

THE AUSTRALIAN METROLOGIST

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From the President

I've been reminded by the editor that another President's column is due. It seems only yesterday that the last was written and it is hard to comprehend that a third of the year has passed. Better busy than idle, but we work in a field where tasks may be completed but work is never finished. Merely keeping abreast of changes in technology, software tools in particular, is sufficient to occupy hours that in the past would have given some breathing space.

At the peak metrology levels, much effort is being put into the database of comparisons and capabilities which will support the Mutual Recognition Arrangement (MRA) on measurement capability between countries (measure once, measure anywhere). The enormity of this task is only just becoming apparent, as regions with differing opinions, methods and terminology seek the common ground that will allow end-users to match their requirements against accuracies available from different sources. Much remains to be done.

The end effect of the MRA on the metrology community in Australia is yet to be determined. In theory, it should be possible for an Australian exporter to provide measurements that will be accepted without question (at least after referring to the MRA database) in, say, the European market. This is a two-edged sword in that local importers can refer to overseas measurements for acceptance here. Who knows where the balance will lie, and what the end result will be for our local calibration laboratories?

- Jim Gardner

Cover Story

Our cover photograph of John Birch and Judith Bennett depicts the change of an era at the National Standards Commission.

Dr Judith Bennett has been appointed as the Commission's next executive director, taking up the position on 1st May, following the retirement of John Birch.

Judith is a physicist with over twenty years experience in strategic planning and management of science and technology programs. She migrated to Australia from the UK in 1973 to undertake post-graduate research in textile physics at the University of New South Wales.

On completion of her studies she joined the Australian Wool Corporation as textile research man-

ager, with responsibility for coordinating international research projects involving CSIRO, Australian universities and specialised research organisations in Europe, New Zealand, South Africa and Japan. A significant component of that research program was the development of objective measurement systems which have revolutionised the marketing of Australian wool.

For the past twelve years, Judith has been a freelance consultant. In that capacity she had a long association with the Meat Research Corporation, developing strategic plans for research and development programs and managing multi-disciplinary research teams. A key achievement of this work was the development of Viascan — video image analysis technology for the measurement of meat quality and yield in abattoirs and food service organisations.

Judith has a Masters in Business Administration from Macquarie University, and has undertaken a variety of management consulting assignments for public and private sector clients, including feasibility studies for new business ventures, performance evaluation and change management.

In her leisure time, Judith is a keen bushwalker and a frustrated golfer. She enjoys listening to classical music and painting colourful Australian landscapes

CONTENTS

From the President	1
Cover story	1
From the Secretary	2
From the Editor	2
Metrology in Retrospect- <i>Our First Metrologist?</i>	3
Rail Survey Unit	5
Imeko News	10
NSC News	11
Dimensional Metrology Seminars	13
News from India	13
Q&A Column	14
Certifying Authorities for CRMs	14
Understanding Vocational Education in Australia	15
1999 Amendments to the National Measurement Regulations and Implications for Traceability	17
Ian Clunies Ross Memorial Foundation	20
Advertising rates	20
MSA Information Page	21

From the Secretary

At the last meeting of the National Committee of the Metrology Society, a major topic of discussion was the strategy to be adopted to make The Australian Metrologist (TAM) more valuable for members. The Editor of TAM, Maurie Hooper, attended the meeting by invitation and made a very substantial contribution to the discussions.

It was felt that for many members the subscription to TAM was the major benefit they received from the Society and that therefore some of the Society's funds should be invested in ways that would maximise its value. Many ideas were canvassed, but there were several major points of agreement:

- TAM was already very useful to members but could be made better.
- The amount of technical information in TAM should be increased markedly.
- Members should be encouraged as much as possible to make individual contributions.
- The journal should serve as a means of communication between members.
- The size (no. of pages) of TAM should be increased.

It was finally agreed that an attractive composition of TAM might look something like this:

- ◆ 12 pages of technical content (3-4 articles), including articles reprinted from other sources
- ◆ 3-4 pages of internal news from the MSA ranks
- ◆ 2 pages of a technical forum (question and answer format)
- ◆ 1-2 pages of reports from local correspondents
- ◆ 1-2 pages of reports from other organisations
- ◆ 1-2 pages of international news
- ◆ A column on items of metrological interest on the Internet

Your input on this matter would be much appreciated. Tell us what you think of the above format or what else you would like from your journal. (Any volunteers to contribute material would also be most welcome, of course.) Contact the Editor, your state representatives, or any of the national committee with your offers and your views. We look forward to hearing from you.

- Laurie Besley

From the Editor

The Secretary has indicated our currently thinking regarding TAM, and has outlined a number of changes in its content we will be aiming for over the next few issues. Because our membership is spread widely - not only across Australia but also NZ, Asia and Europe - TAM and our website become the major vehicles of contact with members.

This issue of TAM is in itself a sort of a milestone, being produced using Adobe PageMaker 6.5 - I believe all previous issues were produced with various versions of Microsoft Word!

As well as introducing some changes in content, it is expected that the visual style of TAM may undergo some changes over the next few issues.

This issue of TAM is the largest since I took over the editorship, and I have almost exhausted the articles on hand for publication.

What this means is that more people need to provide more input for the publication to maintain its expected size and quality of content. Yes, it's been said before many times, and I'm sure it will be said again in the future!

You will also note that the deadlines have now been set to the 1st day of the month preceding publication. This will allow me to produce a better product, rather than 'just throwing it all together' as I have had to do up until now.

Julian Holland's popular Metrology in Retrospect series continues in this issue, and from MSA'99 Len Kerwood's article on a Rail Survey Unit is included as well as a conference article by Grahame Harvey from the National Standards Commission.

I hope you will find something of interest to you in this issue. If not, please let us know what you expect to see in TAM.

I am surprised that we have not had more enquiries about advertising in our pages. Current advertising rates can be found on page 20. TAM has a well-focussed target audience, and should be an attractive place to advertise in. I am hoping to be able to offer more use of colour in the future.

- Maurie Hooper

Metrology in Retrospect

Julian Holland

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Our First Metrologist?

With the beginning of a new millennium (or of the last year of the old one, if you prefer!), it is a particularly apt time to reflect on historical matters. The Metrology Society of Australia is pretty new on the scene. How far back can the practice of metrology be traced in Australia? It is a commonplace of scientific and technical history in Australia to begin with Captain Cook. Certainly Cook's mapping of the east coast of Australia in 1770 was a great feat of precision measurement and cartography in his day - he didn't carry any chronometers until his second Pacific voyage - but he was really just a passer by. This article concerns my candidate for Australia's first resident metrologist - James Blanch.

The Imperial System of weights and measures was introduced into England by an Act of Parliament in 1824. This new system swept away an increasingly unsatisfactory infrastructure of measurement. The Imperial System was not immediately transferred to the colony of New South Wales - which then covered much of mainland Australia. By 1832, however, the need for reform was clear. In July the governor introduced *A Bill for preventing the use of false and deficient Weights and Measures* into the Legislative Council of New South Wales. This was passed on the third reading the following month. This led to the need to procure 'Copies and Models' of the standard weights and measures established by the Act. The Legislative Council set aside £254.10s in its forward estimates for 1833. Where were these 'Copies and Models' to be procured? The mathematical instrument maker and brass founder, James Blanch, was prepared to undertake the work.

James Blanch was probably born in London in 1784. If he followed the usual path for a lad going into trade he would have been apprenticed at the age of fourteen. So far his apprenticeship papers have not been traced but as he emphasised his skills as a 'mathematical instrument maker' - a person who made precision measuring instruments such as those used in navigation and surveying - he presumably served an apprenticeship in this trade. By the end of the eighteenth century London was the world's

leading centre of scientific instrument making - mathematical, optical and philosophical instruments, in the parlance of the time - and there were numerous pieceworkers and wholesalers in addition to the well known makers and retailers.

