INCODO Limited

Building Consultancy and Lab

Building Consultancy, Materials Testing,
Arbitration, Mediation and Adjudication

Report	Comparative Field Test of Electronic Search Type Moisture Meters Evaluation of thermal Imagers for Moisture Detection
Date	December 2006- January 2007 (Ver 3)
Prepared by	P Probett

Ph - 027 28 000 36 **Ph - 07 5767883** **E-mail - mail2us@xtra.co.nz**

Box 8202, Cherrywood, TAURANGA

CONTENTS

1.00 BRIEF

1.01 This report was commissioned by the Weathertight Homes Resolution Service being part of the Department of Building and Housing.

1.02 As such it is the property of the Department of Building and Housing and its use, dissemination and distribution is subject to the approval of the Department who hold copyright.

1.03 The report was prepared following the release at the WHRS Assessor Training Day in November 2006, of a DBH report analysing determinations.

Characteristics and Defects – A study of Weathertightness Determinations
Sue Clark September 2006

Contained within the report were comments regarding the apparent failure of electronic search type moisture meters. Given that a high number of "false negatives" (i.e. readings that wrongfully suggested there was no concerning moisture when invasive or other testing confirmed high moisture levels) were recorded, it was apparent that either equipment or methodology for using equipment should be reviewed with some urgency.

In particular refer to the report page 13 Fig 11 and comment below re Moisture Testing where it comments

"30% of buildings showed elevated moisture levels when using non invasive moisture meters, but more than 65% of buildings had elevated levels when invasive moisture tests were performed"

In other words non invasive moisture testing is failing over 50% of the time. The inference is that some buildings may be determined as dry in whole or in part when they are not.

1.04 Accordingly the writer was engaged to compare a range of electronic search moisture meters on a variety of claddings and evaluate performance and comment on what may be termed "best practise" as well as identify methods or technology that are simply not good enough

1.05 This report has deliberately been kept brief and much of the detail of the tests has been omitted as the conclusions were rather obvious and there may be some urgency in addressing the problem of a high amount of false negatives in reports prepared by contractors to the DBH / WHRS

2.00 ASSESSMENT PROTOCOLS

2.01 Contact was made with BRANZ and with their cooperation a test building clad with 2 examples each of 12 different but common cladding systems was made available.
This is the building Mark Bassett, principle scientist at BRANZ has been using to evaluate drying of wall systems. Mark injected a measured amount of water (10cc) into predetermined points in the timber framed wall approximately 6 days before the comparative testing was done.

2.02 10cc is in practical terms a small amount of water, but sufficient to constitute a leak in a wall and be a relatively demanding test. This was a blind test, the writer was not advised where water was injected into the various walls

2.03 The purpose of the test was not to duplicate what might be found or not be found in investigating leaky home claims or as part of the determination process where often the moisture level may be significantly higher and more widespread. It was purely to determine if the equipment in general use and or available is adequate to alert users to the presence of moisture and if possible reduce the number and incidence of false negatives

2.04 In the past two years the number and performance of electronic search meters has improved dramatically with penetration depths rising from 19mm to 120 - 300mm. The types of units available have increased from simple capacitance “bricks” to more sophisticated dielectric constant and microwave types.

2.05 In addition thermal imagers used to detect building faults have improved dramatically in regard to sensitivity and affordibility has improved signiifcantly For instance about three years ago thermal imagers were rather bulky had a sensitivity of 0.3 K and cost $40-70,000 while requiring special cooling etc Currently units specifically designed for building inspection work have sensitivities of 0.07K or better and are available online in the US at $6900US or cheaper
A readily available portable thermal imager was used in association with the moisture meters

3.00 TEST METHODOLOGY

3.01 GENERAL

1 A cross section of eight electronic search units was used. Each was used on the exterior face only of wall panels individually to locate the wet area.

