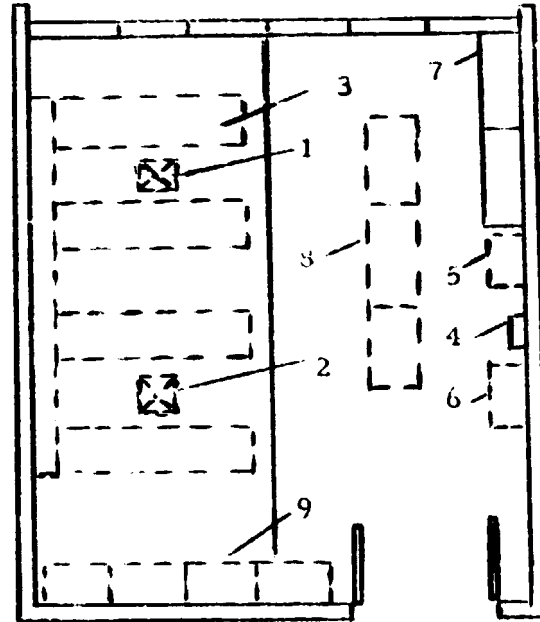
Room M91 - Engineering metrology including pressure and force calibration, lay-out after modifications of walls and special air-conditioning system:

Activities: Dimensional measurements using surface plate and profile projector, inspection of surface finish, Calibration of pressure gauges and barometers, Comparison of dynamometers using hydraulic comparators.

M91 - 1	Profile projector (optical contour magnifier)
M91 - 2	surface plate of diabas stone 1500 x 1000 mm
M91 - 3	Metallic cupboards for inspection equipment
M91 - 4	Laboratory bench 75 cm high for surface finish instruments
M91 - 5	Laboratory bench for engineering metrology, micrometer and oil gauge testers etc
M91 - 6	Laboratory bench for pressure testers
M91 - 7	Barometer test chamber and standard barometer
M91 - 8	Rolling tables, also possible location of Brinell tester for checking hardness blocks if required.
M91 - 9	Bench with dynamometer comparator to 100 kN
M91 -10	Hydraulic dynamometer comparator to 700 kN
M91 -11	Polished stone bench for tape measurements by comparison, width 50 cm, height 90 cm, total length 21 meter, supported on brick pillars at 1 or 1.5 m intervals.
M91 -12	Office desks, laboratory type
M91 -13	Metallic cupboards, 50x 100 cm with strong reinforced shelving for dynamometers, pressure gauges and various.

room 103 - Life tests on lamps

Activities: Life tests on lamps and fluorescent lamps and conformity tests in their dimensions. The light output is measured at regular intervals in the adjacent photometry room 104.

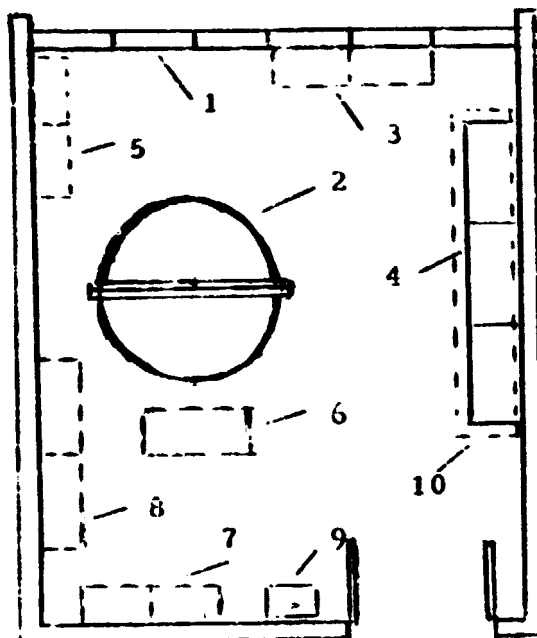


Equipment and installations:

- 103 - 1 Heat exchangers for the room by two 50 cm slow speed fans to the roof if possible with dust protection
- 103 - 2 Test stands for lamps to be manufactured to special order (loc. 114).
- 103 - 3 Power switch 5 x 50 A to be transferred to this location from its position in room 104
- 103 - 4 AC voltage stabilizers, power 1 kVA each, output voltage 220 V adjustable to 240 V
- 103 - 5 Laboratory test benches according to Furniture Fig. 1
- 103 - 6
- 103 - 7 Metallic cupboards 100 x 50 cm, normal height(136 cm)

Room 104 - Photometry

Activities: Determination of luminous flux of incandescent and fluorescent lamps by comparison to standard lamps in an Ulbricht integrating sphere. Calibration of luxmeters using standard lamps.

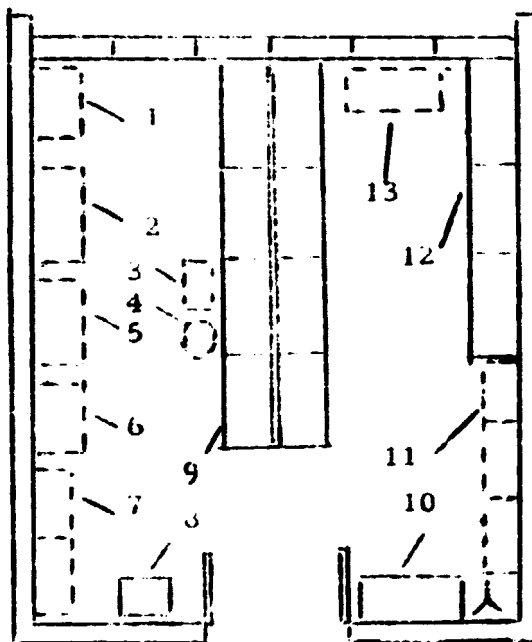


Equipment and installations:

- 104 - 1 Windows obturated by wooden panels or similar
- 104 - 2 Ulbricht's sphere 2.5 m in diameter
- 104 - 3 Mobile racks for storage of test lamps
- 104 - 4 Laboratory bench for supporting optical bench 3 meter consisting of an embly of three stable laboratory benches according to Furniture Fig. 1
- 104 - 5 Metallic cupboards for primary standard lamps 100x 50 cm
- 104 - 6 Laboratory bench for photometric measurements and electrical control of the supply voltage and current to the tested lamps. (Incandescent lamps are tested with DC, an additional bench is needed for the AC controls in case of flourescent lamps)
- 104 - 7 Metallic cupboards for working standard lamps and secondary standards.
- 104 - 8 Laboratory benches, see Furniture Fig. 1
- 104 - 9 Existing ceramic sink. The sink of stainless steel located at 104- should be removed.
- 104 -10 Black curtains, preferably velvet, to be installed around optical bench

Room 105 - Thermometry

Activities: Calibration of liquid-in-glass thermometers, resistance thermometers, thermocouples, optical pyrometers.
Comparisons of hydrometers, viscometers and hygrometers.

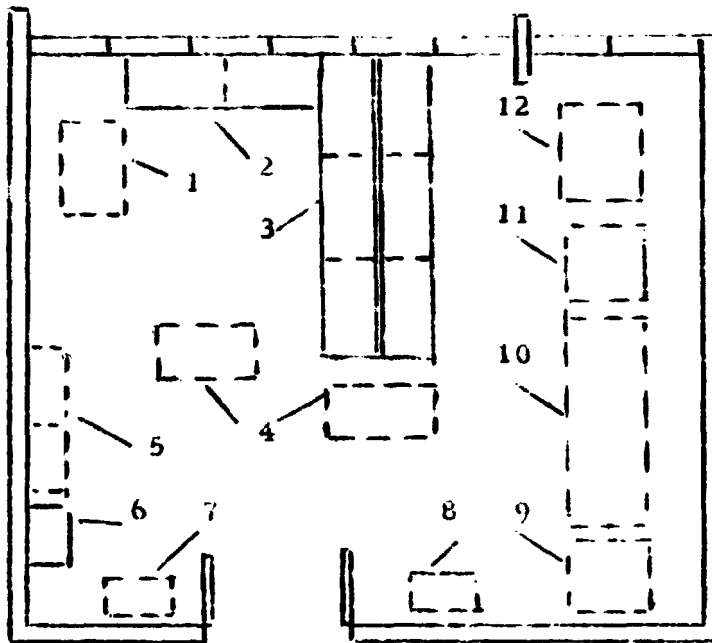


Equipment and installations:

- 105 - 1 Low to medium temperature bath - 100 to + 20 °C
- 105 - 2 Laboratory bench for resistance bridge and triple points
- 105 - 3 Artificial ice point, (frigorator cooled ice bath)
- 105 - 4 High temperature thermocouple calibration furnace
- 105 - 5 Silicone oil bath for calibration from ambient to + 250 °C
- 105 - 6 Pneumatic sand bath for calibrations to 500 °C
- 105 - 7 Hygrometer calibration cabinets
- 105 - 8 Existing ceramic sink
- 105 - 9 Laboratory bench, standard tables with electrical ledge or fixed with electrical ledge, height 76 cm for medical thermometer bath - water bath - potentiometer
- 105 - 10 Laboratory bench for pyrometer lamps and power supply
- 105 - 11 Metallic cupboards 100 x 50 cm, space for tripod
- 105 - 12 Laboratory bench and office desk, hydrometer comparator
- 105 - 13 Thermostat, refrigerated, for hydrometer comparator baths and viscometer comparator, range - 40 to + 100 °C

Room 106 - Energy meter and current transformer testing

Activities: Calibration of electric energy meters, single phase and three-phase up to 200 A. Calibration of current transformers up to 2000 A. Climatic investigations on energy meters as well as magnetic influence, etc.



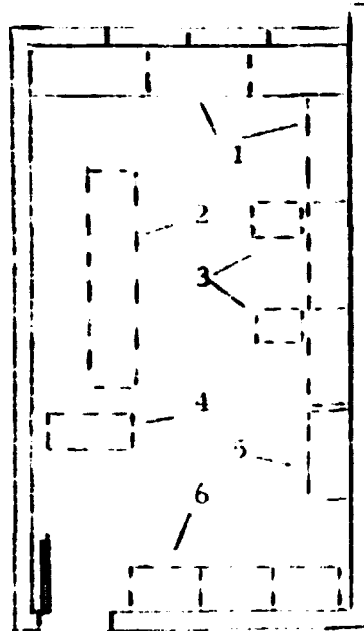
Equipment and installations:

- 106 - 1 Current transformer test set (current comparator type)
- 106 - 2 Laboratory bench
- 106 - 3 Laboratory bench, double with energy ledges both sides
- 106 - 4 Office desks, laboratory bench type
- 106 - 5 Instrument cupboards, 170 x 50 cm
- 106 - 6 Existing sink, ceramic type. The one in stainless steel on the opposite wall should be removed.
- 106 - 7 Rack for incoming test objects
- 106 - 8 Rack for incoming test objects
- 106 - 9 Climatic cabinet - 20 to + 80 °C , 0.5x0.5x0.5 meter internal volume with two lead-through holes to the left (for test cables and thermocouples)
- 106 - 10 Test stand for energy meters equipped with photoelectric scanning device
- 106 - 11 Electronic power and energy reference standard and counter for photoelectric scanner
- 106 - 12 Energy supply for the meters under test comprising three separate control circuits for voltage and three separate control circuits for current including also phase shifting device and metering circuits for active and reactive energy.

Not shown: Test coil, diameter 1 meter or more for magnetic influence tests

Room 107 - Frequency and electronics laboratory

Activities: Calibration of frequency meters and counters, signal generator, future retransmission of standard frequency standards.
Also minor maintenance of electronic equipment including high level milliwatt calibration up to 100 MHz.



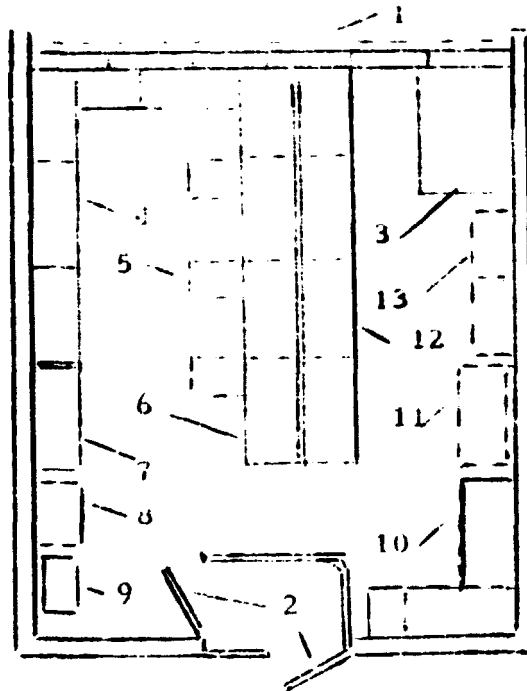
Equipment and installations:

- 107 - 1 Laboratory benches sitting at right angles, 75 cm preferably with energy ledge, (6 sockets 15 A to 15 1363 per bench unit)
- 107 - 2 Electronic rack units containing VLF-receiver, short-wave receiver, long wave receiver, rubidium frequency standard(2), digital clocks, emergency supply, memo oscilloscope for time signal reception, emergency power supply, battery charger etc and in future: cesium beam frequency standard and clock, time signal retransmission equipment
- 107 - 3 Rolling tables for instruments such as oscilloscopes etc
- 107 - 4 Batteries for item 2.
- 107 - 5 Office desk(same as item 3 units)
- 105 - 6 Open racks for storage of electronic instruments

Note: Calibration of voltage at very low level, measurement of parasitics etc requires a screened room which cannot be located inside r. 107. If the testing of parasitics from electrical appliances is required, a screened room has to be foreseen in the section for testing of electrical materials and appliances. In this case measurements at very low level such as sensitivity determinations etc can also be made in the screened room.

Room 103 - Electrical standards and calibration

Activities: Maintenance of the electrical primary reference standards for voltage, resistance and capacitance. Calibration of voltmeters, capacitors, wattmeters, resistors, etc. and the verification of impedance measuring instruments for frequency.



Equipment and installations:

- 103 - 1 Thermal insulation of windows
- 103 - 2 Air gate with two doors to replace the actual double door system. The other parts of the air gate may be made from light wood panels. The command of the lighting of the room should be made from the air gate which should be lighted by a small low-power lamp. see note
- 103 - 3 Special air-conditioner, package type to give $23^{\circ}\text{C} \pm 0.5$
- 103 - 4 Laboratory bench for primary AC standards, sitting height
- 103 - 5 Rolling tables 675 x 550 mm, height 76 mm with casters
- 103 - 6 Laboratory bench with energy ledge for DC calibration, AC/DC transfer and AC calibration of secondary instrument
- 103 - 7 Office desk
- 103 - 8 Rack for incoming test instruments
- 103 - 9 Existing sink
- 103 - 10 Laboratory bench for resistance bridge
- 103 - 11 Precision oil bath for resistance measurements
- 103 - 12 Laboratory bench for capacitance and impedance work
- 103 - 13 Metallic cupboard for standards and instruments

Note: The air-gate shall be installed after the installations of the package air conditioning unit and shall preferably be of removable construction.

NECESSARY EQUIPMENT

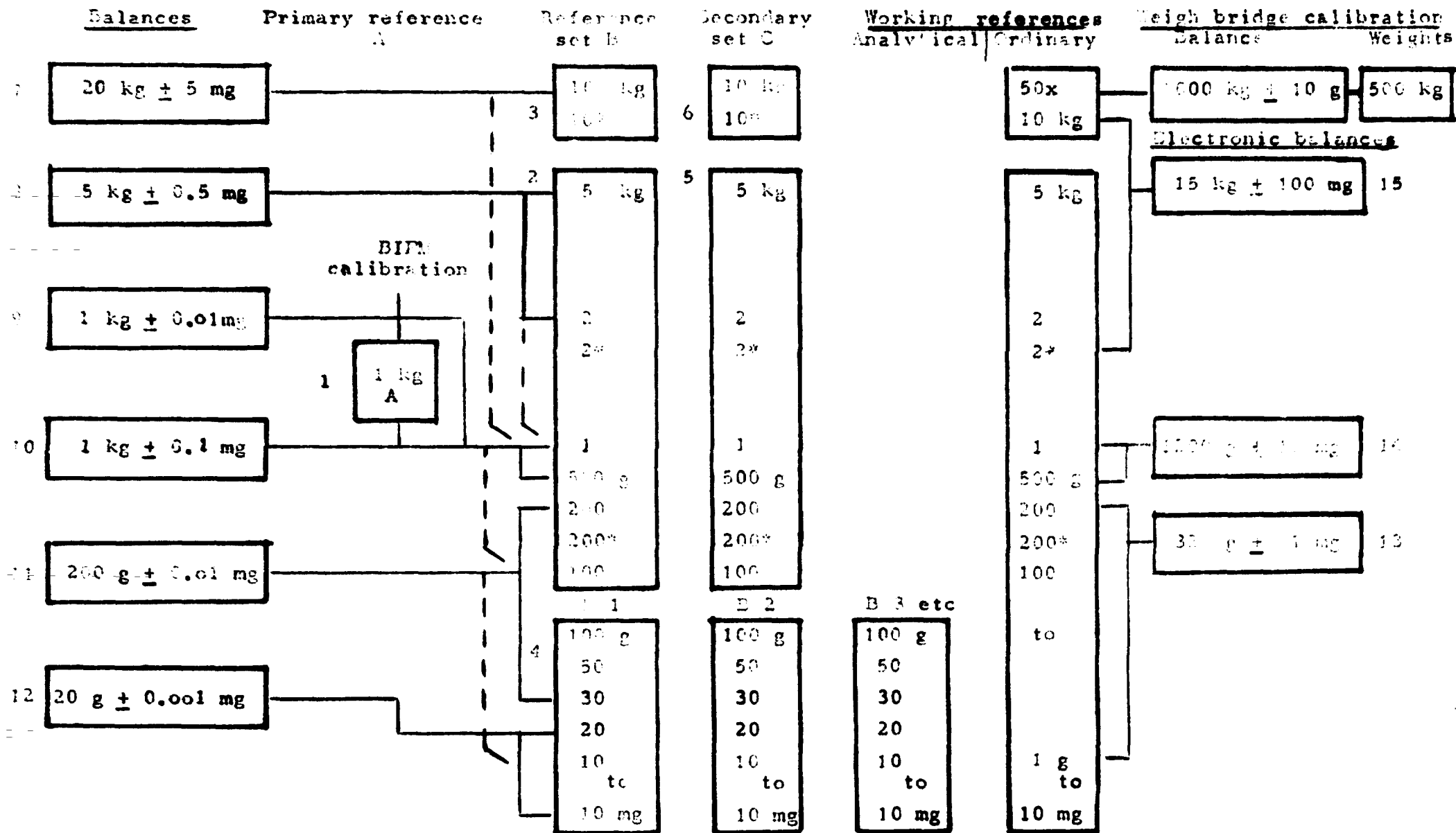
The lists on the following pages indicate the most urgent equipment required for the general analytical activities with the exception of equipment for calibration in the field by local offices or mobile units.

Other equipment required for the machine hall (room 31) and the volume and flow laboratory (room 7) is not included as it will be specified separately when more information about needs and practical solutions are available, see tentative specifications Annex A).

The various items are referenced with the laboratory room number followed by E used as identification letter for "equipment". Generally the use of this equipment is self-explanatory or has been indicated in the specification.







As the specifications by necessity are given in a condensed form, specific type number and manufacturer are listed in several cases with the mention "similar or identical to ...". This statement is exclusively given with the aims of facilitating the required item identification.

Though several of the items have already been included in previous preliminary equipment lists it is advised that the present list is considered as the basis of the planning and that previous lists were mainly intended for obtaining sufficient commercial information.



MASS METROLOGY CALIBRATION SCHEME

- | Item No | Description |
|---|--|
| <u>Mass metrology (Iraq)</u> | |
| 90E - 1 | <p>Primary national reference standard for mass 1 kg consisting of a solid cylinder of non-magnetic stainless steel with diameter equal to diameter and height. Execution with highest surface finish without any scratches, slightly rounded edges. To be adjusted with a tolerance of ± 1 mg or better on density basis 8000 kg/m^3 for the material and 1.2 kg/m^3 for air.</p> <p>The kilogramme shall have the identification mark ICG - A on the side of the cylinder obtained through slight depolishing and not by deep engraving.</p> <p>The kilogramme shall be submitted to Bureau International des Poids et Mesures, 92 Sevres, France for calibration. It shall be delivered in a suitable transport box and with a suitable handling tool.</p> |
| 90E - 2 | <p>One set of first-grade reference mass standards made from non-magnetic stainless steel and delivered in a suitable storage box. The shape of the weights to be cylindrical with integral knob similar to I.L. base but without adjustment cavity. Execution with highest surface finish without any scratch. Each weight to be adjusted to OIML tolerance (class E2) on the assumed density basis of 8000 kg/m^3 for the material and 1.2 kg/m^3 for air. Composition of the set:</p> <p>5 kg - 2 kg - 1 kg - 500 g - 200 g - 200^ag - 100 g</p> <p>The weights should bear no engraving except for a light star engraved on the knob of one of the 2 kg weights and one of the 200 g weights.</p> <p>To be delivered without handling tool but with a supply of 10 soft chamois leather pieces 120x120 mm (This set will be used as secondary standard for Iraq and be calibrated by scaling up and scaling down from the primary one kilogramme standard)</p> |
| <p><u>General for all sets of weights</u> : The manufacturer shall specify the types of material used and the mean density (mass per volume).</p> | |

- Item No Description
- 90E - 3 Two first grade reference mass standards of 10 kg made from non-magnetic stainless steel and delivered in one box. Shape of the weights to be solid cylindrical with integral knob according to OIML but without adjustment cavity. Adjusted to OIML class E2 tolerances on an assumed density basis of 1000 kg/m^3 for the material and 1.2 kg/m^3 for air. Highest surface finish without any scratch. There should be no distinctive marks except for one lightly engraved star on one of the weights.
- To be delivered without handling tool but with a supply of 10 soft chamois leather pieces $200 \times 200 \text{ mm}$. (These two weights will be used as secondary reference standards for Iraq and calibrated using a scaling-up operation from the set item 90E - 2)
- 90E - 4 Ten sets of first grade reference sets of analytical weights ranging from 100 g to 10 mg made from non-magnetic stainless steel exclusively and adjusted to the below-listed tolerances.
- Weights from 100 g to 1 g to be of cylindrical shape with integral knob, no adjustment cavity and no dirt-retaining deep engraving or stamping, slightly engraved identification acceptable. The knobs should have larger diameters than the OIML shape so as to enable easy handling with tweezers without risk of losing the grip. Adjustment basis 8000 kg/m^3 for the density of the material and 1.2 kg/m^3 for air.
- Denominations and tolerances:
- | | | | |
|-------|-----------------------|-----|-----------------------|
| 100 g | $\pm 0.05 \text{ mg}$ | 5 g | $\pm 0.02 \text{ mg}$ |
| 50 g | ± 0.03 | 3 g | ± 0.02 |
| 30 g | ± 0.03 | 2 g | ± 0.02 |
| 20 g | ± 0.03 | 1 g | ± 0.01 |
- Milligram weights to be made from flat band stainless steel wire bent to shapes corresponding to the denomination (, , , 1, , , , 1). Tolerances better than $\pm 0.01 \text{ mg}$. Denominations: 500 - 300 - 200 - 100 - 50 - 30 - 20 - 10 mg
- (Sets similar or identical to Stanton type SR10 but with improved adjustment tolerances)

Item No

Description

90E - 4
(continued)

The sets are to be supplied with suitably formed tweezers fitting the gorges of the weights and tipped with bone or hard plastics.

Each set to be marked on top of the box:

Iraqi Organization for Standards

100 to 10 mg

Set B 1

(or B 2 , B 3 , B 4 etc)

Use of the sets: One of the sets will be used as first grade reference set for Iraq and calibrated regularly by scaling down from the primary 1 kg standard. A second set will be used as secondary standard in various calibration activities in the primary mass laboratory. The remaining sets will be used as working standard weights for calibrating analytical balances inside and outside the ICS compound.

90E - 5

One set of secondary mass standards made from non-magnetic stainless steel for calibration of working standard weights. Shape of weights: cylindrical with integral knob without adjustment cavity.

All weights to be adjusted to OIML class E2 tolerances or better on assumed density basis of 8000 kg/m³ for the material and 1.2 kg/m³ for air.