Blanch did not migrate to the colony to take advantage of the growing economic opportunities. Rather, he suffered the consequences of an ill judged act of petty theft! The earliest documentation turned up so far has Blanch not as an instrument maker but a 'Custom-house Officer' working on the London docks in January 1814. 'Feliciously stealing' ten yards of Russia duck, a heavy linen fabric, worth 30 shillings from the ship, *Lord Harlington*, lately arrived from St Petersburg, saw Blanch, then 29, and his fellow official, John Brennan, 32, appear at the Old Bailey in February. They were both found guilty and sentenced to be transported for seven years. The supply of involuntary passengers must have outstripped the means for sending them 'bound for Botany Bay' as the ship *Fanny* arrived in Sydney with a cargo of convicts, Blanch among them, on 18 January 1816, two days short of two years since the duck-pilfering incident.

Having served his time, Blanch gained his Ticket of Leave in February 1821 and soon began to make a contribution to the comfort and convenience of the inhabitants of Sydney, then a town still rough and ready but beginning to put down roots. Blanch set up business in Pitt Street as a mathematical and philosophical instrument maker, brass founder, brazier, plater and general worker in silver and brass. By February 1822 he had moved to 'a more commodious and central situation' at 78 George Street. 'J.B. makes, and has always for Sale, brass and plated harness furniture, parlour and chamber candlesticks, copper tea-kettles, brass cocks of all sorts, locks and hinges of every description, scales, beams, weights and steelyards, wire fenders, hand bells, ivory and wood rules, &c.' He also advertised 'Sex-tants, Quadrants, Compasses, Telescopes, and other Nautical and Optical Instruments repaired and accurately adjusted.—Umbrellas and Parasols made and repaired; Musical instruments repaired; and every article in brass, copper, silver or ivory, made to any pattern.' Such were the diverse means by which Blanch began to prosper. By this time Blanch was aided in his work by assigned convicts, and before 1822 was out he was seeking an apprentice. His address then was 71 George Street, and in time he also acquired the adjacent properties, nos. 69 and 70.

The range of his goods and services suggests that

his skills as a mathematical instrument maker played a minor part in his business. While he could not have made a living at this alone, his skill was unique in the colony, and was on occasion valuable to the government. At the beginning of 1823 we find him being paid for the repair of compasses at the government dockyard and the following year he received 32 Spanish dollars and 50 cents for repairing mathematical instruments in the Surveyor-General's Department.

With the passing of the *Bill for preventing the use of false and deficient Weights and Measures* in August 1832, a more substantial piece of precision work came to Blanch. 'It then became a question whether the old or New English Weights and Measures Should be declared the Standard in New South Wales [Governor Bourke informed Lord Goderich in the Colonial Office in London], which question was decided by its being found upon enquiry that no Authorised Set of weights and Measures of the Old Standard could be procured; but, from the Commissariat, a standard Set of Imperial Weights and Measures, Sent out by the Lords Commissioners of the Treasury, has been obtained, which, being lodged in the office of the Colonial Treasurer, are declared the Standards of New South Wales, by which all Copies and Models are to be compared and verified.'¹ Bourke added that a Standard Yard had been obtained from the Surveyor-General's Office.

Seven sets were required each consisting of a series of weights (1, 2, 4, and 8 drams, 1, 2, 4, and 8 ounces, 1, 2, 4, 7, 14, 28, and 56 pounds), a series of volume measures (half gill, gill, pint, quart, half gallon, gallon, peck, half bushel and bushel) and a standard yard. Blanch had these ready by February 1833. Then balances and scales were required for 'making a proper comparison of weights'. The provision of these also fell to Blanch, 'the other Iron Mongers in the Town declined furnishing the Articles no one of them being able to make the same'. A note records the result: 'The Surveyor General reports that the Colonial Architect considers the articles to be of as good quality as can be made in the Colony & the prices reasonable'.

Sets were distributed to police offices in various regional towns - Parramatta, Windsor, Bong-Bong, Goulburn, Bathurst, Maitland - as well as one to the police office in Sydney. In the end the production of the weights and measures, and their distribution to the various towns, amounted to £323.11.6, rather more than the sum allocated, but no one seems to have complained.

The late 1830s have been described as 'a period of dazzling but false prosperity'.² Blanch shared in this, acquiring farms at Kissing Point, Brisbane Water and Illawarra in addition to the George Street properties. Blanch died on 27 October 1841 intending the various properties to provide for his wife and three children. His widow, Sarah Blanch, believed the value of his estate did not exceed fourteen thousand pounds. But in the depths of the depression of 1844 it appears that all these properties were auctioned off. Blanch's name has long since vanished into obscurity but his foundry was taken over by Peter Nicol Russell, a name very familiar - at least to engineering graduates of the University of Sydney.³

Note:

This article is based on a variety of primary source materials, published and unpublished, most of which are not readily available. I have therefore omitted references for most of my source material. I have further research to undertake on Blanch and intend to produce a fuller biographical treatment in due course, with full referencing. A number of weights and measures made by Blanch are known to survive. A yard made by him in 1838 is on display in the Museum of Sydney and a large brass weight is illustrated in Caroline Simpson and others, *Australian Antiques, First Fleet to Federation* (Sydney, 1977), p. 134. I would be pleased to hear of any surviving weights, measures or other items made by Blanch.

¹ Bourke to Goderich, Dispatch No. 110, 30 Oct. 1832, *Historical Records of Australia*, Series I, vol. 16 (1923), p. 782

² Joseph Fowles, *Sydney in 1848* (Sydney, 1848; facsimile 1973), p. 50

³ P.H. Russell, 'Sir Peter Nicol Russell 1816-1905, his family and associates, pioneers of the Australian iron and engineering industry', *Royal Australian Historical Society Journal*, vol. 50 (1964): 129-143

RAIL SURVEY UNIT

Len Kerwood

- winner of the MSA 99 Award

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Abstract

The demand for faster elevator speeds and improved ride quality in high rise multi-story buildings of ten floors or more has brought about the requirement to measure and adjust elevator guide rails to a greater degree of accuracy.

The present methods of measurement of alignment of guide rails are slow, expensive and inaccurate. The traditional (and current method) consists of measurement of rail against a tensioned piano wire. Problems are encountered due to building movement, and air drafts which cause movement of the wire.

This paper gives an overview of the Australian design, calibration, and manufacture of a Rail Survey Unit (RSU) data acquisition unit. A joint venture between OTIS Engineering Australia and Gawler Instrument Company.

THE PROBLEM

Perception of Ride Quality

There are many factors which give the customer the perception of poor ride quality in an elevator car. They can be listed as follows:

- Vibration in x y z axis
- Noise from fans, car travel airflow
- The counter weight
- Roller Guides
- Machine Room, etc.
- Vertical Jerk
- Acceleration
- Door Operation
- An Incident or Occurrences
- Elevator features such as lighting, interior finish and ventilation.

To achieve ride quality which is rated as excellent all factors have to be considered and optimized. Any one factor which is bad, will give an overall poor impression even if all other factors are acceptable.

Effect of Frequency on Perception of Vibration

The perception of vibration depends on the frequency. The human response will vary between individuals. It will depend on the direction of vibration and the orientation of the individual with respect to the vibration.

The perception in the vertical direction, is very different to perception in the horizontal direction, when a person is standing.

Typically, the maximum sensitivity in the vertical direction is around 4 to 8 Hz. If a standing person leans against the wall of an elevator, the sensitivity to frequencies in the horizontal direction changes. This can be noticed in an elevator, and more vibration and higher frequencies are detected in the horizontal direction.

The human response to vibration has been measured and is presented in an ISO Standard in tables and graphs -ISO8041. A good understanding of human response to different frequencies, is very useful to achieve elevator performance which feels good to the passengers. This understanding is one of the factors that led to the development of the RSU.

GUIDE RAILS

Straightness

Rails do not need to be straight in their total length. A rail could be a gentle curve over a long distance and the result would be undetectable to an elevator passenger.

How much curve could be acceptable? That would depend on the amplitude, change of direction and frequency.

In the ISO Standard, the frequency of maximum horizontal sensitivity is 1 - 2 Hz. Sensitivity reduces rapidly as the frequency shifts away from 1 - 2 Hz. As an example, for an elevator travelling at 7 metres per second, 1 - 2 Hz corresponds to a travel distance of 3.5 to 7 metres.

It may be possible to achieve a low horizontal vibration level, if the rail is smooth over a range of zero to 20 metres. It is therefore, best to think in terms of smoothness, not absolute straightness.

