ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

FORMATION EN METROLOGIE

Synthèse sur les possibilités et bibliographie

METROLOGY TRAINING

Synthesis of facilities and bibliography

Mars 1987

BUREAU INTERNATIONAL DE METROLOGIE LEGALE
11, Rue Turgot — 75009 PARIS — France

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I - SYNTHESE sur la FORMATION du PERSONNEL d'un SERVICE de METROLOGIE LEGALE

Enquêtes

Afin de remettre à jour et de compléter les informations en possession du BIML, des enquêtes sur la formation du personnel d'un service national de métrologie furent effectuées en 1975, 1977 et 1979.

Une synthèse sur l'enseignement de la métrologie légale fut publiée par le BIML en 1980.

Cette brochure constitue une compilation mise à jour d'après des informations plus récentes. D'autres informations concernant des cours ou des livres de métrologie sont couramment publiées dans le Bulletin de l'OIML.

Métrologie légale

Les renseignements fournis par les pays membres indiquent en général que les ingénieurs supérieurs sont recrutés selon les besoins sur diplômes universitaires et leur expérience pratique. Leur formation complémentaire s'effectue par des stages de travail dans le service national ou parfois dans un service étranger.

Dans la plupart des pays la formation des inspecteurs (aussi appelés ingénieurs des travaux) s'effectue de la même façon. Cependant il existe dans quelques pays de véritables écoles de métrologie légale, comme l'indique le tableau 1, page 5 (section anglaise).

Ces mêmes écoles forment également des techniciens vérificateurs pour lesquels les conditions d'admission sont généralement le niveau du baccalauréat mathématique-physique complété par des cours pratiques en atelier (mécanique et électricité).

Les cours théoriques sont souvent combinés avec un travail pratique dans le service de métrologie national et sont parfois donnés sous forme de cours du soir ou cours par correspondance.

La plupart des services, même ceux qui n'ont pas de véritable école de métrologie, organisent des cours de courte durée (quelques jours à quelques semaines) qui traitent un ou plusieurs sujets à la fois.

Ceci est notamment le cas lorsqu'un changement de la réglementation technique entraîne la nécessité d'un recyclage du personnel. On peut noter qu'il est souvent difficile pour des étrangers d'assister à ce type de cours à moins de déjà se trouver en stage dans le pays.

Dans plusieurs pays (voir p.ex. Grande-Bretagne et certains Etats d'Australie les inspecteurs sont recrutés sur concours selon un programme d'examen spécialement orienté vers la métrologie légale telle que définit par la législation particulière du pays.

Afin de mieux définir les catégories de personnel dont il a été question ci-dessus nous donnons en page F 4 un exemple de schéma simplifié de la formation théorique et pratique de métrologistes d'un service national de métrologie.

Métrologie générale, scientifique et appliquée

Un grand nombre d'universités technologiques ont dans leur programme des cours de métrologie, en particulier pour la formation d'ingénieurs en mécanique ou en électricité - électronique. Pour suivre ces cours il faut dans la plupart des cas être inscrit pour un sujet plus général mais il est parfois possible de suivre ces cours séparément en tant qu'auditeur libre. Quelques adresses d'universités et écoles qui dispensent un tel enseignement ont été communiquées au BIML mais cette information est incomplète et il est conseillé de se renseigner pour chaque pays auprès du Ministère de l'Education supérieure compétent.

Nous signalons aussi sur ce point le répertoire "A World Directory of Institutes providing Higher Education in Measurement and Instrumentation", 40 pages, édité par IMEKO, POB 457, 1371 Budapest, Hongrie.

Cours de métrologie pour étrangers

Des cours de durée limitée spécialement destinés aux étrangers et traitant la métrologie en général (sans considération aux dispositions légales) sont organisés comme l'indique le tableau 2, page 6 (section anglaise).

Des renseignements sur ces cours et les modalités d'admission peuvent en général être obtenus en contactant l'organisateur indiqué dans le tableau.

Dans plusieurs cas ces cours sont organisés dans le cadre des accords d'aide à l'étranger, auquel cas les modalités d'admission sont régies par des accords bilatéraux ou internationaux d'assistance technique. Dans ce cas une partie des frais est prise en charge par le pays hôte.

Stages pratiques dans le service

Les services de métrologie des pays suivants ont répondu qu'ils peuvent, sous condition d'approbation par le Ministère compétent, accepter un nombre limité de stagiaires dans leurs services au niveau d'inspecteurs (ingénieurs des travaux) :

Rép. Féd. d'Allemagne, Rép. Dém. Allemande, Autriche, Australie, France, Hongrie, Inde, Israël, Pays-Bas, Pologne, Suisse et U.S.A.

D'autres pays peuvent probablement également accepter des stagiaires, la condition essentielle étant cependant que les candidats aient une connaissance suffisante de la langue du pays.

En général, ces stagiaires doivent avoir au préalable une formation universitaire correspondant à une licence de physique (B.Sc.). Le stagiaire participe dans la plupart des cas directement au travail du service et s'il n'a pas d'expérience précédente du travail pratique, il faut compter qu'il commence par effectuer un travail correspondant à celui du technicien.

Financement d'études et de stages à l'étranger

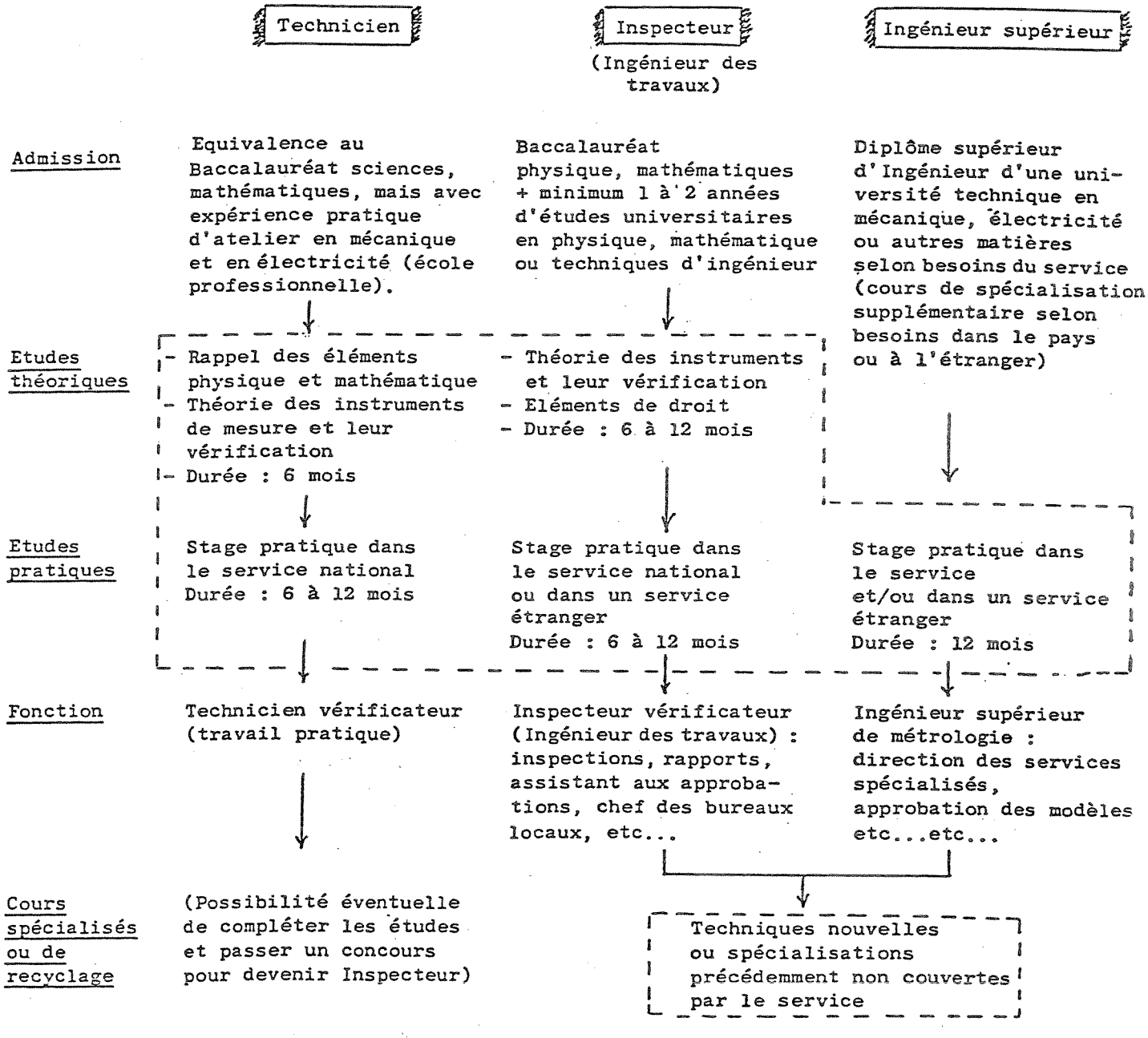
La formation du personnel à l'étranger est en général à la charge entière du service de métrologie demandeur.

Dans certains cas, des subventions peuvent être obtenues grâce à des accords bilatéraux, les renseignements sont alors fournis par les différentes ambassades sur demande expresse formulée par le service de métrologie ou le Ministère compétent.

L'assistance financière par l'intermédiaire des Nations Unies dépend en grande partie des programmes d'assistance signés avec le gouvernement et il est conseillé de demander des renseignements à ce sujet au Ministère assurant la coopération avec les Nations Unies ou dans certains pays directement en s'adressant au Résident Représentant du PNUD (Programme des Nations Unies pour le Développement). Ce représentant est normalement habilité à assurer la liaison pour tous les programmes et bourses des différentes agences, y compris l'ONUDI et l'UNESCO, et il peut rechercher la meilleure voie à suivre selon les disponibilités financières du moment.

Dans certains pays des cours ou séminaires sont parfois organisés par l'intermédiaire des Agences des Nations Unies.

Modèle simplifié d'enseignement spécialisé de métrologie légale



II - SYNTHESE sur l'EXISTENCE de MANUELS d'ENSEIGNEMENT de la METROLOGIE

Cours généraux

Il faut d'abord faire une distinction entre les manuels de métrologie à proprement parler et des cours non spécialisés de mathématique-physique, électronique, chimie, langues, droits, etc.. Ces derniers doivent de toute façon faire partie de l'enseignement de base aussi bien des techniciens vérificateurs que des ingénieurs. Quant il est possible de choisir entre manuels de cette catégorie, on trouve qu'il existe souvent des ouvrages qui font une plus large part aux problèmes rencontrés par le métrologiste et que certains cours de physique par exemple rentrent plus profondément dans les problèmes de mesurages et de l'instrumentation que d'autres. Souvent cependant l'enseignement de base est dispensé par des écoles qui ne sont pas spécialisées en métrologie et le champ étant très vaste, il ne nous est pas possible d'analyser les très nombreux manuels de ce type existant dans divers pays. Il faut dans ce domaine d'abord choisir la langue d'étude et ensuite consulter les écoles ou instituts d'enseignement dans les pays de cette langue en vue de sélectionner les livres de cours les mieux adaptés.

On peut noter cependant qu'il existe pour certaines écoles de métrologie comme par exemple celle de la République Fédérale d'Allemagne une liste de livres de cours, en particulier de mathématique et physique, qui sont disponibles en librairie.

Traités et manuels d'ingénieurs

Il existe très peu de livres de métrologie spécialement orientés vers l'enseignement à l'exception de livres de métrologie mécanique d'atelier et quelques traités de mesures électriques ou électroniques. Quelques traités de thermodynamique font unecertaine place aux mesurages de température et des pressions et certains traités d'hydrodynamique comportent des chapitres consacrés aux mesurages de pressions et débits.

Parfois ces ouvrages débordent des nécessités de l'enseignement et deviennent des véritables livres de références contenant beaucoup de renseignements utiles à l'ingénieur. Nous avons inclus ce type de livres dans un premier essai de compilation d'une liste bibliographique dont le but n'est pas d'inclure toutes les publications de ce type relatives à la métrologie mais bien une sélection de manuels utiles à l'enseignement ou au métrologiste déjà confirmé. Cette liste, limitée aux langues allemand, anglais et français, demande à être révisée et complétée par des renseignements plus récents, voir III - Practical Metrology - Bibliography. Parmi les ouvrages disponibles en français, il convient de mentionner tout particulièrement les 8 volumes "Mesures et Contrôle" de Techniques de l'Ingénieur (voir p.52), les Monographies du BNM (voir p. 26) et les cours du Service de la Métrologie (voir p.14). D'autres livres en français sont inclus aux points 11.1 à 11.15 dans cette brochure.

Manuels d'enseignement de la métrologie

De véritables cours de métrologie pratique spécialement écrits pour la formation de métrologistes d'un service national sont très peu nombreux et sont, de plus, souvent difficilement exploitables pour un étranger, soit à cause de leur forme (par exemple sous forme de fascicules ronéotypés, comportant des notes ou illustrations, destinés à compléter des cours donnés par le professeur), soit à cause de la langue nécessitant une traduction.

D'après les différentes enquêtes effectuées par le BIML, dont les résultats sont disponibles sous forme de rapports, on peut dégager les conclusions suivantes :

Pays	Langue	Type de cours	Remarques
R.F. d'Allemagne	allemand et anglais	Cours de métrologie pour pays en voie de développement	
Australie	anglais	Cours de métrologie légale	Brochures imprimées
Canada	anglais et français	Cours de métrologie légale	Diapositives avec manuels pour l'instructeur, voir p. 13
France	français	Cours de l'Ecole Supérieure de Métrologie	Fascicules ronéotypés
Indonésie	indonésien	Cours de métrologie légale pour ingénieurs	Fascicules ronéotypés
Japon	anglais	Cours de métrologie légale pour pays en développement	Brochures et cassettes vidéo
Pays-Bas	néerlandais	Cours de métrologie légale	Fascicules ronéotypés
Roumanie	roumain	Cours de métrologie légale pour inspecteurs "Curs pentru pregatirea metrologilor autorizati" (1972) Cours de métrologie légale pour techniciens métrologistes "Curs pentru pregatirea muncitorilor metrologi autorizati" (1972)	Livres reliés et illustrés (Editura Tehnica, Bucuresti). Il existe également un grand nombre de livres de base pour techniciens.
U.R.S.S.	russe	Cours de métrologie	voir liste bibliographie URSS, p. 63
Etats-Unis d'Amérique	anglais	Modules de formation en métrologie légale	Manuels pour élèves et instructeurs avec diapositives (voir p. 15)

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Moyens audio-visuels

Le Canada a mis au point une série de modules destinés à la formation des inspecteurs et des techniciens. Ces modules comprennent chacun des diapositives accompagnées d'un texte. Ils sont disponibles en versions française et anglaise, sous les titres suivants :

INT 1-1,	Introduction aux poids et mesures
VOL 2-1,	Citernes mobiles
VOL 3-1,	Mécaniques des fluides
VOL 4-1,	Compteurs de liquide
THE 2-1,	Principes des leviers
THE 20-1,	Métaux et métallurgie
GRV 2-1,	Appareils gravimétriques de moyenne portée
GRV 3-1,	Bascules mécaniques de forte portée
GRV 7-1,	Bascules électroniques de grande capacité

Un système similaire a été adopté par les Etats-Unis d'Amérique (voir p. 15).

L'American Institute of Petroleum a également édité des séries de diapositives accompagnées de cassettes magnétiques d'explications en anglais, relatives aux mesurages des produits pétroliers. Pour plus de détails, s'adresser à :

Petroleum Extension Service
10100 Burnet Road, BSC 2
Austin, Texas 78758
U.S.A.

Plusieurs laboratoires de métrologie ont produit des films ou cassettes vidéo qui montrent leurs activités ou qui servent pour la formation. Ceci est notamment le cas pour la PTB en RFA, le NPL au Royaume-Uni et le NRLM au Japon.

Cours spécialisés de courte durée

Certains instituts ou associations professionnels organisent, plus ou moins régulièrement, des cours spécialisés de courte durée. Ceci est notamment le cas du National Engineering Laboratory en Grande-Bretagne, pour les mesures de débits de gaz ou de liquides et de Cranfield Institute of Technology pour les mesures dimensionnelles (voir adresses à la page 9). Des cours de métrologie en français, en particulier dans le domaine de la métrologie dimensionnelle, sont souvent organisés par le Laboratoire National d'Essais, 1 rue Gaston Boissier, 75015 Paris.