Composition: 5 kg - 2 kg - 2* kg - 1 kg - 500 g
200 g - 200* g - 100 g

Each weight to be marked on the knob though very slight, not dirt retaining engraving as follows

5	2	2*	1	500	200	200*	100
C	C	C	C	C	C	C	C

The set is to be delivered in a box without handling tools but with a supply of 10 soft chamois leather pieces 120x120 mm. The set shall be marked on top of the box:

Iraqi Organization for Standards

5 kg to 100 g

Set C

Item No	Description
90E - 6	<p>Two secondary mass standards 10 kg made from non-magnetic stainless steel for calibration of working standard weights or precision balances, shape of weights to be cylindrical with integral handle(or knob) and no adjustment cavity. Each weight to be adjusted to OIML class E2 tolerances or better on an assumed density basis of 8000 kg/m^3 for the material and 1.2 kg/m^3 for air. Weights to be marked through slight engraving on their handles</p> <p style="text-align: center;">10 kg - IOS - C resp. 10 kg[*] - IOS - C</p> <p>The set shall be marked on the top of the lid</p> <p style="text-align: center;">Iraqi Organization for Standards 2 x 10 kg Set C</p>
90E - 7	<p>Dual-armed precision balance, capacity 20 kg sensitivity 0.05 division per milligram(20 mg per division) or better, equality of arms better than $2 \cdot 10^{-5}$; diameter of pans at least 250 mm. Preferably equipped with optical projection device to facilitate readings, mechanical pointer and scale acceptable if not available. Scale to be divided from left to right in 0 to 100 divisions with positive values only in case of optical reading(0 to 40 division with positive values only in case of mechanical pointer.)</p> <p>Intended use of the balance: Comparisons of precision weights in the range of 2 kg to 20 kg with an accuracy of .5 mg or better using transposition method and repeated weighings.</p>
90E - 8	<p>Dual-armed free-swinging balance, capacity 5 kg, sensitivity 0.2 divisions per milligram(5 milligram per division) or better, pan diameter min. 100 mm</p> <p>Other characteristics as for item 90E - 7.</p> <p>Intended use: Comparisons of precision weights at loads 2 and 5 kg, standard deviation 0.5 mg in repeated transposition weighings</p>

Item No	Description
90E - 9	<p>Primary calibration balance, dual-armed, capacity 1 kg, readability and reproducibility 0.01 mg with suitable optical projection reading device. Sensitivity 1 division(2 mm) for 0.1 mg change of load. Pan diameter minimum 100 mm.</p> <p>Purpose of balance: comparison of weights in the range of 1 kg to 100 g by transposition method using manual interchange of loads.</p>
90E -10	<p>Single pan substitution balance, capacity 1 kg, readability and reproducibility 0.1 mg. Direct reading optical range 1 g (or 1.2 g). Taring to 1 g min.</p> <p>Purpose of balance: Comparison of standard weights in the range 1 kg to 200 g by successive substitutions and taring to middle of optical range,(or by previous calibration of internal weights). To be used as complement to item 90E - 9 for more rapid evaluations.</p>
90E - 11	<p>Single pan substitution balance, capacity 200 g, readability and reproducibility 0.01 mg, optical range 120 mg.</p> <p>Purpose of balance: Comparisons of weights by successive substitutions in the range of 200 g to 10 g.</p>
90E - 12	<p>Microbalance, capacity 30 or 20 g, readability and reproducibility 0.001 mg. Equipped with frontal weight pan extractor for easy loading without disturbing thermal equilibrium of the balance.</p> <p>Purpose: Calibration of milligram weights by preliminary calibration of the in-built weights and of the optical scale using external standards(item 90E-4, set B1)</p> <p>Similar or identical to Mettler type M5SA or equivalent electronic model with at least 20 g capacity.</p>

Item No	Description
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One set of electronic balances for rapid calibration of weights or checking of contents of packages using printing facility. The balances should cover the following ranges with the indicated reproducibilities:

90E - 13	(0) to 201 g	± 1 mg
90E - 14	(0) to 1010 g	± 10 mg
90E - 15	(0) to 10100 g	± 100 mg

The balances shall be easily adjustable using external standard weights.

All balances shall be provided for connection to the same type of printer. Two identical printers shall be supplied with the set preferably with adding and subtraction facility. The apparatus shall be provided for operation on single phase 220 V 50 Hz mains. All necessary spares shall be provided such as fuses, etc as well as a supply of 300 rolls of paper for the printers and 20 spare ribbons if carbon ribbon printing is used.

Equipment to be similar or identical to

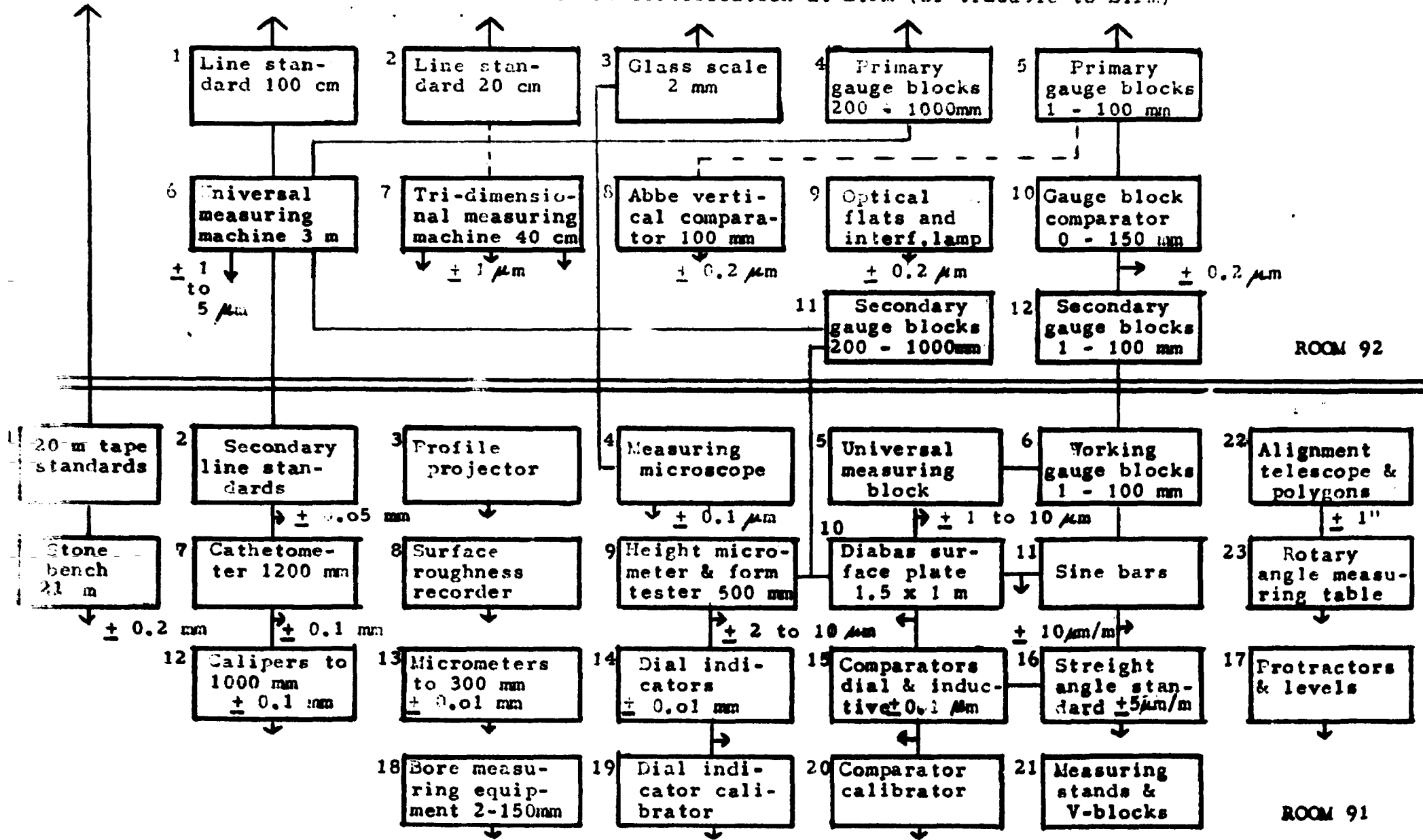
Mettler types

PT 320 + PT 1200 + PT 15 + printers GA20

or improved models subject to the following:

The balances shall be conceived to operate at temperatures between 18 and 32 °C. The influence of stray magnetic field from the balance mechanisms on materials such as cast iron should be less than 10^{-5} in relative value, i.e. less than 0.1 g for a 10 kg cast iron weight measured with item 90E - 15.

International certification at BIPM (or traceable to BIPM)



PRIMARY LENGTH AND DIMENSIONAL METROLOGY CALIBRATION SCHEME

Item No Description

Primary length metrology room

- 92E - 1 Primary reference line standard for length, length one metre made of nickel-plated steel, divided into mm, ciphered at each cm with two parts of the scale covering 1 mm divided into 0.1 mm located outside the normal divisions. Metre to have H-shaped form, accuracy and divisions generally as per SIP specification drawing 302152B. To be certified by BIPM for every cm to an accuracy of 0.1 μm .
- 92E - 2 Line standard 20 cm long, flat or slightly U-shaped, divided in mm, ciphered every cm. To be certified by BIPM to an accuracy of 0.1 μm . Material: nickel-plated steel.
- 92E - 3 Glass scale for calibration of measuring microscopes consisting of high-quality glass plate with 2mm length of divisions spaced at 0.1 mm. Accuracy of division 0.1 μm , thickness of lines 2 to 5 μm .
- 92E - 4 One set of primary gauge blocks grade H 00 consisting of 200, 300, 400 and 500 mm delivered in a box. Gauge blocks to be certified by internationally recognized laboratory. One gauge block, grade H00, length 1000 mm delivered in a box and internationally certified.
- 92E - 5 One set of primary gauge blocks, grade H00, consisting of 111 blocks with the following distribution:
 1.001 mm to 1.009 mm in steps of 0.001 mm
 1.01 mm to 1.49 mm in steps of 0.01 mm
 0.5 mm to 24.5 mm in steps of 0.5 mm
 25 mm, 50 mm, 75 mm and 100 mm.
 International certification required for the following gauge blocks: 10, 20, 25, 50, 75, 100 mm
 (Gauge block set similar or identical to Hommelwerke type V 111)
- 92E - 6 Universal measuring machine for external and internal measurements up to 3 m with incorporated standard scales, suitable for calibration of end gauges as well as line standards to an accuracy of 1 micrometer per meter length. Incorporating all accessories for measuring pitch of threaded spindles, lead errors of screws, thread diameter by three-wire method, optical measurements by silhouetting method, etc. Zeiss Jena model ULMM complete with cabinet for accessories.

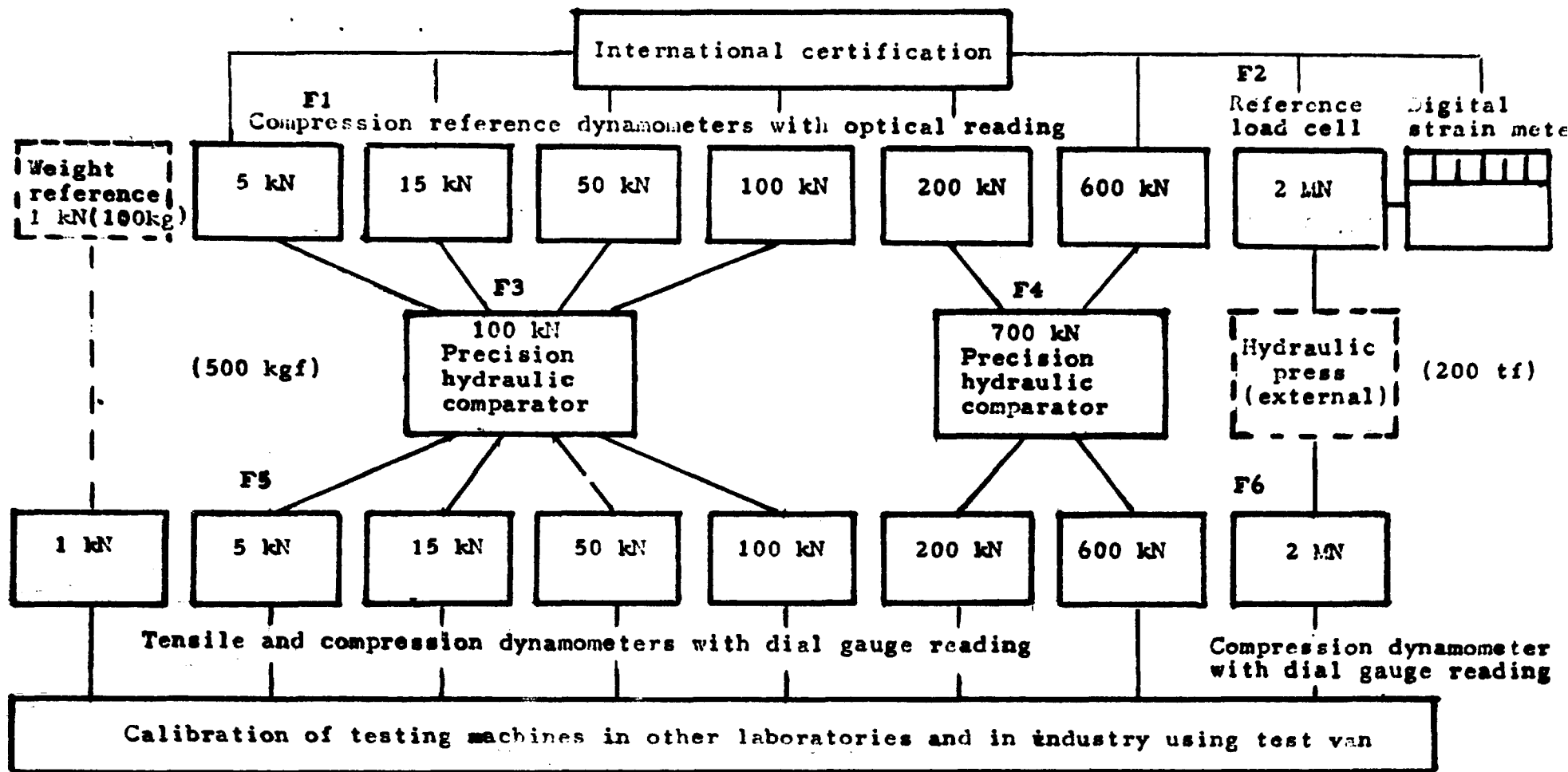
Item No	Description
92E - 7	<p>Universal tri-dimensional measuring machine also equipped for polar measurements, longitudinal travel 400 mm, transversal travel 100 mm, vertical travel 145 mm. Measurements on built-in high precision steel scales, accuracy 1 μm or better, readings possible to 0.1 μm. Equipped with microscope probes and multi-directional coordinate probe, circular table, double-image attachment for bore hole location, goniometric attachment, dividing head, V-supports, center supports, adjustable table, knife edges, attachment for vertical measurements without contact etc including table for supporting the instrument and for accomodation of accessories. SIF model MU-314 complete with additional accessories, including installation and demonstration.</p>
92E - 8	<p>Abbe vertical comparator and direct measuring machine range 100 mm, reading to 0.1 μm on internal glass scale, complete with all accessories, contact tips gauge and thread measuring equipment, spare parts etc Manufacturer: Zeiss Jena</p>
92E - 9	<p>Accessories for checking flatness and parallelism of end gauges consisting of one set of optical parallels in a box(Zeiss Jena) - 1 optical flat 45 mm diameter unevenness less than 0.1 μm and one do. 60 mm diameter (Zeiss Jena) - one interference lamp with one spare bulb(Hommelwerke)</p>
92E - 10	<p>Gauge block comparator comprising two inductive comparators, electronic analog indicator, heavy measuring stand, gauge block locator and manipulator, pneumatic lifting of gauge heads, measuring range minimum 100 mm preferably 175 mm, complete with additional measuring heads of axial and lever type for use on other equipment. (Carl Mahr, Tesa or Cary)</p>
92E - 11	<p>Set of secondary gauge blocks, grade H0, consisting of the following blocks 200, 300, 400, 500 and 1000 mm (make to be different from item 92E - 4, such as Carl Mahr). Gauges to be delivered in one box or separate boxes.</p>
92E - 12	<p>Secondary set of gauge blocks, grade 00, consisting of 111 blocks similar to item 90E-5 but of different make for identification purposes, factory certified. (such as Cary, Switzerland)</p>

Item No	Description
<u>Dimensional metrology, room 91</u>	
92E - 1	Three measuring tapes, 20 meter long, made from stainless steel, with engraved division every cm, graduation at lower edge. Best division quality accuracy 0.2 mm or better to be delivered with international certificate for every meter division. These tapes are to be used as standards for calibrating other tapes on a stone bench.
91E - 2	Meter sticks for secondary calibration, accuracy 0.02 mm or approaching, made of steel, divisions 0.02 to 0.03 mm thick. Two of length 0.5 m (identical or similar to Hommelwerke No 30751103) Two of length 1 m (do No 30751104) One of length 2 m (do No 30751105)
91E - 3	Profile projector for diascopic and episcopic examination and measurements of small parts, screen dimensions 560x460 mm with rotary objective and condenser turrets for magnifications 10x, 20x, 50x, and 100x, with filters, glass scales, circular protractor and spare bulbs and fuses; (Similar or identical to Hauser model H560 complete with accessories)
91E - 4	Precision measuring microscope with eyepiece micrometer and coordinate measuring table 70 x 50 mm and objectives x4, x6.3, x12.5, x16 and spare lamps. (Similar or identical to Zeiss Jena 70x50 equipment III)
91E - 5	Universal measuring block for use on surface plate for checking concentricity, parallelism or axial run-out. Comprising bed with sine bar rolls and removable centers. Center distance 0 to 200 mm, center height maximum 75 mm. Distance between centers of sine rolls 300 mm. (Similar or identical to Carl Mahr type 818 GX)
91E - 6	Working standard gauge blocks, grade H0 consisting of -121 gauge blocks 0.5 to 100 mm (Carl Mahr type 409/0) -20 thin gauge blocks in steps of 0.05 mm, range 0.05 to 1 mm (Carl Mahr type 416/1) -one set of gauge block holders and measuring jaws including scribes (Carl Mahr type 420 + 420h 100 to 420 mm + 42h 400 to 320 mm, maintenance kit 424, thermometer 422) -plug gauge set, nominal 5 mm, 20 gauges (Carl Mahr type 425)

Item No	Description
91E - 7	Cathetometer equipped with level and precision scale with length 1200 mm, accuracy 0.05 mm, with telescope and optics allowing observations at distances from 30 cm to 20 m.
91E - 8	<p>Surface roughness measuring and recording instrument, contact profile type, generally to ISO 3274, equipped with inductive sensor and measuring amplifier for evaluation of arithmetic average roughness R_a, peak to valley value R_{max} and peak to valley average height R_z, complete with</p> <ul style="list-style-type: none"> - drive unit for tracing length 15 mm, tracing speed 0.5 mm/s - single skid tracer for maximum 50 μm - double skid tracer for maximum 50 μm - steel stand with two-coordinate table - set of V-blocks for components up to 160 mm - replica kit - calibration master 50 μm - 50 rolls of special recording paper - supply of fuses and recommended spares <p>(Similar or identical to Perthometer C3A with recorder)</p>
91E - 9	<p>Precision height micrometer with digital indication combined with angle and form tester, total height 500 mm accuracy 5 μm or approaching for use on surface plate including standard accessories such as ball contact point, holders for dial comparators and dial indicators as well as special holders with zero setting, extension rods and setting devices.</p> <p>(Similar or identical to Carl Mahr type Digimar)</p>
91E - 10	<p>-Surface plate made of diabas, dimensions 1500x1000x160 mm, flatness tolerance better than 10 $\mu m/m$(grade 0) with four cast iron supports. Also for bench use: -surface plate, grade 00, dimensions 630x400x30 mm.</p>
91E - 11	Sine bars, 100 and 200 mm centre distances, accuracy better than 2 μm .

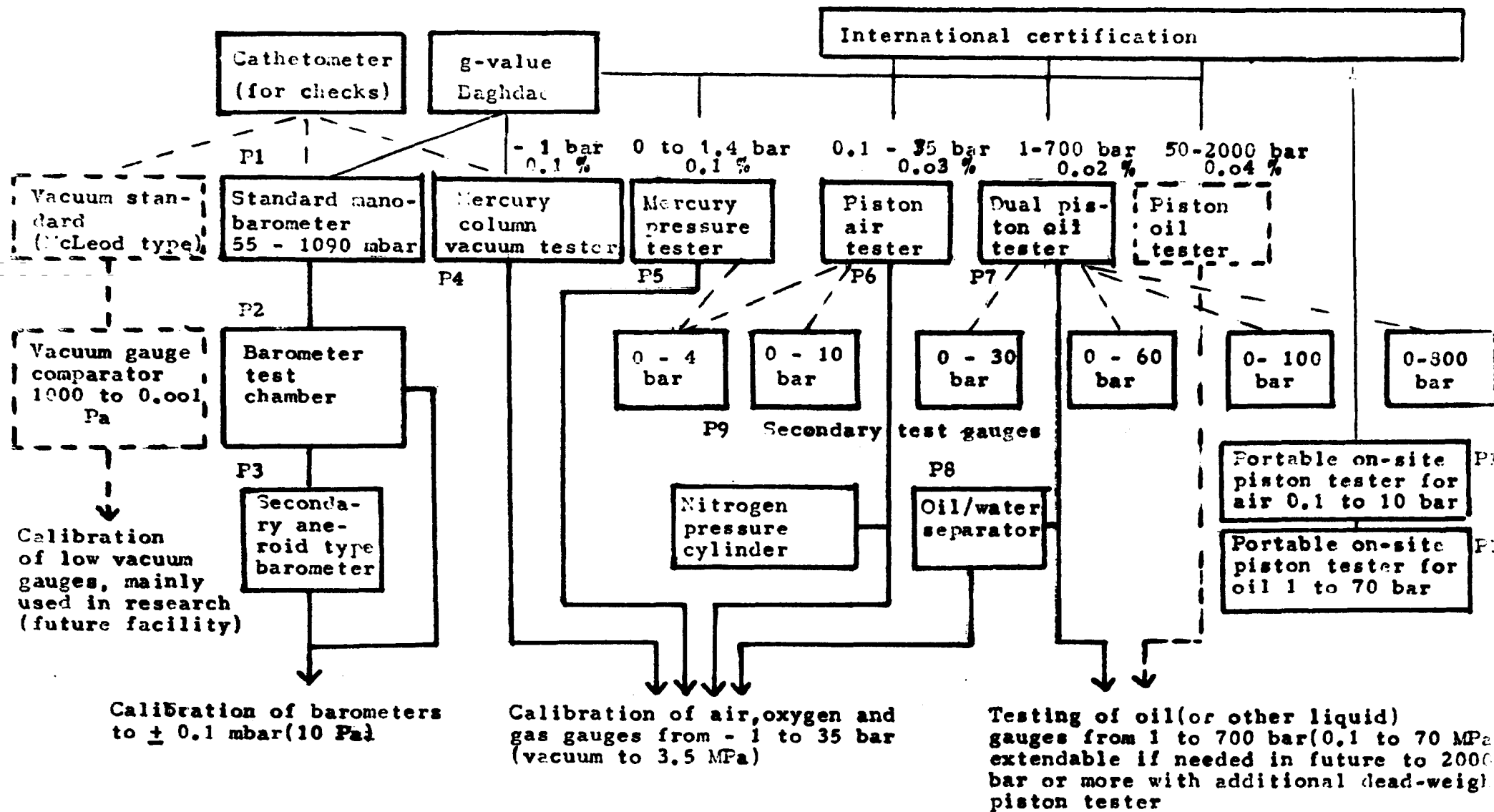
Item No	Description
91E - 12	<p>Precision calipers as follows:</p> <ul style="list-style-type: none"> 5 of stainless steel with hardened knife edges, chrome finish reading to 1/20 mm, length 250 mm supplied in wooden cases 1 inspection type with fine adjustment without knife edges reading to 1/50 mm, length 250 mm in wooden box 1 do. length 500 mm in wooden box 1 do. length 1000 mm in wooden box 1 depth gauge reading to 1/20 mm, range 200 mm 1 do, range 500 mm 1 precision vernier height gauge reading to 1/50 mm range 500 mm in wooden box with tungsten carbide tip and holder for dial indicator
91E - 13	<p>Micrometers as follows:</p> <ul style="list-style-type: none"> 1 set of micrometers from 0 to 200 mm reading to 0.01 mm along with set gauges delivered in one box 2 dial comparator micrometers, measuring range 0 - 25 mm readings on barrel to 0.01 mm, on dial comparator to 0.001 mm (similar to C. Mahr Millimar") 1 dial comparator micrometer with measuring discs, range 0 to 20 mm 1 micrometer holder on heavy base 1 depth micrometer, range 0 to 100 mm complete with accessories in wooden box.
91E - 14	<p>Dial indicators with stylos at right angle "tast" type, metric versions:</p> <ul style="list-style-type: none"> 2 with stylus length 14 mm range 0.8 mm reading to 0.01 mm 1 with stylus length 37 mm range 0.8 mm reading to 0.01 mm 2 with stylus length 14 mm range 0.24 mm reading 0.002 mm <p>Dial indicator with long measuring range:</p> <ul style="list-style-type: none"> 2 shockproof model range 10 mm reading to 0.01 mm 2 with range 30 mm reading to 0.01 mm 2 cable release for above indicators
91E - 15	<p>Dial comparators as follows:</p> <ul style="list-style-type: none"> 2 reading to 0.005 mm range \pm 0.13 mm 2 reading to 0.001 mm range \pm 0.05 mm 2 Electronic gauge heads with axial cable outlets measuring range 1 mm 2 lever type electronic gauge heads("tast" type) connections to fit indicator used for item 92E - 10)