In high rise buildings typical elevator speeds are around 10 metres per second, with the market demanding higher speeds. Rail lengths are around the 3.5 to 7 metres long. One can now see that rail joints are one of the major factors in ride quality.

Causes of Misalignment of Guide Rails

- Bent or damaged rails.
- Bracket misalignment.
- Rail joints stepped. Grinding or filing may hide the problem, but it is still there.
- Rail joints not in line. This is a common and serious problem. The rail forms a vee at the joint as either a crest or valley. The effect on ride quality is dramatic.
- Buckled rails. Due to vertical compression of a building with time, this will also result in rail compression if the rails do not slip through the clips at the brackets.

MEASUREMENT OF RAIL ALIGNMENT

Wire Alignment Problems

Time and cost to measure a hoistway. How long to set up and measure? Perhaps two men for two days to measure at every bracket of a 200 metre hoistway. (Normally at overtime rates, as measurements are conducted at night.)

Reference to the top and bottom of the hoistway, therefore the measurements in the central high speed travel portion of the hoistway are a long way from the reference positions. A small movement in the building may be read as rail deflection. Tall buildings need to overlap plumb lines, hence some transition errors.

Slow deflection of buildings due to sunlight or average wind velocity.

Sway of tall buildings due to wind.

Deflection of the wire by air currents.

Distance between measurements (typically at brackets only) gives only a partial picture of rail profile. (Typical measure, 2 metres centre distance.)

Operator dependent for accuracy. No way to check the operator's measurements.

Laser Problems

The reference is a long way from the position of measurement.

The reference moves relative to the target.

Experience shows poor repeatability.

Accelerometer Based System

Accelerometer and position sensor.

Accelerometer and gyroscope limitation due to cost and difficulty of controlling all error sources.

THE RAIL SURVEY UNIT - RSU

The Need

- A tool to measure relative rail straightness or smoothness in a way that takes into account human response to vibration and elevator speed.
- Operator independent.
- Short set up time and measure time.
- Recheck, after rail correction.
- Measure before quotes for modernization.
- Repeatable and accurate.
- Minimizes corrective action.
- Not referenced to the top or bottom of the hoistway.

The Rail Survey Unit (RSU) has been developed to enable cost effective improvement of ride quality.

The RSU enables fast, accurate mapping of the profile of guide rails of elevators in a shaft.

The output is presented as a graph which displays rail profile against vertical height position which also includes location of rail joins and rail brackets. This enables identification of locations and magnitude of rail errors and enables corrective action.

The RSU consists of

- A carriage which is clamped onto the guide rail above the car and is hauled up and down the rail by the car at inspection speed. The carriage contains data acquisition hardware and software and is battery powered.
- PC software which is used to transfer data from the carriage to a PC (RSU Link).
- PC software which enables plotting of the graphical output from the RSU (RSU Plot).

The RSU enables measurement of both guide rails in less than one hour.

The RSU has been patented world wide.

Product Development

The development of the RSU went through several stages. The first was the concept of a prototype to establish that the principle was sound and the general requirements covered. The second stage was the development of an engineering prototype and testing. The third stage was the production of ten pre-production series to be distributed around the world for on-site evaluation. The final stage was production.

The Concept (Refer to Fig 1 and Fig 2)

A carriage which would ride the rails and by means of displacement, transducers and an encoder, col-

lect data direct to a PC (lap top) for graphical analysis and thus calculate the rail profile.

Figure 1 [1]

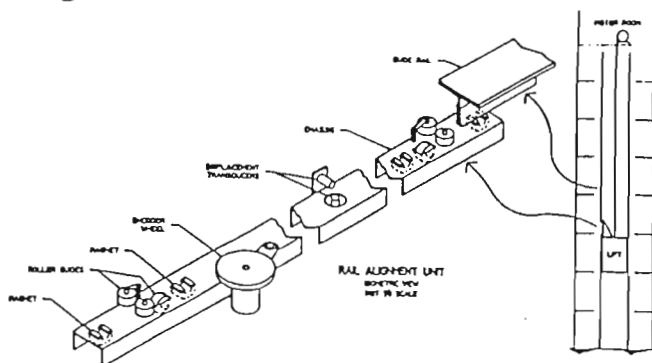
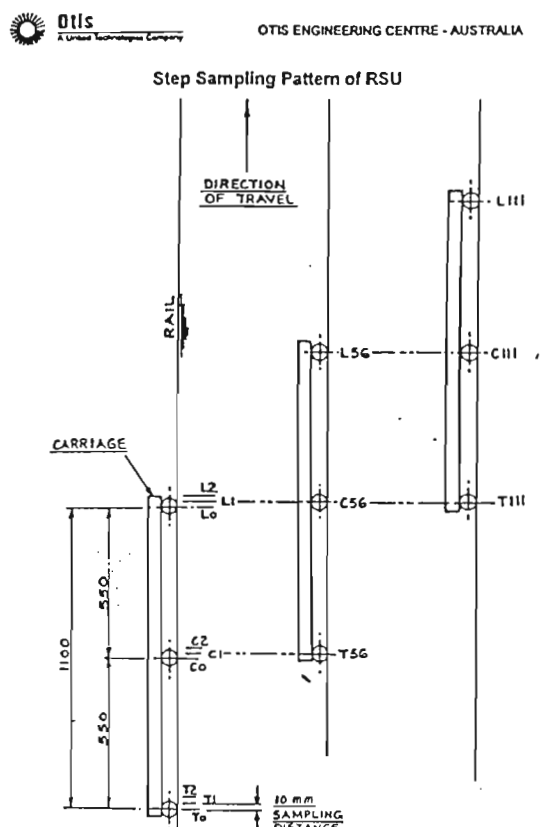


Figure 2 [1]



We have a carriage which is clamped onto the guide rail by means of top and bottom roller guides. The carriage rides on guide rollers being attracted to the rail by means of magnetic force supplied by two sets of magnets. The displacement of the carriage is measured by the optical encoder and the raw data

is gathered by two displacement transducers. One for front-to-back measurement of the rail, and the other for side-to-side measurement.

Other devices (optical proximity detectors) not shown, are used to detect the rail joints and brackets which attach the rail to the hoistway.

Figure 2 shows the sampling pattern of the displacement transducers. The sample distance is every 10 mm, thus giving 111 data samples in the length of the carriage for both front-to-back and side-to-side transducers.

Proving that the RSU works.

It was tested in the OTIS factory in Melbourne on a test rail and several tests were conducted for repeatability. The output graphs for each test were overlaid on each other, and no significant error could be measured.

Tested against other methods, for example wire and inclinometer method. A precision inclinometer was used to plot the profile of an elevator rail. The resultant graph of this measurement which took several days to conduct was overlaid on the output graph as measured by the RSU. Again no significant error could be measured. It was also tested by adjusting an elevator rail so as to achieve measurable amounts of misalignment. The RSU graphs were again measured against these misalignment values and were shown to hold true.

Field Experience

Set up time around 15 minutes.

Measure a hoistway in less than 1 hour.

KLCC Petronas Twin Towers, Malaysia, 76 elevators. 12 elevators measured in one day.

Highest hoistway 380 metres.

Typical 200 metres.

Other locations - Chifley Square, Sydney, and many other local sites.

Field experience is used to develop Engineering Prototype Parameters.

- The main objective was to remove the lap top from the hoistway, and eliminate the wires, boxes and connectors.
- Data capture and storage on the RSU carriage.
- Improve the clamping arrangement.
- Battery powered - internal.
- Encoder and transducers internal to the carriage.

Final Production Specifications.

On board rechargeable battery, 6-8 hours operation life.

On board power supply board, to control Vcc and recharge battery.

An on board 32 bit CPU processor board to convert analog to digital signals, and store data complete with embedded software and real time clock.

LCD display for visual display of various menus.

Key pad to enter data and control the RSU.

Distance measured by an optical encoder with friction wheel running on the elevator guide rail. The distance is used to trigger a data sample at intervals (10 mm) along the rail.

Deflection

Measured by two strain gauge transducers measuring in X and Y axis. Each transducer utilizes a constant stress cantilever leaf spring with four 120 ohm strain gauges to give a full bridge configuration. The transducer's workable range is around 10 - 12 mm, but a maximum of 5 mm is used.