Voir à ce sujet également les point 5.1. ISA et 5.2. IMEKO, page 27.

I - SYNTHESIS of FACILITIES in EDUCATION and PRACTICAL TRAINING of LEGAL METROLOGY STAFF

Enquiries

In order to up-date and complete the information present at BIML enquiries concerning legal metrology education were undertaken in 1975, 1977 and 1979.

A synthesis of metrology training facilities in various countries was first published by BIML in 1980. This brochure is an up-dated compilation on metrology training resulting from additional information received by BIML.

Information about metrology courses and new text books or training source material is currently published in the Bulletin de l'OIML.

Legal Metrology

The information supplied by the member countries shows that generally the high-level metrology engineers (chief staff) are recruited according to the needs on university diplomae and practical experience. Their complementary training is accomplished by practical work in the national service or occasionally abroad.

In most countries the training of inspectors (verification engineers) is done in a similar way. However there exists in a few countries real legal metrology schools as indicated in Table 1, p. 5.

These schools also train verification technicians for which the level of admission is generally a certificate of Secondary Education with some additional workshop training (in mechanics and electricity).

The theoretical courses are often combined with practical work in the metrology service and are sometimes given in the form of evening or correspondence courses.

Most metrology services including those who have no real metrology school organise courses of short duration (a few days to several weeks) dealing with one or several subjects.

This is in particular the case when a change in the regulations requires additional training of the staff. In this case it is often difficult for foreigners to participate unless they are already following a broader training programme in the country.

In several countries (e.g. some States of Australia and U.K.) the inspectors are recruited following an examination, the syllabus of which reflects the particular legislation of the country and the activities concerned.

With a view of trying to define more generally the various categories of staff we give on page 4 a simplified scheme of the theoretical and practical training of metrologists of a national metrology service.

Scientific and applied general metrology

A great number of technical universities and engineering schools give courses in metrology in particular for engineers in production engineering or in electricity and electronics. In order to follow these courses it is in most cases necessary to register for a more general subject but it may sometimes be possible to assist as listener. Some addresses to universities and schools which give such training have been communicated to BIML but this information is incomplete and it is advised to contact the Ministry of Higher Education in the country concerned.

On this point we also like to mention the "World Directory of Institutes providing Higher Education in Measurement and Instrumentation", 40 pages, published by IMEKO, POB 457, 1371 Budapest, Hungary.

Metrology courses specially organised for foreigners

Courses of short duration specially conceived for foreigners and treating general metrology have been organised as indicated in Table 2, p.6

Particulars about possible future courses and the conditions for admissic can be obtained by contacting the organisers as shown in the table.

In some cases the courses are organised within the framework of foreign aid in which case the terms of admission depend on bilateral or international technical assistance agreements. In such cases part of the costs are usually met by the host country.

On-the-spot training in the metrology service

The metrology services of the following countries have replied that they may, subject to approval of the competent Ministry, accept a limited number of trainees in their services at the level of inspector (verification engineer) :

Federal Republic of Germany, German Democratic Republic, Austria, Australia, France, Hungary, India, Israël, the Netherlands, Poland, Swede Switzerland and U.S.A.

Other countries may probably also accept trainees but the essential and restricting condition is always that the candidates have a sufficient knowledge of the language of the country.

In order to be accepted these trainees shall in most cases have a university or engineering school degree equivalent to a B.Sc. in physics. The trainee generally participates directly in the work of the metrology service and should if he has little or no experience of practical work, be prepared to start by doing the work of a verification technician.

Financing of studies or practical training abroad

The training of the staff is generally at the charge of the assistance requesting country.

In special cases subventions may be provided from bilateral agreements, information may then be provided directly by the various embassies on special requests formulated by the service or the competent Ministry.

The aid provided through the United Nations depends to a large extent on the assistance programmes signed with the government and it is advised to ask for information on this subject from the Ministry assuring the liaison with the United Nations or, in certain countries, directly by contacting the Resident Representative of the UNDP (United Nations Development Programme). The Resident Representative is usually a link to all the followship programmes operated by the various UN agencies including UNESCO and UNIDO and his office may look for the best way to follow according to the prevailing budget arrangements.

Courses and seminars sponsered by certain countries are sometimes organized through the agencies of United Nations.

Simplified model of education in legal metrology

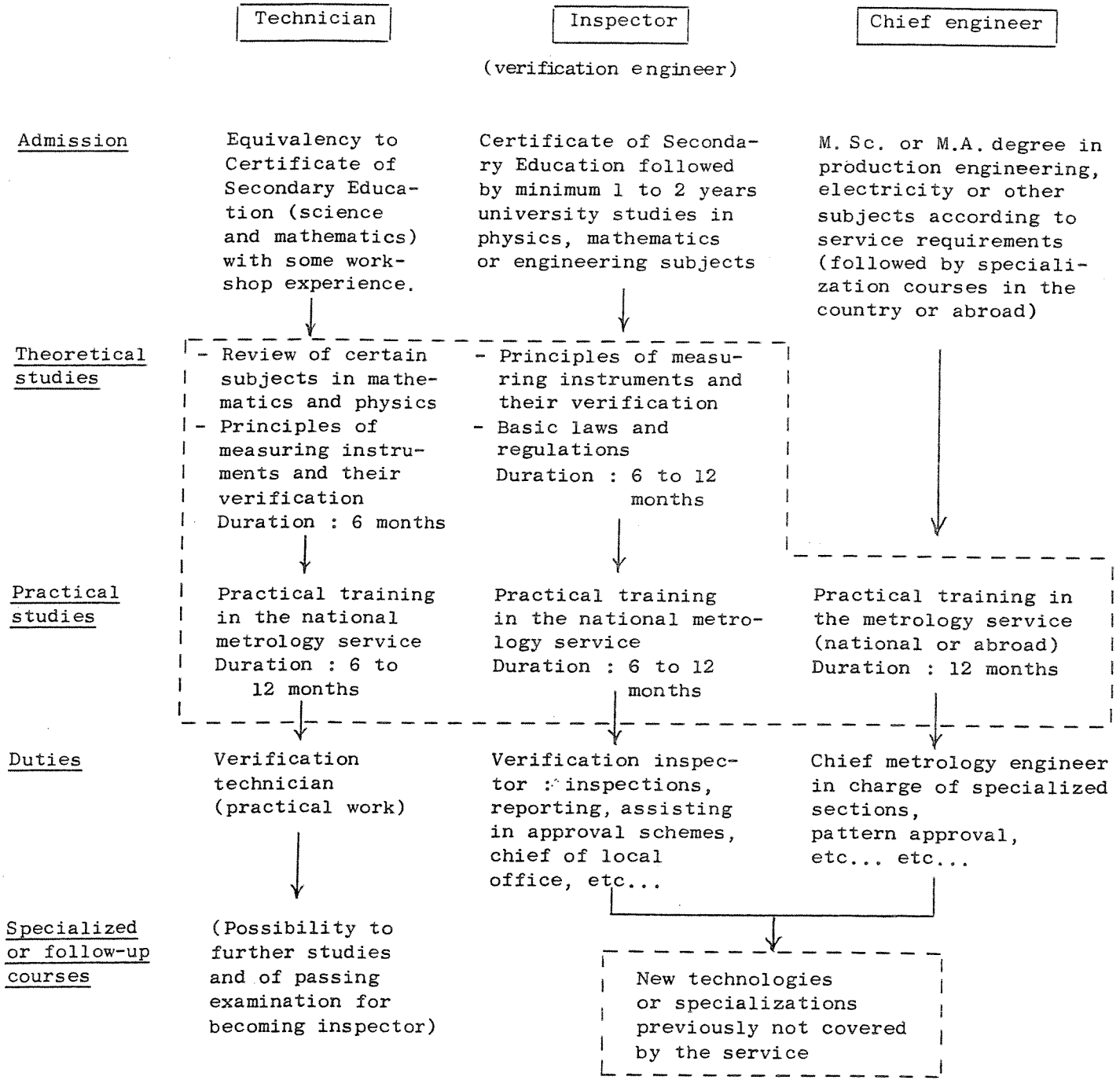

Table 1 - Ecoles de métrologie légale
Legal metrology schools

Country	Language	Duration of the theoretical studies	Name of the school	Address for information
Federal Republic of Germany	German	2 1/2 months technician 4 1/2 months inspector	Eichschule beim Bayerischen Landesamt für Mass und Gewicht	Bayerisches Landesamt für Mass und Gewicht Franz Schrank-strasse 8 D-8000 München 19
Australia State of Victoria	English	600 hours correspondence course (2 years minimum)	Technical and Further Education	National Standards Commission, P.O. Box 282 North Ryde, Sydney, N.S.W. 2113
Canada	French English	2 x 3 weeks (Introduction) 2 x 3 weeks (Complex devices)	—	Mr J.P. Lachaîne, Legal Metrology Branch, Standards Building, Tunney's Pasture, Holland Avenue, Ottawa, Ontario K1A OC9
Cuba	Spanish	less than 4 months	National Centre of Standardization Training	Calle 4 No.111 e/ 1 y 3, Havana City
France	French	6 months technician 2 years verification engineer	Ecole Supérieure de Métrologie	Directeur de l'Ecole Supérieure de Métrologie 941 rue Charles Bourseul, B.P. 838, 59508 Douai Cedex
India	English	4 months + 2 months	Indian Institute of Legal Metrology Ranchi + other institutes.	c/o Directorate of Weights and Measures Department of Civil Supplies, Shastri Bhavan, 12A Jam nagar House, New Delhi 110001
Japan	Japanese	5 months	Measurement Training Institute, Ministry of International Trade & Industry	Measurement Training Institute 12-37, 5-Chome, Fujimi-Cho Higashi-Murayama-Shi, Tokyo 189
Tanzania	English	3 years (inspector)	College of Business Education	The Director, College of Business Education P.O. Box 1968, Dar es Salaam
United Kingdom	English	3 years (inspector)	Trading Standards Officer Training Unit	The Director, South Western Provincial Councils Trading Standard Officer Training Unit, Daunceys Hotel, Claremont Crescent, Weston-super-Mare, BS23 2EE
U.S.A.	English	2 years, Measurement Science (inspectors & weighing technicians)	Yuba College	Yuba College Beale Road at Linda Avenue Marysville, California 95901
U.S.S.R.	Russian	30 months (or more)	Technical School of Measurements, Odessa (and other schools)	Dr L.K. Issaiev, Chief of Metrology Department, Gosstandart, Leninsky Prospect 9, 117049 Moscow

Table 2 - Cours de métrologie légale pour étrangers
Legal metrology courses specially organized for foreigners

Country	Language	Duration	Address for information
Federal Republic of Germany	German or English	6 to 8 weeks *	Physikalisch- Technische Bundesanstalt 3300 Braunschweig Bundesallee 100 (Fed. Rep. of Germany)
German Democratic Republic	German or English	6 to 20 weeks	A S M W - Abteilung Internationale Beziehungen Fürstenwalder Damm 388, 1162 Berlin (DDR)
Australia	English	6 weeks *	Dr G. Harvey, National Standards Commission, 12 Lyon Park Road, North Ryde, 2113 Sydney N.S.W. (Australia)
Cuba	English/Spanish	3 weeks	State Committee for Standardization (CEN) Egido No. 602 entre Gloria y Apodaca, Ciudad Habana (Cuba)
United Kingdom	English	3 weeks	Training in Metrology Course Coordinator, National Weights & Measures Laboratory Stanton Avenue, Teddington, Middlesex TW11 OJZ (United Kingdom)
Japan	English	6 months *	Training Affairs Department, Japan International Cooperation Agency, P.O. Box 216, Shinjuku Mitsui Bldg., No. 1, Nishi-shinjuku, 2-Chome, Shinjuku-ku - Tokyo 160 (Japan)
U.S.A.	English	3 weeks	Franklin University, 201 S. Grant Avenue, Columbus, Ohio 43215 (USA)
U.S.S.R.	English	4 months (1976)	(This course was organized through UNIDO, see OIML Bulletin No.66, March 1977)

* subject to bilateral agreements

Legal metrology courses and training workshops are also organized from time to time by regional organization such as :

- Arab Organization for Standardization and Metrology (ASMO) — P.O. Box 926161, Amman (Jordan)
- African Regional Standardization Organization (ARSO) — P.O. Box 57363, Nairobi (Kenya)
- Sistema Interamericano de Metrologia (SIM) — INTI, C.C. 157, 1650 San Martin B.A. (Argentina)

and by

- the Commonwealth Science Council — Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX (United Kingdom)

II - SYNTHESIS of EXISTING TEXT BOOKS

in METROLOGY

General courses

One must at first distinguish between text-books in metrology and less specialized courses in mathematics physics, electronics, chemistry, languages, laws, etc... These latter will in any case form a part of the basic education of verification technicians and engineers. When it is possible to make a choice between text-books in these fields one frequently finds that there are publications which to a larger extent treat problems encountered by the metrologist or which enter more in detail in measurements and instrumentation than other text-books. One must however first choose the language of study and then consult with the schools or educational institutions in countries using that language in order to select the most suitable courses.

One may note that some metrology schools such as that of the Federal Republic of Germany use text-books in mathematics and physics which can currently be procured through book-shops.

Specialized engineering text-books

There exist very few specialized metrology books which are written as courses with the exception of books in engineering metrology and treatises in electrical and electronic measurements. Some specialized treatises in thermodynamics deal largely with temperature and pressure measurements and some text-books in hydrodynamics include chapters on flow and pressure measurements.

Some of these books contain more information than is required for purely educational purposes and can be used as reference books in the work of engineers. We have included some of them in a separate bibliography list, the scope of which is not to cover all books relating to practical metrology but to constitute a selection of useful literature for teaching staff as well as for the confirmed metrologist. This list is generally limited to literature available in French, German, English and Russian and will have to be revised according to the in-flow of more recent information (see III - Practical Metrology, source material for training).

Educational text-books in metrology

The courses specially written for education of staff in legal metrology are extremely few and are many times difficult to use for a foreigner due to their form (published for instance as roneo-typed notes to be used as a complement to the lecturer's explanations) or due to the language, requiring translations.

Following the various enquiries of BIML, we may any way conclude as shown in the table below :

Country	Language	Type of courses or text-books	Remarks
Federal Republic of Germany	German and English	Practical metrology course for developing countries	
Australia	English	Legal metrology course	Printed instruction booklets
Canada	English and French	Weights & Measures Training Modules	Audio-visual with Instructor's Guide, see page 13
France	French	Courses of l'Ecole Supérieure de Métrologie	Roneo-typed fascicules
Indonesia	Indonesian	Legal metrology courses for engineers	Roneo-typed fascicules
Japan	English	Legal metrology courses for developing countries	Brochures and video cassettes
Netherlands	Dutch	Legal metrology courses	Roneo-typed fascicules
Rumania	Rumania	Legal metrology course for inspectors "Curs pentru pregatirea metrologilor autorizati" (1972) Legal metrology course for technicians "Curs pentru pregatirea muncitorilor metrologi autorizati" (1972)	Printed text-books published by Editura Technica, Bucuresti. The same company has also edited a great number of text books for technicians.
U.S.A.	English	Legal metrology training modules	Audio-visual with manuals, see page 15
U.S.S.R.	Russian	Metrology courses	see Bibliography p. 63

Audio-visual means

In addition to the courses developed on weighing and measuring, Canada prepared several modules which can be used individually as one day courses, complete with slides and a corresponding text for the instructor. These modules have been prepared in both English and French, see page 13.

A similar modular system has been adopted by USA, see page 15.

The American Institute of Petroleum has made available series of slides accompanied by cassette recordings in English for training in the measurement of petroleum products. These may be ordered from

Petroleum Extension Service
10100 Burnet Road, BSC 2'
Austin, Texas 78 758
U.S.A.

Several metrology laboratories have produced films or video cassettes for showing their activities or for training purposes. This is particularly the case of PTB in Fed. Rep. of Germany, NPL in the U.K. and NRLM in Japan.