Item No	Description
91E - 16	<p>-Cylindrical square of solid steel, height 300 mm</p> <p>-Toolmakers knife-edges 150 mm and 300 mm</p> <p>-Hardened square with knife edges 150 x 100 mm</p>
91E - 17	<p>-Optical bevel protractor reading to 5 minutes, blades 150 mm</p> <p>-Universal bevel protractor, blades 150 mm</p> <p>-Precision level with adjustable vial, length 200 mm reading to 0.02 mm per m</p> <p>-Frame level, length 200 mm reading to 0.1 mm per m</p>
91E - 18	<p>Bore measuring equipment, selfcentering two-point or three-point from 2 mm to 120(or 160 mm), delivered in suitable sets. Measurements by dial indicators to 0.005 mm or better. The sets are to be used for occasional checking of bore diameters in an inspection laboratory service, the best economical and technical solution should be chosen.</p> <p>(Suppliers: Zeiss Jena or Hommelwerke) or C. Mahr)</p>
91E - 19	<p>Tester for calibrating dial indicators, measuring range 12 mm readings to 0.001 mm including holding fixtures for most common diameters of dial indicators and inductive gauge heads.</p>
91E - 20	<p>Tester for calibrating comparators of mechanical or inductive type composed of micrometer and lever system. Measuring range ± 0.1 mm reading to 0.1 μm</p>
91E - 21	<p>-Heavy duty indicator stands(three) with triangular base, adjustable along with fixing accessories for dial indicators and dial comparators.</p>
91E - 22	<p>-One indicator stand with magnetic base. -V-blocks for 2-25 mm, 5-30 mm, 30-50 mm, 6-140 mm, 2 of each</p> <p>Alignment telescope, mirror with 100 mm base, 12-sided polygon etc permitting readings in x and y directions to 1 μm. (Suppliers: Zeiss Jena, Leitz or Rank Taylor-Hobson)</p>
91E - 23	<p>Optical circular table, diameter 315 mm, graduation reading to 1" (Zeiss Jena)</p>



FORCE CALIBRATION SCHEME

Item No	Description
<u>Force metrology</u>	
91E - F1	<p>Set of reference dynamometers enabling calibration of other dynamometers with an accuracy of 0.1 % within 10% and 100 % of full range, equipped with optical or other suitable means of observation of frictionless type and highest resolution corresponding to at least 0.01 % of range. To be delivered with international certificated from recognized national laboratory. Equipped for compression tests only with lower support plate and upper ball joint plate. Ranges of the dynamometers:</p> <p>5 kN - 15 kN - 50 kN - 100 kN - 200 kN - 600 kN</p> <p>In case of optical observation a suitable measuring microscope should be delivered which should also be used for the certification.</p>
91E - F2	<p>Reference load cell capacity 2 MN accuracy 0.03 % to be delivered with digital strain meter accuracy 0.01 %. The assembly shall be provided with international certificate delivered by a recognized national laboratory. The required stability between calibrations should be two years for an accuracy of 0.1 % and in normal laboratory use at temperatures between 15 and 35 °C without compression overload.</p>
91E - F3	<p>Precision hydraulic comparator for load cells and dynamometers capacity 100 kN(10 tonforce) consisting of a set of upper plates between which a standard reference compression type dynamometer (see item F1) may be placed and a lower part consisting of plates and traction fittings in which the tested load cell or dynamometer may be inserted. The device should be operated by a precision manual hydraulic jack permitting very fine adjustment of the force and without any leakage with closed valve. (The leakage should in any case not occasion any change of force higher than 1 N in ten minutes and the finess of adjustment of the jack and its needle valve should be such that steps corresponding to 1 N can be obtained).</p>
91E - F4	<p>Precision hydraulic force comparator for load cells and dynamometers capacity 700 kN(70 tonforce) identical to 91E - F3 above in other respects but with stability better than 10 N in ten minutes and adjustment possibility of the force to 10 N, or lower.</p>
91E - F5	<p>Set of compression and tensile dynamometers, accuracy 0.1 %, equipped with ball joints for compressions tests and all necessary linkages for tensile tests. Dial indicator, preferably with one type of divisions only(black). To be delivered with certificate from official test institution or recognized factory calibration service. Ranges:</p> <p>1 kN - 5 kN - 15 kN - 50 kN - 100 kN - 200 kN - 600 kN</p>
91E - F6	<p>Compression dynamometer for testing of compression testing machines, specifications otherwise as for item 91E - F5 , capacity 2 MN.</p>



PRESSURE CALIBRATION SCHEME

Item No	Description
<u>Pressure metrology</u>	
91E - P1	Standard <u>mano</u> -barometer accuracy ± 0.05 mbar or approaching, range 50 to 1100 mbar suitable for calibration of other barometers or manometers. Two-position reading on precision scale of upper and lower mercury level to ± 0.05 mm, inner diameter of tube at least 11 mm. Suitable for certification by official institute.
91E - P2	Barometer test chamber for connection to 91E - P1 above comprising chamber for mercury barometers and horizontal and vertical aneroid type precision barometers and low pressure gauges. Equipped with vacuum and overpressure pumps, pressure regulating valves, all required supplies, such as oil spare fuses etc for 220 V 50 Hz monophase operation.
91E - P3	Precision aneroid type barometer, precision 0.2 mbar or approaching suitable for connection to test chambers, range 50 to 1200 mbar
91E - P4	Mercury column vacuum tester with scale graduated in mm and second scale graduated in bar. Range 0 - 760 mm. Equipped with the following connections: 1/4 " - 3/8 " - 1/2 " BSP for vertical and angle mounting To be delivered with hand pump or (preferably with electrical vacuum pump and regulating needle valves) connection to external vacuum system should be possible through suitable T-connector.
91E - P5	Mercury column pressure tester, range 0 to 1.4 bar to be delivered complete with pump and the following connections 1/4 " - 3/8 " - 1/2 " BSP and angle connector
91E - P6	Single piston dead-weight pressure gauge calibrator for <u>air</u> range 0.1 to 35 bar, accuracy ± 0.03 % to be delivered with official certificate from recognized national laboratory and all adaptors as follows 1/8 " - 1/4 " - 3/8 " - 1/2 " BSP and angle connector 1/4 " - 1/2 " NPT and M 12x1.5 and M 20x1.5 as well as as triplicate sets of gaskets
91E - P7	Dual piston dead-weight pressure gauge calibrator for <u>oil</u> range 1 to 700 bar, accuracy ± 0.02 % to be delivered with official certificate from recognized national laboratory (piston mass and diameter), connectors and gaskets as for item 91E - P6.
91E - P8	Oil to water separator for use with item 91E-P7 in particular for testing of oxygen gauges to be delivered with all suitable connectors. Range of use 0 to 500 bar.

- Item No Description
- 91E - P9 2 sets of secondary test gauges, accuracy 0.25 %, diam. 150 mm consisting of
- 0 - 4 bar for use on air, connection 1/2" BSP
 - 0 -10 bar " " " "
 - 0 - 30 bar for use on oil, connection 1/2" BSP
 - 0 - 60 " " " "
 - 0 -100 " " " "
 - 0 -800 " " " "

All manometers to be delivered without mounting flange in suitable transport boxes.

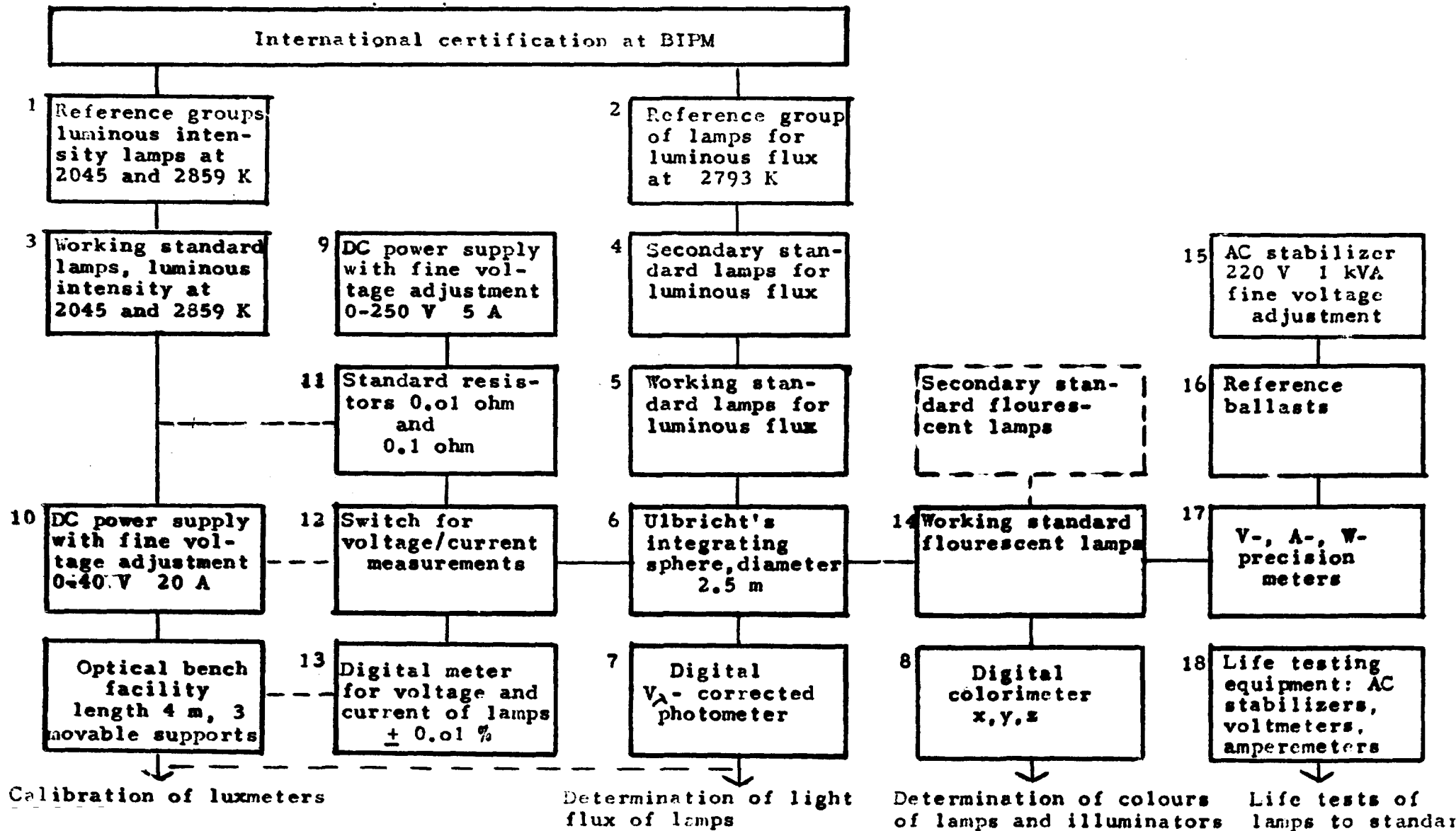
- 91E - P10 Portable on-site piston dead-weight tester complete in transport box. range 0.1 to 10 bar, accuracy 0.03 % to be delivered with official certificate from recognized national laboratory, for tests using air, including suitable pump, and connections for 1/8 " - 1/4 " - 3/8 " - 1/2 " BSP
- 91E - P11 Portable on-site piston dead-weight tester complete in transport box for testing using oil, range 1 to 70 bar, accuracy 0.05 %. To be delivered with official certificate from recognized national laboratory, including connections for 1/8" - 1/4 " - 3/8 " - 1/2 " BSP and sets of gaskets.

Hardness metrology

Hardness testing machines used in industry can be inspected as regards load and intender with equipment foreseen in the mass and engineering metrology laboratories. It is easier however to do such checks using certified hardness blocks. It is for the moment simply suggested to procure the following blocks:

- 91E - H1 Certified hardness blocks for verification of Brinell hardness testing machines under normalized load conditions for steel $F/D^2 = 30$ generally to ISO R156:
- 10 of hardness comprised between 100 and 200 HB
 - 10 of " " " " 200 " 350
- 91E - H2 Certified hardness blocks for verification of Vickers hardness testing machines according to ISO R146, load 30 kgf
- 5 of hardness comprised between 100 and 200 HV30
 - 5 " " " " 250 " 350 HV30
 - 5 " " " " 600 " 750 HV30
- 91E - H3 Certified hardness blocks for verification of Rockwell hardness testing machines according to ISO R716:
- 5 of Rockwell C(steel) between 20 - 30 HRC
 - 5 " " " " 35 - 55 HRC
 - 5 " " " " 59 - 65 HRC
- 91E - H4 Certified hardness blocks for verifications to ISO R716:
- 5 of Rockwell B(metals) between 40 - 60 HRB
 - 5 " " " " 80 - 100 HRB

All blocks should for each type be of the same lot of manufacture.

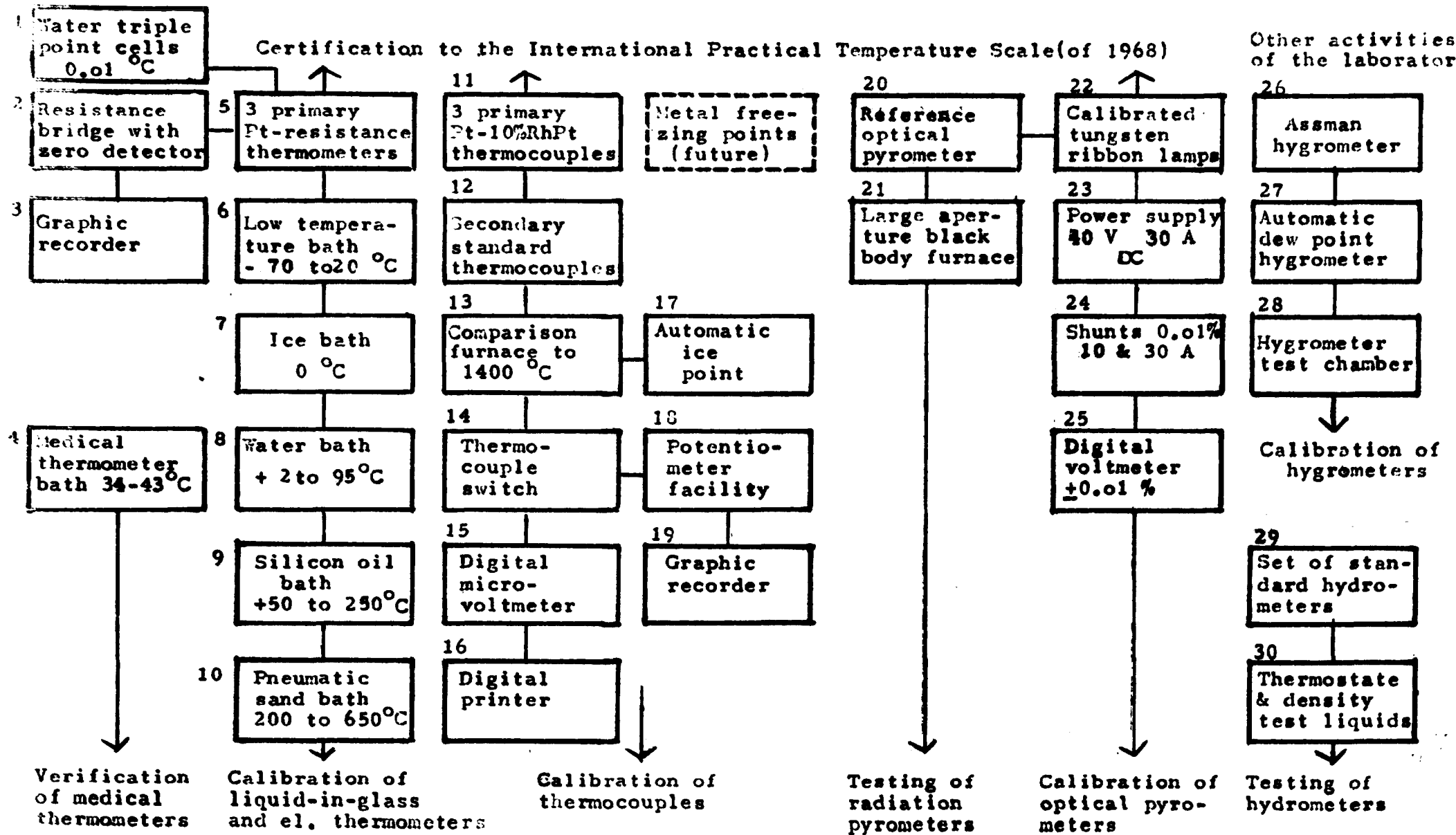


PHOTOMETRY CALIBRATION SCHEME

Item No	Description
<u>Photometry, room 104</u>	
104E - 1	<p>Standard lamps for luminous intensity, construction similar to Osram type Wi 40 V and Wi 40 G. The former will be used at a voltage such that the colour temperature approaches 2045 K. The second type is gas-filled and will be used at a voltage such that the colour temperature approaches 2850 K.</p> <p>Required quantities: 10 of Wi 40 V (whereof 5 shall be selected for the group of Iraqi national reference standards) 10 of Wi 40 G(- ")</p> <p>All lamps shall be sent by the supplier to Bureau International des Poids et Mesures, 92 Sevres, France for calibration. They shall be returned to IOS, Baghdad as hand-carried parcels.</p>
104E - 2	<p>Standard lamps for luminous flux, gasfilled with welded filaments, clear bulbs, nominal wattage 200 W, working voltage 100 V. Similar or identical to Osram type Wi 5. The lamps are to be burnt-in and calibrated at Bureau International des Poids et Mesures, 92 Sevres, and will thereafter be transported hand-carried to IOS, Baghdad. Required quantity: 25, (whereof 10 will after burning in and stability tests be selected by BIPM to constitute the Iraqi national reference group for luminous flux, adjusted to a colour temperature close to 2793 K.</p>
104E - 3	<p>This item is included in item 104E - 1, i.e. remaining lamps not selected as national reference.</p>
104E - 4	<p>This item is included in item 104E- 2 and is constituted by those lamps which were not selected to constitute the national reference group.</p>
104E - 5	<p>Working standard lamps 25 to 500 W selected from best type of lamps available on the local market, they should be of the same type and size as the corresponding lamps tested.</p>
104E - 6	<p>Ulbricht's integrating sphere to be delivered in four parts, diameter of the sphere 2,5 meter along with all lamp fitting accessories for incandescent and fluorescent lamps, auxiliary housing with lamp for absorption measurements, but without photometer.</p>

- | Item No | Description |
|-----------|---|
| 104E - 7 | <p>Digital photometer with V_{λ}- corrected silicon photocell, manually switched ranges, suitable for use at high level as well as low level illumination for calibration of lamps for luminous flux and luminous intensity by comparison attached to Ulbricht's sphere or on optical bench. To be supplied with 3 meter measuring cable and equipped for 220 V 50 Hz mains.</p> <p>(Suppliers, Osram Germany or Lichttechnik, Berlin)</p> |
| 104E - 8 | <p>Digital colorimeter suitable for evaluation in three coordinates of the colour of light sources such as fluorescent lamps etc, with all other accessories for colour measurements on other sources such as illuminated surfaces.</p> <p>(Suppliers: Osram, Germany and Lichttechnik, Berlin)</p> |
| 104E - 9 | <p>DC power supply output 0 to 250 V DC, maximum current 5 A equipped with very fine adjustment of voltage, resolution 0.01 V or approaching. Stability 0.01 % or better against voltage (15 %) variations of mains. For connection on 220 V 50 Hz mains. To be supplied with spare fuses and other consumable parts.</p> <p>(Two units should preferably be ordered, one kept as spare)</p> |
| 104E -10 | <p>DC power supply, output 0 to 40 V, maximum current 20(or 30) A, with very fine adjustment of voltage, resolution 0.002 V or approaching. Stability 0.01 % against 15 % voltage variation of mains. For connection on 220 V 50 Hz monophas. To be supplied with spare fuses and other consumable parts.</p> <p>(Two units shall be ordered, one kept as spare)</p> |
| 104E - 11 | <p>Standard resistors, four-terminal, accuracy 0.01 % 0.001 ohm 50 A, 0.01 ohm 10 A, 0.1 ohm 3 A or approaching values.</p> |

Item No	Description
104E - 12	Switch, two-pole, two - positions, insulation for 500 V DC, silver or special alloy contacts, delivered in box with connection terminals. No overlapping between measuring positions. Current carrying capacity 1 A. Suitable for use as switch for connecting alternatively the potential leads of a shunt and the potential leads from a lamp to a digital voltmeter. (Supplier: Cropico, UK and others)
104E - 13	Digital voltmeter, accuracy class 0.005, minimum 5 to 6 digits, suitable for DC measurements of voltages of the order of 100 V with an accuracy of 0.01 V. Preferably also suitable with rms converter for measurement of AC voltages of the order of 200 V with an accuracy of 0.1 %. True rms conversion preferred. Also equipped with ohms measuring facility. Mains connection: 220 V 50 Hz. To be supplied with all necessary spares such as fuses etc. (Two units should preferably be ordered of this type)
104E - 14	(Working standard lamps may probably be procured on the local market, if not suitable such lamps must be imported. The types should be the same as those intended to be calibrated)
104E - 15	AC stabilizer, stability 0.01 % or approaching for mains variation of ± 10 %. Low limit of operation nominal voltage less 15 %. Output power 1 kVA, nominal voltage 220 to 240 V. adjustable with high resolution. (Suppliers: Philips, Holland - Sorensen, Switzerland)
104E - 16	Reference ballasts for testing fluorescent lamps, to be delivered with individual certificates. The choice of types should be made according to the type of fluorescent lamps to be tested(different wattages). (Suppliers: May & Christie, Germany, Brown Boveri, Germany)
104E - 17	Precision measuring set consisting of two voltmeters one amperemeter and one wattmeter all with very low consumption suitable for measurement and control of fluorescent lamps, insensitive to waveform. Wattmeter range 20 W to 500 W, resolution 0.01 W on lowest range. (Supplier: Marek, Germany)
104E - 18	3 AC stabilizers similar to item 104E-15 but 10 kVA 3 voltmeters 30 to 600 V 0.5 % moving iron type 3 amperemeters 0.3 to 6 A " 1 wattmeter 200 V max 6 A & 1 current trf 0.1 to 50 A



Item No	Description
<u>Thermometry, room 105</u>	
105E - 1	3 triple point cells containing water of isotopic content as specified for realizing the fundamental thermodynamic and IPTS temperature point of 0.01 °C with an accuracy of at least ± 0.2 mK or better. Also 1 suitable dewar container. (Supplier: Spembly, U.K.)
105E - 2	High-accuracy resistance bridge suitable for four-terminal platinum resistance primary thermometer measurements with a resolution better than 1 mK at 0°C. Also suitable for measurements on resistance thermometers with $R_0 = 100$ ohm and $R_0 = 2$ ohm. Double-bridge DC type, or current comparator principle with one balancing only, complete with detector for connection to graphic recorder of potentiometer type. Operation on batteries or on mains 220 V 50 Hz. (Supplier: Leeds & Northrup, model ER, or Guildline, Canada)
105E - 3	Graphic recorder, flat-bed laboratory type, potentiometer principle with ranges from 1 mV to 1 V full scale, 250 mm, and speed ranges from 1 mm/s to 30 mm/h or approaching. Suitable for connection to item 105E - 2. To be delivered for 220 V 50 Hz operation along with 30 rolls of paper and 20 pen cartridges.
105E - 4	Bath for testing medical thermometers with fully electronic control of two set-points. Accuracy of temperatures 0.01 K, range 34 to 43 °C settable. Space for at least 100 thermometers.
105E - 5	3 primary resistance thermometers, platinum wound in protective atmosphere, ice resistance 25 ohm, length of quartz tube at least 400 mm, to be supplied with calibration table established on actual calibration by recognized national laboratory at the points of oxygen boiling point, triple point of water and freezing points of tin and zinc (and antimony) Packed individually in suitable transport boxes. (Suppliers: Tinsley, U.K., Leeds & Northrup)