Rail joint and bracket detection are photoelectric proximity switches, which can be focused from 20 to 80 mm.

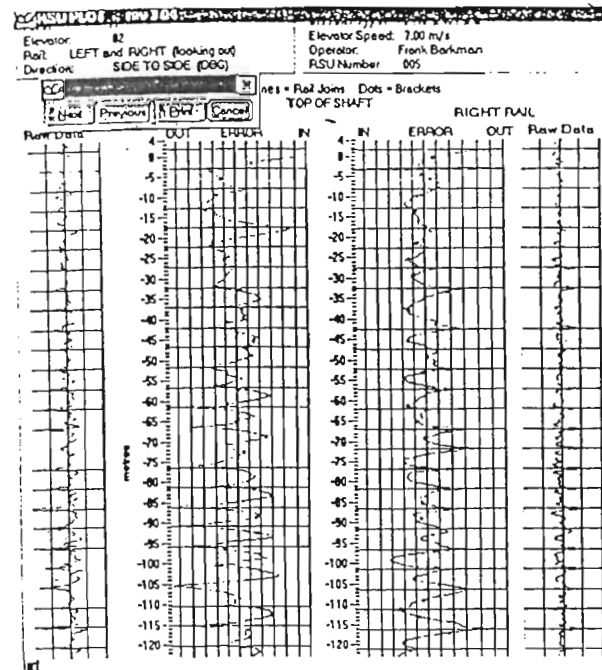
Software

RSU Link is the PC software which is used to transfer data files from the RSU carriage to the PC.

The RSU plot program allows graphical plots of the data in the RSU data files to be viewed on the screen, and to be printed out as hard-copy graphs. Data files downloaded from an RSU for use with this program have an "RSU" extension. The files may contain data for one or two rails; the plotting program is capable of detecting what sort of file it is dealing with, and to display the correct graphs for the file's data.

A number of data files can be selected at the one time, and then all the graphs for these files viewed or printed out directly. The user has control over a number of aspects concerning the graphs produced, such as the lift speed used in the calculations for the graph, the number of metres of vertical rise to be displayed per plot which units to use - metric or imperial. Refer to Figure 3.

Figure 3 [2]



Severe errors at rail joints caused by rail compression & buckling.

System Security

The security is controlled by several means in the embedded software and PC software, and is controlled by the use of a dongle.

Calibration

As the RSU uses its first measurement as a calibration reference, no on-site calibration is required.

However, during manufacture the following are calibrated:

Magnetic clearance to rail.

Optical encoder wheel force.

Magnetic pull off force both top and bottom.

Maximum travel of both side-to-side and front-to-back transducers.

The gain of both transducers and their amplifiers is determined by using NATA Certified pin gauges of different lengths, which are inserted through a test rail to enable the transducer gain factor to be determined. This value is then loaded into the embedded software for each RSU.

QUALIFICATIONS AND EMC TESTING

The qualification and EMC testing were conducted at two separate locations.

EMI, ESD, Drop, Temperature and Humidity testing were carried out at OTIS qualification test centre Bristol, Connecticut, USA

High Accelerated Life Testing (HALT)

HALT testing was conducted at ASTA Components, Port Melbourne, Australia.

ESD Testing

The electrostatic discharge test criteria was no interruption to the operation of the RSU, during or after contact discharge up to ± 6 kV and air discharge ± 8 kV, and no permanent damage during or after contact discharge up to ± 8 kV and air discharge up to ± 15 kV. [3]

Drop Test

The RSU was subject to a handling drop test of 30 drops to ensure that no physical damage would occur to various electronic components [3]. However, the shipping container was not tested.

HALT Testing

The temperature step stresses test was conducted over a temperature range of -40 degrees Celsius to 120 degrees Celsius [3]. A vibration step stresses test was conducted on several power supply boards and main processor boards. Vibrations were in the order of 25 g before a failure occurred.

As a result of qualification testing, some minor changes were implemented. The main modification was the relocation of the real time clock battery from the main processor board to a bulk head in the RSU, as the battery was too large in mass to mount directly on the processor board. This modification has now made it possible for the battery to be changed in the field without special tooling.

GENERAL SPECIFICATIONS

Capacity

Five kilometres of rail measurement can be stored in the carriage memory. This equals 40 rails of the average size building.

Weight

The RSU is packaged in a high quality travelling case with extendible handle and wheels to enable easy transport, as accompanied baggage, or protection for road or air freight.

RSU Carriage Weight 8.75 kg (19 lb)

Total Weight (including all accessories and shipping case) 26 kg (57 lb)

Case Dimensions 850 x 480 x 220 mm
(33.5x19x8.7 inch)

Guide Rail Sizes that can be measured.

Rail blade thickness from 5/8" (16 mm) up to 1 1/4" (32 mm)

By special arrangement the rail blade thickness can be changed to permit 9 mm up to 1" (25 mm).

CONCLUSION

The RSU is an instrument that has achieved its design requirements, and is setting new standards around the world in the art of elevator rail alignment and measurement, with very real cost benefits and safety considerations.

The RSU has been used on many buildings worldwide including:

Petronas Twin Towers, Kuala Lumpur.
John Hancock, Chicago.
Stratosphere, Los Vegas.
Canary Wharf, London.
Chifley Square, Sydney.

Currently

Units have been sold to England, United States of America, Germany, Spain, France, Korea, Malaysia, India, Japan and here in Australia.

Project Team

Geoff Gillingham - Initial concept project management, prototype development, security system and qualification testing.

Frank Griffiths - Initial concept mechanical development and field support.

Alf Katz - Electronic design of carriage.

Jenny Chong - Carriage software.

Declan Trail - RSU plot software.

Juan Rosello - Board design

Em Le - Board layout

Warren Noble - Mechanical component, design, manufacture and assembly.

Len Kerwood - Managing Director Gawler Instrument Company - Mechanical component, design, manufacture and project management.

REFERENCES

- [1] OTIS Training Seminar Notes October 1997.
- [2] RSU Operators Manual 1998.
- [3] OTIS Engineering Qualification Test Report February 1998.

IMEKO NEWS**– Win a Trip to Vienna!**

As part of the MSA's membership of the International Measurement Confederation, TAM publishes reports from time to time of the activities of that body. There is a lot happening within IMEKO that is of interest to our membership.

The next major IMEKO event is the XVI IMEKO World Congress to be held in Vienna, Austria from September 25 to 28 this year. It would be great if the MSA could be represented there and as an inducement the MSA committee is offering sponsorship of up to \$500 to a member who would like to attend. So if you feel like escaping from the Olympics contact the President, Jim Gardner, with a proposal.

(This article was supposed to appear in the last issue of TAM, so I hope the above offer still applies - Ed.)

MEASUREMENT**Journal of the International Measurement Confederation IMEKO**

The latest copies of the IMEKO journal *Measurement* contain the following articles. If any member would like a copy of any of these please contact the Secretary who will be pleased to supply them.

Vol. 26, No 1, July 1999

Analogue neural network design for the processing of measurement signals

Optimal design and organisation of biomedical experiment

Fundamentals and trends of digital measurement

A fast, programmable, multichannel pulse delay generator

A difference resonator for detecting weak signals

Vol. 26, No 2, September 1999

Determination of strain distribution by means of digital shearography

A VXI power quality analyser implementing a wavelet transform-based measurement procedure

Experimental set-up for the characterisation of automated number-plate recognizers

High-frequency Hall probe calibration with a coaxial magnetic field generator

Characterisation of Yb-Er:glass lasers at 1.5mm wavelength in terms of amplitude and frequency stability

Self-calibration measuring methods and application to measurements of electrical quantities

The evolution of tasks within the Metre Convention

Vol. 26, No 3, October 1999

Base concept of feature-based metrology

3-D shape measurement by self-referenced pattern projection method

Design and error analysis of a surface reflector for a laser tracking measurement system

An integrated ultrasonic system for detection, recognition and measurement

Measurement services for quality

ADC testing methods

The influence of operating conditions on the accuracy of in-plane laser Doppler velocimetry measurements

Vol. 26, No 4, December 1999

An intelligent instrument for tracking and adaptive filtering of oscillatory signals using Hebbian learning rules

Frequency response characteristics of gas sensors

Modeling and development of an ANN-based smart pressure sensor in a dynamic environment

An automatic calibrator for wattmeters with harmonic analysis capability

The min-max problem for evaluating the form error of a circle

Events sponsored by IMEKO that are coming up this year:

International Conference on Metrology – Trends and Applications in Calibration and Testing Laboratories, Jerusalem, Israel, May 16-18, 2000

4th International Conference on Vibration Measurements by Laser Techniques, Ancona, Italy, June 20-23, 2000

16th IMEKO World Congress, Vienna, Austria, September 25-28, 2000

National Standards Commission News

Let's Celebrate!