2 Results were tabulated by wall type and 0-10 points awarded for each unit depending on
a) Ease of Use
b) Sensitivity
c) Effectiveness
d) A comments column was also included

3 These results were tabulated as below

3.02 TEST EQUIPMENT

1 **MOBIR thermal imager**

This is a very compact Chinese made clamshell unit having a thermal sensitivity of 0.12K, with many automatic features and records both a thermal image and companion digital daylight image.
Cost $13-18000
Availabilty – Australasian agent

2 **Carol and Carol**

Not used. NZ made
Performance – understood to be below 30mm
Type – capacitance
Cost $$350 plus
Availability – Readily from Auckland manufacturer

3 **Protimeter Surveymaster**

A dual mode meter that in "search" mode indicates increasing moisture levels with a series of LED lights that change form green through yellow to red with accompanying audible beep.
Claimed search depths for Protimeter units vary from 19 -25.4mm
Type - capacitance
Cost $1500.00 aprox
Availability – Readily available through NZ distributors

4

4 **Humitest MC 100**

Single mode unit made in Europe with Liquid crystal read out and settings for various timber densities and other common building materials.
Easy to use
Claimed search depth 55mm
Type – capacitance
Cost $900-1200 aprox
Availability – Bell Technology Auckland

5 **Gann UN1**

Single mode German unit with liquid crystal display and 0-200 scale. Has a remote active probe that allows access to tight areas
Claimed search depth 120mm
Type – dielectric constant
Cost $900 about (300Euros)
Availability – Accurate Instruments Auckland

6 **Trotec T600**

Single mode German unit with liquid crystal display and 0-200 scale
Claimed search depth 300mm
Type – microwave
Cost $1200.00
Availability – Accurate Instruments Auckland

7 **Klortner KT50**

Single mode Italian unit with large liquid crystal display
Claimed search depth 55mm
Type – dielectric
Cost $800.00 about
Availability – not easily available

8 **Harbin MC7825PS**

Dual mode search and pin type made in China with 0-100 scale
Claimed search depth 55mm
Type – dielectric
Cost $800.00 -1200.00
Availability- nor easily available

9 **Generic Chinese Humitest type**

A single mode with search electrodes very similar to the Humitest. Specie/ Density adjustments and 0-100 scale
Claimed search depth 55-60mm
Type – capacitance
Cost $300.00 or less
Availability – online eBay

10 **Tramex Wet wall**

A very large single mode unit with sweep hand display
Two depth settings
Claimed search depth not found – appears to be about 55mm
Cost unknown (borrowed from BRANZ This is an older unit and has probably been superseded)
Availability – unsure if Tramex brand readily available in NZ

3.03 Test Walls

1 & 2	Open Rainscreen, 20mm cavity Textured fibrecement cladding – non reservoir
3	Open Rainscreen Textured fibrecement cladding – non reservoir
4 & 23	Drainage Plane Textured fibrecement cladding – reservoir
5 & 22	Direct fix stucco
6 & 21	Drainage Plane EIFS
7 & 20	Direct Fix Textured fibrecement cladding – reservoir
8 & 19	Open Rainscreen Textured fibrecement cladding – reservoir
9 & 18	Direct fix Bevelback weatherboards
10 &17	Drained and vented Textured fibrecement cladding – reservoir

11 &16	Drained and vented Textured fibrecement cladding – non reservoir
12 & 15	Drained and vented Brick Veneer
13 &14	Direct fix Textured fibrecement cladding – reservoir
24	Drainage Plane Textured fibrecement cladding – non reservoir

NO Pass Ratio A B	**MOISTURE METER**	Open R'screen F'cement 20mm Cav 1,2,3	Drainage Plane F'Cement Resev 4,23	Direct Fix Stucco 5,22	Drainage Plane EIFS 6,22	Direct Fix F'Cement Resev 7,20	Open R'screen F'Cement Resev 8,19	Direct Fix B'Back W'Board 9,18	Drained Vented F'Cement Resv 10,17	Drained Vented F'Cem Non Resv 11,16	Drain Vent Brick Vnr 12,15	Direct Fix F'Cement Resev 13,14	Drain Plane F'Cem Non Resev 24
3	**Protimeter**												
	Ease	2	3	2	2	3	2	2	2	2	3	3	2
	Sensitive	0	5	0	0	5	0	0	0	0	0	0	0
	Effective	0	5	0	0	5	0	0	0	0	0	0	0
0/12	Overall	F	C-	F	F	D	F	F	F	F	F	F	F
4	**Humitest**												
	Ease	7	7	7	7	7	8	7	7	7	7	7	7
	Sensitive	0	8	0	0	9	7	N/R	6	7	0	3	8
	Effective	0	7	0	0	9	7	N/R	6	8	0	4	7
4/12	Overall	F	**B**	F	F	**B+**	C	**B ?**	C-	C	F	D	**B**
5	**Gann**												
	Ease	6	6	6	6	6	6	6	6	6	6	6	5
	Sensitive	8	9	0	4	9	9	9	9	9	0	7	8
	Effective	8	9	0	3	10	9	9	9	9	0	8	7
9/12	Overall	**B**	**A**	F	D	**A**	**B+**	**B+**	**A**	**A**	F	**B**	**B**
6	**Trotec**												
	Ease	9	9	8	8	9	9	9	9	9	9	9	9
	Sensitive	9	9	5	0	10	9	10	10	9	0	8	10
	Effective	9	9	7	0	10	9	10	10	9	0	9	10
10/12	Overall	**A**	**A**	**B+**	F	**A**	**A**	**A+**	**A+**	**A**	F	**A**	**A+**