- | Item No | Description |
|-----------|---|
| 105E - 6 | <p>Low temperature calibration bath for liquid-in glass or electrical thermometers, range - 170 °C (or more) to ambient room temperature (or more), equipped for cooling with liquid nitrogen. Including liquid nitrogen controller. Immersion depth minimum 250 mm, immersion diameter 15 cm. Equipped with bottom agitation and accurate platinum resistance sensor controlled temperature regulation with setting resolution of 0.1 K or better and stability better than 0.01 K. Uniformity of temperature in test zone to be better than 0.005 K at ambient temperature. Alternatively: mechanical refrigeration</p> |
| 105E - 7 | <p>Ice point bath for calibration of liquid-in glass and electrical thermometers, useful diameter of immersion minimum 6 cm, immersion depth minimum 20 cm equipped with air agitation device for maximum air saturation of air-water mixture, glass dewar model.</p> |
| 105E - 8 | <p>Low temperature bath for calibration of liquid-in glass and electrical thermometers in the range of - 30 to + 100 °C using silicon oil (Corning No 200 or similar) or using water between + 2 and 95 °C, equipped with mechanical refrigeration for 220 V 50 Hz mains, immersion depth minimum 250 mm, immersion zone diameter minimum 150 mm. Equipped with bottom agitation and accurate platinum resistance sensor controlled temperature regulation with setting resolution of 0.1 K or better, stability better than 0.01 K. Uniformity of temperature to be better than 0.005 K in the test zone at ambient temperature.</p> |
| 105E - 9 | <p>Special oil bath for calibration of liquid-in glass and electrical thermometers in the range of + 50 to + 250 °C characteristics as for item 105E - 8 but without refrigeration. Suitable calibration liquid to be supplied equivalent to 5 full charges of the bath.</p> |
| 105E - 10 | <p>Pneumatic sand bath suitable for calibration of thermometers in the range of 200 to 650 °C using alumina or other powder. Temperature regulation and stability to be better than 0.1 K. To be supplied complete with air blowing unit and regulator for 220 V 50 Hz mains
(Supplier: Techna, UK)</p> |

- | Item No | Description | | | | | | | | | |
|-----------|--|-------------------------------|---------------------|-----------|--------|---------------------|---------------|--|--|-------------------------------|
| 105E - 11 | 3 primary platinum-10%rhodiumplatinum thermocouples first grade to IPTS - 68, mounted in twin-bore tubing and protective tube of alumina, diameter of wires 0.5 mm, total length of wires 1.5 m, total length of tube 600 mm. To be supplied in individual boxes along with certificate from national physical laboratory in accordance with IPTS-68. | | | | | | | | | |
| 105E - 12 | <p>(a) -2 secondary platinum-10%rhodiumplatinum thermocouples according to IPTS-68, length of individual wires 2 m, diameter 0.5 mm. Supplied without twin-bore tubing nor protective tube.</p> <p>(b) -2 secondary metal-clad platinum-10% rhodiumplatinum thermocouples, length 1 m, diameter 1.6 mm of sheath, sheath made of 10%rhodium-platinum, with adjustable seal and end caps of plug-in type.</p> <p>(c) -2 compensating wire systems with plugs fitting the previous item, length of each 3 meter.</p> <p>(d) - 100 pieces of twin alumina bore tubing, each 5 cm long suitable for 0.5 mm wires</p> <p>(e) - 20 pieces of closed end alumina tubes suitable for the above twin bore tubing, length 600 mm</p> | | | | | | | | | |
| 105E - 13 | <p>Thermocouple comparison furnace, operating temperature 1400 °C or more, furnace chamber minimum 400 mm, diameter minimum 25 mm, suitable for comparison of thermocouples down to 200 °C, complete with monitoring thermocouple and control unit consisting of stabilized voltage or current supply for connection to 220 V 50 Hz monophasic.</p> <p>(Similar or identical to Johnson-Matthey type TK 4 with model 18H1 control unit)</p> | | | | | | | | | |
| 105E - 14 | <p>Thermocouple switches, two pole, with parasitic emf less than 0.1 uV, contacts of suitable material with very thermal emf against copper. Supplied in boxes with copper or gold-plated copper pole screw connections.</p> <table border="0" style="margin-left: 40px;"> <tr> <td>4 each</td> <td>12-way type, 2 pole</td> <td>2 each of</td> </tr> <tr> <td>2 each</td> <td>24-way type, 2 pole</td> <td>4-way, 4-pole</td> </tr> <tr> <td></td> <td></td> <td>(for resistance thermometers)</td> </tr> </table> <p>(Supplier: Croydon Instruments U.K. or similar)</p> | 4 each | 12-way type, 2 pole | 2 each of | 2 each | 24-way type, 2 pole | 4-way, 4-pole | | | (for resistance thermometers) |
| 4 each | 12-way type, 2 pole | 2 each of | | | | | | | | |
| 2 each | 24-way type, 2 pole | 4-way, 4-pole | | | | | | | | |
| | | (for resistance thermometers) | | | | | | | | |
| 105E - 15 | Digital microvoltmeter suitable for thermocouple measurements down to 1 μV, preferably to 0.1 μV, 5-digits with insulated output for digital printer. | | | | | | | | | |

Item No	Description
105E - 16	Digital printer suitable for connection to item 105E - 15, including scanning unit for up to 10 channels connectable to the input of item 105E- 15 for successive recording(or parallel) of thermocouple voltages measured with item 105E-15. Automatic printing times settable from 30 seconds to 30 minutes. Connection through IEC bus. 220V50Hz mains.
105E - 17	Automatic ice point, accuracy 0.01 K comprising tube for thermometers or thermocouples, diameter 15 to 30 mm, depth minimum 150 mm, operating on the principle of frigistor cooled and heated bellow enclosing distilled water. (Similar or identical to "Zerof" made by Mectron Frigistor, U.K.)
105E - 18	Potentiometer facility comprising 5(or 6-digit) precision cascade type potentiometer allowing measurements to 0.1 μ V, preferably to 0.01 μ V. Complete with mains stabilized supply for current, null detector, external connection to standard cell enclosure. Null detector suitable for connection to potentiometric recorder. Linearity of potentiometer better than 0.01 %.(Null detector also to be used separate)
105E - 19	Graphic recorder, identical to item 105E - 3
105E - 20	Precision optical pyrometer suitable for calibration of other pyrometers based on radiation measurements. Complete with tripod stand, battery operated supply calibrated disappearing filament lamp and one spare calibrated lamp. (Suggested supplier: Leeds and Northrup)
105E -21	Large aperture black body furnace, emissivity factor higher than 0.99, temperature range up to at least 1400 $^{\circ}$ C, complete with controllable power supply for operation down to 50 $^{\circ}$ C of the furnace, connectable to 220 V 50 Hz mains (or 360 V threephase). Diameter of horizontal opening minimum 30 mm. Suitable for checking radiation pyrometers(or two-colour pyrometers) with disappearing filament optical pyrometer item 105E -20. (Possible suppliers: Eppley, USA, Leeds & Northrup, U.K.)

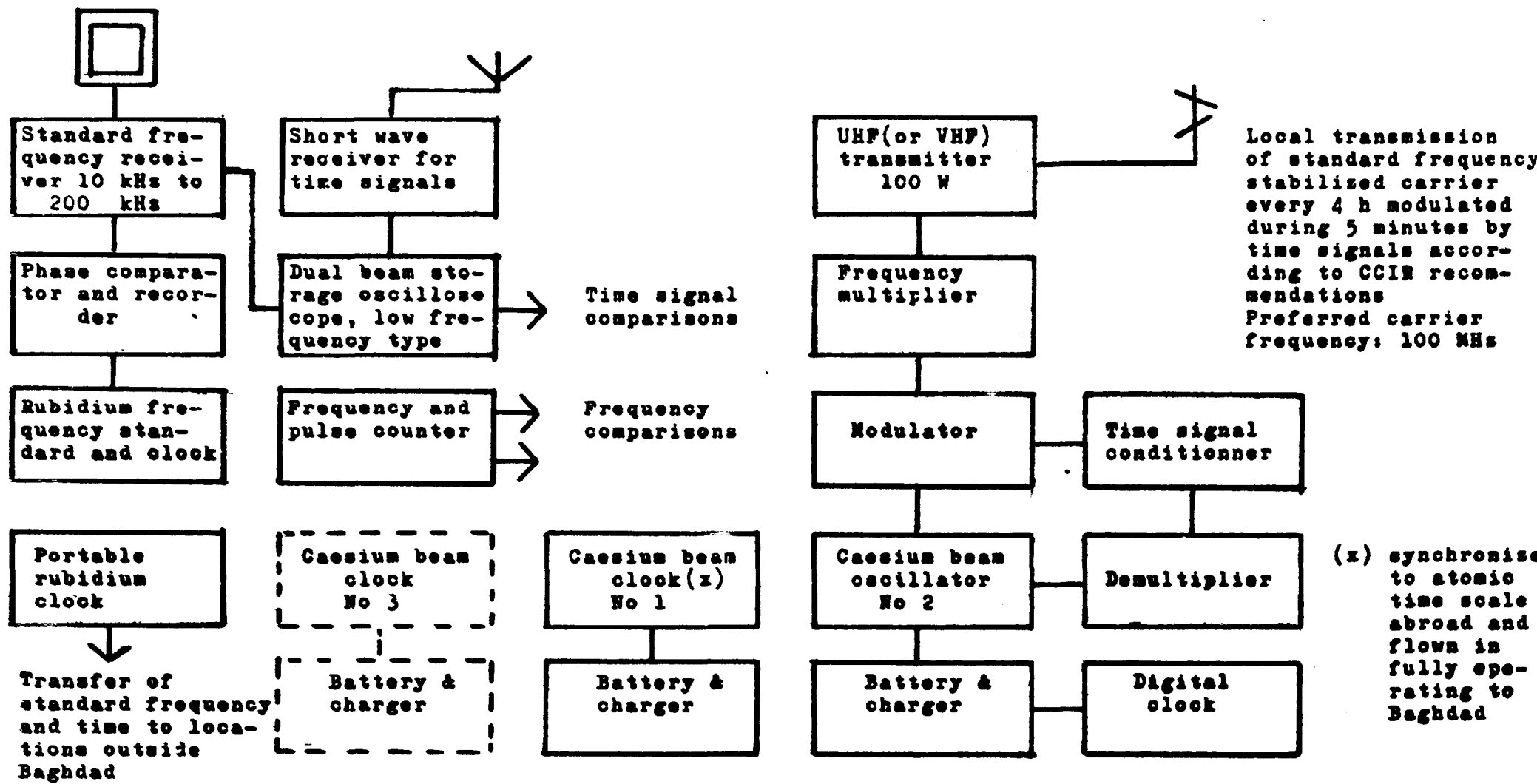
- | Item No | Description |
|-----------|---|
| 105E - 22 | <p>Calibrated tungsten ribbon lamps for calibration of optical pyrometers consisting of</p> <p>3 Vacuum type for temperature range 700 to 1400 °C</p> <p>3 Gas-filled type for range 1000 to 2100 °C</p> <p>To be supplied with calibration certificates with respect to current, established by a recognized national laboratory in terms of IPTS-68, also two supports.</p> <p>(Suppliers: General Electric, U.K. or Osram FRG)</p> |
| 105E - 23 | <p>Direct current power supply stabilized in current to 0.01 %, maximum current 20 A maximum voltage 40 V. Regulation by four-terminal precision shunt, short-circuit safety devices when connected as voltage supply. For connection to 50 Hz 220 V single phase. Current (and voltage) controls to consist of at least two potentiometers, one preferably with multi-turn potentiometer so as to allow a current resolution of 10 mA.</p> <p>(Supplier: P. Fontaine, France and others)</p> |
| 105E - 24 | <p>Four-terminal shunts, output voltage 100 mV minimum current ranges 10 A and 20 A. If not available: 30 mV for 30 A and 100 mV for 10 A to allow direct evaluation of current using digital voltmeter connected to the potential leads. Precision ± 0.02 % or better.</p> |
| 105E - 25 | <p>Digital voltmeter, multimeter type with at least 5 digits. DC - accuracy better than 0.005 %. With ohms ranges, accuracy better than 0.01 %, may be combined with item 105E - 15 for use with printer. Preferably with incorporated calibration check facility.</p> |
| 105E - 26 | <p>Assman hygrometer suitable for connection to or use in climatic chamber for calibration of other hygrometers. Psychrometer table to be supplied as well as certificates for the thermometers used. Quantity: 2</p> |
| 105E - 27 | <p>Dew-point hygrometer, precision type with frigistor cooling and electronic detection. (Tentative specs)</p> |

Item No	Description
105E - 28	Climatic chamber suitable for calibration of, or adjustment of hygrometers, fully saturable type to 98 % humidity or more and drying possibility down to 10 % or less of R.H. Temperature range 5 to 50 °C or ambient to 50 °C.
105E - 29	Set of primary hydrometers for verification of other hydrometers or density determination devices ranging from 600 kg/m ³ (or g/ml) to 1000 kg/m ³ with low surface tension and from 1000 to 2000 kg/m ³ with medium surface tension, adjusted at 20 °C, each with 20 (or 25) kg/m ³ range. Generally according to first grade hydrometers of British Standards Institute specifications. To be supplied with calibration certificate from recognized national calibration laboratory and in suitable boxes, or storage containers. Very careful individual packing should be made for transport so as not to break the stems.
	(a) One set of secondary hydrometers range 600 to 2000 kg/m ³ in suitable boxes, range of each 50 kg/m ³ adjusted at 20 °C.
105E -30	Suitable thermostated jacket for calibration of hydrometers along with circulating thermostate accuracy at least 0.01 K, range - 20 to + 100 °C.
	(b) Also surface tension measuring instrument, preferably electronic model.
105E -31	Laboratory thermometers to BS 593, graduated in 0.1 K steps from - 0.5 to + 40.5 °C for total immersion, maximum error 0.2 K. Quantity : 30
	(b) Reference thermometers to BS 1900, graduated in 0.1 K steps from - 1 to + 51 °C. length 500 mm, maximum error 0.2 K. Quantity: 15
	(c) Short-stem thermometers to BS 1865, length 210 mm, graduated in 0.2 K steps from - 10 to + 55 °C for total immersion. Quantity: 20
	(d) Total immersion thermometers to BS 1704 length 300 mm graduated in 0.5 K from - 5 to + 150 °C. Quantity: 20
	(e) Total immersion thermometers to BS 1704 length 300 mm graduated in 1 K steps from - 5 to + 250 °C. Quantity: 20

Supplier: Zeal, U.K. and others

Item No	Description
105E - 32	Water demineralizer, ion exchange type, with regeneration system, suitable for producing at least 10 litres of pure water per hour, complete with all spares and conductivity meter operating on IEC R 20 or R 14 dry cells.
105E - 33	Ice maker producing ice cubes, capacity at least 20 kg/day. Operating on 220 V 50 Hz mains.
105E - 34	Ice shaving machine, household or restaurant type with all necessary spares (blades) etc for 220 V 50 Hz operation.
105E - 35	Suitable equipment for thermometer reading including telescope on stand reading distance down to 300 mm, magnifying glasses, and tripod stands for holding thermometers and resistance thermometers, heavy duty, adjustable types. (Suppliers: Pye, Spindler & Hoyer, Ealing, or Bouty, France)
105E - 36	Portable thermocouple potentiometer and test set. <u>Thermometry equipment for general use in the other laboratories and distributed by the thermometry laboratory:</u>
105E - 37	Large scale room hygrometers 0 - 100 % R.H.
(a)	Quantity: 20
(b)	Room thermometers, well visible type, precision 0.5 K Quantity: 20
(c)	Recording thermometer with alternatively 24 h or 7 day clockwork paper drive for recording of room temperatures between 15 and 45 °C with highest resolution (control of climatic equipment). Quantity: 6 supply of paper and ink cartridges for two years operation at weekly rate.
(d)	Recording thermo-hygrograph for both temperature and humidity simultaneously on the same paper, range temperature +15 to 45°C or approaching, 0 - 100 % R.H. Quantity: 6 + supply of paper and ink cartridges for two years operation at weekly rate. Clockwork paper drive 24h or 7 day rotation, selectable.
(e)	Barograph calibrated in millibar with 7 days clockwork mechanism. Quantity: 1 + supply of paper and ink for one year operation

Item No	Description
105E - 38	Two analog millivoltmeters suitable for use with iron-constantan thermocouples. Millivolt scale and direct reading scale. (Supplier: Hartmann & Braun, FRG and others)
105E - 39	Thermocouple wire, glassfiber insulated: (a) 200 double meter copper-constantan 0.2 mm diameter (b) 1000 double meter iron-constantan 0.5 mm diameter (c) Platinum resistance sensors Pt 100 with $R_0 = 100$ ohm type P4 Quantity: 10 Supplier: Degussa, FRG



FREQUENCY AND TIME CALIBRATION SCHEME

Frequency and time, room 107

The schematic diagramme is selfexplanatory to experts within the field of frequency and time standards and can be submitted as such for obtaining quotations.

Redundancy is an absolute must for the preservation of the time standard to highest accuracy (of the order of 1 microsecond if synchronized at an observatory abroad and flown-in to Baghdad). Time signals received from foreign radio transmissions are subject to variations up to several milliseconds and sometimes more due to ionospheric variations. The reception of foreign time signals should be made mainly for control purposes.

The local transmission of standard frequency and time signals on VHF or UHF bands is not subject to disturbances but has only line-of-sight coverage. In order to make calibration of frequency and time possible with highest accuracy available at other places than Baghdad, the most convenient is to use a portable rubidium stabilized oscillator and clock together with suitable periferic equipment such as oscilloscope and counters.

As a start it is considered that time can be preserved if the laboratory is equipped with two independent caesium clocks, whereof one is used for transfer of time. To increase the redundancy the system may in future be increased to include a third caesium clock as shown.

All the clocks, but not the transmitter, should have their independant stand-by battery supplies and charging devices and conceived so as to stand a power break for up to 48 hours. The room must be air-conditioned all the time so as to keep the temperature between 18 and maximum 28°C. An emergency air conditionner working on an emergency power supply must therefore be installed and enter into operation when required.

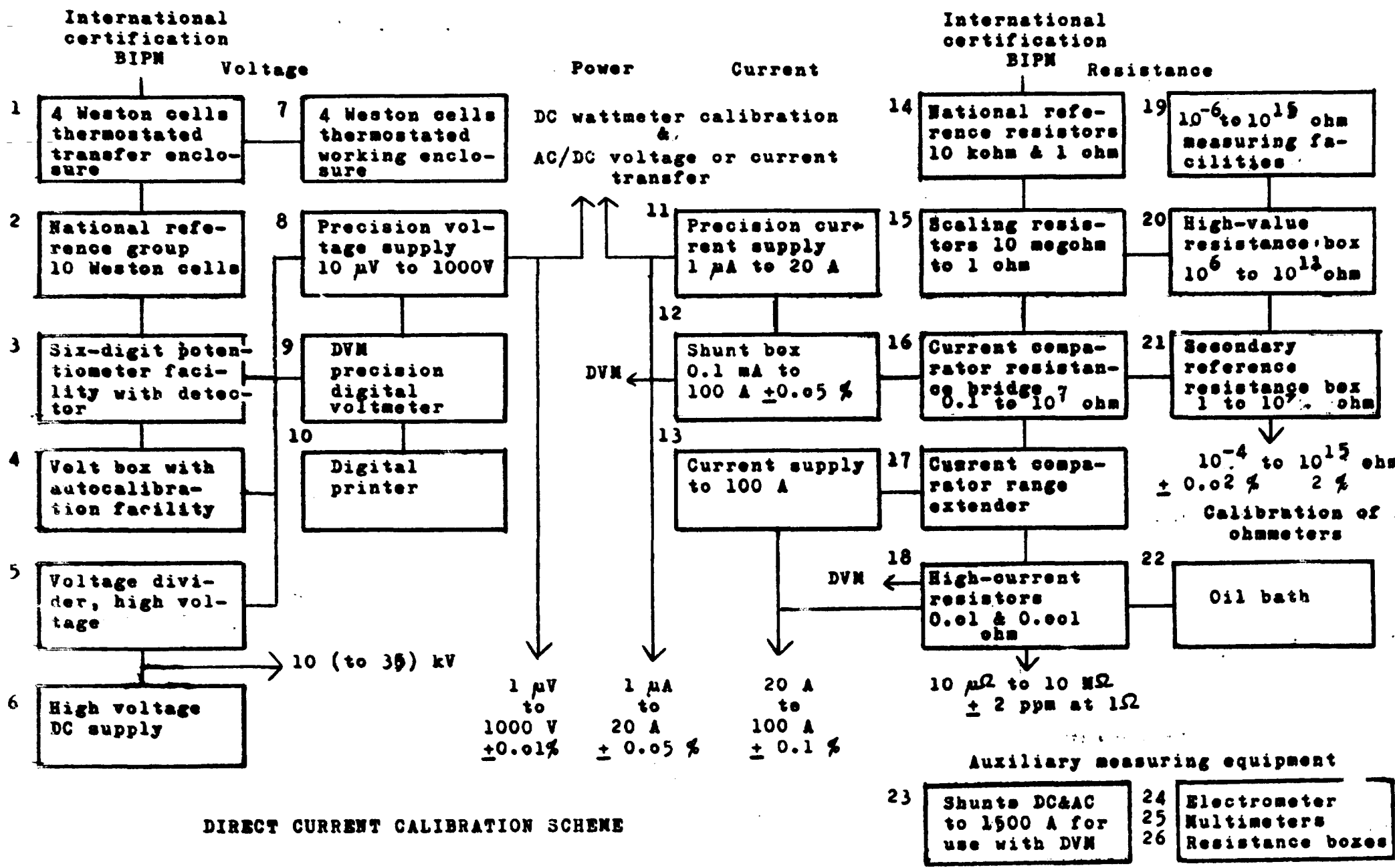
Suppliers of time and frequency standards:

Rohde & Schwartz, P.O.B. 801469, D-8000, Munich, FRG

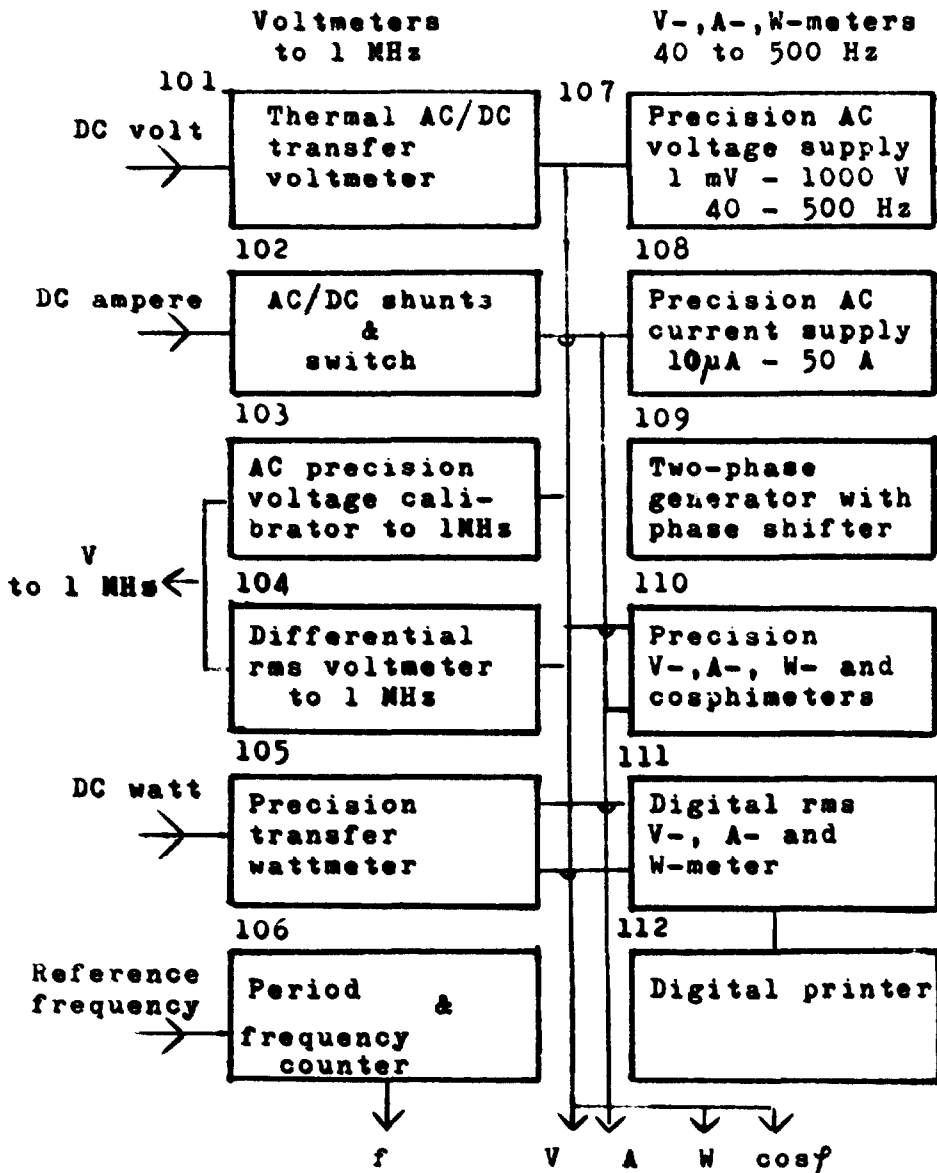
Oscilloquartz SA, 2001 Neuchâtel, Switzerland