The year 2000 is an important year for the Commission as it marks:

- the fiftieth anniversary of the Commission;
- the thirty-fifth anniversary of the Pattern Approval Laboratory; and
- the twenty-fifth anniversary of our move to North Ryde.

To mark the fiftieth anniversary of the Commission a seminar and dinner have been organised for the afternoon and evening of 14th June (see next article).

In addition, past and present staff members will be invited to a lunch on the same day to celebrate the thirty-fifth and twenty-fifth anniversaries. Ian Hoerlein started working for the Commission in October 1966. As his contribution to the anniversaries, Ian is currently producing a short history of the Commission and the people who have worked there during the last thirty-five years. Copies of *The NSC Story* will be presented to all staff, old and new, at this gathering.

Invitations to these events will be distributed in the next few weeks, but if you are interested in attending any of them please contact Val Dunne.

The Commission 1950–2000

The first meeting of the Commission was held fifty years ago at the National Standards Laboratory on 13 November 1950.

The *Weights and Measures (National Standards) Act* enacted in 1948 had a provision for establishing a Commission to advise the Government on weights and measures, and in September 1950 a chairman (Professor Sir Leonard Huxley) and five members were appointed. The members were Dr George Briggs, Norman Esserman and Fred Lehany (chiefs of divisions of the National Standards Laboratory), Walter Holmes (Superintendent of Weights and Measures in Victoria) and Frank Nicholls (CSIRO).

To celebrate our fiftieth anniversary we will be holding a seminar on Wednesday 14 June where we will look at the Commission — past, present and future. There will be contributions by people associated with the Commission's establishment and first fifty years, including Frank Nicholls, the Commis-

sion's first secretary.

A dinner will follow the seminar where we will farewell retiring executive director, John Birch.

The Pattern Approval Laboratory 1965–2000

In 1965 the Commission was given responsibility for the pattern approval of measuring instruments used for trade and so for the first time permanent full-time staff were employed to operate a pattern approval laboratory.

The Pattern Approval Laboratory initially operated in Chippendale near the National Standards Laboratory when the latter was located at the University of Sydney.

The first appointment was Tom Poppy who was hired as a consultant from the Board of Trade in London. Phillip Champion, an engineer, became the manager of the Laboratory in March 1965 and set about hiring more staff and setting up rented premises in Pine Street, Chippendale. Phil was instrumental in setting the procedures and methods of carrying out the pattern approval process which basically still exist today.

Ten years later the Commission moved to North Ryde. The first few years were spent building the test laboratories and equipping the workshop with some large machine tools in order to build some large test equipment such as the 50 tonne load cell test lever and the flowmeter test rig.

Today our Pattern Approval Laboratory is equivalent to the best pattern approval laboratories in the world. In particular, the Commission has become one of the world leaders in load cell testing.

North Ryde 1975–2000

As mentioned above, twenty-five years ago the Commission moved from Chippendale to North Ryde.

Phil Champion, Hazel Millet and Ann Robinson moved in first to set up the new spec built building in what was a showplace industrial estate. The Pattern Approval Laboratory moved later in the year and subsequently staff numbers have grown to carry out all the other functions associated with the national measurement system.

of production instruments, software in metrology and recent OIML technical meetings.

Certifying Authorities

Amendments to the National Measurement Act and Regulations have been made to facilitate the demonstration of traceability of chemical measurements through the use of certified reference materials. The Regulations now provide for the appointment of certifying authorities for the certification of reference materials and legal measuring instruments.

Certifying authorities for reference materials provide certification of appropriate reference materials that will be accepted in a court of law as *prima facie* evidence. This will facilitate demonstration of traceability in courts by organisations such as the police and environmental protection authorities. In support of these initiatives, NATA has developed a laboratory accreditation program for certifiers of reference materials.

The Commission is now able to appoint certifying authorities, however the authority must:

- be accredited by NATA as a producer of reference materials; and
- be able to demonstrate legal traceability of the calibration processes.

Appointments are reviewed three yearly or in conjunction with NATA reassessment.

Contact Richard Brittain if you would like an application form to become a certifying authority. An administration fee of \$200 is payable with the application.

Measurement Skills — Scoping Project

In 1999 the Commission approached the Manufacturing Engineering and Related Services Industry Training Advisory Body (MERS ITAB) to investigate the use of measurement skills in the manufacturing industry and the opportunities available for training in measurement competencies.

Subsequently MERS ITAB was funded by the Australian National Training Authority to undertake a project to identify:

- the ways in which workers in the manufacturing industry are currently being skilled in measurement competencies;
- examples of benchmark best practice companies where metrology skills are highly developed, and where, if relevant, they are not required;
- gaps and needs for further competency standards and learning resource development; and
- the effect access to metrology will have on the

uptake of new apprenticeships in the industry.

Brisbane Institute of TAFE was contracted to undertake the work for MERS ITAB and their report *Scoping Project — Competencies and Application Levels of Measurement in the Manufacturing Industry* was published in March 2000.

For copies of the report or further information contact MERS ITAB on (02) 9955 5500.

Quotation from the Report

The role of measurement in industry is a complex issue. While the project scope was large, the project report must be seen as preliminary. Although it reinforces much of the anecdotal evidence about attitudes and practice of measurement in industry, the report does not provide enough information or data to allow definite analysis.

Time frames and access played a role in preventing the consultants from surveying the scope of enterprises necessary to provide a comprehensive picture. To be truly representative, a larger cross section of the processes of both high and low end manufacturers would need to be examined and analysed.

The report does reinforce that there is no cohesive picture of measurement or measurement skills within industry, and that skills used often depend on what the organisation makes or produces and the exposure of the staff to in-house procedures. Staff are often unaware that many of the procedures they follow concern measurement.

The findings in the report reiterate the view that many enterprises do not consider the role measurement can play in their bottom line unless they do so for contractual reasons, e.g. have specific tolerance allowances written into their contracts. Even then quality is often the 'consideration' or factor. There has been little comprehensive linkage or investigation of quality processes and their links to measurement by the report and the steering committee feel strongly that further work would need to be carried out in order to adequately investigate measurement's role in industry processes.

Dimensional Metrology Seminars

If you had to come up with a model of a good educational project for MSA to present then the seminars given recently by Georg Henzold would have to come close to winning the Gold Figurine in the Best Performance category, and perhaps a few other categories as well.

Mind you, it could be difficult to reproduce the conditions that produced this masterpiece. The subject is topical and of immediate economic importance. The speaker is exceptional both in authority on his subject and on presentation ability; a man who can hold an audience interested for an hour with a talk off the top of his head, given in a language foreign to him! And although MSA has benefited to the tune of a few thousands of dollars, the whole thing was sponsored by S.G. Prittie Precision Gauges (they deserve a free plug after all that).

And now for the inevitable statistics: 150 participants enrolled, 14 in Sydney, 38 in Melbourne and 28 in Adelaide. The rest were at special in-house seminars arranged for particular companies (25 at Britax, Taree; 20 at Caterpillar, Melbourne; 25 at Robert Bosch, Melbourne). Five participants were tertiary lecturers of various kinds, and a number of others were in senior management positions.

A few lessons were learned along the way. The timing of early February was a bit awkward, with Christmas spanning the publicity. The demand for in-house seminars was not anticipated and a couple of companies indicated that they would have liked one if given more notice. As always the level of presentation was problematic, but with some people wanting it more simple, and others wanting to concentrate more on the detail, the level was probably optimum. Arrangements will probably be more complicated for any future event because Georg gave a warmup seminar last year and had a very relaxed attitude towards contractual arrangements. We may need to be more cautious in the future.