Short-term specialized courses

Some other professional institutions, associations or commercial companies also organise regularily short courses in metrology and edit manuals in particular in the field of gas and fluid flow measurements. Further information may for example be obtained from

National Engineering Laboratory
East Kilbride
Glasgow G75 OQU
United Kingdom

Courses in engineering (length) metrology are organised from time to time by

Cranfield Institute of Technology
Cranfield
Bedford MK430 AL
United Kingdom

Training courses in electronics and process instrumentation (higher technician level) are also organised from time to time by

- Instrument Society of America, see p. 27
- IMEKO, see p. 27

PAPERS CONCERNING METROLOGY TRAINING

PUBLISHED IN THE OIML BULLETIN

I - Enseignement de la métrologie en République Démocratique Allemande
Bulletin de l'OIML N° 62 - mars 1976

II - Enseignement de la métrologie aux Etats-Unis d'Amérique
Bulletin de l'OIML N° 63 - juin 1976

III - Enseignement de la métrologie en Inde
Bulletin de l'OIML N° 64 - septembre 1976

IV - Enseignement de la métrologie en Autriche
Bulletin de l'OIML N° 65 - décembre 1976

V - Enseignement de la métrologie en République Fédérale d'Allemagne
Bulletin de l'OIML N° 67 - juin 1977

VI - Enseignement de la métrologie aux Pays-Bas
Bulletin de l'OIML N° 70 - mars 1978

VII - Training in metrology in the United Kingdom
Bulletin de l'OIML N° 71 - juin 1978

VIII - Enseignement de la métrologie au Vénézuela
Bulletin de l'OIML N° 72 - septembre 1978

IX - Enseignement de la métrologie légale en France
Bulletin de l'OIML N° 78 - mars 1980

U.R.S.S.

Training of metrological cadres through UNIDO In-plant group training programme
Bulletin de l'OIML N° 66 - mars 1977

GERMAN DEMOCRATIC REPUBLIC

Lehrgänge für die Prüfung von Industriellen Längenmessmitteln
Bulletin de l'OIML N° 72 - septembre 1978

Recent information on training in FRANCE is given in Bulletin de l'OIML N° 102, mars 1986 and concerning FED. REP. of GERMANY and JAPAN in Bulletin de l'OIML N° 104, septembre 1986.

Document International N° 14 :

Qualification du personnel en métrologie légale.
Qualification of legal metrology personnel.

III - PRACTICAL METROLOGY

Bibliography of publications and books suitable as source material for teaching or selfstudies

1. STANDARDS (NORMES)

A great number of international and national standards provide useful source information in the field of metrology. It is advised to consult the catalogues of publications in particular of

IEC (International Electrotechnical Commission)
and
ISO (International Organisation for Standardisation)

Some of the ISO standards have been collected into handbooks which exist in both English and French editions among which the following are of particular interest to metrologists :

Handbook 2 - Units of measurement
Handbook 3 - Statistical methods
Handbook 4 - Acoustics, vibration and shock
Handbook 15 - Measurement of fluid flow in closed conduits

A great number of instructive standards on metrology are also found in the "DIN Catalogue of Technical rules" which not only comprises the DIN standards but also includes the lists of guidelines issued by technical associations in the Federal Republic of Germany such as VDE/VDI. This bilingual English/German catalogue can be procured from

Beuth-Verlag GmbH
Burggrafenstrasse 4-10
1000 BERLIN 30

A choice of DIN metrology standards is listed in PTB-Mitteilungen 6/1983.

There exists a great number of publications in Russian in the form of standards and verification instructions which give detailed technical descriptions of measuring instruments and their verification.
These documents are listed in a pamphlet concerning metrology publications of Gosstandart :

Ykazetel (Indicator)
"Gosodarstvennij Standartii, Metodicheskie okazaniya,
Instruktzi i Metodiki Institututov po poverke mer
i ismeritelnih priborov"

published by
Isdatelstvo Standartov
Moscow.

The verification instructions are since 1971 published in the series 8 000 - State system for ensuring the uniformity of measurement.

Standards and verification instructions for a number of mechanical, electrical and thermal instruments are also published in the respective national languages by the German Democratic Republic, Bulgaria and Cuba, lists of which may be obtained at request from BIML.

Verification instructions for almost all measuring instruments used in commerce and industry are also described with great detail and figures in the Romanian Standards : "Norme technice de métrologie". Lists and full text of some of the more important standards are published from time to time in the review "Metrologia Applicata".

2. GUIDE-BOOKS and TECHNICAL MANUALS ISSUED BY LEGAL METROLOGY SERVICES

Whereas requirements and verification operations usually are described in the form of standards in the socialist countries they are in many other countries subject to legal regulations some of which may also be useful as source material for teaching.

Thus the following guide-books, some of which explain OIML Recommendations have been issued in Australia :

Document 100 - Design rules for non-automatic weighing instruments for trade use

Document 101 - Design rules for liquid-measuring systems for trade use

Document 102 - Design rules for belt conveyor weighers for trade use

Document 103 - Inspection rules for non-automatic weighing instruments for trade use

Document 104 - Test procedure for the elimination of rounding error for weighing instruments with digital indication

Document 105 - Design rules for the graduation of analogue scales

Document 106 - Approval and certification procedures for measuring instruments for trade use

Document 107 - Design rules for length-measuring instruments for trade use

Document 108 - Design rules for liquor dispensers

Document 109 - Design rules for area-measuring instruments for trade use

Document 110 - Symbols for units of measurement

Document 111 - Procedures for the submission and testing of load cells and indicators

Document 112 - Procedure for the submission of LPG measuring systems

Document 113 - Procedures for the submission and testing of weighing-in-motion systems,

Document 114 - Design rules for farm milk tanks for trade use

Document 115 - Application of the Roman level in inspection of farm milk tanks

Document 116 - Design rules for load cells for trade weighing instruments

Document 117 - Design rules for weighing-in-motion systems for trade use

Document 118 - Schedule of maximum permissible errors

Document 119 - Procedures for the submission and testing of belt conveyor weighers

They may be purchased from

National Standards Commission
P.O. Box 282
North Ryde
N.S.W. 2113
Australia

Canada has prepared a number of modules, for the training of inspectors and technicians. These modules each comprise a text and a set of slides. They have been prepared in either French or English, under the following titles :

INT 1-1, Introduction to Weights & Measures;

VOL 2-1, Mobile tanks;

VOL 3-1, Applied Fluid Mechanics;

VOL 4-1, Liquid Measuring Meters;

THE 2-1, Principles of Levers;

THE 20-1, Metals and Metallurgy;

GRV 2-1, Medium Gravimetric Devices;

GRV 3-1, Large Static Devices; and

GRV 7-1, Large Electronic Devices.

The metrology service of Canada has also published a booklet in French and English dealing with the theoretical problems of the calibration of sets of mass standards :

New developments in the metrology of mass standards
(with historical introduction)
by M. Romanowski and G. Mihailov
2 x 27 pages, first edition, August 1981

This latter publication is available, without charge, from Department of Consumer and Corporate Affairs Canada, Legal Metrology Branch, Tunney's Pasture, Ottawa, Canada K1A OC9.

Among French educational publications in metrology we would first like to mention the series "Mesures et Contrôle" published by "Techniques de l'Ingénieur", 123 rue d'Alésia, 75680 Paris Cedex 14, as shown in detail on the photocopy on page 52. This collection is up-dated through a subscription system. The collection though somewhat expensive gives a fairly detailed picture on metrology aspects in France and it should be noted that a number of engineers from the official metrology services have collaborated including those of the Service des Instruments de Mesure (S.I.M.) (now named Service de la Métrologie).

We would also like to mention a few old publications concerning some special subjects which are probably still available from the Service de la Métrologie, 30/32 rue Guersant, 75840 Paris Cedex 17.

H. Boissy : Les mesures dans l'industrie des cuirs et peaux.
Paris, Imprimerie Nationale, 1950.
(Measurements in the leather industrie)

H. Bouchet : Détermination du volume des citernes ordinaires et en forme chalands-citernes et navires-citernes.
Paris, Imprimerie Nationale, 1950.
(Determination of volume of containers on ships)

G. Maugein : Le contrôle des appareils mesureurs de liquides.
Paris, Imprimerie Nationale, 1951.
(Verification of liquid volume measuring devices)

G. Maugein : L'évolution du mesurage des produits pétroliers à l'aide de compteurs volumétriques.
Extrait de la Revue de Métrologie Pratique et Légale, 83 pages, juin-juillet 1967.
(Measurement of petroleum products by volumetric meters).

More recently the following ronetyped courses have been used for training purposes :

- Le mesurage de l'ammoniac liquéfié (measurement of liquid ammonia)
par L. Silvert (1979)
- Le mesurage des gaz de pétrole liquéfiés (measurement of LPG)
par L. Silvert (1980)
- Le jaugeage des navires transporteurs de gaz liquéfié (1980)
(Gauging of ships transporting LPG)
- Compteurs turbines (turbine meters)
par L. Silvert (1980)
- Réception de betteraves sucrières : balances proportionneuses , saccharimétrie (sugar beetroot measurements, balances and saccharimeters
par J. Boesch (1981)
- Humidimètres pour grains de céréales et graines oléagineuses (humidimeters for cereals)
par J. Boesch (1981)

The following handbooks of the National Bureau of Standards, USA are in many respects interesting as resource books, for foreign metrology services although the units of measurement and the legal requirements are different :

H-44	Specifications, tolerances and other technical requirements for weighing and measuring devices	(annual editions)
H-117	Examination of LPG measuring devices	1975
H-130	Uniform laws and regulations	(annual editions)
H-133	Checking of net contents of packaged goods	(1984)
	Supplement : Package checking field manual to accompany NBS Handbook 133	(1986)
H-137	Examination of distance measuring devices	(1980)

The National Conference on Weights and Measures (NCWM) of the United States of America has initiated a professional development program for State and local weights and measures officials, largely based on NBS Handbooks 44 and 130.

This training program consists of a series of self-contained training courses or "modules" on specific subjects related to the functions and concerns of weights and measures officials.

Each NCWM training module consists of :

- An Inspector's manual and
- an Inspector's (or Student's) manual.

The Instructor's manual contains : course objectives, a teaching outline, training aids, such as slides or transparencies, chapter review quizzes, and a final exam. The Inspector's manual contains : chapter objectives, detailed technical information (including references to applicable NBS Handbooks and examination procedure outlines), and illustrations and tables.

A list of published and planned training modules as of December 1986 is provided below. Copies of the published modules are available for purchase. For more information contact the National Conference on Weights and Measures, P.O. Box 3137, Gaithersburg, Maryland 20878 USA.

NCWM Training modules

Module No.	Subject
1	Mechanical retail computing scales (cylinder, fan, and prepackage)
2	Electronic retail computing scales
5	Vehicle and axle-load scales
6	Monorail scales and meat beams
8	Retail motor fuel dispensers and consoles
10	Checking the net contents of package goods
27	Introduction to electronic weighing and measuring systems

Modules under development (1986)

Module No.	Subject
3	Bench and counter scales
4	Dormant and industrial medium capacity scales (portable, floor, built-in, and crane)
7	Livestock and animal scales
13	Hopper scales (automatic grain and construction material)
19	Loading-rack meters
20	Vehicle-tank meters (power-operated and gravity, compensated and uncompensated)
21	Liquefied petroleum gas liquid meters
23	Weights and Measures Administration (functions, history, organization, legal authority including uniform laws and regulations)

Modules planned for development

Module No.	Subject
9	Linear measuring devices (taximeters, odometers, fabric, wire, and cordage measuring devices)
11	Prescription scales and jewelers balances
12	Dairy-product-test and grain-test scales
14	Wheel-load weighers
15	Belt conveyor scales
16	Weights (equal arm and counterpoise)
17	Hand-crank fuel pumps
18	Lubricant devices and motor oil bottles
22	Labeling of packaged products (net contents statement, responsibility, method of sale)
24	Handbook 44 (organization and use and related references)
25	Communications (Weights and Measures Officials relationships with device owners and operators, industry and consumers)
26	Test equipment, use and calibration
28	Solid state circuits and applications
29	Load cells and analog-to-digital conversion
30	EMI,RFI, electrostatic discharge
31	Statistics as applied to weights and measures
32	Variable frequency inspection
33	Environmental testing
34	Application of computer systems to Weights and Measures Administration
35	Theory of scale tolerances
36	National Type Evaluation Program
37	Laboratory Administration

In the USSR there are a great number of specialized text-books in Russian in the field of linear and angular, mechanical, thermal, acoustic, electrical, radiotechnical, physico-chemical measurements and in the measurement of the characteristics of materials, metrological inspection etc. a few of them are listed in the book list on page 63.

3. SCIENTIFIC and PRACTICAL METROLOGY GUIDE-BOOKS ISSUED by NATIONAL METROLOGY LABORATORIES

3.1. Publications of the National Bureau of Standards, USA

Recent publications may generally be obtained from

Superintendent of Documents
US Government Printing Office
Washington, D.C. 20402 (USA)

Some old publications may be obtained as microfiches or photocopies from

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161 (USA)

Among metrology publications of general interest one may mention in particular the collection "Special Publication 300 - Precision measurement and Calibration" which contains selections of papers, monographies and circulars previously published :

SP 300 Volume 1 — Precision measurement and calibration. Selected papers on statistical concepts and procedures, 436 pages (Feb.1969)

SP 300 Volume 3 - Precision measurement and calibration. Selected NBS papers on electricity - low frequency, 498 pages (Dec. 1968) (available from NTIS only)

SP 300 Volume 7 - Precision measurement and calibration. Radiometry and photometry, 685 pages (Nov. 1971) (available from NTIS only)

SP 300 Volume 8 - Precision measurement and calibration. Selected NBS papers on mechanics, 590 pages (Jan. 1972) (available from NTIS only)

SP 705 - Precision measurement and calibration : Electricity (1986)

Among the numerous other NBS publications the following ones may be used as resource literature for training :

Monograph 125 - Thermocouple reference tables based on the IPTS 68
410 pages (Mar. 1974)

Monograph 126 - Platinum resistance thermometry
129 pages (Apr. 1973)

Monograph 133 - Mass and mass values
39 pages (Jan. 1974)

Monograph 140 - Time and frequency. Theory and fundamentals
470 pages (May 1974)

Monograph 141 - The measurement of lumped parameter impedance :
A metrology guide, 211 pages (June 1974)

Monograph 148 - The role of standard reference materials in measurement systems, 56 pages (Jan. 1975)

Monograph 149 - Measurement assurance programme. Part I. Long gauge blocks (5 in to 20 in)
75 pages (Nov. 1975)

Monograph 150 - Liquid-in-glass thermometry
30 pages (Jan. 1976)

Monograph 163 - Measurement assurance of gage blocks (1979)

SP 700-1 - A primer for mass metrology by K.B. Jaeger and R.S. Davis, 1985

The NBS Special Publication No.250 "Calibration and related services of the National Bureau of Standards" provides descriptions of the currently available NBS calibration services, special test services and measurement assurance programs. Each section describing specific services contains valuable references to other publications giving more detail about the measurement techniques and procedures used.

Other publications of interest :

NBS SP 420 - The International Bureau of Weights and Measures 1875-1975
by C.H. Page - P. Vigoureux (May 1975)
(translation of the BIPM centennial volume)

3.2. Publications of the Physikalisch- Technische Bundesanstalt (PTB) Federal Republic of Germany

Among the publications of this institute which may be of general and educational interest one may first mention the series of booklets "Prüfregeln" published in German.