Hewlett-Packard, CH-1217 Meyrin 2, Geneva, Switzerland

Note: Receiving and transmitting antennas should be quoted



DIRECT CURRENT CALIBRATION SCHEME

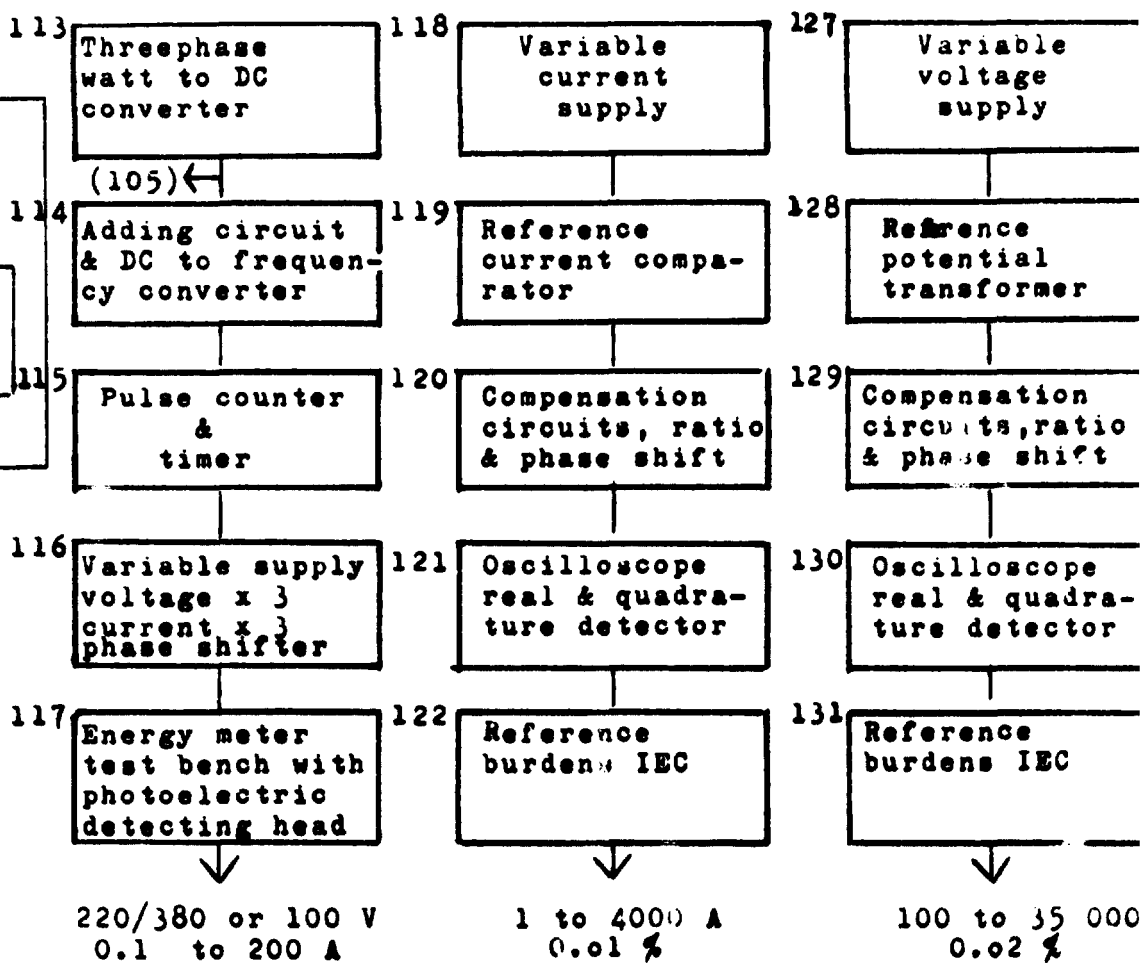


ALTERNATING CURRENT CALIBRATION SCHEME

**Energy meters
50 Hz**

**Current transformers
50 Hz**

**Potential transformers
50 Hz**

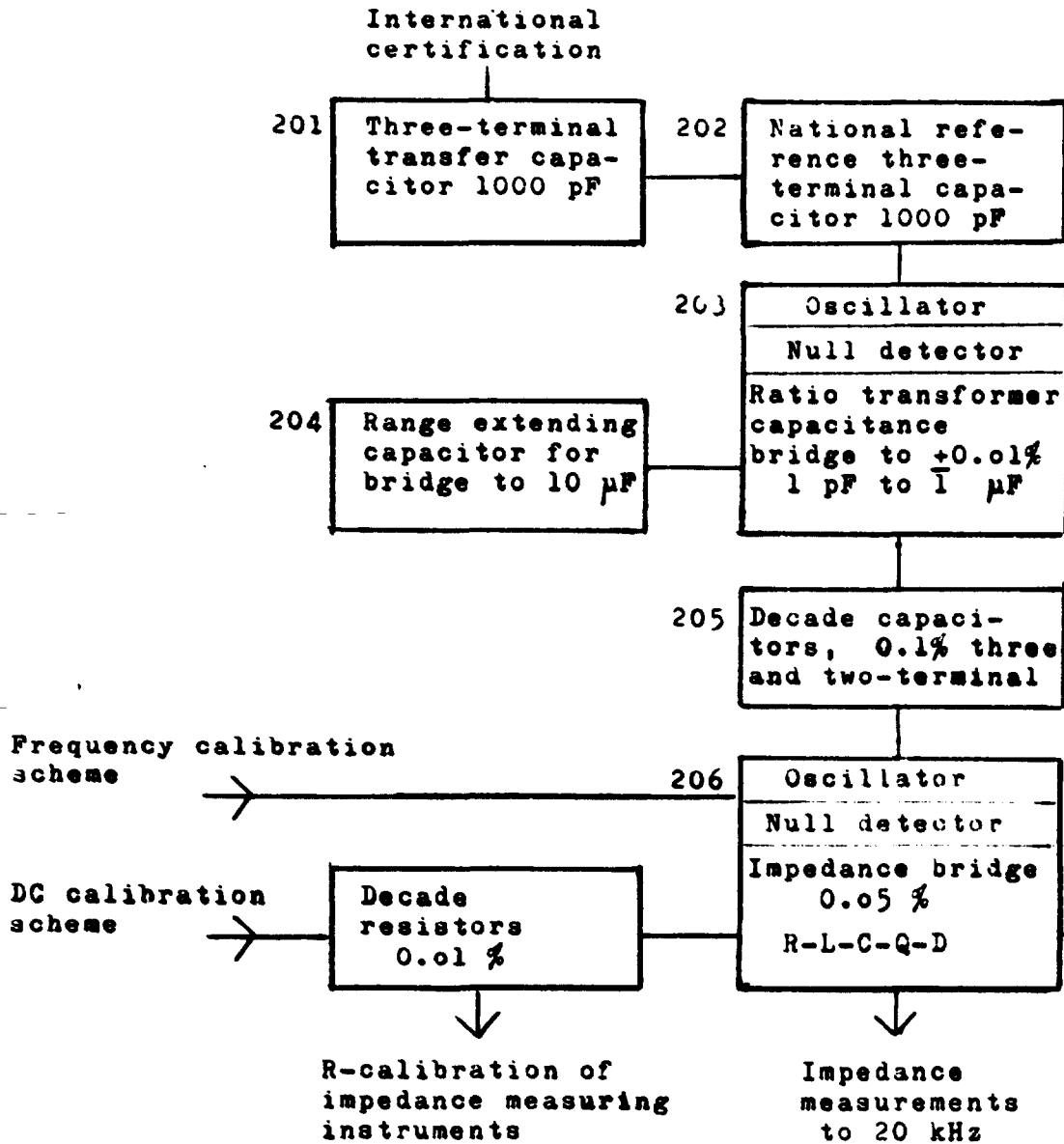


Auxiliary equipment

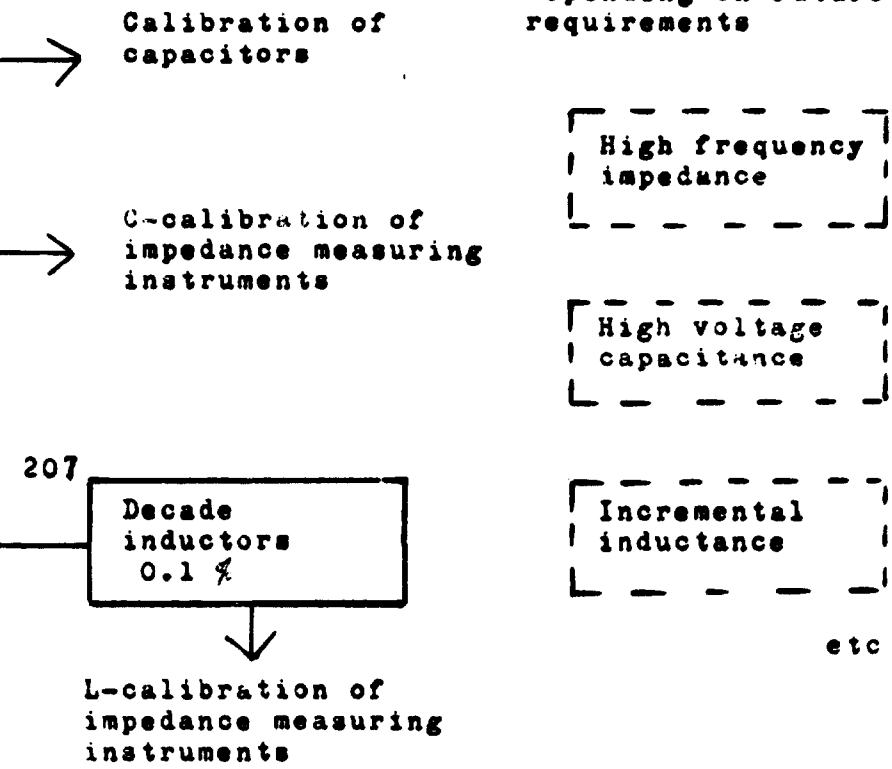
123. Dual beam, low frequency storage oscilloscope

124. Voltage & frequency recorders,
125. stabilized AC supplies, trfs

132. Distortion & spectrum analyzer to 50 kHz



CAPACITANCE, INDUCTANCE AND LOW FREQUENCY



IMPEDANCE CALIBRATION SCHEME

Item No Description

Electrical metrology

- 108E - 1 Transportable thermostated enclosure containing four selected saturated Weston cells of reversible construction with internal emergency supply for up to 24 h operation. Similar or identical to Guildline model 9154D. To be calibrated at BIPM, Sèvres, France, and hand-carried to Baghdad.
- 108E - 2 National reference group of 10(or 12) saturated Weston cells, shippable type, in precision thermostated enclosure for connection to 220 V 50 Hz mains or to 12 V battery with automatic change-over. To include two means of temperature measuring devices: one with thermistor bridge, resolution 0.005 K, and the other selected sensor Pt 100 type P4 Degussa or Rosemount ruggedized type with four-lead connection to external bridge. This sensor should preferably be demountable from the enclosure for ice-point checks. Only factory certification of the Weston cells required. Similar or identical to Guildline model 9152 modified to include Pt 100 sensor.
- 108E - 3 Potentiometer facility consisting of six-dial guarded potentiometer, null detector sensitive to 0.01 μ V and stabilized current supply. Ranges 0 to 1.6 V, resolution 1 μ V, 0 - 0.16 V resolution 0.1 μ V and 0 to 16 mV resolution 0.01 μ V. No standard cell to be supplied, external. Fully floating, earthed negative or earthed positive connection possibilities of unknown emf. Two emf inputs. Maximum internal resistance 4 kohm. Null detector to be connectable separately for other instruments. Overall-accuracy 0.001 % or better. Similar or identical to Leeds and Northrup type K-6 measuring assembly.
- 108E - 4 Volt box with autocalibration facility, normal range 1 to 1000 V DC overranging to 1500 V, adjustable to 1 ppm(using item 108E-8 and the null detector in item 108E-3). Yearly stability 10 ppm. Equipped with guard for tappings over 100 V. Similar or identical to Guildline model 9719.
- 108E - 5 High-voltage DC voltage divider, output 1(or 10 V), preferably also possible for use at 50 Hz. Fully guarded type. Range preferably up to 35 kV. Fully safe execution. Also electrostatic voltmeter for simultaneous use with divider. Accuracy of divider preferably 0.1 %, accuracy of electrostatic voltmeter 2 %.
- Possible suppliers: Tinsley, U.K., Pye U.K., Messgeraete-bau, Bamberg, FRG and others
- 108E - 6 High-voltage DC supply with very fine voltage adjustment and regulation better than 0.001 %. Output voltage 10 kV output current 10 mA minimum.
- Supplier: Fluke and others

Item No	Description
108E - 7	<p>Transportable standard cell enclosure containing 4 saturated Weston cells identical to item 108E - 1</p> <p>(One of the standard cell enclosures of this type will be used with the potentiometer provided for thermocouple measurements, see thermometry)</p>
108E - 8	<p>Precision voltage supply, range 0 to 1100 V in four ranges with six-dials, output current 50 mA (min <u>25mA</u>) on 100 to 1000 V ranges (for calibration of precision moving iron or electrodynamic meters). Accuracy and stability of output better than 0.005 %.</p> <p>Suppliers: Fluke, Yokogawa (2552 modified to give min 25 mA on highest range instead of 10 mA) or combined with Precision current supply, item 108E-11, see below), Philips, etc</p>
108E - 9	<p>Precision digital voltmeter, accuracy 0.002 % or approaching, resolution minimum 1 μV, six-digit (full 5-digit) execution, mainly for DC, ranges from 100 mV to 1000 V. Manual or automatic ranging with BCD output and suitable isolation for digital printer item 108E-10.</p> <p>Also with resistance measuring range from 100 ohm to 10 Megohm. four-terminal connection possibility, accuracy on low range minimum 0.01 %. 220 V 50 Hz mains. Non-compulsory options: AC measurements and digital to analog output of three lowest or three highest digits for graphic recording. Easy autocalibration, check facility.</p> <p>Suppliers: Fluke, Yokogawa (model 2501), Solartron, Hewlett-Packard, etc Leeds & Northrup etc</p>
108E- 10	<p>Digital printer suitable for above item 108E - 9, including 100 rolls of paper, supply of printing ribbon, automatic printing control and optionally second printer channel and mains operated digital clock (50 Hz) connectable to second channel.</p> <p>Suppliers: same as for item 108E - 9</p>
108E- 11	<p>Precision current supply, ranges 100 μA to 20 A, six-dial type resolution 1 μA on lowest range to 100 μA on highest range (resolution figures up to ten times still acceptable according to these specs). Stability and accuracy generally 0.01 % of setting, 0.1 % on highest range.</p> <p>May be combined with item 108E - 8.</p> <p>Suppliers: Yokogawa model 2561 combined with 2552-01 see however restrictions output current of 2552-01.</p> <p>Consult also Fluke, Hewlett-Packard and Holt</p>
108E- 12	<p>Four-terminal shunt box for DC and 50 Hz AC. Selection of currents by copper plugs. Range 100 μA to 100 A minimum, accuracy 0.01 %, 0.05 % on 100 A range.</p> <p>Also: Second shunt box for currents to 10 A only.</p> <p>Supplier: Guildline model 9211A and 9200 or Hartmann & Braun</p>

- | Item No | Description |
|-----------|--|
| 108E - 13 | <p>Direct current stabilized power supply with fine adjustment of current (or voltage), output current adjustable from min. 1 to 100 A, output voltage maximum 8 V. Suitable for calibration of current measuring instruments and shunts and for connection to Guildline range extender for current comparator bridge.</p> <p>Supplier: Guildline, Canada (Hewlett Packard model 6260B for 230 V 50 Hz mains)</p> |
| 108E - 14 | <p>National reference resistors consisting of</p> <p>(a) 2 (or 3) Special reference resistors, high range four-terminal with very low temperature coefficient, adjusted at 23 °C, in protective transportable enclosure, value 10 kohm, stability 1 ppm/year or better. (Suppliers: Gen. Radio or ESI)</p> <p>(b) 1 Thomas-type, four-terminal resistor low range 1 ohm, stability 1 ppm/year, for use in oil bath. (Supplier: Leeds & Northrup)</p> <p>Note: One of the the 10 kohm resistors and the 1 ohm resistor shall be calibrated at BIPM, Sèvres in terms of the mean value of the ohm.</p> |
| 108E - 15 | <p>Suitable resistance boxes, four-terminal, for scaling down from primary reference (a) 10 kohm to primary reference (b) 1 ohm using bridge 108E - 16 allowing ratio cross-checking of that bridge, construction principle similar to Hamon system.</p> <p>Suitable resistance boxes for scaling up to 10 (or 100) megohm from primary high resistance reference 10 kohm resistor consisting of individually connectable resistors in boxes, two-terminal, arranged in decade order from 10 kohm to 1 megohm individual values.</p> <p>One air reference resistor in air enclosure with very low temperature coefficient value 100 ohm for use as intermediate measuring reference standard with current comparator bridge item 108E - 16</p> <p>Suppliers: General Radio, Leeds & Northrup, Guildline, ESI</p> |
| 108E - 16 | <p>High accuracy resistance bridge, current comparator type, accuracy 0.5 ppm (or better), range when used as resistance comparator 0.01 ohm to 10 kohm with four-terminal connection, (generally with 1:10 resistance ratio using standards of 1 kohm, 100 ohm and 1 ohm) or in two-terminal connection using 10 kohm standard reference for measurements up to 10 Mohm, accuracy on 1 Mohm and 10 Mohm measurements reduced to 10 ppm.</p> <p>Similar or identical to Guildline model 3975</p> |
| 108E - 17 | <p>Range extender for item 108E - 16 allowing measurements down to 100 microhm connected resistance. Current comparator principle along with reversing switch for 100 A. Guildline model 3606.</p> |

Item No Description

108E - 18 Four-terminal high-current resistance standards accuracy 0.01 % or better for use in oil bath:
2 x 0.1 ohm 3 A in oil or oil-filled
2 x 0.01 ohm 30 A
1 x 0.001 ohm 100 A

108E - 19 Resistance measuring facility consisting of

- (a) precision tera-ohmmeter or bridge with fully guarded facility along with calibration resistor, value max 10 megohm. Range: 10^6 to 10^{15} ohm, measuring voltage to comprise 500 V. Accuracy: 0.1 % at lowest range, 2 % at highest range or better
- (b) digital ohmmeter (may be included in item 108E - 9) preferably combined with volt and millivolt-ranges. Accuracy generally better than 0.02 %, milliohm ranges 10^{-6} - 10 ohm 0.01 % ohm ranges, megohm range to at least 10 megohm accuracy 0.2 % or better. Preferably equipped also for resistance ratio measurements in four-terminal mode. Six-digit model for 230 V 50 Hz operation.

Suppliers: item (a) similar or identical to Guildline model 9520
(b) similar or identical to Tettex model 2227

108E - 20 High-value resistance decade box, guarded execution comprising the following decades:

10 x (1 + 10 + 100 + 1000 + 10 000) megohm accuracy 0.1 %
10 x (1 + 10 + 100) Mhm, accuracy 1 %

Similar or identical to Tettex models 1146 and 1147

108E - 21 Medium-values resistance decade box, accuracy generally 0.01 % suitable for checking multimeters of digital or analog type, resistance bridges etc consisting of

7 decades 10 x (1, 10, 100, 1000, 10 000, 100 000 ohm and 1 megohm)

Similar or identical to General Radio model 1433 connectors with low thermal emf.

108E - 22 Oil bath with incorporated cooling system for operation between 0 and 60 °C, temperature settability and stability to 0.01 K at ambient temperature 23 °C. Working space approximately 60 x 40 cm, 20 cm deep. To be supplied with 5 charges of suitable insulating oil. Controlled by Pt 100 or thermistor sensor.

Suppliers: Guildline, Leeds & Northrup, Haake, etc

108E - 23 Set of individual shunts suitable for connection to digital voltmeters, output min. 100 mV, ranges 30 A, 60 A, 150 A, 300 A, 750 A, 1500 A, accuracy 0.1 % or better, also for use with AC 50 Hz.

Item No Description

108E - 24 Multi-purpose voltmeter-electrometer with very high resistance input combined with nanoampere-meter. Low-drift type, suitable for connection to recorder. Range 1 mV to 10 V. Accuracy 2 % minimum. Input impedance higher than 10^{14} ohm

Suppliers: Keithley USA, Tekelec, France and others

108E - 25 Multimeters as follows

- (a) 2 analog multimeters, internal resistance 20 000 ohm/V, ranges from 50 μ A to 5 A, 1 V to 3 kV 1 ohm to 10 megohm (or more). Batteries IEC R 14 or R 20 exclusively.
- (b) 2 digital multimeters, 5-digit, battery or charger operation for 230 V 50 Hz, 0.1 or 1 V full scale to 1000 V DC, 1 V to 500 V rms AC, 1 ohm to 20 megohm resistance. Accuracy 0.02 % DC, 0.2 % AC. If provided for dry battery operation, the batteries should exclusively be IEC R 14 or R 20.
- All accessories, test leads etc to be supplied except shunts.

108E - 26 Variable resistors and resistance boxes as follows

- (a) Variable resistors, circular or longitudinal construction, dissipation 1 kW, complete in boxes

Quantity	Resistance	Maximum current
2	0.1 ohm	100 A
2	1 ohm	32 A
2	10 ohm	10 A
2	50 ohm	4 A

- (b) Variable resistors, circular type, complete in ventilated boxes with three pole screws; dissipation maximum 250 W otherwise as follows:

Quantity	Resistance	Maximum voltage
3	250 ohm	250 V
3	1 kohm	500
3	5 kohm	500
3	250 ohm	80

- (c) Decade resistance boxes, five-decade type with copper or gold-plated copper binding posts or pole screws, low thermal emf type, accuracy 0.1 % or better for use as adjusters in precision circuitry:

Quantity	Resistance (DC and AC to 20 kHz)
3	10 x (0.1 to 1000 ohm)
3	10 x (10 to 100 000 ohm)

Maximum current or voltage to be indicated on each decade.

Suppliers: Tettex (item c), General Radio (item c), Ruhstrat, FRG etc

- | Item No | Description |
|------------|--|
| 108E - 101 | Thermal transfer AC/DC voltmeter, range 0.5 V to 1000 V, 5 Hz to 500 kHz, accuracy 0.01 % in the range of 5 Hz to 20 kHz. Detector for operation on 220 V 50 Hz mains. Connection for current shunt sets, item 108E - 102 |
| 108E - 102 | Set of shunts for use between 2.5 mA and 20 A (or 25 A) in connection with item 108E - 101. Also switch for AC/DC transfer using the shunts. |
| | Supplier for both items: Fluke or Holt |
| 108E - 103 | Precision voltage calibrator range 1 mV to 100 V (or 1000 V), output current minimum 25 mA, four-terminal connection of load, frequency range 5 Hz to 500 kHz or 1 MHz. Six-digit resolution, stability better than 0.01 %. For 220 V 50 Hz mains. |
| | Supplier: Fluke or Hewlett-Packard |
| 108E - 104 | Differential rms voltmeter based on thermal transfer, 100 mV to 1100 V in five ranges, frequency range 2 Hz to 2 MHz, accuracy in middle range 0.1 % or better. With internal rechargeable battery (compulsory for use on 1 and 0.1 V ranges to avoid influence of parasitics). |
| | Similar or identical to Fluke model 931B |
| 108E - 105 | Precision wattmeter, volt range 100 V, current range 5 A, suitable for AC/DC transfer of the watt unit. Resolution minimum 0.05 %, including frequency transfer error from DC to 50 Hz. Electrodynamic or electronic type, light-spot deviation or compensation. |
| | Suppliers: Consult Tinsley, Goertz, Yokogawa, Hartmann & Braun, Leeds & Northrup, etc Cambridge instruments |
| 108E - 106 | Period and frequency counter suitable for continuous or triggered measurement of low frequencies in the range of 0.1 to 20 kHz as period counter and 10 kHz to 10 MHz (or more) as frequency counter. Triggering level down to 0.1 V. Input attenuator for up to 300 V. Also useable as universal pulse counter with two start-stop inputs. BCD output preferably with IEC bus to fit digital printer, item 108E- 112 (and 108E - 10). |
| 108E - 107 | Precision AC supply frequency range 40 to 500 Hz (minimum), amplifier type with internal oscillator, also for connection to external oscillator. Stability of output 0.02 %, 1 V to 1000 V in six ranges, resolution minimum 0.01 % of range. Complete with all accessories and spares for 220 V 50 Hz mains. Voltage output minimum 50 VA on each range. |

Similar or identical to Yokogawa model 2858 which combines items 108E - 107 and 108E - 108.