The success of the capital-city seminars was undoubtedly due to the work of MSA members in those centres, particularly Richard Duncan in Adelaide, Carl Sona in Sydney, Ron McBain, Horst Sieker and the staff of S.G. Prittie in Melbourne. If members of similar interest and enthusiasm had been on deck in other centres, the enrolment could have been significantly greater.

Finally we must present to you the entry for Best Script, from Ron McBain's thank-you speech after the Melbourne seminar.

"It is difficult to express in words the thanks we must convey to Georg. We are indeed fortunate to have Georg present this very difficult subject matter in such a professional manner, so in technical terms we must say to George the following:

Co-axially speaking we have found that you have no parallel on any plane in the world today.

You have positioned yourself at the peak projected tolerance zone and you expressed yourself symmetrically to all in attendance, we especially enjoyed the tolerance level exhibited in answering the many questions. You offered advice in a straightforward manner without deviation from any orientation or location, you enveloped your subject with little deviation to arrive at an unparalleled seminar on Geometric Tolerancing. We are indeed grateful for the subject matter presented over these two days and thank you very much for the excellence exhibited in the subject matter and your friendly manner in presenting this difficult subject."

News From India

The MSA has received the latest copy of MAPAN, the journal of the Metrology Society of India. It contains articles on:

"Vehicular Pollution in Delhi and its Control in Line with Euro Norms"

"Present Status of Temperature Standards and Calibration Facilities at NPL, New Delhi, According to the ITS-90."

"Humidity Generation using Water-Glycerine Mixtures"

Members interested in obtaining copies of any of these articles should contact the Secretary who will be happy to supply them.

In addition, the MSA has been asked to publicise a conference being hosted by the Metrology Society of India in New Delhi between February 8th and 10th, 2001. The meeting is entitled the **Third International Conference on Metrology in the New Millenium and Global Trade**. There is also to be a satellite meeting entitled **The International Conference on Time and Frequency**, from February 6th to 7th, also in New Delhi. Abstracts for both meetings are called for by July 1, 2000 with camera-ready manuscripts by Nov 1st, 2000. The registration fee is US\$200. Anyone interested should contact Dr A K Agrawal, Convenor MMGT-2001, National Physical Laboratory, Dr K S Krishnan Marg, New Delhi 110012, India.

NEW**Q&A Column**

We are going to try something different in TAM. It is a question and answer section modelled on the Last Word page in New Scientist magazine, where questions from readers are published, and answers sent in by other readers are published in a subsequent issue.

To set the ball rolling we are publishing an example where both the question and answer are given. We are also giving some questions which could have been sent in by readers.

If you think you can answer one of these questions succinctly and authoritatively, or if you want to take issue with a previous answer, we invite a response from you. And if you have a query related to measurement, serious or frivolous, send it to the Editor.

Question: The ISO Guide to uncertainties specifies that *degrees of freedom* be calculated to accompany an uncertainty estimate, but the new ISO standard 14253 on geometric product specification for dimensional metrology doesn't even mention *degrees of freedom*. Why is this so?

Answer: Uncertainty components are meant to be standard deviations, but we always have incomplete knowledge so the component is only an estimate of the standard deviation. So the uncertainty component itself has an uncertainty. Of course some components are not measured directly to get the estimate of the standard deviation, but whatever the means of arriving at the estimate, it can be considered to be equivalent to measuring less than an infinite number of times. For a measured component the *degrees of freedom* is (usually) one less than the sample size, and for a type B component (one that is not actually measured by you), the *degrees of freedom* is an estimate of the sample size that would produce the same uncertainty in the component. The *degrees of freedom* is then a means of expressing the uncertainty of the uncertainty component, or in other words its reliability.

Overall effective *degrees of freedom* are supplied so that anyone using the measurement result has information about how reliable it is, so that the reliability of their measurement can in turn be estimated. ISO14253 concerns conformance with specifications, so the result of the process is not a measurement result, but a simple "yes" or "no". The uncertainty of the uncertainty is then not an issue, so neither is the *degrees of freedom*. So there is no point in calculating effective *degrees of freedom*.

There you have a sample Q & A.

While we eagerly await the barrage of questions from our readers, the following questions are offered to get things moving.

- 1) Why do we use 95% confidence levels? It seems to me that a chance of one in twenty of being wrong is a bit big.
- 2) Does anyone know what the oldest known measuring instrument is?
- 3) What is the status of the move to redefine the unit of mass from an artefact to a value of Avogadro's number and the mass of a particular type of atom?

Send your letters to:

The Editor, TAM,
11 Richland Road,
Newton SA 5074
or maurieh@ozemail.com.au

Certifying Authorities for CRMs

Amendments to the National Measurement Act and Regulations have been made to facilitate the demonstration of traceability of chemical measurements through the use of Certified Reference Materials.

The 1999 Regulations provide for the appointment of Certifying Authorities for the certification of reference materials and legal measuring instruments. Certifying Authorities for reference materials will provide certification of appropriate reference materials that will be accepted in a court of law as *prima facie* evidence. This will facilitate demonstration of traceability in courts by police, the environment protection authority and other like bodies.

In support of these initiatives, NATA has developed a laboratory accreditation program for certifiers of reference materials. The Commission will appoint technically competent certifying authorities that are accredited by NATA as a producer of reference materials and can demonstrate legal traceability of their calibration processes.

An application form to become a Certifying Authority is available upon request from Dr Richard Brittain (02) 9888 3922. There is a \$200 administration fee payable with the application.

Your appointment is reviewed at least every three years or in conjunction with your NATA reassessment.

Understanding Vocational Education in Australia

The National Training Framework

In 1996 the federal government started reforming the delivery of vocational education to ensure that Australia has a world-class vocational education system. A National Training Framework is being developed to ensure that:

- the training products and services available through training providers meet enterprise and industry needs;
- the skills and qualifications which people gain are portable and recognised across the country;
- employers can have confidence in the quality of the training undertaken by an employee from another part of the country; and
- employers who operate in more than one State or Territory are able to put common training arrangements in place across their organisations.

Two major components of the training framework are:

- the development of Training Packages; and
- revised and simplified regulatory arrangements.

What does all this mean in practice?

Training Packages are developed by *Industry Training Advisory Bodies* (ITABs) in consultation with industry, the community and training organisations. The consultation process provides an opportunity to ensure appropriate competency standards will be included within *Training Packages*. *Training Packages* contain endorsed and non-endorsed components. The endorsed components are the competency standards, assessment guidelines and qualifications. The competency standards define the full range of workplace requirements across a particular industry sector. Each competency standard is broad but will incorporate underpinning skills and knowledge, key competencies, language, literacy and numeracy and occupational health and safety requirements etc. to meet workplace outcomes. They can be flexible in their application but must be sufficiently detailed to guide *Registered Training Organisations* (RTOs) and assessors so that there are consistent outcomes. The standards in a *Training Package* provide an industry benchmark for both training and assessment. Assessment is the bridge between skill development and competency recognition for qualification

Many ITABs have completed the task of developing their *Training Packages*. Once the *Training Package* is approved the next step is to match the compe-

tency standards it contains to appropriate training. It is the role of the RTO to provide a training pathway that will achieve a qualification. Starting this year all funding provided for vocational education courses will operate as part of this new agenda. Some 70% of school leavers who do not go to University look towards vocational education to provide the training they require. Many laboratory personnel will receive the bulk of their training in this manner so it is worthwhile understanding how the new training agenda works. Two important features of the agenda are *User Choice* and *New Apprenticeships*.

User Choice

User Choice has the potential to make training providers more responsive to individual needs. Competition has been introduced into the training market with employers choosing those providers who best meet their needs. No longer is TAFE the only provider of vocational training. In many cases large enterprises are developing their own training courses, becoming *Recognised Training Organisations* and providing a qualification for their employees that meets the needs of their industry. The terms *Skills Passport* is used to describe the transportable nature of the qualification of the future.