Band 1 - Messmachinen für Längenmessung (Length measuring machines)
Schreuer E., Beyer W.
47 pages, 9 figures, 2nd edition 1973

Band 2 - Flüssigkeits-Glasthermometer (Liquid-in-glass thermometers)(*) (**)
Rahlfs P., Blanke W.
96 pages, 14 figures, 1967

Band 5 - Feinwaagen (Precision mechanical balances)(**)
Hess E.
71 pages, 15 figures, 1970

Band 7 - Eiersortiermachinen (Egg sorting machines)
Döring H., Stiller H.
33 pages, 12 figures, 1972

Band 8 - Stoppuhren (stopwatches)
German S.
58 pages, 19 figures, 8 annexes, 1972

Band 9 - Scheinwerfereinstellprüfgeräte (Headlight adjustment testers)
Hieke H.
51 pages, 20 figures, 1973

Band 10 - Lagerbehalter in Form stehender Zylinder (Vertical cylindrical storage tanks) (*)
Bünke K.
90 pages, 20 figures, 1974
Ergänzung (complement) : Teil 2, 1982

Band 11 - Strahlenschutzdosimeter für Photonenstrahlung mit Energien zwischen 5 keV u. 3 MeV (Radiation protection dosimeters)
Engelke B.A., Oetzmann W.
36 pages, 9figures, 1977

Band 12 - Messwandler (Instrument transformers for voltage and current)(*) (**)
Zinn E.
114 pages, 45 figures, 1977 (English edition 1983)

Band 13 - Lagerbehälter in Form liegender Zylinder (Horizontal cylindrical storage tanks) (*)
Bönke K., Raschke S.
73 pages, 7 figures, 1977

(*) updated English translation available.

(**) Spanish translation available.

More recently the following Prüfregeln have been issued (from OIML Bulletin No 88, September 1982) :

Band 4 — Volumengaszähler (Gas volume meters) by R. MATSCHKE, H. SCHLIETER, A. ASCHENBRENNER, 62 pages, 17 illustrations, 20 references, 2nd edition 1982. (*)

This edition replaces the 1969 one which was limited to bulk gas meters. The booklet describes the current designs of gas meters, the auxiliary equipment required for their calibration, the climatic requirements for the testing laboratory, the installation of the meters for testing together with thermometers and manometers, the schedule of operations for the calibration and sources of errors.

Band 6 — Elektrizitätszähler (Electrical energy meters) by R. FRIEDL and G. VOLKMANN, 62 pages, 11 illustrations, 14 references, 1 Anhang (Annex) of 56 pages, 1982. (*) (**)

This latest edition has been completely revised and comprises also descriptions of static (electronic) energy meters. The methods of testing and calibration follow largely those of the International Electrotechnical Commission (IEC). The new technologies applied in the calibration equipment have incited the authors to collect in an annex the descriptions of such equipment existing in the European market. One may note in particular a certain number of digital wattmeters and joulemeters which may be calibrated with direct current. These instruments may thus be used for AC/DC transfer and replace precision electrodynamic wattmeters which become more and more difficult to find in the market.

Band 14 — Zustands-Mengenumwerter (Gas volume correctors) by A. ALBRECHT and H. KREBS, 92 pages, 11 illustrations, 6 references, 1979.

Gas volume correctors are mainly used in bulk gas flow installations (pipeline or industry). These correctors are subject to legal control in the Federal Republic of Germany. The booklet describes the mode of operation of currently used designs, the errors and influence of humidity. The chapter relative to verification has an annex showing the schedule to follow.

Band 15 — Flüssigkeitsmanometer (Liquid column manometers) by J. GIELESSEN, J. JÄGER and G. SCHOPPA, 67 pages, 4 illustrations, 1980. (*) (**)

This booklet describes the methods of pressure calculation and the verification of U-tube and cistern type manometers as well as of some particular constructions of micromanometers. The calibration of mercury column barometers is also briefly described. The booklet comprises models of calculations and density tables of liquids and gases used.

Band 17 — « Störfestigkeit » (Procedures for testing the effect of electromagnetic disturbances on measuring instruments) (*) (**)

and

Band 16 — « Therapiedosimeter mit Ionisationskammern für Photonenstrahlung mit Energien unterhalb 3 MeV » (Ionizing chamber therapy dosimeters for energies lower than 3 MeV).

Band — Kraftmessgeräte (Force measuring instruments) (in preparation)

These booklets may be obtained from

Physikalisch- Technische Bundesanstalt
- Referat Schrifttum -
Bundesallee 100
3300 Braunschweig, Fed. Rep. of Germany.

(*) English translation available.

(**) Spanish translation available.

The PTB also publishes reports among which may be mentioned :

PTB - Bericht E-13. L. Bliek : Grundlagen der elektrischen Temperatur-Messtechnik, 1981

which exists in English translation :

PTB - Bericht E-13e L. Bliek : Principles of electric temperature measurement, 66 pages Braunschweig, July 1981

and

M. Kochsiek (Editor) : The determination of mass, Part I and II (December 1983)

Complete lists of PTB-publications are published yearly in the form of PTB-Berichte (Referat Schriftum).

3.3. Publications of the National Physical Laboratory, United Kingdom

Among the NPL publications in the field of practical metrology training one may mention the series "Notes on Applied Science," published by Her Majesty's Stationary Office (HMSO). Most of these booklets are now out-of-print but it may be possible to obtain photocopies (see p. 32).

The following are of particular interest :

N° 1 Gauging and measuring screw threads, HMSO (reprinted 1969)

N° 4 Measurement of humidity HMSO (1970)

N° 6 Volumetric glassware. Scientific aspects of design and accuracy. HMSO (1957)

N° 7 Balances, Weights and precise laboratory weighing HMSO (1960)

N° 9 Measurement of pressure with the mercury barometer HMSO (1962)

N° 25 Hydrometers and hydrometry HMSO (1961)

N° 26 Measurement of angle in engineering HMSO (1964)

N° 27 Inspection and gauging involving linear and angular measurements HMSO (1962)

Some of the following publications edited with the same purpose were still available in 1982 :

Swindells B. and Debnam R.C. - Measurement of force by elastic devices, HMSO (1977)

Anderton, Pamela and Bigg P.H. - Changing to the metric system : conversion factors, symbols and definitions. HMSO (1972)

NPL - The International Practical Temperature Scale of 1968 (English version of the BIPM publication). HMSO (1976)

Rayner G.H. and Drake A.E. - SI units in electricity and magnetism. HMSO (1970)

Vigoureux P. - Electric units and standards. HMSO (1970)

Campion P.J., Burns J.E., Williams A. - A code of practice for the detailed statement of accuracy. HMSO (1973)

These publications are sold by
Her Majesty's Stationary Office
P.O. Box 569
London SE1 9NH

With a view of guiding customers, NPL has edited a series of booklets out of which some contain valuable metrology information concerning accuracy and references to British Standards. The following booklets are available :

NPL Measurement Services

- Colorimetry, Spectrophotometry, Photometry and Radiometry
- Direct Current and Low Frequency Electrical Measurements
- Engineering Dimensional Metrology
- Optical Metrology
- Pressure and Vacuum
- Temperature
- Viscosity
- Acoustics
- Hardness Measurement Services at NPL, DMOM/1 (1981)

We would also like to mention the following reports :

NPL report MOM 22 (March 1977) (being revised) : Recommendations for the Design and Equipping of Engineering Metrology Laboratories

NPL report QU 64 (May 1978) : The Design of a standards Laboratory for thermometry by P.B. Coates

NPL report QU 62 (March 1981) : Tungsten ribbon lamps for the calibration of disappearing filament pyrometers by P.B. Coates

NPL report QU 61 (1981) : The calibration of radiation pyrometers black body sources and standard lamps by P.B. Coates

Lewis S. and Peggs G.N. (1979) : The pressure balance : a practical guide to its use

These booklets and reports are available directly from
The National Physical Laboratory
Teddington, Middlesex TW11 OLW (U.K.)

British Calibration Service

This service which now has its headquarters at NPL has published a series of guides which may be obtained by writing to

British Calibration Service
National Physical Laboratory
Teddington, Middlesex TW11 OLW

The titles of some of these BCS Guidance publications are reproduced on the next page.

National Engineering Laboratory

Address : East Kilbride
Glasgow G75 OQU (U.K.)

has published proceedings from two conferences on fluid flow (Fluid flow measurements in the mid-70 and the mid-80 s) and on practical engineering metrology (NELEX 76 and NELEX 78).

Lists of publications are frequently published by this laboratory.

(extracts from BCS catalogue dated June 1984

British Calibration Service

Guidance publications

GENERAL

3002	Tables of the Convolution of Gaussian and Rectangular Probability Density Distributions	April	77
3003	The Expression of Uncertainty in Electrical Measurements	January	84

ELECTRICAL

4001	Preferred Frequencies for Electrical Measurement	October	73
4051	In-House Checking of Electrical Measuring Equipment	August	69
4053	Maintaining Confidences in Laboratory Standards (with particular reference to the 'all-nines-ten' method)	August	69
4055	The Use and Calibration of Direct Acting Measuring Instruments	March	71
4056	The Calibration and Certification of Oscilloscopes	October	77
4151	In-House Checking of Precision DC Potentiometers Using a Potentiometer Calibrator	September	77
4152	In-House Checking of Resistance Bridges	August	74
4155	Two-Terminal Build-Up Resistance Boxes	January	77
4181	The Calibration of Digital Voltmeters	January	78
4301	The Expression of Voltage Standing Wave Ratio	April	71
4302	Testing of Pulse Generators	September	79

THERMAL

5501	The Calibration of Thermometers (This guidance document, prepared by the late C R Barber, and originally published as BCS Publication 5501, is available on request from BCS Headquarters).		
5551	Thermocouples, Reference Tables and Traceability	February	75
5552	The Use of Standard Reference Tables for Thermocouples	October	77

THERMAL CONDUCTIVITY

5561	The Preparation of Thermal Conductivity Test Specimens from Masonry Materials	October	80
5562	Uncertainties Associated with Imperfect Surfaces in Standard Hot-Plate Thermal Conductivity Measurements	October	80

RADIOLOGICAL

6601	Calibration of Radiological Instruments at Protection and Therapy Levels	January	77

MECHANICAL

7002	Length Bars — Calibration Procedure and Uncertainties	November	82

3.4. Publications of the National Measurement Laboratory (NML), Australia

The following publications suitable as training source material have been issued by the National Measurement Laboratory and can be obtained by contacting

CSIRO Division of Applied Physics
National Measurement Laboratory
P.O. Box 218
Lindfeld, N.S.W. 2070

Modern techniques in metrology, edited by P.L. Hewitt, World Scientific Publishing Co. (1984)

Trends in dimensional measurement, edited by J. Field, CSIRO (1984)

Calibration of balances, by D.B. Prowse, CSIRO (1985)

Division of Applied Physics Technical Papers :

The calibration and verification of volumetric measures, by J.W. Humphries (1980)

Design and construction of the CSIRO hydrogen masers by L.U. Hibbard (1981)

The WHO psychrometer, by R.G. Wylie and T. Lalas (1981)

Techniques for the calibration of liquid-in-glass thermometers by M. Beavis (1981)

The melting point of ice as a reference temperature for mercury-in-glass thermometers, thermocouples and platinum resistance thermometers by M. Beavis (1981)

Liquid-in-glass thermometers - care and use in measurement by M. Beavis (1982)

Temperature school notes, Sydney (1985) :

Thermocouple pyrometry, by R.E. Bentley

Resistance thermometer measurement instruments, by J.J. Connolly

Bath thermometry, by E.C. Borrigan

Optical and radiation pyrometry, by T.P. Jones

Resistance thermometers, by J.V. McAllan

Practical visual optical pyrometry, by J. Tapping

How to get the right answer from your optical pyrometer, by J. Tapping

Temperature measuring instruments, by J. Tapping

Notes on film "Liquid-in-glass thermometry techniques", by M. Beavis (1981)

Pressure measurement course, 1986 :

Introduction to pressure measurement, by N. Bignell

Vacuum measurement, by D.B. Prowse

Pressure measurement using barometers and manometers, by D.B. Prowse

Industrial pressure measurement, dead-weight testers, by D.G.S. Groeneveld

Measurement and uses of high pressure, by E.C. Morris

Pressure transducers, N. Bignell

Differential pressure measurement, by N. Bignell

Assessment of accuracy in precision measurement, by J.S. Cook

3.5. Publications of the Bureau National de Métrologie (BNM), France

This organ which coordinates the scientific and practical metrology in France publishes a quarterly bulletin, the Bulletin du BNM of which some issues are dealing with special fields :
pressure (No.28), temperature (No. 32, 33), force (No.34), electricity (No.36), ionizing radiation (No.37), dynamic pressure (No.38).

The following monographs issued by BNM on special subjects may be useful in teaching, and are published by

Editions Chiron
40 rue de Seine
75006 Paris

- Etat actuel et perspectives de l'holographie en métrologie
  par J.C. Perrin (91 pages)
- La mesure des parasites, caractéristiques des parasites, action sur un récepteur, possibilités et principes de mesure
  par E. Fromy (132 p.)
- Métrologie des cales étalons, méthode de mesure par comparaison
  par J. Leclerc et J.M. Lebègue (44 p.)
- Contrôle statistique de qualité
  par L.F. Pau (264 p.)
- Mesure de la diffusivité thermique par méthode impulsionnelle
  par H. Poncin (236 p.)
- Méthodes et moyens de mesure de débits de gaz
  par P. Hébrard, F. Liousse et P. Calvet (200 p.)
- Introduction aux techniques de conditionnement des laboratoires
  par U. Zelbstein (70 p.)
- La mesure des températures par rayonnement thermique
  par J. Martinet (240 p.)

4. PETROLEUM INSTITUTES

The publications of the various Petroleum Institutes are mainly of interest as concerns measurements of volume of liquids.

Catalogues of publications may be obtained from

Institute of Petroleum (IP)
61 New Cavendish Street
London W1M 8AP
United Kingdom

(The parts published of the IP Petroleum Measurement Manual are listed on p. 56)

and

American Petroleum Institute (API)
2101 L. Street, N.W.
Washington, D.C. 20037 (USA)

We have reproduced on pages 57 to 61 the chapter concerning measurements in the catalogue "Publications and Materials 1986" of API.

The publications of Institut Français du Pétrole (IFP) are edited by :

Editions Technip
27 rue Ginoux
75737 Paris Cedex 15
France

Among the metrology publications of this institute one may mention the text-books used by the National School of Petroleum and motor studies (Ecole Nationale Supérieure de Pétrole et des Moteurs) :

Defix A. - Eléments de métrologie générale et de métrologie légale, 204 pages, 1967

Defix A. - Mesurages des volumes des carburants et combustibles liquides, 230 pages, 1975

5. INSTRUMENT ASSOCIATIONS

5.1. Instrument Society of America (ISA)

This association has a special education department dealing mainly with training of technicians in industrial process control. Films, video tapes and books are listed in a special catalogue "Publications and Education Aids" obtainable from

Instrument Society of America
67 Alexander Drive
P.O. Box 12 277
Research Triangle Park, N.C. 27 709, USA

5.2. International Measurement Confederation (IMEKO)

Secretariat : 1371 Budapest, P.O. Box 457, Hungary

There exists a great number of papers published by this association in connection with various conferences and congresses. Many of the papers are very specialized and of interest mainly to designers and users of industrial instrumentation.

Some of the papers included in the textbook of a course held in Yugoslavia in 1983 are of particular interest for training purposes :

J. Božičevič (Editor) : Maintenance and calibration of instruments in industry (1983) published by Institute for Developing Countries, Zagreb.

Other seminar organisers frequently collaborate with IMEKO; the following publication may thus be obtained through the IMEKO Secretariat :

Proceedings of the Interregional Training Course on Ensuring Measurement Accuracy org. ed. Austrian Research Centre, Seibersdorf and the Austrian Federal Office of Metrology, 1985, Vol. 1-2, 650 pages.

6. INTERNATIONAL ASSOCIATIONS IN SPECIALIZED FIELDS

6.1. Commission Internationale de l'Eclairage (CIE) (International Commission on Illumination)

A list of current publications in photometry and colorimetry is reproduced on pages 54 and 55.

6.2. International Commission on Radiation Units and Measurements (ICRU)

A list of publications is reproduced on pages 62.

7. ORGANISATIONS HAVING REGIONAL METROLOGY PROGRAMMES

7.1. The European Economic Community (EEC)

A list of directives has been published in the OIML Bulletin No 80 (Sept.1980), p.32-35 and completed in Bulletin No 91 (June 1983) p.39-40. The research activities are listed in Bulletin No 89 (Dec.1982), p.40-41.