Note: This item is not necessary if item 108E- 103 is procured with an amplifier to 1000 V and with sufficient output VA. See however below.

Item No Description

108E - 108 Precision AC current supply 10 μ A to 50 A, frequency range 40 to 500 Hz or more, resolution 0.01 %, stability 0.02 %, internal oscillator and connection for external input. May be constituted by transformers connected to the voltage supply described in item 108E - 107. Current output corresponding to at least 40 VA.

Supplier: See item 108E - 7 , also consult
Fluke, Holt and Dynamco

Note: Items 108E - 7 through 108E - 9 together with one electronic wattmeter may be supplied by Yokogawa as a complete rack-mounted system type 3862. This system is convenient for series checking of several instruments at the same time. The expert prefers however bench distributed instruments as this allows the operator to adjust more easily voltages and current to correspond to divisions of the instrument under test. The proposed rack mount of 3862 is not so convenient from this point of view. The items listed in the "alternating current calibration scheme" allow the set-up of a practically identical system as the 3862 using the bench system and includes a precision digital wattmeter and printer to print successively calibration values, in which case the values read on the supplies only serve as a redundant control, in the case of all measurements i.e. current, voltage and wattage. The precision in energy may be increased if a standard watt converter and digital voltmeter of the type Yokogawa 2882-15 is procured. This instrument is included in the assembly type 3862 but it cannot be calibrated or checked locally to a better accuracy than item 108E-105 will allow. It may thus not be necessary and in any case precision wattmeters which may have to be calibrated can generally be calibrated with DC as they are in fact electrodynamic meters with very low frequency dependency.

108E - 109 Two-phase generator 1 to 100 000 Hz or more, output minimum 3 V over 600 ohm, continuously variable. Variable phase through 360 $^{\circ}$. Sinusoidal output with low distortion. For connection to mains 220 V 50 Hz.

Similar or identical to Hewlett-Packard model 203A

108E - 110 Set of precision moving-iron or electrodynamic (rms) analog meters composed as follows:

class 0.1 light-spot wattmeter for 100 V and 220 V
DC and 50 Hz AC, currents 1 and 5 A
Precision cosphimeter

class 0.1 light-spot amperemeter, current 5 A

class 0.02 current transformer for 50 Hz, range
0.1 to 50 A primary, 5 A secondary

spare lamps and transformer for the above instruments

Three class 0.5 milliamperemeters to 600 mA, four ranges

Three " amperemeters to 6 A in four ranges

Three " voltmeters to 300 V in four ranges

Three AC/DC moving iron multimeters

- | Item No | Description |
|-------------------------------------|--|
| 108E - 111 | <p>Digital rms - measuring volt- , ampere- and wattmeter for single-phase operation, accuracy 0.1 % at 50 Hz ranges: voltage 3 to 600 V in six ranges
current 100 mA to 30 A in seven ranges
wattage 300 mW to 18 kW</p> <p>Conversion based on multiplication of pulse height and pulse width followed by integration to obtain AC to DC conversion or direct indication of root-mean-square(rms) values of voltage, current and wattage in the frequency range of at least 1.2 kHz down to 40 Hz or lower.</p> <p>Resolution at least 5 digits. BCD-output for connection to printer preferably through IEC bus.</p> |
| 108E - 112 | <p>Digital printer for item 108E - 111(preferably of the same type as for item 108E - 10) to obtain redundancy and interchangeability. To be supplied with 100 rolls of printing paper and spare printing ribbons.(Printing to be black not blue so as to enable photocopying.)</p> <p>Supplier: item 108E - 111 and 112 Yokogawa model 240321 + printer</p> |
| 106E - 113
through
106E - 117 | <p>Energy meter test installation for single phase and threephase meters for 220/380 V systems and for 100 and 110 V single phase meters all 50 Hz, comprising electronic standard to 0.05 %, supply circuits for current and voltage including phase snifter, pulse counter and photoelectric scanner suitable for individual tests of meters. Test bench with universal mounts for at least 10 meters. To be used for type testing and sample testing of energy meters as well as for calibration of portable energy meters of secondary standard type. Supply device also to include facility and standard (rotational) meters for checking reactive energy meters.</p> <p>Important: The electronic standard should have such connections so as to allow control or calibration to other standards using a transfer wattmeter(electrodynamic high accuracy device which can be checked with DC). It should for checking purposes also be possible to connect an AC stabilizer of suitable size so as to enable accuracy limit checking using the wattmeter-time method.</p> <p>Suppliers: Consult Landis & Gyr, Switzerland and Zera, FRG</p> <p>One secondary standard energy meter for portable use shall also be supplied as well as one for reactive energy.</p> |

Item No	Description
106E - 118 through 106E - 122	Current transformer test set for 50 Hz current instrument transformers with 1 and 5 A secondary complete with supply circuits, reference transformer or current comparator internationally certified, detector and reference burden according to IEC. Current ranges primary 1(or 0.1) A to 4000 A (minimum 2000 A). Accuracy in ratio min 0.01 %, phase angle 1 minute or better.
and	Light-weight, reduced space and low-power consumption of supply gear essential for ordering.
	Consult: Guildline, Tettex and Haftmann & Braun
106E - 127 through 106E - 131	Potential transformer test set for potential transformers up to 11 kV and to 35 kV, secondary 100 V or 110 V 50 Hz. Characteristics similar to 106E - 118 in other respects, possibility to combine both should be considered. However, space weight and safety requirements should be taken into account as regards the location of the equipment. Suitable AC voltmeters should also be supplied. (Item 119 is considered as last priority for the department whereas item 118 is essential for most calibration purposes).
106E - 123	Dual beam storage oscilloscope, preferably portable, independant beams but driven by the same horizontal deflection plates so as to avoid any phase shift. Suitable for measurements of two signals using identical vertical channels, split-screen storage, band-width to 2 MHz, sensitivity 1mV/div to 5 V/div Supplier: Tektronix
106E - 124	Graphic recorder for mains voltage variations, range 150 to 260 V AC 50 Hz or approaching with emergency spring or battery operation of the chart in case of power breaks possibly combined with frequency variation rec order range 48 to 52 Hz. With supply of paper and other spares for one year continuous operation.
106E - 125	Three stabilized AC power supplies, electronic instantaneous regulation with very low distortion, input 220 V \pm 15 %, output 220 V, regulation 0.1 % or better including thermal and time stability. Output power 5 kVA. One three-phase stabilizer of similar characteristics for 380 V/220 V star connection, output power 15 kVA. Note: The last one will be used only in special cases such as calibrations using the watt-meter-time method. The other stabilizers will be installed for use in other rooms where voltage effects measurements, mainly for AC power, current and voltage.

Item No Description

106E - 126 Transformers for 220 V 50 Hz primary connection as follows

Quantity	Secondary voltage	Maximum secondary current
2	variable 0 to 300 V	4 A
2	" 0 to 250 V	4 A
2	" 0 to 250 V	8 A
2	fixed 12 V	100 A
2	" 24 V	30 A
2	" 6 - 12 - 24 - 48	5 A

All fixed transformers to be insulated for 2 kV and have screen windings between primary and secondary.

106E - 127 Spectrum analyzer 10 to 50 kHz frequency range, voltage input up to 300 V, cathode-ray tube with digital magnetic storage for analyzing harmonic content of distorted AC signals and mains voltages.

Note: The instrument is useful for the study of influence of third harmonics on measurements, influence of ballasts and flouerescent lighting on current wave-forms etc

Suitable also for graphic recording using XY-plotter.

(These instruments may be ordered later but before the item 108E - 127 to 131)

Supplier: Hewlett-Packard

108E - 201 Three-terminal reference capacitor 1000 pF
and stability 20 ppm/year similar or identical to
108E - 202 General Radio model 1404.

108E - 203 Capacitance measuring assembly similar or identical to General Radio model 1620A. Detector to be supplied for operation on ordinary batteries type IEC R20 (or IEC R 14). Also supply of all necessary cables for connections to 1404 capacitors, total 4 cables, mains cord for 220 V 50 Hz for generator, cord for three-terminal connection to GR decade capacitance box, etc

108E - 204 Range extending capacitor Genral Radio model 1615-P1

108E - 205 Decade capacitor precision 0.1 % or approaching range 50 pF to 1.1 uF, and Genral Radio model 1412, also Four-terminal (and two-terminal) capacitance box consisting of ratio transformers and a 1 uF standard capacitor, allowing calibration of the capacitance component of impedance bridges up to 1 F. General Radio model GR 1417

108E - 206 Impedance bridge General Radio model 1608A
108E - 207 Decade inductors, supplied General Radio

Item No	Description
106E - 208	Climatic cabinet for temperature and humidity influence testing on energy meters and electrical measuring instruments, temperature range - 20 to + 80 °C, accuracy of settings ± 0.5 deg C humidity range from 10 to 95 % R.H. (depending on temperature range but usually from 10 °C to 60 °C), accuracy of setting better than ± 4 %. Dimensions of internal test chamber minimum 0.5 x 0.5 x 0.5 m. Test chamber to be equipped with two holes on the left side diameter 30 mm or more equipped with stoppers of insulating material and suitable for passage of measuring cables, thermocouple wires etc.

(Suppliers: Weiss or Votsch, Herxens, FRG)

Note:

Other equipment will be used in common with the thermometry laboratory or, if not, ordered in common such as thermocouple switches (which may be used also for connections of items such as standard cells etc), also the same goes for graphic recorders, thermocouples and thermometers.

METROLOGY LABORATORIES, report on lay-out and equipment
by S.A. Thulin

Equipment for weights and measures verification

The extent of legal metrology

Before suggesting the equipment necessary to accomplish the tasks of the legal metrology operations which is required in addition to the primary equipment already listed in the present chapters it may prove useful to recall the various stages of the application of legal dispositions which generally involve

- type approval of the instrument(model and make)
- primary verification and sealing
- reverification

Type approval

The type approval consists of investigating in the central laboratory and offices whether the particular model of instrument is conform to general prescriptions or regulations such as laid forth by IOS standards. This examination is done by inspecting drawings and test results submitted by the supplier of the instrument(manufacturer or importer). Samples of the instrument are thereafter submitted to repeated tests in accordance with the requirements. If these examinations are satisfactory and no additional objections can be raised on matters not foreseen in the original prescriptions for the type of instrument, the model may be accepted for legal use provided each individual instrument is properly adjusted and sealed. The instruments accepted through type approval should bear a label specifying make and model, the name and sigle of the type approving organization as well as the year and chronological approval number for reference to a centrally kept file system.

Primary verification

As mentioned no measuring instrument even when bearing the type approval label should be allowed for use unless it has the seal of primary verification. Depending on the number of instruments manufactured and imported and put into use, the primary verification may represent a considerable part of the work of

the metrology service. It must thus be organized in the most rational way to reduce loss of time as customers may not expect long waiting times.

When it is found practical the primary sealing may be done at the central laboratory, however in a number of cases the sealing operations have to be done outside using mobile units or semi-fixed installations. Instruments such as weights and rough balances (such as the commonly used Beranger type) can be verified and sealed as a series work at the factory (or at the store of the importer), or in the machine hall of the central laboratory.

Precision balances, direct indicating and automatic balances, weigh bridges and similar must be sealed at the place of their final installation in which case it will be the duty of the installer, vendor or user to notify the metrology service so that steps can be taken to execute the primary verification and sealing with a minimum of delay.

Instruments such as electricity meters and water meters can be sealed by the manufacturer or distributor under the supervision of the metrology service. In this case the work of the metrology service may be limited to

- periodic verification of the reference instruments used by the manufacturer or distributor
- control of already sealed samples on random basis at the factory (or at the central laboratory)

Reverification

One may say that the aims of the primary verification is to ensure that the approved type of instrument really is adjusted to be within its limits of tolerance according to the regulation (or written standard). The mere granting of the type approval involves that the instrument in normal use shall preserve its metrology characteristics within set limits for a long period, at least several years. Unnormal use, excessive wear, damage may lead to the necessity for reverification within a shorter or longer period which has to be done on the site, except when the instrument can be exchanged (electricity meters, water meters and similar are exchanged after a certain number of years of service or when their registers are full). In case of repairs the primary seal is broken and the reverification to be done on the site is similar to the primary verification.

Any instrument which is found without seal or a filed request for reverification will induce legal action against its user if employed for commercial transactions or involving human safety.

In cases where the reverification is not determined by a request or complaint it will be limited to

- visual inspection of the instrument and the presence of its seal
- tolerance control of the instrument

Such reverification can be organized on periodic and geographical basis depending on the possibilities of the metrology service. Though primary verification has to be done to 100 % this may not prove possible or necessary as regards the reverification unless safety is involved and the frequency of reverification will have to be determined from case to case. If it is felt that reverification cannot be executed on a regular yearly or two-yearly basis it should not be charged for as should always be the case for the primary verification or sealing. In cases where the primary seal is broken, the verification and resealing is similar to the primary verification and subject to charges by the service.

As a summary one may say that the amount of reverification will much depend on the instrument in use, the economic value or safety involved in its use and the frequency will have to be determined on a case to case basis and adapted to the possibilities of staff and means of transportation of the service. Finally control for legal purposes may also be divided in two operations: - control by visual inspection and simplified means followed by reporting in cases where justified to a more qualified and better equipped mobile unit which can execute the full reverification and if necessary resealing of the instrument.

Sources of information for the planning of the legal metrology equipment

a) Local requirements

It is not feasible to include in the equipment of the IOS laboratories items which are very rarely used such as for a special type test. Arrangements should in such cases be done with the manufacturer so that type tests may be executed in the factory under supervision of IOS. Type tests of water meters may come under this chapter. For volume gauging it may generally as a start be advised to procure only standard gauges which are transportable.

The demand for weigh bridge calibration is known to be relatively important and one calibration vehicle will have to be provided already from the start.

Other equipment required for primary verification or re-verification at more or less remote locations will in addition to suitable transport vehicles also include that of a few local offices. It is however not advised at the present stage to equip these local offices with so-called local standards and corresponding measuring equipment. The equipment used for field operations should preferably all be of the same type and exclusively checked or overhauled at the central laboratory in Baghdad. The role of the local offices will then mainly be that of clerical work for direction of the control operations and storage of mobile equipment including vehicles. The latter will regularly at least every two months return to Baghdad for control of the verification equipment, repairs and related business. The vehicles and this type of local office must maintain good communications with the central laboratories.

Pending the needs to be better defined it is suggested that procurements of verification equipment is based on let us say twenty units and that at least five local offices are created with suitable geographical distribution.

Presently about 250 000 sets of weights in the range of 50 g to 5 kg are being distributed all over the country. The control of gasoline and kerosene distribution gauging equipment has all to be done at the distribution stations, there are presently about 300 in Iraq. This control can be done preferably

of special vehicles in the densely populated areas but in remote locations this may have to be done by the same mobile units as for other verifications. As the volume standards for such purposes are not very costly it is suggested as a start to procure the same number as for the other mobile verification equipment for length and mass.

b) Commercial solutions for equipment procurement problem:

In many cases the equipment for weights and measures verification is not available on simple catalogue ordering basis but must be specially manufactured. It would take too much time for IOS to make all the required drawings for such equipment and to find workshops that accept to manufacture such items to special order. The expert has therefore contacted a number of national metrology services, members of OIML (Organisation Internationale de Metrologie Legale), in order to obtain the required information. Generally the replies received give little detail as to the specifications of the equipment but a number of suppliers and workshops have been indicated which may undertake the manufacture and supply to special designs.

When contacting such suppliers it will be necessary to refer for details of construction of the various instruments to designs used by the national service in the country of order.

c) Recommended types of equipment according to OIML

The OIML has established suggestions for the type of equipment to be used by a national metrology service including the central laboratory, the local offices and the mobile units. The equipment listed in chapter IV for the central laboratory largely covers the list published by OIML and generally includes commercial solutions to all equipment (the specified items should be completed where necessary by information received in the quotations submitted by the suppliers).

The equipment for the local offices as recommended by OIML has been reduced to be identical of that for the mobile units for the reasons explained above.

Special considerations have been made as concerns volume measurements including reference instruments which were not included in the first part of the report.

**LEGAL METROLOGY VERIFICATION EQUIPMENT FOR THE IRAQI
ORGANIZATION OF STANDARDS**

The following notes describe suggestions for equipment procurements which were not included in the main report concerning the metrology laboratories due to lack of information at the time of writing. The information so far received (September 1978) is still incomplete as regards mainly the local requirements. Though the commercial solutions for such special equipment also are limited, enough references and suppliers are available to undertake ordering action in most cases.

The primary and secondary reference standards and measuring equipment for length and mass has already been described in the first report including also equipment for verification of force and pressure measuring instrumentation (see pages 31 to 50). The equipment for the verification of weighbridges has been described in a separate note. This is also the case for the volume calibration equipment (report of 31 August 1978).

The descriptions below are thus limited to verification equipment previously not included in the reports and concern mainly instruments for the verification of weights and balances.

Equipment for the verification of weights and balances
to be installed in the central laboratory of IOS(machine hall)
(Length measures are verified in room M91, equipment p. 39-45)

Precision work such as calibration of analytical weights will be executed in room 90, mass metrology for which all necessary equipment has been described. The work in the machine hall will thus consist of

- examination of commercial balances (for type approval)
- verification and adjustment of weights

The machine hall will also be used for storage of the mobile equipment, calibration vans and weigh bridge calibration lorry. However, the problems of dust entering this room must be solved in a suitable way.

One part of the machine hall should be used for storage of items subject to type testing, commercial weights and possibly samples of type-approved instruments. (The latter is however subject to space and other limitations and will only be required for non-voluminous items in current use in Iraq). The room located under the air-handling equipment in the machine hall may prove satisfactory for this purpose and be equipped with suitable storage racks such as shown on page 18 in the main report. This room should also be provided with at least 15 workbenches similar in size as indicated on page 17 of the main report but their working height should be 90 cm. This special room may also be arranged so that type testing of automatic and similar balances can be executed there.

Work of more rough nature should be executed in a part of the machine hall. Such work may consist in the examination of rough balances (Beranger or Roberval type) and bigger equipment. If there is no big walk-in climatic test chamber provided in other parts of the IOS compound, the expert suggests that such a chamber is installed in a corner of the machine hall so as to allow climatic (mainly temperature) testing of measuring instruments whether mechanical or electrical. It is particularly important to consider the fact that modern measuring equipment contains electrical and electronic parts which may not resist the high temperatures experienced in many places in Iraq, or at least effect the accuracy, climatic testing facilities must thus be present.

For the adjustment of weights it will be necessary to provide for steel workbenches of heavy resistant type with steel sheet top. The dimensions should preferably be the same as for the tables mentioned above. About 15 tables of this type will be required along with the same number of metallic cupboards. One of the tables should be equipped with lead melting facility. Furthermore a bench drill should be installed, possibly also a small press. A small sheet metal cutter may also prove useful for approval labels. A number of punches should be available for stamping of the weights as well as various sealing material, all to be safely stored in the

metallic cupboards.

The other equipment to be installed is summarized as follows:

Working standard weights

84 - 1 Two sets of adjustable weights of stainless steel (antimagnetic Immaculate V or equivalent) from 1 mg to 20 Kg. Weights from 20 kg to 1 g to be cylindrical with a screw-in knob. Weights of 0.5 g and less to be of flat-section wire formed into a shape signifying the value. The adjustment class should be OIML F₁ or better. (Note: if local offices are to be created the number of these sets should be increased, see also mobile equipment requirements in this report)

These specifications are met by the type Metric Weights ST3 supplied by Avery Export Ltd, cost 1779 £.

84 - 2 Fifty rectangular weights of 10 kg for calibration of heavy balances up to 500 kg. The weights should preferably be made of cast steel or special shock-resistant cast iron and suitably corrosion protected. The weights should be easily adjustable using a screw type seal (no lead seal for stamping required). The shape shall be such as to allow easy and safe piling up on bascule platforms. The weights shall originally be adjusted within the limits of 0 to - 0.5 g. (Note as regards quantity such weights will also be required for mobile applications see below)

84 - 3 Fifty rectangular weights of 20 kg for calibration of heavy balances. Other specifications identical to item 84-2.

(Note: it is considered that other working weights required for verifications and adjustments can be selected from weights currently manufactured in Iraq or specially machined in the ICS workshops according to the needs)

Balances required for the machine hall

Calibration of secondary standard weights, working standard weights and analytical or precision weights will as previously mentioned take place in room 90 with the equipment recommended for that room including electronic balances for rapid calibration in particular of the 10 kg weights listed in item 84-2. The balances in the machine hall should thus be working balances for adjustment of commercial weights and heavy balances required for the calibration of heavy weights and occasional checking of volume standards up to 100 litres at least. The following balances are thus required:

- item 84 - 4 Balance suitable for calibration and adjustment of weights, capacity 200 g sensitivity 5 mg (The balance is preferably of the so-called "trebuchet" type. However, a top-loading electronic type of balance may also be used if the environmental conditions allow (temperature, dust, vibration etc))
- item 84 - 5 Balance suitable for calibration and adjustment of commercial weights, capacity 5 kg, sensitivity 50 mg. The balance should preferably be of the so-called "trebuchet" type. (Electronic balances could be used but are usually not available with the required sensitivity and capacity).
- item 84 - 6 Balance suitable for calibration and adjustment of weights in the range of 5 to 20 kg, capacity 20 kg minimum, sensitivity 500 mg. Balance to be used for fixed installation.
- item 84 - 7 Balance suitable for calibration of heavy weights up to 1000 kg, reproducibility ± 10 g in substitution weighings, including corner errors. The weighing platform should be 1500 x 1500 mm so as to enable the calibration of the flat type of 1000 kg weights according to OIML as well as of cylindrical weights of 500 kg and 1000 kg. The balance is calibrated using the weights in item 84-2 and 84-3. (Manufactured by BIW, Berlin)

The balance, item 84-7, will allow calibration of volume containers as well, even with low capacity down to 20 litres, in view of the high sensitivity of the suggested balance. It may prove convenient, however, to procure an additional balance of a capacity of approximately 100 kg and the same sensitivity or reproducibility ± 10 g. This balance may be used for general purpose precision weighings and be installed either in the machine hall (suitably dust protected) or in the room 87 where the low-capacity volume calibrations and similar work shall take place:

item 84 - 8 High-capacity commercial platform balance with reproducibility of ± 10 g, smallest readable division 5 g, capacity of weighing 100 kg plus taring range (minimum 10 kg). Size of weighing platform (fully free) 600 x 600 mm minimum.
(Similar or identical to Sauter model SD 100 T/5)

Equipment for site verification of

a) Means of transportation

It is supposed that all site inspectors or inspection units are provided with vehicles allowing the transport of the verification equipment. In some cases the equipment may be light and private cars may be used if a convenient indemnity system can be arranged. It is in any case essential that the cars used by the verification service when belonging to IOS are exclusively used for that purpose because of the requirements for proper maintenance of both the measuring equipment and the cars.

As the verification equipment especially for work in industries may be heavy and voluminous it is suggested that IOS already from the start equips itself with a certain number of minibusses or vans which are exclusively used for verifications and suitably equipped. These vans need as a start at least mainly be used for transport of the instruments and can be of a type currently manufactured. It should however be possible for IOS to install a small workbench 50 x 150 cm

in the van as well as wood-work for storage of various instrument cases. The van should therefore have such dimensions as to allow standing work and have a few windows or shutters which may be opened so as to provide for enough light on the workbench. The vans shall normally return to their base of operation every day which will need the creation of some local offices in major areas. At regular intervals the equipment installed or transported by the vans must be verified at the central laboratory. This could be done every 2 or 4 months depending on the experience and wear of the equipment. During such verifications the vans are entered into the machine hall. The latter will not be sufficient to be used as garage for the vans in the Baghdad area and special garages have to be foreseen both for Baghdad and for the local offices.

In addition to the requirements mentioned above the vans should have a transport capacity of at least 400 kg of equipment requiring a total space of between 2 and 4 m³.

With a view of gaining enough experience of the operations it is suggested to order as a start a minimum of five vans. If possible two of these vans should be equipped with special air-conditioning to allow work at remote locations during the summer season.