	MOISTURE METER	Open R'screen F'cement 20mm Cav	Drainage Plane F'Cement Resev	Direct Fix Stucco	Drainage Plane EIFS	Direct Fix F'Cement Resev	Open R'screen F'Cement Resev	Direct Fix B'Back W'Board	Drained Vented F'Cement Resv	Drained Vented F'Cem Non Resv	Drain Vent Brick Vnr	Direct Fix F'Cement Resev	Drain Plane F'Cem Non Resev
7	**Kloritner**												
	Ease	8	9	8	8	9	9	9	9	9	9	9	9
	Sensitive	0	0	0	0	8	5	10	8	7	0	8	8
	Effective	0	0	0	0	9	6	10	9	8	0	9	7
5/12	Overall	F	F	F	F	**B+**	C-	**A+**	**B+**	C	F	**A**	**B**
8	**Harbin**												
	Ease	8	9	7	8	9	8	9	9	9	8	8	9
	Sensitive	4	6	4	0	8	3	9	7	5	0	8	8
	Effective	4	6	3	0	9	3	9	7	4	0	8	8
4/12	Overall	D	C-	C	F	**B+**	F	**B+**	C+	D	F	**A**	**B+**
9	**Humi Clone**												
	Ease	9	9	9	9	9	8	9	9	9	9	9	9
	Sensitive	4	6	4	0	9	5	9	9	8	0	7	8
	Effective	4	6	3	0	9	6	9	9	8	0	7	8
5/12	Overall	D	C-	C	F	**A**	C-	**B+**	**B+**	**B**	F	C+	**B**
10	**Tramex**												
	Ease	9	9	9	9	10	9	9	9	9	9	9	9
	Sensitive	0	6-9	0	2	8	9	9	9	9	0	?	10
	Effective	0	7	0	2	8 ?	9	8	8	7	0	?	7
5/12	Overall	F	C+	F	D	**B**	**B**	**B**	**B+**	C-	F	C?	**B-**

4.00 RESULTS AND OBSERVATIONS

4.01 Results have been tabulated above

4.02 Individual meters have been assessed according to ease, sensitivity and effectiveness in relation to each cladding system. Some cladding systems were more difficult to operate on depending on the unit and recorded values reflect the opinion of the operator both subjectively and objectively

4.03 Each unit has been assigned a test result and for ease it ranges from A - F with C being a measure of the unit being of some value,
A being a clear pass mark and
F a total failure.

4.04 Looking along the Pass/Fail line quickly indicates that there is a large range of overall effectiveness amongst the units with some failing nearly all the time and others being effective most of the time.

4.05 Performance is clearly related to manufacturer's claims in regard to the respective units indicated penetrating depth

4.06 All units are reasonably priced and cost has little relation to utility. Most units fitted into the $370-1200 range except for the Protimeter

4.07 The limited volume of water, its dispersal through the framing and or drainage made for a relatively difficult test. Unfortunately intrusive probing to measure actual moisture levels was not possible so the setting of control ranges for dry framing was not possible
Additionally the walls contained a variety of water injection tubes, sensors, sensor wiring and it was possible that some residual water from previous tests may have been retained in some claddings in part. I.e. some results indicated positives in other areas away from feed points – often downstream patches

4.08 In spite of the above set of variables it is felt that the test clearly show that low spec meters give poor results and conversely higher spec units reduce the risk and incidence of false negatives

4.09 The Trotec T600 microwave unit and the Gann UNI 1 dielectric constant units gave consistently better results than other units tested

5.00 THERMAL IMAGER

5.01 As part of the scope of this report a thermal imager was hired from an Australian distributor for a week to test it in parallel with the search moisture meters.