The revised and simplified regulatory arrangements allow for any training provider to become a RTO and to partner with industry to use flexible delivery methods to suit the needs of their clients. This can be any combination of on the job training, recognition of prior learning and training courses. Industry has the ability to shape future training to their needs by providing input as the standards are developed. RTOs deliver training linked to the industry endorsed standards developed through a lengthy consultative process. These standards are the building blocks of all future vocational training. They describe the skills required for employees at various levels within an enterprise. The RTOs in partnership with the enterprise assess and provide national accreditation for the courses they present.

New Apprenticeships

The term *New Apprenticeships* is the new contemporary way of defining what were traditional apprenticeships and traineeships. They rely on strong partnerships between training providers and the enterprise. They have expanded the scope of apprenticeships particularly in those industries where apprenticeships have never been utilised, for example IT, retail and Sport & Recreation. As part of this partnership the enterprise is able to provide on the job training and a learning environment, with systematic as-

assessment to validate achievement of workplace competency requirements that is assessed and accredited by the RTO. Employers may favour this approach as they can use the required standards in a context that is both applicable and relevant to their workplace. New apprentices may also attend courses provided by RTOs. The program of study is worked out in consultation with the enterprise. The bottom line is whether the apprentice can demonstrate achievement of the standard. If they can, they are assessed as competent against a standard. Once they have achieved all the standards required for a qualification they are awarded that qualification. The flexibility this scheme provides is particularly appealing to employers. It is a win-win situation - the employee receives a recognised qualification and the employer is able to use a system that ensures the employee is trained to suit their enterprise.

Who judges competence?

The new agenda is about acknowledging that an individual can show they are competent against a given standard. It recognises that competency is developed in a number of ways, for example 'prior' learning, and supporting on the job training and courses of study. Qualified assessors make a judgement about whether a competency has been achieved. The assessors are not necessarily technical experts in all areas, so in some cases they assess in partnership with a technical expert.

Measurement - where does it stand?

As a metrologist you are aware of the importance of measurement to quality and ultimately to profitability. However if those preparing the Training Packages do not recognise this then measurement will not be adequately described within the standards. A possible consequence of this could be a lack of development of measurement skills. The National Standards Commission developed some Metrology Modules in the early '90s to meet the needs of metrologists. When the competencies within these modules were mapped against the Training Package developed by Manufacturing Engineering and Related Services ITAB very little correlation was found. The National Standards Commission approached MERS ITAB to investigate the use of measurement skills in the manufacturing industry and the opportunities available for training in measurement competencies. MERS ITAB applied to the Australian National Training Authority for funding to run a scoping project. The scoping project report has just been completed.

The findings in the report reiterate the view that many enterprises do not consider the role measurement can play in their bottom line unless they do so for contractual reasons, eg have specific tolerance allowances written into their contracts. Even then quality is often the 'consideration' or factor. There has been little comprehensive linkage or investigation of quality processes and their links to measurement by the report and the steering committee feel strongly that further work would need to be carried out in order to adequately investigate measurement's role in industry processes.

Having your say

Since *Training Packages* are developed consultatively there is ample opportunity for providing input. If you feel certain skills are not adequately developed in the workforce then take the time to give this feedback to the appropriate ITAB. All Training Packages will be reviewed and updated. The National Standards Commission provided feedback during the consultation process for the development of the Laboratory Operations Training Package. The standards contained in the Training Package were examined to ensure that adequate measurement skills were included. Initially there was concern that the Training Package did not develop an understanding of why measurement is important. The training package was modified through the feedback process to strengthen the measurement skills expressed in the standards.

Measurement is the basis of many laboratory operations and all quality systems. All laboratory personnel require some measurement theory to ensure they can identify a valid measurement, know the source of and can calculate measurement uncertainty and have an understanding of how the National Measurement Act operates within Australia. It is important to develop a measurement culture and a confidence based on understanding rather than the mechanics of reading instruments.

At higher levels personnel require skills and understandings to interpret data and to determine the validity of results. Measurement uncertainty and the decision about whether certified reference materials are required are important decisions. A thorough understanding of how the National Measurement Act works is required in order to determine if legal traceability is desirable.

Designed to make future employees better prepared and to achieve workplace qualifications?

The new agenda promises to make training more

flexible, relevant and affordable for industry. Understanding the new language is the first hurdle. If the standards are effective then future employees will

be more effectively prepared. It is up to all of us to ensure the standards and training deliver a quality workforce.

Reprinted from MSA'99 Proceedings

1999 AMENDMENTS TO THE NATIONAL MEASUREMENT REGULATIONS AND IMPLICATIONS FOR TRACEABILITY

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National Standards Commission

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ABSTRACT

The proposed National Measurement Regulations 1999 represent a rewrite and consolidation of the present National Measurement Regulations and the National Measurement (Patterns of Measuring Instruments) Regulations. New provisions have been included for certified measuring instruments, certified reference materials and the compliance of production measuring instruments with their approved pattern. Australia's legal units of measurement will now be prescribed in an internationally harmonised manner and the maximum permissible errors for trade measuring instruments will be prescribed. It is expected that the new regulations will be made before the end of August 1999. This paper describes these changes and discusses their implications for legal traceability.

AUSTRALIAN LEGAL UNITS OF MEASUREMENT

Section 7 of the National Measurement Act (the Act) states that the Australian legal units of measurement of a physical quantity are the sole legal units of measurement of that physical quantity. Section 7A provides for the regulations to prescribe the Australian legal units of measurement of any physical quantity.

The previous regulations prescribed the legal units of measurement exhaustively. For each physical quantity the base units was prescribed and an associated schedule listed all of the compound legal units of measurement, comprising the base unit and a prefix, and any additional units of measurement for use for a particular purpose. It is important to note that legal units of measurement were not prescribed for every physical quantity. For example no legal units of measurement were prescribed for concentration or flow rate. In addition, for each physical quantity mentioned in the regulations, only that sub-

set of the possible combined legal units of measurement required by existing technology was prescribed.

Part 2 of the new regulations prescribes the Australian legal units of measurements. These are now prescribed in the same abbreviated manner as has been adopted by the International Organisation for Standardisation (ISO). Schedule 1, parts 1 to 4 list the SI base units of measurement, the SI derived units of measurement with special names, the non-SI units of measurement and additional derived units of measurement. Schedule 2 lists additional units of measurement prescribed for special purposes, and schedule 3 prescribes the SI prefixes.

Guidelines issued by the Commission under section 7B of the Act govern how Australian legal units of measurement may be formed from the prescribed SI units and prescribed prefixes. The physical quantities for which Australian legal units of measurement may be formed are listed in the guidelines and are unchanged from the previous regulations apart from the addition of several to satisfy the needs of the electricity industry.

The new method of prescribing Australian legal units of measurement means that the full range of prefixes may be used with the base unit of measurement for each physical quantity. This obviates the need to amend the regulations from time to time as technology advances to include specific compound units of measurement.

TRACEABILITY

Section 10 of the Act provides a mechanism to allow the demonstration of a measurement's traceability. It states:

When, for any legal purpose, it is necessary to ascertain whether a measurement of a physical quantity for which there are Australian legal units of measurement has been made or is being made in terms of those units, that fact shall be ascertained by means of or by reference to, by comparison with or by derivation from:

(a list of standards of measurement)

and not in any other manner.

The list of standards includes, in addition to the highest level standards, reference standards of measurement. In 1992, the list was amended to include certified measuring instruments and certified reference

materials. However, it is only with the making of the new regulations that these additional pathways to demonstrate traceability will become available.

Reference Standards of Measurement

A reference standard of measurement is defined in the Act as being a standard of measurement, other than the highest level standards, that is verified in accordance with the regulations. In practice this means one that has been verified according to regulation 80 of the old regulations. Because of the rearrangement of the regulations, this becomes regulation 13 of the new regulations.

Organisations that may verify standards of measurement under regulation 13 are the CSIRO, the Commission and a body or person appointed by the Commission to verify particular standards of measurement. The Commission appoints as verifying authorities both private and public business entities provided that they meet the necessary criteria.

The Commission was advised by CSIRO that the previous requirement for reference standards of measurement to be verified under standard reference conditions was too onerous and impractical. This requirement has been removed from the new regulations but a new requirement has been introduced in regulations 18(2)(e) and 19(1)(f) to provide that the relevant environmental or other influence factors pertaining to a verification are reported in the certificate of verification.