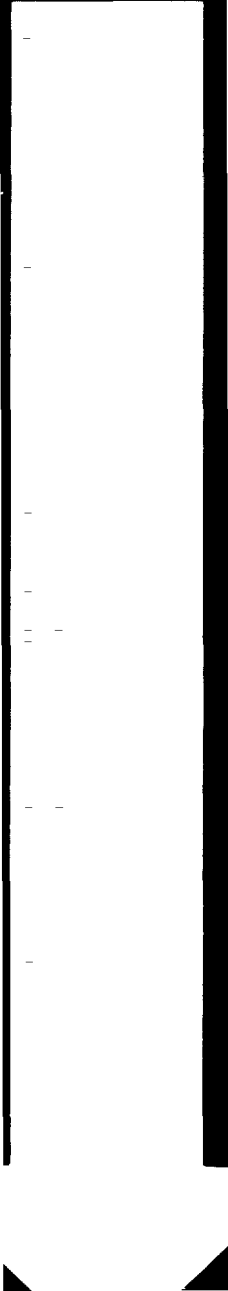
b) Reverification of weights on the site

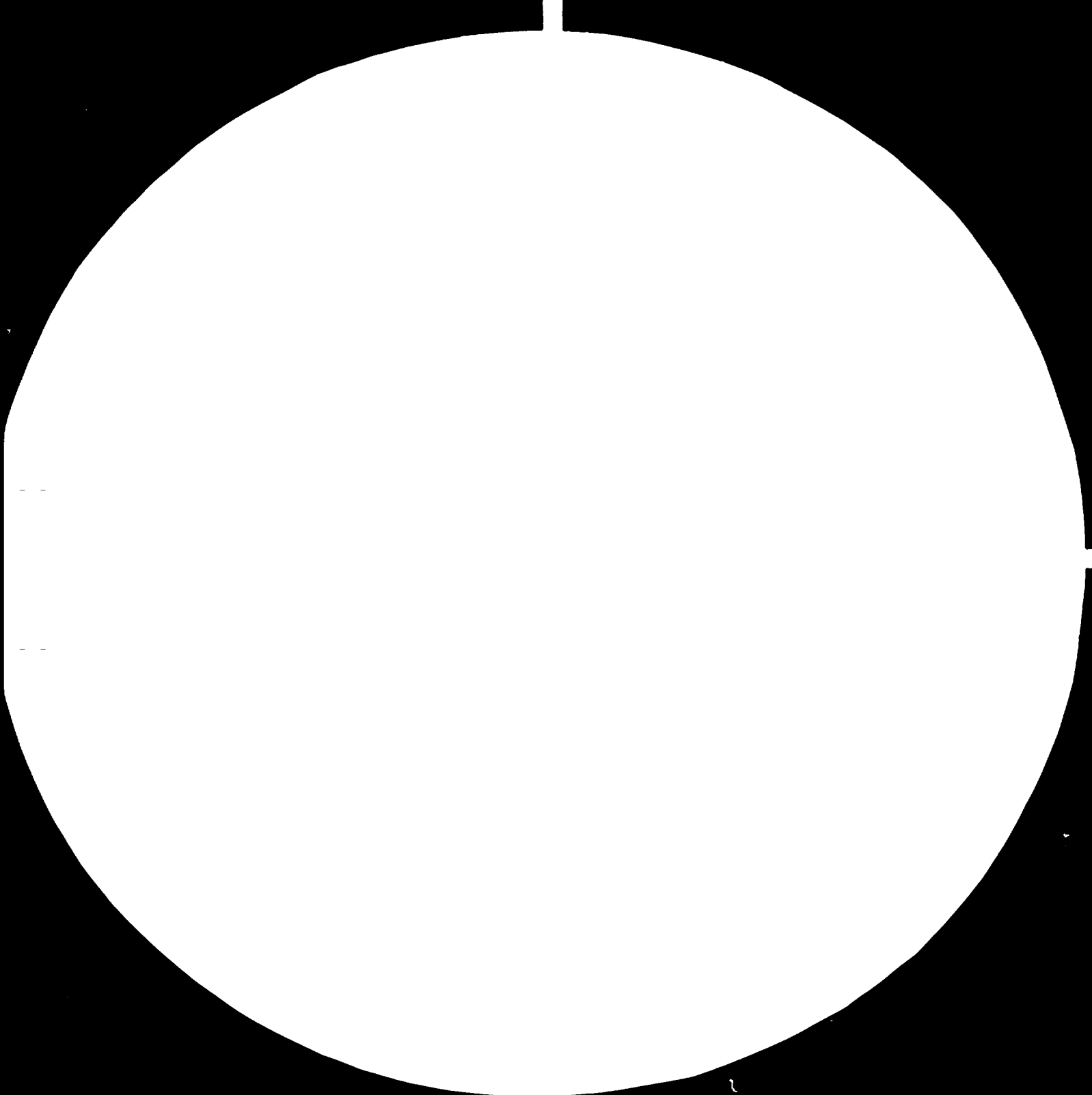
The primary verification of weights is always to be done centrally at the factory (Iskanderia factory) or at the IOS central laboratory. The same goes for weights which have to be readjusted. Adjustment of weights and resealing can of course also be done at the local offices to be created. In view of the situation in Iraq whereby all weights will be distributed through IOS it is suggested that defective weights are simply returned to the central laboratory and replaced by weights transported in the van. The reverification of weights by the mobile units will thus as a first step consist of visual inspection of the weights and their seal followed by a rough test on the balance with which the weights are normally used by comparison through substitution on the same balance pan to working reference weights.

In cases where the balance is defective or not enough sensitive according to the verification requirements, the reverification must be made on mobile verification balances. This operation can be done using transportable beamscales and may be convenient in particular for small weights up to 100 g, but the balance becomes bulky and less convenient if weights up to 5 kg have to be verified. In such cases the weights may be verified on a balance installed in the mobile van (or in the local office).

The equipment for the reverification of weights will thus essentially consist of a set of working reference weights in the range of 10 mg to 5 kg packed in a hand transportable case, a small hand scale for weights below 100 g and the remaining equipment for reverification of weights in the range of 100 g to 20 kg should be kept in the mobile van which should be installed as close to the verification site as possible.

The usual reverification equipment of weights consists of so-called inspector's outdoor beamscales. These balances have beams which are lifted off at each stop or balance station. This may not always be convenient unless a certain number of shops are verified using one stop or station of the van. Another solution is to use a balance of such construction that it can be transported even on rough roads without necessity for demounting. The latter solution will generally provide for less sensitivity than the demountable beamscale, which in turn however may be easily damaged in operations of demounting and transport. Inspector's beamscales are currently manufactured by a few specialized firms whereas there are no special balances of the other type which are conceived for use in mobile equipment. However, it is suggested that some dual-pan trip-scale balances currently manufactured for engineering laboratories are tried in practice. It may hardly be possible to find such a balance for calibrating 10 and 20 kg weights. In this case, which anyway is less common, a demountable tripod beamscale must be used. The above considerations result in the suggestions formulated below:







28

2.5



32

2.2

2.0

1.8

1.25

1.4

1.6

MP RECOVERY RESOLUTION 11.1.1.1.1.1.1

1.25 1.4 1.6

item 84 - 9 Set of adjustable weights for site verification of weights and balances made of brass or bronze, adjustment class OIML F1, cylindrical execution from 1 g to 2 kg, flat-section stainless steel wire from 10 mg to 500 mg formed into shape signifying the value. To be packed in suitable transport case preferably of metal. Weights to be included in the set:

2 kg - 2 kg - 1 kg - 500 g - 200 g - 200^{*}g

100 g - 50 g - 20 g - 20^{*}g - 10 g

5 g - 2 g - 2^{*}g - 1 g Quantity: 20 sets
500 mg to 10 mg as above

(Note: The duplicate weights are not required for verification of weights but are used for verification of balances)

item 84-10 Twenty rectangular weights 10 kg for calibration of weights and balances, specifications as for item 84-2. Each set consists of twenty weights. It is estimated that as a start 10 sets of this type is sufficient. Therefore the total number of weights will be 200 + 50(for item 84-2). If manufactured abroad specially for IOS the total number may be raised to 400 so as to allow for expansion of the service. (The value of 10 kg instead of 20 kg has been chosen so as to facilitate the manipulations by hand and allow calibration by the Mettler electronic balance in the mass metrology room, the capacity of which is limited to 15 kg) Two of the weights in each set will be used as working references for calibrating 10 and 20 kg weights on a balance installed in the mobile van or outside this van.

item 84 - 11 Hand scale (or so-called foldable trebuchet) in wooden case with stand as used in precious metal trade (carat balance), capacity 50 g, sensitivity 5 mg.

item 84 - 12 Robust precision type trip scale (Roberval system or similar) suitable for mobile use in vehicles. Capacity 5 kg, sensitivity minimum 0.1 g. Flat pan size 100 mm in diameter or approaching. (Note samples of the balance should be submitted to road tests. The balance is intended to be used for verification of commercial weights in the range of 100 g to 5 kg when the vehicle is at rest. The mechanism should however not be affected by transport on rough roads) Quantity required: 20.

or alternatively, if the solution above is not satisfactory:

item 84-12A Demountable beam balance suitable for reverification of commercial weights when installed in a mobile van. Sensitivity 50 mg, capacity 5 kg

item 84 - 13 Demountable beam balance for reverification of commercial weights in the range of 5 kg to 20 kg. Sensitivity 500 mg or better. (The balance will normally be transported by a mobile van and installed inside or outside the van for the verification. The mounting and transport arrangements should be fully safe so as to avoid wear and damage in transport)

c) Reverification and primary verification of balances

The primary verification as well as reverifications are practically always done on the balances where they are definitely installed. The working standard weights for this purpose may be the same as listed above in item 84 - 10 and 84 - 9. However, if the number of verifications is great, it may prove convenient to use a rather light special weigh set for the

verification of commercial balances. This set is a so-called "divided kilogramme" and is suitable both for the control of equality of arms and step-by-step control of direct indicating balances:

item 84 - 14 Set of balance verification weights made of non-magnetic stainless steel in storage pocket consisting of

1 piece or box weighing 500 g
 4 hexagonal weights of 100 g
 2 " " 50 g
 4 flat circular weights 5 g

All weights except the 5 g ones should be adjustable using a hole tightened by a screw. (Other shapes than those indicated may also be accepted such as flat parallelepipedic shape. It is important that weights do not roll)

The above-mentioned sets are used by the French national metrology service and may be supplied by "Anciens Ets Vial, Paris".

Suggested quantity: 20

d) Equipment for site verification of length measures

The equipment for site verification of length measures can be quite simple unless special type of survey work is required such as for verification of big reservoirs (see note on volume measurements). For commercial measures the following may be recommended:

item 84 - 15 Stainless steel rule of the flexible rigid type graduated in mm, length 2 meter

Quantity: 20

item 84 - 16 Stainless steel tape graduated in cm, length 20 m on rerolling device

Quantity: 10 (or 20)

e) Equipment for site verification of capacity measures

See note on volume calibration equipment, items V-6 to V-9. p. 97 to 105.

f) Equipment for verification of weighbridges. See note p. 106

Verification equipment of weights, balances and length
measures

List of references and suppliers according to information at IOS

- Ref. 1 - Organisation Internationale de Metrologie Legale:
"Equipment de base du departement de controle des
Poids et Mesures d'un service national de metrologie
legale" (published in 1968 or earlier)
- Ref. 2 - P. Delplanque: "Le nouveau necessaire de verification
du Service des Instruments de Mesure Francais"
Revue de Metrologie Pratique et Legale, October 1966

<u>Suppliers</u>	<u>Comments</u>
Ref. 3 - Anciens Ets Vial 4 bis rue Asseline 75014 Paris France	Quotation for item 84-14 according to SIM specs
Ref. 4 - Avery Export Ltd, Smethwick, Warley, West Midlands B66 2LP England	Quotation item 84-1 see also Kern ref. 6 for quantity required
Ref. 5 - Reverification Ltd Stocklake Aylesbury Buckinghamshire U.K.	Price list items 84-5 to 7 and 84-9, 84-11, 84-12A 84-13
Ref. 6 - Gottl. Kern & Sohn Albstadt(Ebingen) Postfach 48 D-7470 Albstadt 1 F.R. Germany	Quotation item 84 - 1 and item 90E-2 and 90E-3 90E-5 90E-6 total <u>4 sets</u> required
Ref. 7 - August Sauter KG Postfach 250 D-7470 Ebingen 1 F.R. Germany	Descriptive leaflet for item 84-8 and item 84-11
Berliner Industrierwagen- fabrik, Berlin	1000 kg balance, item 84-7 quotation received(with primary mass equipment files)
Ohaus, USA	Item 84-12
Hommelwerke, F.R.Germany	Item 84-14 & 15
Mitotoyo, Japan	Item 84-14 & 15

Suppliers of 10 and 20 kg rectangular weights according to specifications for items 84-2 and 84-3. (Information received from national metrology services)

France

Ets F. Winterberger
72300 Sable-sur-Sarthe

Societe Generale de Fonderie(Chappee)
8 place d'Iena
75016 Paris

Ets Leon Zwiebel
St Jean Saverne
67700 Saverne

Switzerland

Hegi & Cie AG
Eisengiesserei
CH-3414 Oberburg
Switzerland

Sweden

Skeppshults Gjuteri
S-330 24 Skeppshult
Sweden

(A list of suppliers is awaited from the Federal Republic of Germany in accordance with their letter of 2 June 1978)

VOLUME CALIBRATION EQUIPMENT

General considerations

It is not yet established to which extent the Iraqi metrology service will have to calibrate volume measuring equipment. Usual liquids which are distributed by volume measure are gasoline, gasoil(fuel oil) and kerosene. As regards the food industry most distribution is prebottled. The metrology service will thus have to verify the volume measures used in the food industry or for collection of milk and similar products.

As regards the needs for gauging equipment for big volume reservoirs, tank wagons etc it will be necessary to make a survey of the needs and to find out a suitable working arrangement with the National Iraqi Oil company which is responsible for the distribution of petroleum products. The distribution of kerosene is done by individual merchants using measures in the range of 15 to 20 litres. These measures can be duly verified by a mobile inspection unit which is stationed for a day or so at the filling stations attended by the merchants. The verification of hydrocarbon counters, whether fixed or installed on tank lorries, however, needs a special verification vehicle.

The local survey should also show the requirements for IOS as regards the verification of water meters. The expert does not advise that an installation for water meter calibration is installed at the IOS central laboratory if it will only be used for some type testing or testing of samples. The organisations in charge of the water distribution and installation of domestic water meters in Iraq will most probably have such an installation or it will be installed in the planned factory for assembly of water meters. It is in fact difficult to separate the adjustment operations from the sealing of such meters. The sealing is therefore generally entrusted to the manufacturer under the supervision of the metrology service. However, if the adjustment and the sealing of all imported water meters has to be executed by the metrology service at the central laboratory it will be

necessary to provide not only for the verification installation but also for considerable storage space of meters.

The following suggestions for volume calibration equipment are made on the assumption that the adjustment of water meters will not be the regular duty of IOS and that therefore only transportable working standards (etalons) are used for calibration of other test installations (or for occasional verification on the site of such meters).

Primary references for volume measurements

Volume measurements are generally limited in accuracy due to wetting problems. If no special precautions are taken such phenomena usually limit the accuracy to about 0.02 % which however is sufficient for most purposes. (Non-wetting surfaces consisting of a teflon coating have been introduced lately for accurate volume standards to improve the accuracy). Temperature problems sometimes constitute another limit of accuracy. As a primary reference for volume it is usually the best to employ glass as construction material as the risks for deformations usually are smaller and the containers can be easily inspected or cleaned.

- item V-1 The primary reference of the metrology service is preferably constituted by a set of conically shaped flasks terminated by a long cylinder which is graduated in parts of 0.1 % over a range of ± 1 %. The capacities of these flasks should be
0.1 - 0.2 - 0.5 - 1 - 2 - 5 - 10 litres
They should be certified by a national metrology service whereby the deviations from the indicated graduation lines should be given in parts to 0.01 %
- item V-2 A set of certified precision pipettes of glass in the range of 1 to 100 millilitres
- item V-3 A stainless steel standard of precision type, capacity 100 litres and equipped with discharge tap. This gauge should be fully protected from shocks inside a tubular tripod mount equipped with levelling devices.

Working references for volume measurements

The working references (or working "etalons") to be chosen depend much on the amount of work to be executed. In certain countries there are requirements for certification of precision glassware. This will most probably not be the case in Iraq and the working standards in the low range of capacities may then simply consist of glassware similar to items V-1 and V-2 or of calibrated measuring cylinders such as usually employed in chemistry. For high accuracy and high speed of calibration several metrology services use so-called automatic burette systems. The principle is shown in Fig 4 of ref. 1.

item V-4 (optional): Automatic burette system of glass consisting of a set of automatic burettes from 5 ml to 10 l mounted on a panel or using a manifold system on a laboratory washbench. The system shall include all necessary taps and tubing and should be connected to a high tank to be installed in the laboratory volume 160 litres or approaching made from PVC covered glassfiber. The tank shall be filled from a demineralizer (permutit type).

(See ref 1, 2 and 3)

Alternatively the burette system from 1 to 20 l can be made from stainless steel and glass, see ref 4, suitable for calibration of working standards item V-8.

Note: The automatic burette system is usually not very expensive but may not prove necessary at least as a start. The glass-fiber tank and the demineralizer will however be necessary in any case.

The other working references should be conceived as regards packing and transport so that they can be used for field work as well as in the laboratory. The quantities indicated as regards the following items take into account the use in mobile applications including the planned minibusses:

- item V-5 For use as secondary standards in the central laboratory and occasionally in mobile applications: 10 sets of volumetric flasks (conical similar to item V-1 or ballon type) with long graduated neck of cylindrical shape composed of
- | | | | | |
|--------|---|--------|---|-----------|
| 100 ml | - | 200 ml | - | 500 ml |
| 1 | - | 5 | - | 10 litres |
- according to highest quality ISO, DIN or BS standards
Supplier: Laboratory glassware suppliers
- item V-6 For use in the central laboratory as well as in mobile applications:
10 sets (or twenty) of graduated metric cylinders packed in transport case, range of cylinders from 50 ml to 2000 ml.
Suppliers: Reverifications Ltd
S. Garcia Ltd
Astell-Hearson Ltd, U.K.
- item V-7 For use in the central laboratory as well as in mobile applications:
10 sets (or twenty) of graduated volumetric pipettes packed in transport case, range 1 ml to 100 ml (or 500 ml)
Suppliers: as for item V-6
- item V-8 10 sets (or twenty) of stainless steel cylindrical volume standards with visigauge system (similar to ref. 6 and ref 7 as regards construction) consisting of
- | | | |
|----|--------------------|--------------------------------------|
| 1 | litre graduated to | ± 40 ml divisions or approaching |
| 2 | " | ± 40 ml |
| 5 | " | ± 100 ml |
| 10 | " | ± 100 ml |
| 20 | " | ± 200 ml |
- Suppliers: Wragg Bros, U.K.
Ets Vial, France
- item V-9 One (or two) sets of transportable high-volume standards preferably made from stainless steel of such thickness as to be fully resistant to deformations. (Galvanized austenitic steel also acceptable). These standards should be fully transportable and equipped

item V- 9(continued)

with levelling devices and legs, transport wheels should be fitted on the higher capacity ones as shown below. A drain valve of large size shall be provided for connection to standard tubing, a connector shall be supplied for this purpose. The set shall consist of

capacity 50 l	with legs		
100 l	" "		
200 l	" "	and wheels	
500 l	" "	"	"
1000 l	" "	"	"

The construction shall correspond to a design approved by a national metrology service for use as secondary mobile standards. The accuracy of the units shall be $\pm 0.05 \%$ and graduations shall extend over a range of minimum 0.5 to 1 % depending on the capacity.

Suppliers: Ets Viel, France (see ref. 8 and 9)

or

Oval Engineering, Japan

and others

Special equipment for the verification of hydrocarbon liquid counters

The working reference equipment which has been listed above may be used for transportation to the sites of verification in occasional tests such as calibration of factory installed containers etc. or for verification of water meter test installations. It may also be used for site verification of measures used for direct distribution of kerosene(see item V-8). However, for the verification of hydrocarbon distribution counters the minimum volume debited during verification should in accordance with several national regulations be at least 500 times the lowest graduation unit(or for continuous counters 1/50 of the volume measured in one hour at maximum flow). It is thus generally not possible to use the smaller type of transportable volume standards, furthermore suitable discharge pumps and safety devices must be provided. The best solution is thus a special vehicle

which may be universally used for the verification of a great number of types of counters of hydrocarbon liquids.

item V-10 (optional depending on agreement with the National Iraqi Oil Co):

Van for the verification of hydrocarbon counters for gasoline, fuel oil, kerosene and similar products) comprising volume standards for 1000, 200, 50 litres fixed on stands made from strong galvanized sheet steel and movable volume comparators of capacity 2, 5, 10 and 20 litres made from stainless steel. All standards to be equipped with visigauge system with plus and minus scale readings. Accuracies 0.05 % for all standards. Design and execution in conformity with specifications of a national metrology service, including certification.

Hydraulic driven pump and drum filed tubing at least 20 meter long ending by pistol valve. All necessary safety devices including earthing, fire extinguisher, etc. The van used shall have maintenance facilities in Iraq.

(A quotation has been received for a type of van used by the French metrology service, see ref 10)

Secondary so-called master meters are used in applications for reverification of some types of meters. As these master meters in any case need to be calibrated regularly on fixed or mobile volume standards, they are not suggested for procurement at the present stage. Literature for such meters has however been received from the firms Avery-Hardoll, U.K. and Neptune, U.K. and are included in the reference file of the original report.

Other special equipment for volume gauging

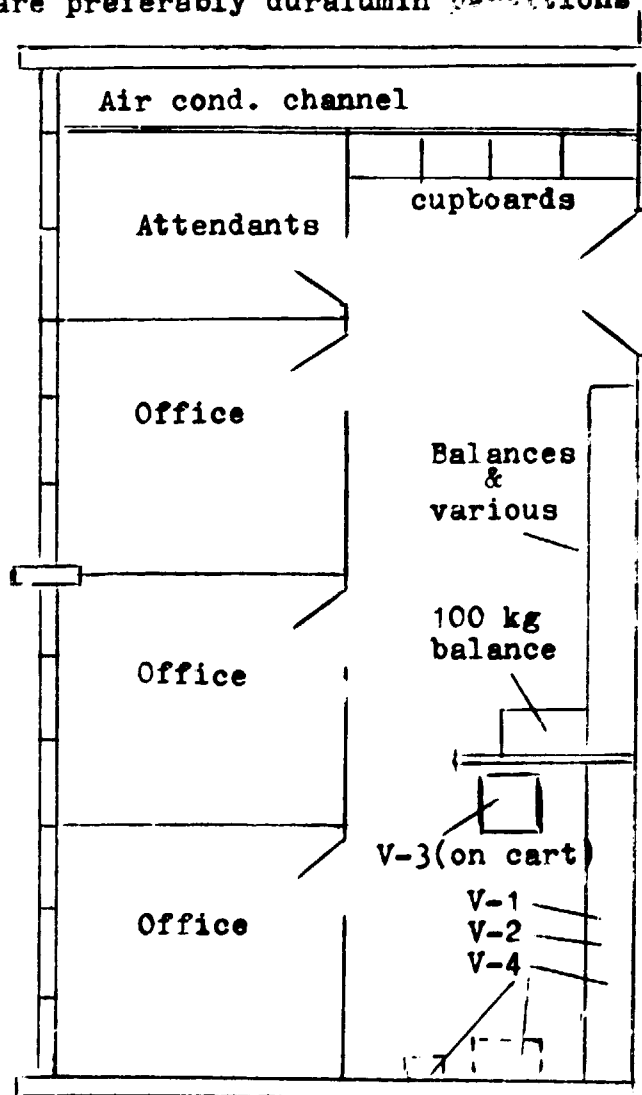
The requirements for gauging big reservoirs and tank wagons must be determined through a local survey. Fixed reservoirs are usually measured using steel tapes (20 to 100 m long) which should be procured along with various mechanical accessories and a calibrated tank truck (appr 10 000 litres) for the deter-

mination of non-accessible volume parts such as the bottom of the reservoir. Sometimes special surveying equipment is used (see photographs and reprints obtained from the Federal Office for metrology of Switzerland, ref 11).

Special filling and gauging installations are used for calibration of tank trucks, generally using two volume standards of 1000 litres which are alternatively filled and drained. Such an installation is only required if a great number of tank lorries have to be calibrated.

Lay-out of room 87

This room which was reserved for water meter testing can preferably be arranged so as to include a small laboratory for primary and secondary volume measurements as well as offices for the legal metrology staff as shown below. The walls are preferably duralumin partitions 3 m high with windows.