5.02 The BRANZ tests were made on 11 and 12 December with the 12th being a particularly windy day with warm wind blowing from before daylight. This impacted on tests as a) they were limited to exterior surfaces only and the strength and warmth of the winds ensured that there was little in the way of surface temperature variations. Usually temperatures before sunrise are 5-6 C or more less than late morning temperatures giving a gradient sufficient for the camera to pick up damp areas as these take longer to heat up
As mentioned this wasn't the case on 12 December between 7am -11.30am
On the 11th access to the buildings at BRANZ didn't occur until about 9.30am.
Although unfamiliar with the unit good indicative results as to where moisture was in the walls were noted on direct fixed walls

5.03 When thermal imagers are used to detect moisture they rely on water being sufficiently close to the surface of the cladding or lining to impact on temperature fluctuations. Obviously mass claddings like brick with cavities and polystyrene based claddings or others with cavities would provide very poor results if they were dry even though underlying framing was wet.
Depending on ones point of view, fortunately or unfortunately nearly all of New Zealand's leaky homes do not have cavity cladding systems

5.04 As internal temperatures are generally more stable and strong air currents are rare thermal imagers do tend to work somewhat better / easier indoors. The unit was able to clearly indicate where wall framing was with most direct fix claddings and in all internal views

5.05 The imager was used on a further two buildings in Wellington, (exterior) one in Pukekohe (interior late afternoon) and the exterior of some leaky homes in new Lynn (early morning)
It was found to be more than merely useful for moisture detection, particularly as it allowed large sweeps of whole walls are the norm rather than the isolated readings taken at likely points carried out with search type moisture meters.

5.06 Some surveyors are considering obtaining units and doing a short thermography course

6.00 CONCLUSIONS

6.01 When a leaky home is very wet any search meter should be able to find moisture. However if leaks are minor, or decay has reduced framings water holding abilities, or investigation is done in late summer after a prolonged dry spell or walls are particularly thick, there is an increased risk of missing wet areas all together or concluding that the extent of moisture spread and percentages in framing is less than it really is. This especially true if units with low penetrating capabilities are used

6.02 Given that most leaky homes have 10mm gib linings and 12mm thick skirtings it is likely that search meters that have claimed maximum depth penetration capabilities of less than 30mm would generally not even be measuring moisture in bottom plates of wall frames, which are invariably common clamping points where water accumulates.

Usual procedure at such clamp points is to trace water back to entry points above or to the side and again instruments that cannot reach to full frame depth are severely limited as they would tend to miss water held between the building wrap and inside face of direct fixed claddings.

6.03 Thermal imaging has received a somewhat bad press in New Zealand, largely, in the writer's opinion, as a result of untrained individuals who are unfamiliar with leaky homes making outlandish claims and charging outlandish fees. Thermal imagers have a proven track record particularly in USA and UK and are effective in the hands of skilled people in detecting probable moisture intrusion, delamination of claddings, thermal bridges, omitted insulation, framing decay and even patch repairs.

6.04 It is felt that the disparity recorded in Sue Clarks report regarding the failure of non-invasive moisture meters is probably related to choice of meters by operators and a reluctance to upgrade equipment for various personal reasons. The Gann UNI 1 was featured at and Assessor training day in early 2005 with its 120mm search depth advantage, along with details as to how units could be obtained by ordering from the German manufacturer. In the following year and a half it is believed that only one has been imported since
Anecdotally and based on discussions with other Building Surveyors, plus noting equipment referred to in assessors reports it is likely that about 50% would be using Protimeters or Carol and Carol non-invasive units and another 50% using Humitest or similar.

7.00 RECOMENDATIONS

7.01 It is suggested that DBH / WHRS require individuals contracting to them to possess and use electronic search equipment capable of searching to the full depth of external walls when operated from exterior and interior. (in other words, given that a direct fix fibrecement wall is usually

7.5mm + 90mm + 10mm + 12mm = 120mm overall

Meters must be capable of searching to at least 55- 60mm

This would rule out Protimeter and Carol & Carol units with their 19-30mm range

For EIFS and brick the search range would need to be 100mm minimum

7.02 It is suggested that DBH / WHRS indicate to building surveyor type contractors that if and when evaluation of contractors take place the quality of investigative equipment will be an evaluating factor.

7.03 Importing of thermal imagers often involves difficulties relating to special certificates from the US State Department to export. Some limited range imagers may be exempt but there is little clear procedural information available for individuals to import.