7.2. The Council of Mutual Economic Assistance (CMEA)

A list of CMEA standards has been published in OIML Bulletin No 83 (June 1981) p.28-31 with an addendum in OIML Bulletin No 86 (March 1982), p.37

7.3. Commonwealth Science Council (CSC)

A description of the CSC regional metrology activities and list of reports has been published in OIML Bulletin No 87 (June 1982), p.28-36. Some of these reports contain papers useful in training in particular CSC (77) MS-2, CSC (79) SQC-5 and CSC (81) MS-15.

The report CSC (80) MS-11 METROLOGY ABSTRACTS contains a bibliography of reports on metrology issued by national physical laboratories.

More recently (not included in the mentioned list) the Proceedings of the Regional Workshop on Metrology for Developing Countries (30 August - 10 September 1982) in Sydney, Australia report No CSC (82) MS-21 published in six parts, provides some excellent review papers useful for establishment of calibration laboratories :

MS 21 Volume 2 part 2 - Mass standards
3 - Length standards
4 - Temperature standards
5 - DC Electrical standards
6 - AC Electrical standards

Address : Commonwealth Science Council
Commonwealth Secretariat
Marlborough House,
Pall Mall,
London, SW1Y 5HX
United Kingdom

8. BIBLIOGRAPHIES AND ABSTRACTS PUBLISHED IN PERIODICALS

8.1. Bibliographies in periodicals

Many survey articles in periodicals give references to publications available through library services, some of them are included in chapter 10 together with separately published bibliographies.

Some periodicals publish regularily lists of recent papers (and books) on metrology subjects.

We would here in particular like to mention
" PTB-Mitteilungen" published by Physikalisch- Technische Bundesanstalt, Fed. Rep. of Germany

which gives in each issue a survey ("Aktuelles Schriftum zum Mess und Eichwesen") of papers and books published in German, English, French, Russian and sometimes other languages.

Similarily in the field of industrial instrumentation, the review "In Tech" published by the Instruments Society of America (ISA) gives in each issue a selection of papers or books classified by technical subjects under the heading "For further reading", the information concerns mainly publications in English selected through use of two US computer information services.

The Journal of Research of the National Bureau of Standards, USA publishes in each issue classified abstracts of NBS publications including papers by NBS staff in other reviews.

8.2. Abstract journals

In addition to the abstracts or titles of publications given in technical reviews as mentioned above a very great number of technical papers, patents and commercial publications from all over the world and covering the whole field of metrology and instrumentation are referenced with an abstract in Russian in

Referativnij Journal
Section 32 - Metrology and Measuring technique
edited by the USSR Academy of Science, Publications
VINITI, Ljobertsy 10, Oktyabrskij Prospekt 403, Moscow obl.

Each monthly issue contains about 200 pages with about 10 entries per page. This abstract review is available at the BIML Documentation Centre.

Abstracts in French are published by

Centre National de la Recherche Scientifique (CNRS)
Centre de Documentation Scientifique
et Technique (CDST)
26 rue Boyer
75971 Paris Cedex 20

The subject of Metrology is unfortunately not covered by one but by 4 journals divided as follows :

Section 130 - Physique mathématique. Optique. Acoustique. Mécanique. Chaleur
(includes subsection 06 - Metrologie, techniques de laboratoire et appareillage)

Section 140 - Electrotechnique
(includes subsection 02 - Métrologie. Normalisation. Essais. Fiabilité)

Section 145 - Electronique
(includes subsection 04 - Métrologie. Appareillages. Matériaux)

Section 890 - Industries mécaniques. Bâtiment. Travaux publics. Transports
(includes subsection 04 - Métrologie industrielle, contrôle et 05 - Machines d'essais)

In English the widest coverage of metrology and related subjects is most probably provided by INSPEC (Information Services for the Physics and Engineering Communities) which belongs to the Institution of Electrical Engineers (U.K.). Enquiries shall be addressed to

INSPEC Marketing Department
Institution of Electrical Engineers
Station House
70 Nightingale Road
Hitchin, Herts SG5 1RJ.
England

The following abstract publications are available

- Physics Abstracts (monthly, about 190 000 abstracts per year)
- Electrical and Electronic Abstracts (monthly, about 55 000 abstracts per year)
- Computer and Control Abstracts (monthly, about 35 000 abstracts per year)

These publications are usually much too comprehensive for the library of a metrology service and rather expensive.

The most interesting abstract journals for metrology services, and the most economic, are however probably the following

INSPEC Key Abstracts - Electronic Instrumentation
and
Measurements in Physics

It should also be mentioned that the subject classification system used by INSPEC is rather well fitted to the needs of metrology services.

Another abstract service in English is provided by
the Engineering Index, Inc.
345 East 47th Street
New York, NY 10017

(Enquiries for abstracts may be limited to the subject area 94 - Instruments and Measurement).

In the field of flow and pressure measurement (of liquids and gases) a bi-monthly abstract publication with the title "Fluid flow measurement abstracts" is published since 1974 jointly by the British Hydromechanics Research Association (BHRA) and the National Engineering Laboratory. Information about subscriptions can be obtained from

BHRA Fluid Engineering
Cranfield
Bedford MK 430 AJ
United Kingdom

9. PHOTOCOPIES OF PUBLICATIONS

Photocopies of publications (with the exception of standards) which are not available in local libraries may generally be obtained from any of the following services (regardless of the origin of the publication) :

France

Centre de Documentation Scientifique et Technique
26 rue Boyer
75971 Paris Cedex 20

Fed. Rep. of Germany

Mrs C. Heese
Universitätsbibliothek und TIB
Welfengarten I B
D-3000 Hannover I

United Kingdom

User Services-International
British Library Lending Division
Boston Spa
Wetherby, West Yorkshire
LS 23 7 BQ
England

U.S.A.

Antoinette Colbert
Information on Demand
P.O. Box 9550
Berkeley, California 94 709

10. VOCABULARIES AND DICTIONARIES

10.1. Metrology terminology

In addition to the already well-known OIML bilingual vocabulary of legal metrology a new vocabulary on general metrology terms edited by BIPM-IEC-ISO and OIML is available.

The International Electrotechnical Commission has also published a multi-lingual vocabulary covering most electrical activities.

The International Commission on Illumination (Commission Internationale d'Eclairage) has also a French and English vocabulary which is very useful for work in photometry and colorimetry.

The ISO Handbook 3 "statistical methods" contains an English-French vocabulary on useful statistical terms.

10.2. Dictionaries

Among the numerous existing technical dictionaries the BIML has found the following quite useful

- Dictionary of Physics
  English-German-French-Russian
  compiled by Ralf Sube and Günther Eisenreich
  3 volumes (2896 pages and about 75 000 entries in each language)
  4th edition 1983
  VEB Verlag Technik, Oranienburger Strasse 13/14, Postfach 201
  DDR-1020 Berlin, German Democratic Republic

- Chambers dictionary of science and technology, 2 volumes,
  (available as paperbacks), W.R. Chambers Ltd (U.K.) 1974

For readers familiar with the Russian language there exists a specialized "English to Russian dictionary on metrology and precise measurement technology" (Anglo-russkij slovar pa metrologij i technike toshij ismerenij) comprising about 17 000 terms :

Authors - V.I. Ignatiev and M.F. Yudin
Editors - V.I. Kiparenko and L.K. Isaiev
Publisher - Russkij Jesik, Moscow 1981

11. PUBLICATIONS DISPONIBLES EN LIBRAIRIE
LITERATURE OBTAINABLE THROUGH BOOKSELLERS

This list compiled from information available at BIML and classified by subject is very incomplete. We have tried to include only literature which is still commercially available, however in the meantime some of them may already be out of print.

The publications obtainable from official institutions and associations are generally to be found in the preceding chapters

In order to reduce space reference is sometimes made to survey papers or separately published bibliographies (available from BIML or from other institutions).

Books in Russian language have for ease of reproduction been listed separately at the end of this chapter.

11.1. LIVRES D'INTERET GENERAL / BOOKS OF GENERAL INTEREST

En français (in French)

- Techniques de l'Ingénieur - Tomes Mesures et Contrôle

BIPM - Le Système International des Unités, 5è édition, bilingue, 1985

Defix A. - Eléments de métrologie générale et de métrologie légale
Ed. Technip, Paris, 1967

Bassière M., Gaignebet E. - Métrologie générale
Dunod, Paris, 1966

Moreau H. - Le Système Métrique (historique)
Ed. Chiron, Paris, 1975

C.E.A. - Statistique appliquée à l'exploitation des mesures
Tome 1 & 2, Masson, Paris 1978

Deliov J., Giraudon J., Marchand J., Simplot J. -
Mesures industrielles et régulation automatique
(niveau IUT)

Quatremer R., Trotignon J.P. -
Précis Unités et Grandeurs, Système SI
AFNOR et Nathan, Paris, 1981

Asch G. - Les capteurs en instrumentation
Dunod, Paris, 1982

Asch G. - Les capteurs en instrumentation industrielle
Dunod, Paris, 1983

Monographies du BNM, voir page 26 et CIAME page 53

Note : An extensive list (75 pages) of mainly English, German and Russian book titles with indication of author and editor is given in a compilation for IMEKO TC-1 edited by P.H. Sydenham (Australia) : "A working list of books published in measurement science and technology in the physical sciences". This list can be obtained from

Delft University of Technology
Department of Applied Physics
P.O. Box 5046
2600 GA DELFT

The list comprises books published from 1950 (and earlier in a few cases) to 1979. It may be expected however that many of the earlier books are no longer commercially available.

En allemand (in German)

Niebuhr J. - Physikalische Messtechnik
Band I : Aufnehmer und Anpasser
Band II : Messprinzipien und Messverfahren
2nd edition, R. Oldenbourg Verla
München-Wien, 1980

Merz L. - Grundkurs der Messtechnik, 5th edition, Oldenbourg, 1977-198

Hart H. - Einführung in die Messtechnik, 4th edition
VEB Verlag Technik, Berlin 198

Hofmann D. - Handbuch Messtechnik in Qualitätssicherung
VEB Verlag, Berlin, 1979 and
Vieweg-Verlag, Braunschweig, 1

Hengstenberg J., Sturm B., Winkler O. -
Messen, Steuern und Regeln in der Chemischen Technik
(3 volumes), 3rd edition, Springer 1981

- Das Internationale Einheitensystem, 2nd edition of German version of the BIPM publication concerning SI
Vieweg Verlag 1982

German S., Draht P. - Handbuch SI - Einheiten
Vieweg, F.R. Germany, 1979

Profus, Domeisen (Ed.) - Lexikon der industriellen Messtechnik
Vulkan Verlag, 1980

Fischer R., Vogelsang K. - Grössen und Einheiten in Physik und Technik,
4th edition VEB Verlag Technik, Berlin, 1986

Qualitätssicherung und Standardisierung.
2. überarbeitete Aufl., Verlag Die Wirtschaft, Berlin, 1985

Bender D., Pippig E.-E. : Einheiten, Masssysteme, SI.
5. bearbeitete Aufl., Akademie-Verlag, Berlin, 1986

Götte K., Hart H., Jeschke G. : Taschenbuch
Betriebsmesstechnik. 2. stark bearbeitete Aufl.
VEB Verlag Technik, Berlin, 1982

Hart H., Lotze W., Woschni E.-G. : Messgenauigkeit.
VEB Verlag Technik, Berlin, 1986

Seiler E. (Ed.) - Grundbegriffe des Mess- und Eichwesens,
Vieweg Verlag, Braunschweig 1983
(The OIML Vocabulary of Legal Metrology translated to German along with original text)

En anglais (in English)

BIPM - The International System of Units, 5th bilingual edition 1985

Doeblin E.O. - Measurement Systems
Mc Graw-Hill (available in International Student Edition), 1976 (and later editions)

Juran J.M., Gryna, Bingham - Quality Control Handbook
Mc Graw-Hill, 1974

Topping J. - Errors of observation and their treatment
Chapman and Hall, 1977

Considine D.M. - Process Instruments and Controls Handbook, 2nd edition
Mc Graw-Hill, 1974

Chatfield C. - Statistics for Technology
Chapman and Hall, 1975

Hayward A.T.J. - Repeatability and Accuracy
London Mechanical Engineering Publications, 1977

Dietrich C.F. - Uncertainty, Calibration, Probability
Adam Hilger, 1973

Fribance A.E. - Industrial Instrumentation Fundamentals,
Mc Graw-Hill, 1962

Sinha S.K., Kale B.K. - Life testing and reliability estimation
Wiley, 1980

Sydenham P.H. - Handbook of Measurement Science, Vol. 1 & 2
J. Wiley, 1982

Jones B.E. - Instrument Science and Technology
Vol.1 (1982) Vol.2 (1983) and Vol.3 (1985), Adam Hilger U.K.
(Collection of survey papers published in the Journal of Scientific Instruments)

Hald A. - Statistical Theory of Sampling by Attributes
Acad. Press, 1981

Adams L.F. - Engineering Measurements and Instrumentation,
The English Universities Press Ltd, 1975

Hewitt P.L. (Ed.) - Modern Techniques in Metrology,
World Scientific Publishing Co., Singapore
(distributed by J. Wiley), 1984

Bentley J.P. - Principles of Measurement Systems,
Longman, Harlow U.K., 1983

Handbook of Chemistry and Physics
Tables published by Chemical Rubber Co., U.S.A., 60th edition 1979-1980

Beyer W.H. - Standard Mathematical Tables
Chemical Rubber Company, 25th edition 1978

11.2. MASSE ET FORCE / MASS AND FORCE METROLOGY

Comments

There are few publications on mechanical weighing devices which are still commercially available in this field.

The book by Colijn - "Weighing and proportioning of bulk solids" is very useful.

The well-known metrology text-book by Doeblin "Measurement systems" contains a chapter on force and torque measurements.

More recently the "Dictionary of Weighing Terms" by Bietry and Kochsiek available from Mettler representatives contains useful information (English, French, German and Chinese editions).

A large number of principles and descriptions of constructions of all types of weighing machines with a great number of references is given in the book by Kemény Tamas - Mérlegtechnikai kézikönyv (1980) (see OIML Bulletin No.84, p.35). Due to the large number of illustrations this book may be useful even for those who cannot read Hungarian.

A good book in German (see OIML Bulletin No.100, p.41) has been published under the direction of M. Kochsiek : Handbuch des Wägens, Fr. Vieweg & Sohn, Braunschweig, 1985

Papers of special interest are from time to time published in the German revue Wägen + Dosieren, Verlag Keppler - Kirchheim GmbH, Postfach 2524 , 6500 Mainz, Fed. Rep. of Germany.

Since 1979 conferences under the name of "Weightech" are organised in Europe (U.K.) and also in U.S.A. (1983). The proceedings of Weightech 79, 81 and 83 may be procured from

The Institute of Measurement and Control
20 Peel Street
London W8 7PD
U.K.

PTB seminars were organised in 1979 and 1984, see conference proceedings in PTB-Bericht PTB-Me-26 (April 1980) and PTB-Me-60 (June 1984). See also PTB-report by M. Kochsiek : The determination of Mass (Part I and II), English translation December 1983.

Some of the papers presented at the OIML seminars may also be useful, see OIML Bulletins No.85, 86, 90, 100, 101, 102, 103 and 104.

See also Index to OIML Bulletins No 1 to 89 page 18, and
the BIML brochure "Mobile equipment for the verification of road weighbridges".

The IMEKO TC 3 Mass and Force conference proceedings frequently contain suitable source material for teaching and references to other publications. Some of the proceedings are published as VDI-Berichte (papers are in English and German depending on the author) :

VDI-Bericht No 137 (1st IMEKO TC 3 Conference, Braunschweig, 1968)
No 176 (2nd IMEKO TC 3 Conference, den Haag, 1971)
No 202 (3rd IMEKO TC 3 Conference, Ostrava, 1972
No 212 (4th IMEKO TC 3 Conference, Udine, 1974)
No 312 (7th IMEKO TC 3 Conference, Braunschweig, 1978)

These are available from VDI-Verlag GmbH, Postfach 1139, 4 Düsseldorf, Fed. Rep. of Germany.

The proceedings from 5th Conference (Szeged), 6th Conference (Odessa, 1977) and 8th Conference (Krakow, 1980) may be obtained by contacting IMEKO Secretariat, P.O. Box 457, 1371 Budapest 5, Hungary.