Certified Reference Materials

Part 5 of the regulations specifies the requirements for reference materials to be certified. Chemical measurements make an important contribution to the Australian economy and rely to a large extent on reference materials. This part will facilitate the demonstration of traceability, where it exists, of these measurements.

Organisations that may certify reference materials are the Commission and a body or person appointed by the Commission to certify particular reference materials.

Certified Measuring Instruments

Part 4 of the new regulations specifies the requirements for measuring instruments to be certified. The provisions provide additional means by which a measurement can be shown to be made in terms of Australian legal units of measurement under section 10(h) of the Act. This goes part way towards implementing one of the recommendations (Recommendation

6) of the 1995 Review of Australia's Standards and Conformance Infrastructure that recommended that mandatory requirements be introduced for legal measuring instruments. However consultation revealed that voluntary requirements, as have been included in the new regulations, were more likely to be accepted by State and Territory regulatory authorities. The proposed provisions will facilitate the presentation of evidence in court by regulatory authorities such as the police.

Organisations that may certify measuring instruments are the CSIRO, the Commission and a body or person appointed by the Commission to certify particular measuring instruments.

In order to appreciate the new provisions for certified measuring instruments it is instructive to review the components of a metrological control system. This comprises the following elements:

- pattern approval to ensure that the measuring instrument will retain its calibration;
- pattern compliance to ensure that production instruments comply with the approved pattern;
- certification to ensure that the instrument is operating within the maximum permissible errors for that instrument;
- auditing of certification;
- re-certification as required; and
- the above to be carried out by suitably trained and accredited third-party organisations.

The regulations make provision for certified measuring instruments to be pattern approved and certified. Therefore all of the above elements are required. The Act requires that the specifications against which a measuring instrument is pattern approved are harmonised to the greatest extent possible with the relevant specifications published by the International Organisation of Legal Metrology (OIML).

Recognition of Overseas Calibrations

One of the issues faced by the Australian measurement system is the appropriate recognition of international calibrations and testing. It is not possible for the full range of calibrations and reference materials required by industry to be provided within Australia. However section 10 of the Act requires traceability to Australia's primary standards of measurement. Therefore the regulations provide for the Commission to recognise by written instrument foreign verifications of reference standards of measurement, foreign certifications of measuring instruments and foreign certifications of reference materials.

CONSOLIDATION OF REGULATIONS

Historically the national Measurement (Patterns of Measuring Instruments) Regulations relating to the pattern approval of measuring instruments had been separate to the National Measurement Regulations. With the rewrite of the regulations, the opportunity was taken to consolidate these two sets of regulations. This is appropriate now that pattern approval is required for certified measuring instruments as well as trade measuring instruments. Part 6 specifies the requirements for the pattern approval of measuring instruments.

Organisations that may approve measuring instruments are the Commission and a body or person appointed by the Commission to approve particular measuring instruments.

Pattern Compliance

Provision has been made for the Commission to examine a particular measuring instrument that it has in its possession in order to determine if the instrument conforms to its approved pattern. The Act contains offences and penalties (section 19B of the Act) relating to non-compliance of a measuring instrument with its approved pattern. However under the previous regulations the Commission did not have the power to examine a measuring instrument, provided to it by a trade measurement authority and suspected of being non-compliant, to determine if it complies with its approved pattern. Regulation 64 remedies this deficiency in the present regulations.

Maximum Permissible Errors for Measuring Instruments

At the request of State and Territory trade measurement authorities, the maximum permissible errors for trade measuring instruments have been included as a schedule. Previously these were published as a Commission document and included in certificates of approval. This schedule will also contain maximum permissible errors for certified measuring instruments as they are brought within the purview of the regulations.

IMPLICATIONS FOR TRACEABILITY

A couple of issues have arisen in recent times that impinge on the traceability of measurements.

Environmental Court Case

In 1998 the Kalgoorlie Court of Petty Sessions heard a case between the Department of Environmental Protection of Western Australia (the EPA) and WMC Resources Ltd (WMC). WMC was charged with having caused the concentration of sulphur dioxide at a

monitoring station to exceed the statutory limits. The measurements of sulphur dioxide concentration were carried out by WMC under a license agreement with the EPA.

When the lawyer acting for the EPA attempted to introduce evidence relating to the concentration of sulphur dioxide, it was opposed by the lawyer for WMC on the basis that the measurements were not traceable under section 10 of the National Measurement Act. During the case the prosecution contacted the Commission for its views. They were advised that as no Australian legal units of measurement had been prescribed for the physical quantity "concentration", the Commission believed that section 10 did not apply to the WMC measurements of concentration. Under this circumstance the matter is outside the ambit of the Act and would need to be resolved by argument based on the evidence and common law precedent.

Notwithstanding this advice, the court found that the evidence was inadmissible and the prosecution failed. The EPA has appealed this decision to the Western Australian Supreme Court and hopefully the matter will be concluded soon.

Common Law Presumption of Accuracy

The introductory wording of section 10 is "When, for any legal purpose, it is necessary to ascertain". This wording has featured in several court cases where it has been argued, successfully on occasions, that it was not necessary to ascertain that a measurement was made in terms of Australian legal units of measurement. The reason given was that the presumption of accuracy would apply unless an alternative measurement was provided to cast doubt on the original measurement.

One of the absurdities of common law is the presumption of accuracy of notoriously accurate scientific instruments. Any scientist or metrologist would know that a better presumption would be one of inaccuracy of scientific instruments. After all no measurement is completely accurate. Nevertheless the former presumption forms part of common law.

The Commission sought a legal opinion on this matter from the Attorney General's Department. The opinion relied on a further presumption, that legislation is not taken to override common law rules (such as the presumption of accuracy of scientific instruments) unless it shows a clear intention to do so. If the legislation does show such an intention (express or implied), it automatically prevails over the common law. In the present context, the question is

whether section 10, read in the context of the Act as a whole, shows an intention to override the presumption of accuracy of scientific instruments. The Attorney General's view was that it did not.

If this view is correct, then the presumption of accuracy of scientific instruments provides *prima facie* evidence as to the accuracy of the measurement. Only if that presumption is rebutted, does it become "necessary to show that a measurement has been made in terms of Australian legal units of measurement ..." and then section 10 comes into effect.

CONCLUSION

The major thrust of the new regulations is to facilitate the demonstration of traceability of measurements by government agencies and industry. This is achieved by activating additional traceability pathways introduced previously into section 10 of the Act, namely certified measuring instruments and certified reference materials. Parts 4 and 5 of the proposed regulations provide for the certification of measuring instruments and reference materials respectively. The body of legislation controlling measurement now comprises the Act, the regulations and the guidelines issued by the Commission under section 7B of the Act.

The recent environmental case in Western Australia has forced the Commission to rethink the ambit of section 10. Our understanding of this matter will be informed by the outcome of the appeal to the Supreme Court.

Ian Clunies Ross Memorial Foundation

In March, the MSA was awarded accreditation to the Ian Clunies Ross Memorial Foundation. The Foundation was established in 1959 to perpetuate the memory of Sir Ian Clunies Ross by promoting the development of science and technology in Australia's beneficial interest. There are no costs associated with accreditation to the Foundation.

The Foundation now has some 150 accredited societies accredited to it all of whom:

- ◆ Provide a forum in which to communicate, train and discuss developments and advances in a particular scientific or technological community
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- ◆ Serve a sector of science/technology through activities and publications.

The Foundation also operates a centre for science and industry in the Brisbane Technology Park in Queensland. The Centre provides a multi-functional professional facility servicing the seminar, training and conference markets. The MSA is eligible to use the facility at a 50% discount as an accredited Foundation member.

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SURFING THE WEB

A good start for metrologists could be: <http://www.bipm.fr> which is BIPM in Paris. It has links-to-links to about 180 other sites under the following headings:

Web homepages of national metrology institutes - about 50 sites

Web homepages of regional metrology organizations - 6 sites

Web homepages of other international organizations - about 40 sites

On the lighter side, an article from the New Scientist on a 'Magic Clock' can be found at:

www.newscientist.com/nsplus/insight/time/magicclock.html

Happy surfing!

- Jim Miles

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Letters should normally be limited to about 200 words. Writers will be contacted if significant editorial changes are considered necessary.

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