Currently base units such as the Fluke Insight XS are available in the US online for about $6900.00US The same is retailed in New Zealand for about $24,000/00-26,000 with a 4-8 week delay while they are indented.(Since preparing the first draft of this report the Insight XS is now $19000NZ and dropping. A modified low refresh rate unit is coming to market which will not require US State Department approval for export)

It is to be expected that thermal imager costs will continue to reduce while performance increases.

7.04 It is not recommended that every contractor avail himself of an imager but their usage for at least preliminary assessments should be encouraged. To my knowledge there are currently no reputable inspection companies or trained individuals regularly using thermal imaging in the leaky homes or prepurchase fields.

8.0 APPENDICES

8.01 The Writer

2.03 The writer operates as an independent building consultant and apart from holding an NZCBuilding, also belongs to various professional bodies including the Building Surveyors Institute, the Building Officials Institute, the Claddings Institute, the Adjudicators Association, the Arbitrators and Mediators Institute, LEADR mediator's organization, and the Society for Construction Law.
The writer was additionally a BRANZ Accredited Adviser until the scheme was terminated and is currently a BRANZ Trained Adjudicator.

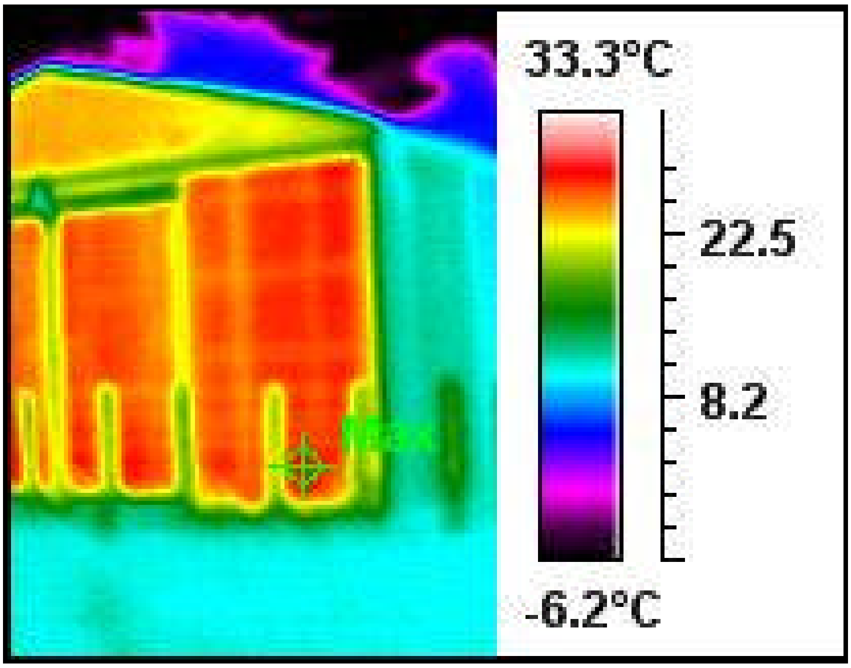
Experience includes managing the Auckland office of the Joyce Group, Development Manager for the Kirkpatrick property group, being a licensed cladding contractor and franchise builder as well as being currently engaged by the Department of Building as a WHRS Assessor and researcher.

He also gives the odd lecture to WHRS Assessors and is shortly to lecture the Building Surveyors Institute on moisture detection and related technology