(The proceedings of the 7th Conference VDI-Bericht No 312 contains in particular several good survey papers).

The National Scale Men's Association USA has published in 1981 the "Scalemen's Handbook of Metrology" which is both a tutorial and a practical instruction book for weighing machine technicians, covering : mechanical scales, hydraulics, electronic scales, instrumentation, system trouble-shooting and calibration, tank and batch weighing, tests and tolerances.

The book is in loose leaf form with a three hole system but a binder may also be obtained from the publishers :

International Society of Weighing and Measurement
2506 Gross Point Road
Evanston, Illinois 60201
U.S.A.

Two recent survey papers also provide for instructive material

Erdem U. - Force and Weight Measurement
J. Phys. E : Sci Instrum. Vol.15, 1982, p.857-872

Hugh-Jones F.B. - The modern balance and its development
J. Phys. E : Sci. Instrum. Vol.15, 1982, p.981-987

En français (in French)

- Manuel de l'apprenti ajusteur-balancier, 1955
e t
Compléments au Manuel de l'apprenti ajusteur-balancier, 1976

publiés par la Fédération Nationale du Pesage
36 avenue Hoche, 75008 Paris

Tramus J. - Notions élémentaires sur les instruments de pesage
(2 volumes).
Cours de l'Ecole Supérieure de Métrologie,
Service des Instruments de Mesure, Ministère de l'Industrie,
1975
éditeur : Elysées-copies
7 rue d'Artois
75008 Paris

Voir également Techniques de l'Ingénieur - Tome Mesures et Contrôle.

En allemand (in German)

Raudnitz, Reimpell - Handbuch des Waagenbaues
Band I : Handbediente Waagen
Band II : Selbstanzeigende und selbsttätige Waagen
Verlag Bernh. Friedr. Voigt, Berlin, 1955

Reimpell J., Bachmann W. - Handbuch des Waagenbaues
Band III : Elektromechanische Waagen
Verlag Handwerk und Technik, Hamburg, 1966

- Feinwaagen
PTB-Prüfregeln, Band 5, 1970
Deutscher Eichverlag, Braunschweig

Brocki G., Stiller H. - Leitfaden für Wäger
Erwin Mundt Verlag, Braunschweig

Baumann E. - Elektrische Kraftmesstechnik, VEB Verlag Technik, 1976

Padelt E., Damm H. - Wägetechnik, Akademische Verlagsgesellschaft, Leipzig, 1970

— " — - Wägetechnik in der Automatisierung, VEB-Verlag Technik, Berlin, 1972

Sawelski F.S. - Die Masse und ihre Messung
(translated from Russian by H. Sommer)
VEB Fachbuchverlag, Leipzig 1977

Kochsiek M. (Editor) - Handbuch des Wägens
Fr. Vieweg & Sohn, Braunschweig 1985

En anglais (in English)

Metcalfe T.J. - Weighing Machines
Vol. 1 : Non-self-indicating mechanisms
Vol. 2 : Semi-self-indicating and self-indicating mechanisms
Griffin, London, 1971

Colijn H. - Weighing and Proportioning of Bulk Solids
Trans Tech Publications, C-4711 Aedermansdorf, Switzerland
(new updated edition published in 1984)

Window A.L., Holister G.S. - Strain Gauge Technology
Applied Science Publishers, 1982

Norden K.E. - Electronic Weighing in Industrial Processes
Granada Publ. Ltd, P.O. Box 9, St Albans AL2 2NF, U.K.
1984

11.3. METROLOGIE DES LONGUEURS ET METROLOGIE D'ATELIER
LENGTH AND ENGINEERING METROLOGY

En français (in French)

Castell A., Dupont A. - Métrologie appliquée aux fabrications mécaniques (enseignement technique)
Ed. Desforges, Paris, 1978

Gerling H. - Techiques de contrôle dimensionnel dans l'usinage (traduit de l'allemand)
Eyrolles, Paris, 1979

Leclerc J. et Lebègue J.M. - Métrologie des cales étalons, méthode de mesure par comparaison
Ed. Chiron, Paris

En allemand (in German)

Gerling H. - Längeprüftechnik

Berndt G. - Grundlagen und Geräte technischer Längenmessungen

Schlesinger - Messung der Überflächengüte

Leinweber - Taschenbuch der Längemesstechnik

Trumpold H. - Längenprüftechnik
VEB Fachbuchverlag Leipzig, 1980

Kahmen H. - Elektronische Messverfahren in der Geodäsie
Wichman Verlag, Karlsruhe 1977

Warnecke H.J., Dutschke W. - Fertigungsmesstechnik
Springer-Verlag 1984

Graf A. - Messtechnik für Maschinenbau und Feinwerktechnik
Carl Hanser Verlag 1969

Brezina J. - Grundlagen der Winkelmesstechnik
VEB Verlag Technik, Berlin 1986

Lichtensteiner K. - Längenprüftechnik,
Oldenburg Verlag 1984

En anglais (in English)

Hume K.J. - Engineering Metrology
Mac Donald, London, 1963

Thomas G.G. - Engineering Metrology
Butterworth, London, 1974

Busch T. - Fundamentals of Dimensional Metrology
Delma Publishers Inc., New York, 1965

Scoles C.A., Kirk R. - Gear Metrology
Mac Donald, London, 1969

Scarr A.J.T. - Metrology and Precision Engineering
Mc Graw-Hill, London, 1967

Galyer J.F.W., Shotbolt C.R. - Metrology for Engineers
Cassell, London, 1969

Lissaman A.J. - Metrology for the Technician
Eng. U.P., London, 1967

Hume K.J. - Metrology with Autocollimators
Hilger and Watts, London, 1965

Dyson J. - Interferometry as a measuring tool, 1970
The Machinery Publishing Co, New England House,
Brighton, Sussex BN1 4HN

Cook A.H. - Interference of Electromagnetic Waves
Clarendon Press, 1971

Vest C.M. - Holographic Interferometry
Wiley, 1979

Town H.C., Moore H. - Inspection Machines, Measuring Systems
and Instruments
B.T. Batsford Ltd, London, 1978

Hume K.J. - A History of Engineering Metrology
Mechanical Engineering Publications, 1980

Parry V.G. - The Control of Quality
Mc Millan, 1973

Dagnall H. - Exploring Surface Texture
Rank Taylor Hobson, 1980

Dagnall H. - Lets Talk Roundness
Rank Taylor. Hobson, 1976

Adams L.F. - Engineering Measurements and Instrumentation
The English Universities Press Ltd, 1975

Beckwith T.G., Lewis Buck N. - Mechanical Measurements
Addison-Wesley Publ. Co, 1973

Brooker K. (Editor) - Manual of British Standards in Engineering
Metrology, Hutchinson & Co (publishers),
London 1984

Hariharan P. - Optical Interferometry
Academic Press, 1986

Luxmoore A.R. (Ed.) - Optical Transducers and Techniques in Engineering
Measurement, Applied Science Publ., 1983

11.4. MESURES DE VOLUME ET DE DEBIT / VOLUME AND FLOW MEASUREMENT

(see also chapter 4 Petroleum Institutes)

Survey papers including bibliographies

The following survey articles may prove useful as source material as they include numerous references to suitable publications :

- Brain T.J.S. and Scott R.W.W. : Survey of pipeline flowmeters
  J.Phys. E - Scientific Instruments (U.K.)
  Vol. 15, 1982 p.967-980

- Schröder A. : Durchflussmesstechnik - eine Übersicht
  (Flow measurement engineering - a survey)
  Technisches Messen (F.R. Germany)
  1979 Heft 3 p.91-100
  1979 Heft 4 p.145-149
  1979 Heft 5 p.179-188

- Moore R.L. : Liquid flow metering - whither the orifice plate
  ISA Transactions (USA)
  Vol 21 No 2 (1982), p.41-51

Books

En français (in French)

Defix A. - Mesurages des volumes des carburants et combustibles liquides
Editions Tecnip, Paris, 1975

Deliov J., Giraudon J., Marchand J., Simplot J. - Mesures industrielles et régulation automatique

Hébrard P. - Méthodes et moyens de mesure de débits de gaz,
Ed. Chiron, Paris

En allemand (in German)

Matschke R. - Volumenmessung strömender Gase
VDI Verlag 1983

Adunka F. - Wärmemengenmessungen,
Vulkan-Verlag-Essen, 1984

En anglais (in English)

Hayward A.T.J. - Flowmeters : A Basic Guide and Source Book for Users
Mc Millan, London, 1979

"FLOMEKO 78" - (IMEKO) proceedings North Holland Publ. Co., 1978

"FLOMEKO 85" proceedings published by H.S. Stephens & Ass., 55 Goldington Roa
Bedford MK40 3LS, U.K.

Flow - Its Measurement in Science and Industry, Vol. 1 (1974), 3 parts
and Vol.2 (1981), Instrument Society of America (or Wiley)

Displacement Meters
America Meter Co., USA

Benedict R. - Fundamentals of temperature pressure and flow measurements (Wiley)

Doeblin - Measurement Systems (Mc Graw-Hill)

Cheremisinoff N.P. - Applied Fluid Flow Measurement : Fundamentals and Technolo
Marcel Dekker Inc., N.Y. and Basel 1979

Scott R.W.W. (Ed) - Developments in Flow Measurement
Applied Science Publishers, U.K., 1983

Miller R.W. - Flow Measurement Handbook
Mc Graw-Hill, 1983

Danen G.W.A. (Ed.) - Shell Flow Meter Engineering Handbook 2/e
Mc Graw-Hill, 1985

En roumain (in Roumanian)

Nadolo A. - Masurarea Volumului si cantitatii Lichedelor in Industrie
(Mesures de volumes de liquides dans l'industrie)
Editura Tehnica, Bucarest, 1975
(ouvrage très illustré avec nombreuses références bibliographiques)

11.5. MESURE DE TEMPERATURE / TEMPERATURE MEASUREMENT

Survey reports

A selected list of books and other publications in English is given in Appendix IV of

Coates P.B. "The design of a standars laboratory for thermometry"
NPL report QU 64, May 1982
available from the National Physical Laboratory, Teddington, U.K.

(This list also includes references to other complete bibliographies mostly on scientific thermometry published by NPL and NBS).

A different list including a selection of German and English publications is included in

Bliek L. "Principles of electric temperature measurement"
PTB-report E-13e, July 1981
available from Physikalisch- Technische Bundesanstalt, Braunschweig
F.R. of Germany

See also chapters 3.1. and 7.3. of this bibliography concerning temperature measurements, and the BIPM monograph "Supplementary information for the IPTS-68 and EPT-76" published in 1983 and obtainable from Pavillon de Breteuil, F-92312 Sèvres Cedex, France.

Books

En anglais (in English)

Benedict Robert P. - Fundamentals of temperature, pressure and flow measurements
John Wiley, USA, 2nd edition, 1977

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A separate bibliography is available from BIML.

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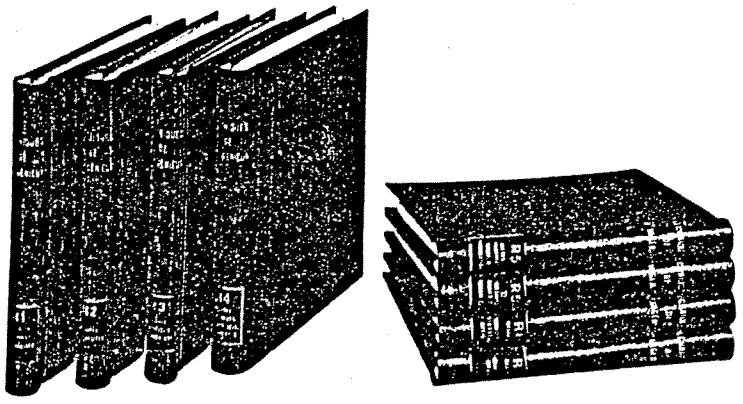

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Part XIII. Fidelity and security of measurement data section 3. Electrical and/or electronic data capture systems for flow meters ISBN 0 471 90962 9	64 p.	1986

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(Extracts from 1986 API catalogue)

MEASUREMENT COORDINATION

PUBLICATIONS ON EVAPORATION LOSS MEASUREMENT

852-25142
Publ 2514A, Atmospheric Hydrocarbon Emissions from Marine Vessel Transfer Operations, Second Edition, 1981
This publication presents new correlations and emission factors for estimating total hydrocarbon emissions and evaporative cargo losses from marine vessel loading and ballasting operations. 23 pages.
Price each, $4.00

852-25160
Bull. 2516, Evaporation Loss from Low-Pressure Tanks, 1962
Breathing, working, and leakage losses encountered in low-pressure tanks (atmospheric to 15 psig) are discussed in this bulletin, which also provides equations for calculating these values. 12 pages.
Price each, $3.00

852-25170
Publ 2517, Evaporation Loss from External Floating-Roof Tanks, Second Edition, 1980
A method of estimating total evaporative stock loss from volatile stocks stored in external floating roof storage tanks is presented along with a description of roofs and seals and details of loss analysis. 29 pages.
Price each, $7.00

852-25180
Bull. 2518, Evaporation Loss from Fixed-Roof Tanks, 1962
This bulletin contains the correlation and evaluation of test data from companies with evaporation loss from fixed-roof tanks. The information has been used to develop methods of estimating breathing and working losses from gasoline and crude oil tanks. Also included are a loss calculation summary and sample calculations. 38 pages.
Price each, $7.00

852-25190
Publ 2519, Evaporation Loss from Internal Floating-Roof Tanks, Third Edition, June 1983
This publication contains a method for estimating total evaporative losses and/or the equivalent atmospheric hydrocarbon emissions from freely vented internal floating-roof tanks containing multicomponent hydrocarbon mixtures, as well as single component stocks. 28 pages.
Price each, $7.00

852-25210
Bull. 2521, Use of Pressure-Vacuum Vent Valves for Atmospheric Pressure Tanks to Reduce Evaporation Loss, 1966
This bulletin describes the use of pressure-vacuum vent valves to reduce evaporation loss of petroleum and petroleum products stored at essentially atmospheric pressure in aboveground fixed-roof tanks and variable vapor-space systems. It also presents factors to be considered when selecting vent valves and serves to increase the awareness of operation and maintenance requirements. 13 pages.
Price each, $4.00

MANUAL OF PETROLEUM MEASUREMENT STANDARDS

The Institute currently maintains a comprehensive API *Manual of Petroleum Measurement Standards*. This manual is an ongoing project, as new chapters and revisions of old chapters will be released periodically. The following list includes all current chapters of the manual and other API measurement standards that have not yet been released as chapters of the new manual.

Manual of Petroleum Measurement Standards (Complete Set)
The complete set, with the exception of Chapters 11 and 16, is available by ordering "one complete set, MPMS." Since the price of the complete set is subject to change as new chapters and sub-chapters are released, an order for one complete set would include the chapters and publications listed below (excluding Chapters 11 and 16), new chapters released after the release date of this catalog, and the binders to house the set.

852-25238
Manual of Petroleum Measurement Standards Binders
This four-volume set of three-ring binders and index tabs will house the chapters and standards that make up the manual. Holders of existing two-binder sets may purchase binders three and four individually. When all the chapters and existing publications (excluding Chapters 11 and 16) are ordered, the binders, index tabs, and table of contents are included free of charge.
Price per set of four, $30.00

852-30011
Chapter 1, Vocabulary, First Edition, 1977
This chapter defines and describes the words and terms used throughout the API Measurement Manual. 25 pages.
Price each, $4.00

Chapter 2, Tank Calibration
This chapter covers the standardized procedures necessary for calibrating closed storage vessels larger than a drum, and the procedures recommended for computing the volumes contained therein. Chapter 2 is in preparation. The following API standards now cover the subject of tank calibration and are included in the manual.