Literature or quotations referred to in the note concerning
volume calibration equipment

- Ref. 1 - E.W. Allwright: Les Bureaux des Poids et Mesures
en Grande-Bretagne.
Bulletin de l'OIML No. 24 , 1966
- Ref. 2 - Catalogue of glassware volume calibration equipment
manufactured by Sutherland Thomson Co,U.K. and
distributed by Astell-Hearson, Laboratory Equipment
suppliers, U.K.
- Ref. 3 - Local standard automatic pipettes 5 ml to 10 l
Catalogue sheet from S. Garcia, Ltd, U.K.
- Ref. 4 - Automatic burette system used by the Federal office
of metrology of Switzerland (photograph)
- Ref. 5 Graduated glass cylinders in packing case(according
to BS 604 part 1)
Catalogue sheet from S. Garcia, Ltd, U.K.
(also distributed by Avery U.K. and Reverifications,U.K.)
- Ref. 6 - British D.T.I. visigauge standards 2 litres to 20 litres
letter and photographs from Wragg Bros, Ltd, U.K.
- Ref. 7 - Drawing of volume gauges of metal used by the
&
Ref. 8 Service des Instruments de Mesure, France.
&
Ref. 9 - ranges 5 to 1000 litres (quoted by Ets Vial, ref. 10)
- Ref. 10 - Quotation and photographs of volume gauging
equipment including a van for verification of
hydrocarbon liquid counters.(Ets Vial, France)
- Ref. 11 - Dr W. Lotmar: Jaugeage des Grands Reservoirs de
Petrole(Federal Office of Metrology, CH-3084 Wabern,
Switzerland)
Bulletin de l'OIML, No. 26- December 1966
&
Schweiz. Bauzeitung 82, p. 749-52, 1964
One photograph showing the equipment used and one
photograph showing 1000 litre volume standard on
trailer chassis.
- Ref. 12 Catalogues of master meters obtained from
Avery-Hardell, Ltd, U.K. and Neptune Co. U.K.

List of suppliers of volume calibration equipment
according to information received at IOS as per 1 Sep 1978

Glassware constructions

Anciens Ets Vial
 4 bis rue Asseline
 75014 Paris
 France

Comments
 May be consulted on
 item V-1 which conforms
 to SIM and OIML specs

Astell-Hearson
 172 Brownhill Road
 Catford
 London SE6 2DL , U.K.

catalogue present from
 the subsidiary co Suther-
 land-Thomson, see ref 2
 items V-4 (and V-5,6,7)

Reverifications Ltd
 Stocklake
 Aylesbury
 Buckinghamshire, U.K.

items V-6 and V-7
 (see ref. 5)

S. Garcia Ltd
 The Croft Factory
 Nobel Road
 Eleys Estate
 London N18 3BH.

items V-4, V-6 and V-7
 (see ref. 3 and 5)

Stainless steel (or other metal) construction

Wragg Bros
 Robert Way
 Wickford Industrial Estate
 Wickford
 Essex, SS11 8DQ, U.K.

item V-8 is series manu-
 factured fro 2 to 20 litres
 cost appr 728 £
 (The same set can be supplied
 through Avery, U.K. but at
 50 % higher cost)

Anciens Ets Vial
 4 bis rue Asseline
 75014 Paris
 France

items V-3, V-8 according to
 SIM specs see ref 7 and 8
 new quotation required for
 stainless steel
 item V-9 quoted for galva-
 nized steel), see ref 10

Franke AG
 Metallwerke
 CH-4563 Heerbrugg
 Switzerland

for quotation: send IOS specs
 type of construction should
 be conform to requirements
 of the Federal Office of
 Metrology, Wabern, Bern
 (mainly item V-9 but also
 V-8 and V-3)

Wartmann AG
 Industriestrasse
 CH-4538 Oberbipp
 Switzerland

Oval Engineering
 10-8 Kamiochiai 3 chome
 Shinjuku-ku
 Japan

catalogues available at
 IOS. Mainly interesting as
 concerns items V-3, V-9 and
 possibly V-10. However,
 constructions must conform
 to NRLM specifications. Japan

(Other suppliers of stainless steel constructions may be
 found in Denmark, Sweden and Germany, see addressees included
 in the special 2011/78 series from the national metro offices)

NOTES CONCERNING MOBILE UNITS FOR THE VERIFICATION OF
ROAD(AND RAILWAY) WEIGHBRIDGES

Methods of verification

The verification of bascules up to 200 kg capacity will be possible with the equipment to be provided in the minibusses suggested for the regular weights and measures verification.

For higher loads it was customary to use a number of 20 kg calibrated weights which are transported to the verification site by an ordinary truck and handled by labourers without special lifting equipment. This has been also the case in Iraq where calibrated weights of this type are rented to the industries which verify their weigh-bridges by their own services.

This method is usually not practical up to more than 5000 kg of total load. Depending on the type of weighbridge this method may allow the calibration over the full range of the weigh-bridge provided another unknown but adjustable load is available such as a water tank truck(or sand tipper). There are in fact basically three methods of loading:

1. Verification using calibrated weights up to the total capacity of the weigh bridge(or approaching). This may be called "integral weight method"
2. Verification using calibrated weights representing at least 1/10 of the total capacity of the weigh-bridge and an unknown additional load which is increased in steps corresponding to the total load of the calibrated weights. This is the "full step by step method".
3. For certain types of oscillating weighbridges which use either movable weights on a calibrated balancing arm or calibrated weights which are added at specific positions of the balancing arm(drop weights): a simplification of method 2 whereby the verification is done using only the first and the last steps. This may be called "the simplified step method". It cannot be used for weighbridges using load cells or incorporating automatic balancing using sliding weights or ribbon with counterweight.

It is evident that the method 2 is very time-consuming unless

the number of steps can be reduced to two or three. For primary verification of all the steps of the indicating devices when using methods 2 and 3, the positions of the sliding weights on the balancing arm can be checked by demounting this arm (the so-called "romaine" in French). This check must be done in the laboratory.

From the above it will be seen that the integral method No. 1 is the most universal and it allows primary verification to be done on the site including all steps from 1 kg up to the maximum capacity of the weights. In a primary verification the following is usually verified:

- a) the levelling of the weighing platform
- b) the mobility of the platform including sensitivity and reproducibility at no load (by adding 1 to 10 kg weights)
- c) the equality of the ratios of the arms linkages connecting the platform to the central lever system (or electronic balancing of the load cells in the case of electronic bridges) by corner loading. It is usually recommended that this verification is done by applying $1/3$ of the total weighing capacity of the bridge to each of the four corners. This operation should be done preferably four times or more.
- d) the calibration of the individual steps of the weighing device (steps of 10, 100 and 1000 kg and thereafter in steps of 5000 kg up to the full load). Several readings or printings are taken at each load.
- e) if required and especially when a minor defect has been found the operation d) may be repeated in the reverse sense by unloading weights down to zero load. Otherwise full unloading of the weights and verification track from the bridge and recording of the zero indication.

In case of a reverification of a weigh-bridge which has not been repaired or damaged the above procedures may be simplified to checks at no load, $1/10$, $1/2$ and full load including reproducibility tests at each of these loads.

Background information for the choice of means of transportation and types of weights

It seems evident that the present system of verifying weigh bridges in Iraq must be updated to fit the present needs. The expert has therefore suggested that a survey should be done by circular letter or otherwise and addressed to all State organizations, port authorities, the National Oil Company, municipalities, road authorities and industry as well as the State railways. The following information for weighing equipment of capacity higher than 100 kg should be given in the replies:

1. Capacity in kg of the weigh bridge and size of the weighing platform
2. Make and type
3. Equipped with printing device, yes or no
4. Year of installation
5. Frequency of use: daily, weekly or monthly
6. In case of daily use, approximate number of weighings per day
7. Location

(The above requirements were already included in the expert's letter of 6 June 1978 to the counterpart)

As the survey has not yet been undertaken, because of lack of staff, it is difficult to make recommendations which fully fit the local requirements.

The type of weighbridge verification equipment varies from one country to another and is usually built to the requirements of the national metrology service of the country. The mode of transportation (truck) adopted depends on the distances to be covered and the frequency of verification, etc. The expert has tried to collect as much information as possible by writing personally to fifteen national metrology services. Only seven replies have been received (it is possible that some replies have gone lost). No specifications, drawings or other material was received except from Switzerland which furnished photographs of their equipment.

The expert had suggested that the matter should be further investigated through a study tour to some of the metrology services in Europe but this idea has not materialized. Such a study tour would allow not only to see the equipment used but also to follow the mode of operation and recording used by the verification services. It would also prevent ordering of obsolete equipment which may be offered by some suppliers.

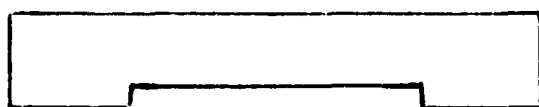
Though only limited information about weights and trucks is presently available at the project the expert is trying to summarize below the actual status of the technology in this field according to his knowledge and by consulting descriptions published in the bulletin of OIML (Organisation Internationale de Metrologie Legale) some of which however are about ten to fifteen years old. Very little has in fact come out of the circular letters addressed to the institutes concerned, as already mentioned.

WEIGHTS

Various types of weights are being used and an OIML recommendation has recently been finalized which includes several alternatives in the range of 100 to 5000 kg. A copy of this recommendation has been requested and is expected to be forwarded to IOS. The material used should for cylindrical weights not be ordinary grey cast iron which may be too fragile but should be of the alloyed shock-resistant type (malleable cast iron) or cast steel.

The usual OIML rectangular shape is used for 10 and 20 kg weights which are employed in sufficient number up to 500 kg. Thereafter the choice stands between cylindrical weights (usually limited to a capacity of 500 kg each) and parallelepipedic weights. Cylindrical weights have the advantage of enabling easy transport on the site by rolling.

More recently some countries have started to use a flat type of parallelepipedic weights which can easily be handled using a lift fork, see below



1500 mm



250 mm

400 mm

The advantage is that the weights can be transported on an ordinary truck without the need for a crane provided the weights are placed so that they can be accessible for the fork lift. The latter can be transported by the same truck(see Fig. 3 in ref. 1).

In order to reach a calibration capacity of 20 tonnes or more it will be necessary to use several trucks to transport weights or a special trailer hauled by the truck(ref. 1).

Thus in Holland where this system seems to have originated, they use a covered truck to transport the hydraulic fork lift and 8 weights of 1000 kg. This truck is three-axled and hauls a two-axled trailer which can contain up to 16 weights of 1000 kg. In operation, weigh-bridges up to 40 000 kg can be tested with the equipment using two steps whereby the truck and the trailer are used as additional loads adjusted to 20 000 kg. The platform of the weigh-bridge must in this case however be at least 13 meter long. A full description of the equipment is given by Mr J.N. van Pelt in Bulletin de l'OIML No 54 March 1974 (ref 1), of which a photocopy is attached(to the original)report.

Though no reply has been received from Holland it may be possible to obtain more details about the equipment and the suppliers from the author, the address of which is

Dienst van het Ijkwezen
Eisenhowerlaan 140
's- GRAVENHAGE
Holland

In Sweden distances to be covered by the trucks are bigger than in Holland. The same type of weights as in Holland have been adopted there but the weights are stored at various locations in the country(local offices) and are transported to the verification site by hiring the truck in each case. Also in the German Democratic Republic this system has been used but special trucks are planned to be procured for this purpose. The weights in that country correspond to the OIML recommendation mentioned and have the dimensions 1500 x 400 x 250 mm. The advantages of these weights are enumerated in a paper by M.Jacob(ref 2) as follows:

- shape and execution in accordance with international recommendations(OIML)
- the mass corresponds to a main division of the weighbridge
- the loading or unloading of the weigh-bridge of each weight can be done in 45 to 60 seconds using a hydraulic device
- the capacity of 1000 kg is covered by standard hydraulic fork lifts so that in case of failure, a replacement can easily be found
- the centre of gravity is very low
- no point-shaped overloading of the surfaces on which the weights are placed
- the risk for accidents is much lower than with weights having cylindrical shape
- the dynamic effect on the weighing platform is low when the weight is being applied
- simple technology of manufacture using ordinary cast iron
- temperature equilibrium with the surroundings is reached in a relatively short time

All these advantages seem to speak in favour of the use of 1000 kg flat rectangular weights. Cylindrical weights were however much used previously and a number of metrology services are still equipped with them. On the site they can be rolled but they have to be unloaded by a suitable crane. Some services use a covered truck with a motor-operated carriage system which slides on a rail so that the weights can be unloaded at the rear of the truck using a winch(France, Belgium, Iran etc , see p. 29 in ref. 4 and p. 58 in ref 5). However, the tendency is to shift to the usual types of hydraulic cranes directly mounted on the truck. In order to increase the total capacity of calibration which ten years ago was typically of the order of minimum 15 tonnes, the tendency is to use trailers hauled by the truck. The hydraulic crane should in this case be mounted at the rear of the truck so as to reach over the trailer (see reference 6).

The cylindrical weights have usually a mass of 500 kg and may be of the French type(indicated on p. 33 of ref. 4) or the German type(see p. 23 of ref. 7) or the Soviet type with garden roller handle(see ref. 6). Further details are contained in the OIML recommendation mentioned above. The material used for the

cylindrical weights must as previously mentioned be shock-resistant and ordinary grey cast iron should not be used unless specially alloyed. Cylindrical weights may therefore have to be manufactured abroad.

Conclusions and recommendations concerning the weigh bridge verification equipment

1. The expert feels that it is absolutely necessary to conduct the local survey of the weigh-bridges installed in Iraq. This survey will in addition anyway be required for the start of verification using the new equipment. It is in fact essential to know the capacity and the length of the weigh-bridges so that it can be established whether both trailer and truck can simultaneously be placed on the weighing platform to increase the calibration capacity of the equipment. In the case that the capacity is high of the weighbridge but its length is limited only the truck may be placed on the weighbridge and weights added around the wheels as shown in the pictures of ref. 9 (Switzerland). The flat type of rectangular weights can be piled up on the weigh-bridge without the use of truck as dead-load but in this case the transport capacity of truck and trailer must be sufficient to cover the range of the weigh-bridge.
2. The trend is actually to use parallelepipedic weights of the low flat type with mass 1000 kg especially if a calibration capacity of more than 20 tonnes is required. The truck and trailer are then practically standard equipment which can be supplied by any firm having maintenance facilities in Iraq. The total calibration capacity including the weight of the truck and the trailer should be at least 30 to 40 tonnes but it may be difficult to reach a higher capacity due to the limitations imposed by the roads unless the transport trucks are duplicated for such calibrations and the pile-up system of weights is used. The main truck should have a space and loading board for the fork lift. The latter should have a lift capacity of 2 meter and 1000 kg and be chosen from a brand which is currently used and has maintenance facilities in Iraq.

The use of cylindrical weights may be advantageous if the capacity of calibration is limited to 20 or 30 tonnes.

For calibration of high capacity weighbridges(over 20 tonnes) the use of cylindrical weights may take a long time and the risks for accidents in unloading are greater. Therefore, again, the final choice of equipment will depend on the local conditions.

3. Personally, the expert would according to the information so far received make a choice between the solution described in ref. 1(rectangular weights 1000 kg) and in ref 6(cylindrical weights with garden roller type of handle) depending on the outcome of the local survey. He would also prefer to order the truck and the trailer from a supplier who has regular maintenance facilities in Iraq and chose models of standard type as much as possible. He also thinks that the flat rectangular weights can be manufactured in Iraq from ordinary grey cast iron which may be painted for corrosion protection, whereas cylindrical weights, if adopted, may have to be ordered abroad specifying cast steel or at least specially alloyed shock-resistant cast iron/malleable cast iron or similar).

4. Calibration of the heavy weights: This should be done on a suitable balance installed in the machine hall by a comparison method to a number of 10 kg(or 20 kg) weights which have been calibrated on the primary balance. It is necessary to pay attention to the size of the weighing pan or platform of this balance in particular if 1000 kg weights are to be calibrated. The French, Swiss and probably the Japanese services use equal-armed balances of a capacity of 500 kg only. The decimal balance(ratio 1/20) proposed by the expert, manufactured by Berliner Industriewagenfabrik, is probably the less expensive and has the required capacity of 1000 kg and a sensitivity approaching a few grammes. It is being used by a large number of metrology services. The experience of the balance has been extremely good so far in several countries. For the calibration of the 1000 kg flat type of weights it is important however that the platform dimensions are increased to 1500 x 1500 mm like has been the case for the balance delivered to Sweden.(The actual quotation is for a balance with platform of 1000 x 1000 mm). No special well has to be made as a recessed execution may be used. Preferably however the balance should be installed by the manufacturer.

5. Installation requirements in the machine hall:

It may be an advantage to install immediately a traveling crane of 4 tonnes capacity as was originally foreseen, though this crane may not be required for the normal metrology activities when using a fork lift. Cylindrical weights or other items such as big volume containers which may have to be weighed for calibration purposes, may require the presence of a crane which will also be useful for unloading other heavy or bulky equipment from trucks.

The installation of a 50 tonne weighbridge in the machine hall may also be an advantage as originally planned but it will not be required for the calibration of road weighbridges though it may facilitate quick checks with loaded trucks for the Baghdad area. If IOS is charged with the certification of the dead weight of trucks, tank wagons etc this bridge may however prove very useful.

In any case, if the weighbridge is not installed, the floor must be reinforced to carry the load of the calibration truck and the trailer. The floor should then on the mean support loads of at least $6\ 000\ \text{kg/m}^2$ and point loads (on $0.2\ \text{m}^2$) of at least 1 500 kg.

The machine hall must also be equipped with workshop benches for adjusting weights, equipment for melting lead, a drilling machine and possibly a small press etc

Other machine hall equipment will as regards metrology depend on the type and amount of work required for volume calibration, suggestions for which are given separately in this report.

Annexes:

- Summary of information available at the project concerning weigh bridge calibration equipment
- References to publications (a set of photocopies of these papers are attached to the original handed over to the counterpart on 26 Aug 1978)
- List of manufacturers of weigh bridge calibration equipment and special trucks in accordance with information received from some national metrology services

Summary of information available at the project concerning weigh-bridge calibration equipment

Country & year	Ref.	Type of weights	Truck		Trailer		Total calibration mass	Remarks
			unloaded	weights	unloaded	weights		
Holland(1974)	1	P - 1000 kg	12 t	8 t	6.8 t	16 t	40 t	Length between external wheels 13 m from truck + trailer
Sweden(1978)		P - 1000 kg	(hired trucks for transport)					
German Democratic Republic(1977)	2	P - 1000 kg	(hired trucks, special trucks under construction)					
France(1967)	4	C - 500 kg	7 t	5 t			12 t	
" (1978)	11	C - 1000 kg	7.5 t	13 t		(10 t)	20+(10)	In construction
Belgium(1964)	5	C - 500 kg	8 t	10 t			20 t	
" (1967)	3	C - 500 kg	6 t	3 t			3 t	For small weigh-bridges only
Zambia(1969)	6	C - 500 kg		12 t		18 t	30 t	Only the weights are used
Berlin, FRG(1962)	7	C - 500 kg F - 500 kg			4 t 8.5 t	8 t 21.5 t	12 t 30 t	Small hauling truck
Austria(1962)	8	P - 500 kg	5 t	5.5 t			11.5 t	Experimental type
Switzerland(1978)	9	C - 500 kg	(total capacity including trailer at least 30 t)					
As supplied by Avery, U.K.(1978) (for Middle East)	10	C - 500 kg	(complete truck without trailer)				20 t	Unloading devices not safe in the expert's opinion

Note: P = parallelepipedic weights, C = cylindrical weights
 Datas given above for any year earlier than 1974 may not apply any more

References

1. - J.N. van Pelt: Equipment pour la vérification des ponts-basculés routiers du service de la métrologie des Pays-Bas
Bulletin de l'OIML No 54, March 1974
2. - M. Jacob: Einsatz grosser Massenormale fuer die Pruefung elektromechanischer Waagen
Feingeraetetechnik, 26, Heft 4 1977, p. 168-69
3. - Camions automobiles équipés du matériel nécessaire à la vérification de certains ponts à peser et bascules
Bulletin de Metrologie(Belgium) No 323-324 August- September 1967
4. - Les Camions Etalons du Service Français des Instruments de mesure.
Bulletin de l'OIML, No. 3, March 1961
5. - J. Leonard: Nouveaux camions de vérification des ponts à peser les véhicules routiers
Bulletin de l'OIML, No. 16, June 1964
6. - J.L. Penn: Test vehicle commissioned in Zambia
The monthly review, 77, No 8, August 1969
(published by the Weights & Measures Dep.U.K.)
7. - H. Johannsen: Equipment de l'administration berlinoise des poids et mesures en vue de la vérification des bascules pour véhicules routiers
Bulletin de l'OIML, No. 9, Sept. 1962
8. - Kraftfahrzeug mit besonderer Einrichtung fuer die Eichung von Fuhrwerksbrueckenwaagen
"Der Oesterreichische Eichdienst", 1962
issued by Bundesamt fuer Vermessungswesen, Wien
9. - Set of photographs of calibration truck and trailer used by "Office federal de metrologie" CH-3084 Wabern BE, Switzerland
(letter to A.Thulin, IOS dated 3 July 1978)
10. - Avery Export Ltd, U.K. - Weighbridge test unit.
Two pages of description and two drawings, as well as 5 photographs included in letter from Avery Export to A. Thulin, IOS.
(Letter dated 22 May 1978 but posted 17 August 1978)
11. - Information given to Mr Thulin in July 1978 when visiting Mr Marmy, Service des Instruments de Mesure Section matériel, 66 rue Bellechasse, Paris 7e
The new equipment uses a regular hydraulic crane mounted at the rear, but is still in construction so experience have not yet been obtained(can be supplied by Ets Vial. Paris)

List of manufacturers of special equipment for verification of weigh-bridges in accordance with information received from some national metrology services

Complete truck and weights

- Avery Export Limited, Smethwick, Warley, West Midlands,
B 66 2 LP, England

(Note the truck quoted uses rather unsafe unloading devices of the weights in the expert's opinion. The approximate cost is 55 000 £ and 366 £ for each weight. The truck is stated to take up to 40 of 500 kg cylindrical roller weights)

Specially arranged trucks (standard models)

- Franz Brozincevic VCo AG, FBW
CH- 8620 Wetzikon, Switzerland
- Saurer AG
CH-9320, Arbon, Switzerland
- Leyland International, Leyland House, 174 Marlebone Road,
London NW1 5AA, U.K.
(see letter ref LHM/CAB/65.603 dated 5 June 1978)
- Scania, Iraq
- Anciens Ets Vial
4 bis, rue Asseline- 75014 Paris
(Equipment in accordance with French specifications, cylindrical weights) quotation received, cylindrical weights 1000 kg (x)
- Manfred Zierath
Am Staatsforst 2
3171 Eickhorst
F.R. Germany
(Is prepared to supply lorry with crane, capacity 50 weights of 500 kg, rolling weights or rectangular as used in Germany)
- Addresses of eight other German manufacturers of special trucks have been furnished by the Physikalisch-Technische Bundesanstalt, Germany, see photocopy page 118

Weights

- Hegi & Cie AG, Eisengiesserei, CH- 414 Oberburg, Switzerland
- Skeppshults Gjuteri AB S- 330 24 Skeppshult, Sweden
- Ets Vial, France, see above

(x) experience of this type of weights and equipment has so far not been obtained as the French service has not yet put their units in operation. Such weights may however be used by manufacturers of weigh-bridges.

Adresses to suppliers furnished by PTB, Germany

Weigh bridge test units on trucks

In this respect we are very much pleased to inform you that the following manufacturers could supply you such units and hence we request you to get in touch with them for further details.

- | | |
|---|--|
| <p>1) MAN
Unternehmensbereich Nutzfahrzeuge
Postfach 500620
Dachauer Str. 667
8000 München</p> | <p>2) Daimler Benz AG
Abteilung Nutzfahrzeuge
Postfach 202
Stuttgart 60</p> |
| <p>3) Fa. Klöckner-Humboldt Deutz AG
Abteilung Nutzfahrzeuge
5000 Köln - Kalk</p> | <p>4) Fa. Karl Kaschöhrer
Fahrzeugwerke GmbH
Postfach 2600
Peter Schmidt Str.
79 Elm/Donau</p> |
| <p>5) Langendorf Fahrzeugbau
Postfach 260
Bahnhofstr. 115
4355 Waltrop</p> | <p>6) Fa. Wille Schwaerle
Fahrzeugfabrik
Postfach 20
7114 Pfedelbach</p> |
| <p>7) Klaus GmbH & Co
Fahrzeug & Maschinenfabrik
Postfach 2640
Schlachthof Str. 46
8940 Memmingen</p> | <p>8) SFH-Spezialfahrzeugbau (GmbH)
Postfach 189
Carl Leverkus Str. 16
4018 Langenfeld</p> |