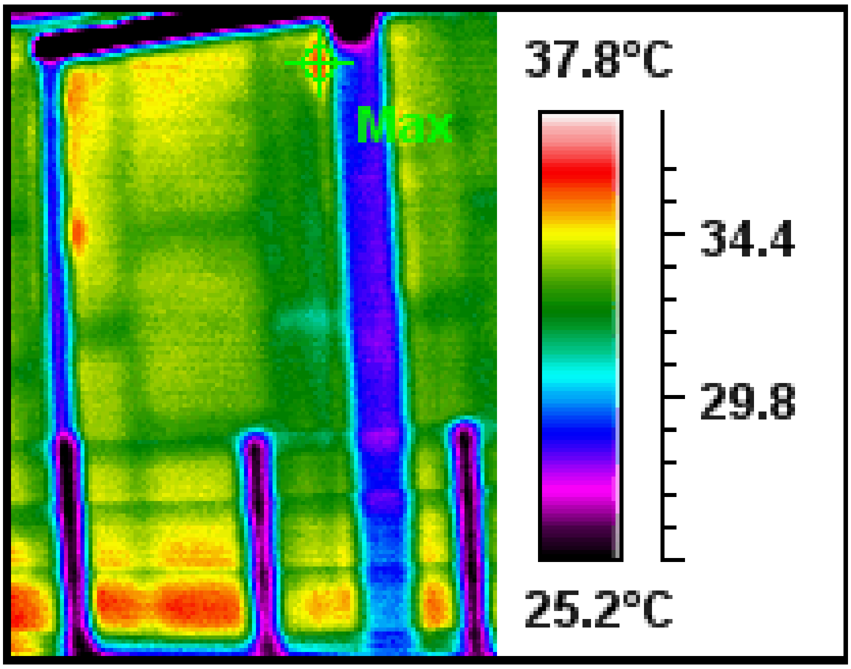
....Paul Probett NZCB, MNZIBS, MBOINZ, AAMINZ,
LEADR Panel, BRANZ Adjudicator

....2006, .Tauranga

8.02 Photographs



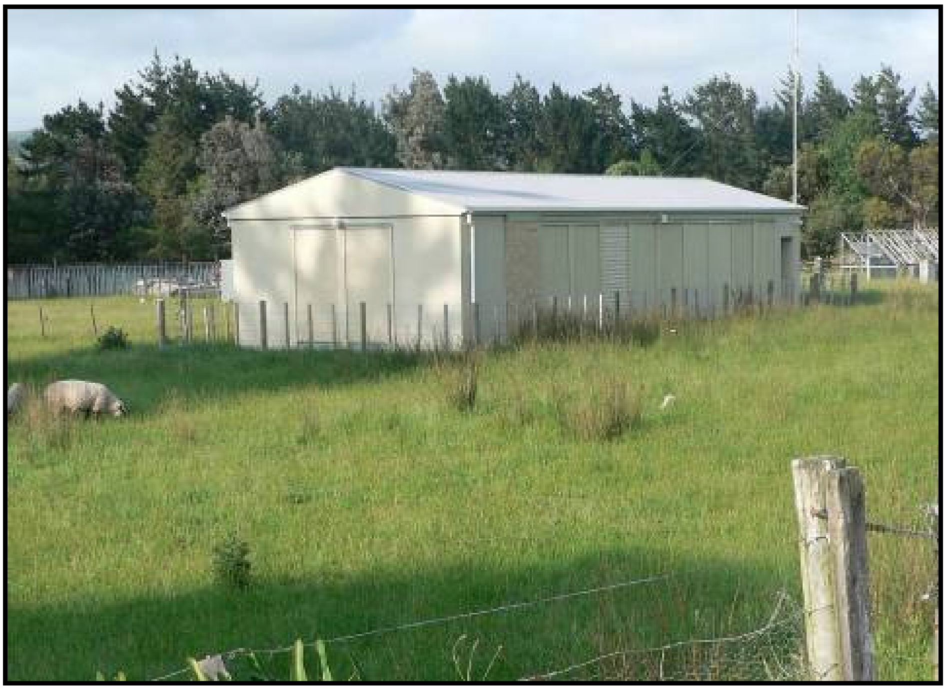
PIC 001 Thermal image of corner of test building at BRANZ with green fence battens just below midpoint and framing in wall “visible “as orange lines



PIC 002 Test panel with fence battens at lower level note blue area at centre indicating possible moisture

PIC 003 MOBIR thermal imaging camera

PIC 004 MOBIR thermal imaging camera



PIC 005 BRANZ test building, Judgeford

PIC 007 Close-up of typical test panels

PIC 008 Meters top row from left Gann UNI 1, Trotec T600, Chinese clone of Humitest
Level 2 Humitest 100s, Protimeter, Harbin MC785 PS
Level 3 Tramex Wet wall, Kloritner KT 50

Appendix 1 (ver 1.02 1/07)

3 APPLICATIONS OF NON DESTRUCTIVE MOISTURE METERS

1 Capacitance, dielectric and probably microwave units have, according to literature severe limitations to their use. Virtually all literature from independent studies and that from a cross section of manufacturer's indicates that moisture meters of the type used in New Zealand for "leaky home" work have been designed purely for measuring wood they are in direct contact with. (It is appreciated that some meters are designed for concrete roofing and other materials but these would form a very small sample of what is used by assessors and experts).