852-25500
Std 2550, Measurement and Calibration of Upright Cylindrical Tanks, 1965 (ANSI/ASTM D 1220)
61 pages.
Price each, $6.00

852-25510
Std 2551, Measurement and Calibration of Horizontal Tanks, First Edition, 1965 (ANSI/ASTM D 1410)
47 pages.
Price each, $6.00

852-25520
Std 2552, Measurement and Calibration of Spheres and Spheroids, First Edition, 1965 (ANSI/ASTM D 1408)
17 pages.
Price each, $4.00

852-25530
Std 2553, Measurement and Calibration of Barges, First Edition, 1966 (ANSI/ASTM D 1407)
19 pages.
Price each, $4.00

852-25540
Std 2554, Measurement and Calibration of Tank Cars, First Edition, 1966 (ANSI/ASTM D 1409)
41 pages.
Price each, $6.00

852-25550
Std 2555, Liquid Calibration of Tanks, First Edition, 1966 (ANSI/ASTM D 1406)
14 pages.
Price each, $3.00

852-25560
RP 2556, Recommended Practice for Correcting Gage Tables for Incrustation, First Edition, 1968
6 pages.
Price each, $3.00

Chapter 3, Tank Gaging
This chapter contains the standardized procedures for gaging liquid hydrocarbons in various types of tanks, containers, and carriers. Chapter 3 is in preparation. The following API standard now covers the subject of tank gaging and is included in the manual.

852-25450
Std 2545, Method of Gaging Petroleum and Petroleum Products, 1965 (ANSI/ASTM D 1085)
39 pages.
Price each, $4.00

852-25092
Bull. 2509B, Shop Testing of Automatic Liquid-Level Gages, 1961
This publication is not included in the manual. 49 pages.
Price each, $3.00

852-30080
Chapter 4, Proving Systems, First Edition, 1978 (ANSI/API MPMS 4-1978)
This publication serves as a guide for the design, installation, calibration, and operation of meter proving systems. All types of proving systems in general use by the petroleum industry are covered, including field standards, pipe provers, tank provers, and master meter provers. Meter proving and analysis of sphere position repeatability are also included, along with 18 detailed illustrations. 49 pages.
Price each, $8.00

Chapter 5, Metering
This chapter covers the dynamic measurement of liquid hydrocarbons, or metering. It is divided into subchapters as follows.

852-30101
Chapter 5.1, Foreword, General Considerations, and Scope of Metering, First Edition, 1976 (ANSI/API MPMS 5.1-1976)
This is an overall introduction to Chapter 5, Metering. 1 page.
Price each, Free with any section of Chapter 5

852-30102
Chapter 5.2, Measurement of Liquid Hydrocarbons by Displacement Meter Systems, First Edition, 1977 (ANSI/API MPMS 5.2-1977)
This publication describes and illustrates methods and practices that may be used to obtain optimum measurement of liquid hydrocarbons and maximum service life when using displacement meters. 8 pages.
Price each, $4.00

852-30103
Chapter 5.3, Turbine Meters, First Edition, 1976
This publication specifies the characteristics of turbine meters and gives rules for applying appropriate considerations to the nature of the liquids to be measured. It also covers the installation of metering systems that use a turbine meter, and their performance, operation, and maintenance in liquid hydrocarbon service. 19 pages.
Price each, $4.00

852-30104
Chapter 5.4, Instrumentation or Accessory Equipment for Liquid Hydrocarbon Metering Systems, First Edition, 1976 (ANSI/API MPMS 5.4-1976)
This publication specifies the characteristics of available and necessary equipment that can be used to attain desired purposes when used in conjunction with volumetric hydrocarbon meters. 7 pages.
Price each, $4.00

852-30105
Chapter 5.5, Fidelity and Security of Flow Measurement Pulsed-Data Transmission Systems, First Edition, June 1982
This chapter provides a guide to the selection, operation, and maintenance of pulsed-data, cabled transmission systems for fluid metering systems to provide the desired level of fidelity and security of transmitted data. 7 pages.
Price each, $4.00

Chapter 6, Metering Assemblies
This chapter discusses the design, installation and operation of metering systems for coping with special situations in hydrocarbon measurement. Portions of Chapter 6 are in preparation. The following chapters and standards now cover the subject of metering assemblies.

852-30121
Chapter 6.1, LACT Systems, First Edition, February 1981 (ANSI/API MPMS 6.1-1981)
This chapter serves as a guide for the design, installation, calibration, and operation of lease automatic custody transfer systems. 6 pages.
Price each, $4.00

852-30122
Chapter 6.2, Loading Rack and Tank Truck Metering Systems, First Edition, October 1983 (ANSI/API MPMS 6.2-1985)
This chapter serves as a guide in the selection and installation of loading rack and tank truck metering systems for most gasoline and oil products other than liquefied petroleum gas. 5 pages.
Price each, $4.00

852-30123
Chapter 6.3, Service Station Dispensing Metering Systems, First Editi October 1983 (ANSI/API MPMS 6.3-1985)
This chapter covers service station metering systems used for dispens motor fuel (except liquefied petroleum gas fuels) to road vehicles relatively low flow and pressure. 4 pages.
Price each, $3

852-30124
Chapter 6.4, Metering Systems for Aviation Fueling Facilities, First E tion, June 1984
This chapter is a guide to the selection, installation, performance, a maintenance of metering systems for aviation fuel dispensing systen 5 pages.
Price each, $4.(

852-30125
Chapter 6.5, Metering Systems for Loading and Unloading Marine Bu Carriers, First Edition, July 1980 (ANSI/API MPMS 6.5-1980)
This chapter deals with the operation and special arrangement of mete provers, manifolding, instrumentation, and accessory equipment us for measurement in loading and unloading marine bulk carriers. 6 page
Price each, $4.(

852-30126
Chapter 6.6, Pipeline Metering Systems, First Edition, August 1981 (ANS API MPMS 6.6-1981)
This chapter provides guidelines for the selection of the type and siz of meters to be used to measure pipeline oil movements, as well as th relative advantages and disadvantages of three meter proving method 10 pages.
Price each, $4.0

852-30127
Chapter 6.7, Metering Viscous Hydrocarbons, First Edition, January 198 (ANSI/API MPMS 6.7-1981)
This publication serves as a guide for the design, installation, operatior and proving of meters and their auxiliary equipment used to meter viscou hydrocarbons. 14 pages.
Price each, $8.0

Chapter 7, Temperature Determination
This chapter covers the sampling, reading, averaging, and rounding o the temperature of liquid hydrocarbons in both the static and dynami mode of measurement for volumeteric purposes. Portions of Chapte 7 are in preparation. The following chapters and standard now cover th subject of temperature determination.

852-30142
Chapter 7.2, Dynamic Temperature Determination, First Edition, June 1985
This section describes the methods and practices used to obtain flowing temperature measurements using portable electronic thermometers ir custody transfer of liquid hydrocarbons. This section also covers blan keted tanks and tanks that have been made inert and are under pressures of less than 3 psig (21 kilopascals). It does not cover hydrocarbons under pressures in excess of 3 psig or cryogenic temperature measurement. 7 pages.
Price each, $5.00

852-30143
Chapter 7.3, Static Temperature Determination Using Portable Electronic Thermometers, First Edition, June 1985
This section provides a guide to the use of portable electronic thermometers to determine temperatures for custody transfer of liquid hydrocarbons under static conditions. It does not cover hydrocarbons under pressures in excess of 3 psig or cryogenic temperature measurement. 7 pages.
Price each, $5.00

852-25430
Std 2543, Method of Measuring the Temperature of Petroleum and Petroleum Products, 1965 (ANSI/ASTM D 1086)
12 pages.
Price each, $4.00

Chapter 8, Sampling
This chapter covers standardized procedures for sampling crude oil or its products. It is divided into subchapters as follows.

852-30161
Chapter 8.1, Manual Sampling of Petroleum and Petroleum Products, First Edition, October 1981 (ANSI/ASTM D 4057)
This chapter covers the procedures for obtaining representative samples of stocks or shipments of uniform petroleum products, except electrical insulating oils and fluid power hydraulic fluids. Sampling crude petroleum and nonuniform petroleum stocks and shipments are also covered, although the representativeness of results obtained using these sampling methods is in doubt. 21 pages.
Price each, $6.00

852-30162
Chapter 8.2, Automatic Sampling of Petroleum and Petroleum Products, First Edition, April 1983 (ANSI/ASTM D 4177)
This chapter covers automatic procedures for obtaining representative samples of petroleum and nonuniform stocks or shipments, except electrical insulating oils. 32 pages.
Price each, $6.00

Chapter 9, Density Determination
This chapter describes the standard methods and apparatus used to determine the specific gravity of crude petroleum products normally handled as liquids. It is divided into subchapters as follows.

852-30181
Chapter 9.1, Hydrometer Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products, First Edition, June 1981 (ANSI/ASTM D 1298)
This chapter describes the methods and practices relating to the determination of the density, relative density, or API gravity of crude petroleum and liquid petroleum products using the hydrometer method (laboratory determination). 5 pages.
Price each, $4.00

852-30182
Chapter 9.2, Pressure Hydrometer Test Method for Density or Relative Density, First Edition, April 1982
This chapter provides a guide for determining the density or relative density (specific gravity) or API gravity of light hydrocarbons, including liquefied petroleum gases, using a pressure hydrometer. 4 pages.
Price each, $3.00

Chapter 10, Sediment and Water
Chapter 10 describes methods for determining the amount of sediment and water, either together or separately. Laboratory and field methods are covered as follows.

852-30201
Chapter 10.1, Determination of Sediment in Crude Oils and Fuel Oils by the Extraction Method, First Edition, April 1981 (ANSI/ASTM D 473) (IP 53)
This publication specifies a method for the determination of sediment in crude petroleum by extraction with toluene. 4 pages.
Price each, $4.00

852-30202
Chapter 10.2, Determination of Water in Crude Oil by Distillation, First Edition, April 1981 (ANSI/ASTM D 4006)(IP 358)
This publication specifies a method for the determination of water in crude petroleum by distillation. 13 pages.
Price each, $5.00

852-30203
Chapter 10.3, Determination of Water and Sediment in Crude Oil by the Centrifuge Method (Laboratory Procedure), First Edition, April 1981 (ANSI/ASTM D 4007)(IP 359)
This publication describes the method of laboratory determination of water and sediment in crude oil by means of the centrifuge procedure. 15 pages.
Price each, $5.00

852-30204
Chapter 10.4 (Publ 2542), Methods of Test for Water and Sediment in Crude Oils, 1970 (ANSI/ASTM D 96)
This standard describes procedures for the determination of water and sediment in crude oils using the laboratory and field centrifuge methods, as well as the base method. 6 pages.
Price each, $4.00

852-30205
Chapter 10.5, Determination of Water in Petroleum Products and Bituminous Materials by Distillation, First Edition, December 1983 (ANSI/ASTM D 95)
This publication describes the test method for determination of water in petroleum products and bituminous materials by distillation. 5 pages.
Price each, $4.00

852-30206
Chapter 10.6, Determination of Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure), First Edition, December 1983 (ANSI/ASTM D 1796)
This publication describes the test method for laboratory determination of water and sediment in fuel oils by centrifuge. 6 pages.
Price each, $3.00

Chapter 11, Physical Properties Data
Because of the nature of this material, it is not included in the complete set of measurement standards. Each element of Chapter 11 must be ordered separately. Chapter 11 is the physical data that has direct application to volumetric measurement of liquid hydrocarbons. It is presented in tabular form, in equations relating volume to temperature and pressure, computer subroutines, magnetic tape, and microfilm.

852-27150
Chapter 11.1, Volume Correction Factors, August 1980, Magnetic Tape (Includes paper edition of Volume X) (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Tape is 9 track, 1600 bpi, EBCDIC, unlabeled, fixed block and requires a 32-bit or higher machine.
Magnetic tape, $450.00

852-27152
Chapter 11. 1, Volume Correction Factors, August 1980, Microfiche (includes paper edition of Volume X)(ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Microfiche, $450.00

Chapter 11.1, Volume I, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 5A—Generalized Crude Oils, Correction of Observed API Gravity to API Gravity at 60°F
Table 6A—Generalized Crude Oils, Correction of Volume to 60°F Against API Gravity at 60°F
Paper, $45.00

Chapter 11.1, Volume II, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 5B—Generalized Products, Correction of Observed API Gravity to API Gravity at 60°F
Table 6B—Generalized Products, Correction of Volume to 60°F Against API Gravity at 60°F
Paper or plasticized paper in binder, please specify, $45.00

Chapter 11.1, Volume III, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 6C—Volume Correction Factors for Individual and Special Applications, Volume Correction to 60°F Against Thermal Expansion Coefficients at 60°F
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852-27045
Chapter 11.1, Volume IV, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 23A—Generalized Crude Oils, Correction of Observed Relative Density to Relative Density at 60/60°F
Table 24A—Generalized Crude Oils, Correction of Volume to 60°F Against Relative Density 60/60°F
Plasticized paper in binder, $45.00

852-27060
Chapter 11.1, Volume V, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 23B—Generalized Products, Correction of Observed Relative Density to Relative Density at 60/60°F
Table 24B—Generalized Products, Correction of Volume to 60°F Against Relative Density 60/60°F
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Chapter 11.1, Volume VI, August 1980 (ANSI/ASTMD 1250)(IP 200) (API Std 2540)
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852-27100
Chapter 11.1, Volume VII, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 53A—Generalized Crude Oils, Correction of Observed Density to Density at 15°C
Table 54A—Generalized Crude Oils, Correction of Volume to 15°C Against Density at 15°C
Plasticized paper in binder, $45.00

852-27115
Chapter 11.1, Volume VIII, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 53B—Generalized Products, Correction of Observed Density to Density at 15°C
Table 54B—Generalized Products, Correction of Volume to 15°C Against Density at 15°C
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852-27130
Chapter 11.1, Volume IX, August 1980 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 54C—Volume Correction Factors for Individual and Special Applications, Volume Correction to 15°C Against Thermal Expansion Coefficients at 15°C
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Two combined volumes, containing Petroleum Measurement Subsidiary Tables 1-4, 8-14, 21, 22, 26-31, 33, 34, 51, 52, 56-58, which provide intraconversions between volume measures and density measures.
Order from ASTM*

852-27185
Chapter 11.1, Volume XIII, January 1982 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 5D—Generalized Lubricating Oils, Correction of Observed API Gravity to API Gravity at 60°F
Table 6D—Generalized Lubricating Oils, Correction of Volume to 60°F Against API Gravity at 60°F
Price each, $14.25

852-27200
Chapter 11.1, Volume XIV, January 1982 (ANSI/ASTM D 1250)(IP 200) (API Std 2540)
Table 53D—Generalized Lubricating Oils, Correction of Observed Density to Density at 15°C
Table 54D—Generalized Lubricating Oils, Correction of Volume to 15°C Against Density at 15°C
Price each, $20.00

852-25393
Chapter 11.1.77 Extrapolated Table 6 to -50°F, Volume Reduction Factors (Formerly Chapter 11.1.6A), 1976
This chapter is a computer printout of Subroutine Table 6 in extrapolated form.
Price each, $15.00

852-27300
Chapter 11.2.1, Compressibility Factors for Hydrocarbons: 0-90° API Gravity Range, First Edition, 1984
This chapter provides tables to correct hydrocarbon volumes metered under pressure to corresponding volumes at the equilibrium pressure for the metered temperature. It contains compressibility factors related to meter temperature and API gravity (60°F) of metered material. 149 pages.
Price each, $12.00

*ASTM, 1916 Race Street, Philadelphia, PA 19103.

852-27305
Chapter 11.2.1M, Compressibility Factors for Hydrocarbons: 638-10 Kilograms per Cubic Meter Range, First Edition, 1984
This chapter provides tables in metric (SI) units to correct hydrocarb volumes metered under pressure to corresponding volumes at the eq librium pressure for the metered temperature. It contains compressibil factors related to meter temperature and API gravity of metered materi 187 pages.
Price each, $16.

852-27307
Chapter 11.2.2, Compressibility Factors for Hydrocarbons: 0.500-0.6 Relative Density Range and 20-128°F, First Edition, 1984
This standard contains compressibility factors related to meter tempe ature and relative density (60°F/60°F) of the metered material. Its purpos is to correct hydrocarbon volumes metered under pressure to the cc responding volumes at the equilibrium pressure for the metered ter perature. 13 pages.
Price each, $5.