2 Some few meters have adjustments that allow wood specie correction (but basically this is a density correction factor adjustment only) and a few have settings for plasterboard and other materials.

3 Literature indicates that search meters even in direct contact with wood (as opposed to composite walls) can have error levels indicating variance of 5 % or more. It is also reported that meters are affected by temperature, variation in density, amount of pressure applied to contacts, surface moisture, moisture spread, metals, preservatives, decay (affecting density) and other variables that skew results.

4 Additionally even with adjustment settings, meters are not designed to provide an accurate measurement of moisture when used on sandwiched materials. This is nearly always the predominant use in the New Zealand situation when meters typically are used to determine moisture in wall sandwiches such as

Interior (paint>customwood skirting>gib>timber framing – preservative not determined)

Or

Exterior (paint> sand cement additive texture >fibrecement sheet>building wrap>framing –preservative not determined)

Or even more complicated sandwich layers

5 **With the type of technology used it is impossible to determine what is being measured, or how the layers of different materials with different densities and electrical characteristics is affecting the observed results. When measurements are taken from walls values shown on meters usually tend to be a reflection of the underlying material with the greatest density (eg Fibrecement clad wall results tend to reflect the fibrecement (dry density 1541kg/m3) rather than dry pine framing (450kg/m3). The same situation occurs when readings are taken internally (gib density 680kg/m3) when the lining is 50% more dense than framing**

6 In addition where it was possible to read manufacturers instructions for operating "search" meters operators were to ensure good direct contact with material ensuring bases. Contacts and similar were not overlapping the edge or bridging across twp parallel materials (eg stud and trimming stud. This situation exists in the field, particularly around doors and windows, at floor and between floor levels

6 **It follows that the current WHRS protocol and direction to assessors not to use "search" meter results as evidential to "prove" the presence of moisture is the correct procedure.**

7 However electronic search meters are valuable indicator tools and the results when used to do comparative measurement provide an excellent indication of raised moisture levels in parts of structures measured.
But given that values generated can be affected by a variety of materials, and other factors reliance on them to prove moisture or determine an accurate or even an approximate moisture percentage in hidden framing would be to provide highly questionable evidence

8 Of those tested the units with higher performance levels (search depth and adjustment capability) give markedly better results.

4 RECOMENDED USEAGE METHODS

1 Select meter appropriate to application i.e. able to measure to 50% of overall wall thickness

2 Ensure meter is operational, batteries charged and contacts cleared of all materials – particularly material that provides a short between contacts such as spider webs, etc. Ensure contacts are dry. Ensure probes are aligned and not twisted or bent.

3 If meter is used on timber only follow instructions

4 If meter is used on multi component structure such as walls and ceilings (hereafter called strata) adjust setting so that indication range when testing is maximised i.e. if the range is only 5-10 the chances of finding problem areas is less than when the range is adjusted to give a 5-90 spread
Try this on the type of strata to be used eg, unsupported plasterboard and insulation and plasterboard with timber framing behind

5 Try this in several locations on known dry strata areas to establish base ranges for the types of walls or ceilings to be checked. Same principle applies to particle board or other floors and exterior cladding systems

6 Record the safe ranges for the various strata types

7 Use the meter on suspect walls and note results where figures exceed safe range.

8 Note the figures are comparative figures only having little direct relation to moisture in whatever layer of the strata it happens to measure.

9 Appreciate that wall temperature will affect results and differences between south and north walls are to be expected

10 If using meters with deep penetration (i.e. 100mm plus) ensure meter id not measuring temporary condensation in a cavity or surface moisture on an outside wall surface. May be necessary to use polystyrene spacer blocks between meter and wall strata to lower effective penetration range

11 Always verify suspect results with invasive testing using a tested, and checked meters with probes approved by the manufacturer. set to the right specie setting. Identify preservative.

12 if material can’t be measured by the meter (i.e. some only measure wood, other polystyrene with special probes) take sample, double bag and have weighed on oven balance.

13 To determine moisture in material weigh material then dry in microwave or ordinary oven and weigh regularly until weight is constant (i.e. its dry)

Moisture content of sample is found by using formula below

$$\frac{\text{Wet weight} - \text{Dry weight x100}}{\text{Dry weight}} = \text{MC \%}$$

5 REFERENCES

DECEMBER 2003 **PN01.1306** **FACT SHEET**

Australian Government
Forest and Wood Products Research and Development Corporation

KEY BENEFITS

- Establishment of appropriate protocols and corrections for moisture meters to enable the hardwood industry to use electrical moisture meters with greater confidence and meet Australian Standards on hardwood drying
- Recommendation that species corrections developed in the project be included in a revision of AS/NZS 1080.1 and dielectric type meters be included in the revised Standard

A copy of this report and a list of other reports published by the FWPRDC is available on the FWPRDC website or by contacting:

Forest & Wood Products Research & Development Corporation
PO Box 69
World Trade Centre
Melbourne Vic 8005

Tel: + 61 3 9614 7544
Fax: +61 3 9614 6822
info@fwprdc.org.au
www.fwprdc.org.au

TIMBER DRYING: SETTING THE STANDARD FOR ELECTRICAL MOISTURE METERS

Project: PN01.1306
The use of hand-held moisture meters with commercially important hardwoods.

Researchers: CSIRO Forestry and Forest Products

Objectives

- Establish the scientific and technical basis for Australian Standards on drying of Australian hardwoods, in particular AS/NZS 1080.1 (1996) and AS 2796 (1999)
- Establish accuracy limits for both resistance and capacitance moisture meters based on the procedure prescribed under AS/NZS 1080.1 (1996)
- Benchmark the accuracy limits against the Oven Dry method under AS/NZS 1080.1 (1996)
- Develop protocols to enable moisture meters to be calibrated to meet the requirements of the Australian Standards
- Develop appropriate correction factors for the main commercial hardwood species

Key Results

The selection of species and sample material covered a wide range of basic densities ranging from a mean of 414 kgm-3 for plantation grown Shining Gum (*Eucalyptus nitens*) up to 865 kgm-3 for mature Lemon Scented Gum (*Corymbia citriodora*).
The expected accuracy (95% confidence intervals for predicted OD MC%) for most of the species corrections on boards within the MC% range of between 7-21% were:

- mostly between ±1.5% MC and ±3% MC for **resistance** type meters. The species corrections for the low density species were generally more accurate than for the higher density species.
- mostly between ±3% MC and ±6% for **dielectric (capacitance)** type meters. The accuracy limits depend on thickness as well for dielectric meters.

The main reason the accuracy of the resistance meters was about twice that for the dielectric meters was the effect of sample density on meter readings. For most meters and species, when boards were equilibrated under the same conditions, density explained as much or more of the variation in meter readings as oven dry MC% and thickness.

When using moisture meters to assess drying quality, the approach taken in AS/NZS 4787 (2001) of defining allowable ranges for meter readings is much more practical and achievable tha n the absolute OD MC% limits set in AS 2796.

Application of Results

The species corrections developed in this project should be included in a revision of AS/NZS 1080.1 (1996). Given that accuracy limits are provided with the species corrections, dielectric type meters can be included in this revised standard, but they are only likely to be of limited practical use to industry when used to estimate the mean MC of a number of boards.

The Forest & Wood Products Research & Development Corporation provides a national integrated focus for the Australian forest and wood products industry. The Corporation is jointly funded by the industry and the Australian Government.

http://www.fwprdc.org.au/content/pdfs/moisture%20meters%20fs.pdf (above) highlights include that results on timber for capacitance meters may need to be corrected by 3-6% MC

Additional references

http://www.gann.de/downloads/IN_BAUFEUCHTE_GB.pdf (Gann publication describing outline to oven drying

http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr06.pdf (reference publication from US government)

http://virtual.vtt.fi/inf/pdf/publications/2000/P420.pdf (exhaustive analysis of moisture meters and performance 102 page study incl resistance and capacitance/dielectric)

http://www.gann.de/downloads/IN_BAUFEUCHTE_GB.pdf Paper from moisture meter explaining methods and limitations of moisture search equipment

http://www.gann.de/downloads/IN_HOLZFEUCHTE_GB.pdf Paper from same manufacturer discussing moisture measurement of wood
(This paper observes that measurements are the sum of a variety of readings often based on those with the greatest density. Given that very wet pinus radiata i.e. green has a density of about 800kg/m3 and dried timber has a density of about 500kg/m3 and both figures are less than that of fibrecement sheet which is made up of calcium silicate, silica (quartz) and wood fibre – search meters on fibrecement are more likely to obtain their indicated figures from the cladding rather than the framing below.)