852-27310
Chapter 11.2.3, Water Calibration of Volumetric Provers, First Editio 1984
This chapter contains volume correction factors in standard units relate to prover temperature, and the difference in temperature between th prover and a certified test measure. 115 pages.
Price each $12.0

852-27315
Chapter 11.2.3M, Water Calibration of Volumetric Provers, First Editio 1984
This chapter contains volume correction factors in metric (SI) units relate to prover temperature, and the difference in temperature between th prover and a certified test measure. 167 pages.
Price each, $16.0

Computer Tape and Documentation of Chapters 11.2.1 and 11.2.1M, Com pressibility Factors of Hydrocarbons, and Chapters 11.2.3 and 11.2.3M Water Calibration of Volumetric Provers, First Edition, 1984
This package includes a magnetic tape of tables found in Chapters 11.2.1, 11.2.1M, 11.2.3 and 11.2.3M, along with a computer documentation manual containing text information from those chapters. The tables, presented in both standard and metric (SI) units, cover compressibility factors for hydrocarbons and water calibration of volumetric provers. The tape is 9-track, 1600 bpi, unlabeled, 4-file type, and is available in either ASCII or EBCDIC format. Format desired must be specified when ordering.

852-27290
ASCII Tape and Documentation Manual
Price each, $48.00

852-27295
EBCDIC Tape and Documentation Manual
Price each, $48.00

852-27320
Computer Tape Information and Documentation for Chapters 11.2.1, 11.2.1M, 11.2.3, and 11.2.3M, First Edition, 1984
This document provides only the text information from Chapters 11.2.1, 11.2.1M, 11.2.3, and 11.2.3M, and information pertaining to the use of the magnetic tape described above. The manual is included with orders for the magnetic tape. 11 pages.
Price each, $5.00

852-25410
Std 2541, Standard Tables for Positive Displacement Meter Prover Tanks, 1966 (ANSI/ASTM D 1750)
These tables provide multipliers for converting to 60°F the volumes of petroleum and petroleum products measured at temperatures between 0° and 125°F in insulated mild steel prover tanks for positive displacement meters. 4 pages.
Price each, $2.50

852-25650
Chapter 11.3.2.1, Ethylene Density, 1974
This chapter is a computer subroutine and includes subordinate subroutines "rubin" and "taint" on one Fortran IV card deck. It will produce either a density (pounds/ft^3) or a compressibility factor for vapor phase

ethylene over the temperature range from 65 to 167°F and the pressure range from 200 to 2100 psia.

Price each, $100.00

852-25654

Chapter 11.3.3.1, Propane Compressibility Table, 1974

This Fortran IV subroutine is applicable to liquid phase propane in the following ranges: relative density, 0.500 to 0.510; temperature, -20 to 120°F; saturation pressure to 1500 psia. The subroutine computes the following two values: average compressibility per psi (this factor would be applied in the same manner as compressibilities in Chapters 11.2.1 and 11.2.2) and the ratio of volume at flowing temperature and pressure to volume at flowing temperature and saturation pressure.

Price each, $100.00

852-25656

Chapter 11.3.3.2, Propylene Compressibility Table, 1974

This Fortran IV subroutine is applicable to liquid propylene in the following ranges: temperature, 30° to 165°F; and saturation pressure to 1600 psia. The subroutine computes the following two values: density (pounds/ft^3) at flowing temperature and pressure, and the ratio of density at flowing conditions to density at 60°F and saturation pressure.

Price each, $100.00

Chapter 12, Calculation of Petroleum Quantities

This chapter describes the standard procedures for calculating net standard volumes, including the application of correction factors and the importance of significant figures. The purpose of standardizing the calculation procedure is to achieve the same result regardless of what person or computer does the calculating.

852-30302

Chapter 12.2, Calculation of Liquid Petroleum Quantities Measured by Turbine or Displacement Meters, First Edition, September 1981 (ANSI/API MPMS 12.2-1981)

This publication defines the terms used in the calculation of metered petroleum quantities and specifies the equations that allow the values of correction factors to be computed. Rules for sequence, rounding, and significant figures are provided, along with tables for computer calculations. 39 pages.

Price each, $10.00

852-30303

Field Manual, Chapter 12.2., Instructions for Calculating Liquid Petroleum Quantities Measured by Turbine or Displacement Meters, First Edition, September 1981 (ANSI/API MPMS 12.2F-1981)

The field manual to Chapter 12.2 provides instructions to individuals charged with calculating metered petroleum quantities without detailed explanations of why a particular course of action is necessary. 35 pages.

Price each, $10.00

852-25093

Bull. 2509C, Volumetric Shrinkage Resulting from Blending Volatile Hydrocarbons with Crude Oils, Second Edition, 1967

This publication presents data on the subject of volumetric changes resulting from blending volatile hydrocarbons (propane, butane, produced distillates, and natural gasolines) with crude oils. This publication is not included in the current manual. 21 pages.

Price each, $3.00

Chapter 13, Statistical Aspects of Measuring and Sampling

The more accurate petroleum measurement becomes, the more its practitioners stand in need of statistical methods to express residual uncertainties. This chapter covers the application of statistical methods to petroleum measurement and sampling. Chapter 13 is in preparation. The following portion now covers the subject of statistical aspects of measuring and sampling and is included in the manual.

852-30321

Chapter 13.1, Statistical Concepts and Procedures in Measurement, First Edition, June 1985

This chapter is designed to help those who make measurement of bulk oil quantities improve the value of their result statement by making proper estimates of the uncertainty or probable error involved in measurements. 17 pages.

Price each, $5.00

Chapter 14, Natural Gas Fluids Measurement

This chapter standardizes practices for measuring, sampling, and testing natural gas fluids. Chapter 14 is in preparation. Sections 1, 3, 5, 6, and 8 have been completed and are included in the manual.

852-30343

Chapter 14.3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids, Second Edition, September 1985 (AGA Report #3)(GPA 8185-85)(ANSI/API 2530)

This standard provides a procedure for measuring natural gas, hydrocarbons, and other related fluids using flange taps and pipe tap orifice plates, meter tubes and fittings. It provides the standards for construction and installation of orifice plates, meter tubes and fittings and instructions for computing the flow of natural gas and hydrocarbon fluids through orifice meters. Also included are tables of the basic factors to adjust for the primary element expansion, Reynolds number, temperature, pressure, relative density, and supercompressibility. 126 pages.

Price each, $12.00

852-30345

Chapter 14.5, Calculation of Gross Heating Value, Specific Gravity, and Compressibility of Natural Gas Mixtures from Compositional Analysis, September 1981 (AGA 2172) (ANSI/API MPMS 14.5-1981)

This publication outlines a procedure for calculating, from compositional analysis, the following properties of natural gas mixtures: heating value, specific gravity, and compressibility factor. 4 pages.

Price each, $2.50

852-30346

Chapter 14.6, Installing and Proving Density Meters, September 1979

This publication provides a method for installing and accurately proving density meters that measure light hydrocarbons under static or dynamic conditions. 29 pages.

Price each, $6.00

852-30348

Chapter 14.8, Liquefied Petroleum Gas Measurement, February 1983

This chapter describes dynamic and static metering systems used to measure liquefied petroleum gas in the density range of 0.30 to 0.70 grams per cubic centimeter. 20 pages.

Price each, $6.00

852-25640

Chapter 15, Guidelines for Use of the International System of Units (SI) in the Petroleum and Allied Industries, Second Edition, December 1980

This publication specifies the API preferred units for quantities involved in petroleum industry measurements and indicates factors for conversion of quantities expressed in customary units to the API-preferred metric units. The quantities that comprise the tables are grouped into convenient categories related to their use. They were chosen to meet the needs of the many and varied aspects of the petroleum industry but also should be useful in similar process industries. 38 pages.

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Chapter 16, Measurement of Petroleum by Weight

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Chapter 17, Marine Measurement

This chapter provides guidelines for the measurement and reporting of crude oil or petroleum product transfers by shore terminal operators, vessel personnel, and other parties involved in marine cargo transfer measurement and accountability operations.

852-30401

Chapter 17.1, Guidelines for Marine Cargo Inspection, First Edition, April 1982

This chapter provides guidelines to encourage uniform marine cargo inspection practices and to simplify the making of contracts that can be clearly interpreted and executed between parties. 7 pages.

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33	*Radiation Quantities and Units* (1980)
34	*The Dosimetry of Pulsed Radiation* (1982)
35	*Radiation Dosimetry: Electron Beams with Energies Between 1 and 50 MeV* (1984)
36	*Microdosimetry* (1983)
37	*Stopping Powers for Electrons and Positrons* (1984)
38	*Dose and Volume Specification for Reporting Intracavitary Therapy in Gynecology* (1985)
39	*Determination of Dose Equivalents Resulting from External Radiation Sources* (1985)
40	*The Quality Factor in Radiation Protection* (1986)

A list of instructional materials used in the USSR for training metrologists

Moscow, 1986

Nos.	Author	Title	Publishing House	Year
1	2	3	4	5

I. Textbooks for higher educational institutions

1.	Mendeleev D.I.	Collected works. Vol. I,II,IV,VI,VII	Moscow, AN SSSR	1949
2.	Boitsov V.V.	Mendeleev-metrologist	M., Standarti	1969
3.	Kamentseva V.I.	Russian metrology	M., Visshaya shkola	1975
4.	Malikov S.F., Turin N.I.	Introduction to metrology	M., Standarti Publ.House	1966
5.	Ogryzkov V.M.	Standard, quality, law	M., Yuridicheskaya literatura	1980
6.	Atamalyan E.G.	Instruments and methods of measuring electrical quantities	M., Visshaya shkola	1982
7.	Asarutyan V.I.	Experiment planning theory	M., Radio i svyas	1983
8.	Baida L.I., Fremke A.V.	Electrical measurements	Leningrad, Energia	1980
9.	Bratslavsky D.A., Petrov V.V.	Accuracy of measuring devices	M., Mashinostrojenie	1976
10.	Berliner M.A.	Humidity measurements	M., Energia	1973
11.	Burdun G.D., Markov B.N.	Basic Metrology	M., Standarti Publ.House	1975
12.	Burdun G.D., Nemchinov Yu.V.	Teaching of metrology in higher educational institutions. (A book of instructional meterials).	M., Standarti Publ.House	1977
13.	Granovsky V.A.	Dynamic measurements. Fundamentals of metrological assurance	L., LO Energoatomizdata	1984
14.	Moisjuk B.N.	Elements of optimum experiment theory	M., Visshaya shkola	1982
15.	Ornatsky P.P.	Automatic measurements and instruments	M., Visshaya shkola	1981
16.	Sobolev V.I.	Information and statistic theory of measurements	M., Mashinostrojenie	1983
17.	Shirokov K.P., Boguslavsky M.G.	International system of units	M., Standarti Publ.House	1984
18.	Burdun G.D., Bazakutsa V.A.	Units of physical quantities	Kharkov, Visha shkola	1984
19.	Besfamilnaja L.B., Kurnikov I.B.	Estimation of economic effectiveness of metrology service	M., Standarti Publ.House	1984
20.	Afanasjev V.A.	Optical measurements	M., Visshaya shkola	1981
21.	Bromberg E.M., Kulikovsky K.L.	Test methods of increasing the accuracy of measurements	Leningrad, Energia	1978
22.	Burjan V.I., Glagolev V.I., Matveev V.V.	Fundamentals of the theory of measurements	M., Atom	1977
23.	Gaparov E.F.	Methods and means of verification of instruments for ionizing radiation	M., Atomizdat	1978
24.	Ivanov V.I.	A course of dosimetry	M., Atomizdat	1978
25.	Ivanova G.M., Chistyakov V.S., Kuznetsov N.D.	Thermal measurements and instruments	M., Energoatomizdat	1984
26.	Korotkov V.P.,Taits B.A.	Fundamentals of metrology and theory of accuracy of measuring devices	M., Standarti Publ.House	1978
27.	Kushnir F.V., Savchenko V.G.	Measurements in communication technique	M., Svyas	1976
28.	Kushnir F.V.	Electroradio measurements	L., Energoatomizdat	1983
29.	Levshina E.S., Novitsky P.V.	Electric measurements of physical quantities. Measuring transducers.	M., Energoatomizdat	1983
30.	Lubimov L.I., Forsilova I.D.	Verification of means for electrical measurements	L., Energia	1979
31.	Sena L.A.	Units of physical quantities and their dimensions	M., Nauka	1977
32.	Faustov R.N., Shelest V.P.	Quantum metrology and fundamental constants	M., Mir	1981
33.	Tsvetkov E.I.	Fundamentals of the theory of statistic measurements	L., Energia	1979
34.	Shirokov K.P., Balalayev V.A., Selivanov P.N.	100 years of the Metric Convention	M., Standarti Publ.House	1975

II. Textbooks for secondary specialized educational institutions

35. Agasjan M.V.,Orlov E.A.	Electrical engineering and electrical measurements	M., Radio i svyas	1
36. Bartnovsky A.L.	Electrical measurements. Laboratory practical work	Kiev., Visha shkola	1
37. Burdun G.D.,Birukov G.S., Boguslavsky M.G.	Dimensional measurements	M., Standarti Publ.House	1
38. Vasiljev A.S.	Basic metrology and technical measurements	M., Mashinostrojenie	1
39. Belenkij A.M., Berdyshev V.F. (a.o.)	Technological measurements and control and measuring instruments	M., Metallurgia	1
40. Voronin Yu.V., Rubtsov A.A.	Checking up measuring instruments and specialized tool	M., Mashinostrojenie	1
41. Glebov G.D.	Units of physical quantities in electrical engineering	M., Visshaya shkola	1
42. Gvozdeva N.P.,Kurkina	Theory of optical systems and optical measurements	M., Mashinostrojenie	1
43. Demidova-Panferova D.M., Malinovsky V.N.	Electrical measurements (with laboratory work)	M., Energia	1
44. Zuravlev A.N.	Tolerances and technical measurements	Kiev, Visha shkola	1
45. Zajchik I.Yu.,Zajchik B.I.	Practical work in electroradio measurements	M., Visshaya shkola	1
46. Kutuzova A.V.	Laboratory work in dimensional measurements	M., Standarti Publ.House	1
47. Kushnir F.V.	Radiotechnical measurements	M., Svyas	1
48. Livshits N.S., Terechevsky B.E.	Electroradio measurements	M., Visshaya shkola	1
49. Murin G.A.	Thermal technical measurements	M., Energia	1
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51. Tarasevich V.A., Pulcho L.N.	Laboratory work in mass, volume and density measurements	M., Standarti Publ.House	1
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53. Turin N.I. Ed. by Burdun G.D.	Introduction to metrology	M., Standarti Publ.House	1
54. Popov V.S.	Electrical measurements	M., Energia	1
55. Tseitlin V.G.	Flowrate and liquid, gas and vapour quantity measuring technique	M., Standarti Publ.House	1
56. Gauzner S.I. (a.o.)	Mass, volume and density measurements	M., Standarti Publ.House	1

III. Textbooks used for up-grading of metrologists

57. Artemjev B.G.,Golubev S.M.	A guide for officers of metrological services	M., Standarti Publ.House	1
58. Vikulov A.M. (a.o.)	Temperature measurements	M., Standarti Publ.House	1
59. Vikulov A.M.	Pressure gauges	M., Standarti Publ.House	1
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61. Vishenkov A.S.	Methods and means of certification, verification and tests of force measuring instruments	M., Standarti Publ.House	1
62. Boguslavsky M.G., Tseitlin J.M.	Instruments and methods of precise measurements of lengths and angles	M., Standarti Publ.House	1
63. Vaisband M.D. (a.o.)	Ways of increasing accuracy	Kiev, Znanie	1
64. Vinnik V.I.,Artemjev B.G.	Metrological supervision	M., Standarti Publ.House	1
65. Danilchenko V.P., Egoshin R.A.	Metrological assurance of industrial production. A guide.	Kiev, Tekhnika	1
66. Zimin G.F. (a.o.)	Contact methods and instruments for temperature measurements	M., Standarti Publ.House	1
67. Zimin G.F. (a.o.)	Temperature measurements	M., Standarti Publ.House	1
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75. Pugatchev N.S., Tumanov Yu.A.	Thermotechnical measurements	M., Standarti Publ.House	197
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