

Moisture in Framing Lumber

Volume 2: Appendices

APPENDIX A
SAMPLE BOOKLET
FOR RECORDING FIELD MOISTURE DATA

CMHC FIELD STUDY
of
MOISTURE IN LUMBER FRAMING

by
FORINTEK CANADA CORP.

LOCATION WINNIPEG
HOUSE NO. 11
BUILDER BLAIR CONSTRUCTION
DATE 22/3/90
D/M/Y



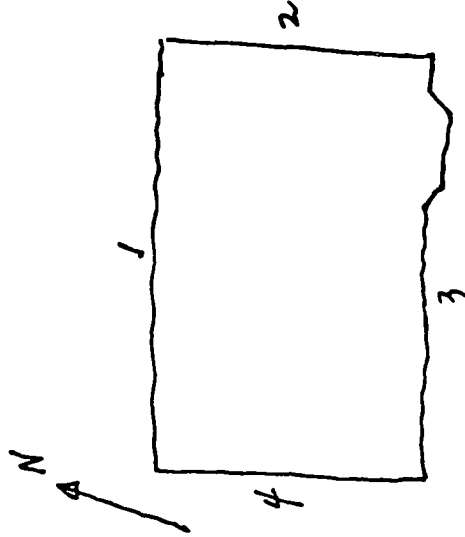
WALL ASSEMBLY INFORMATION

Note: wall assembly information is the same for some walls
check () only one set of information.

	Wall 1	Wall 2	Wall 3	Wall 4
Framing Information				
2 x 4				
2 x 6	✓	✓	✓	✓
other				
staggered vertical studs				
horizontal spacers				
Sheathing Information				
waferboard	✓	✓	✓	✓
plywood				
fibreboard				
boards				
gypsum board				
Glasclad				
polystyrene (beadboard)				
polystyrene (extruded)				
other				
Building Paper				
asphalt paper	✓	✓	✓	✓
housewrap				
Exterior Finish				
wood siding			✓	
vinyl siding				
aluminum siding				
stucco	✓	✓		✓
batten strips				
face brick				
concrete block				
other				
Other Information				
is this an exterior wall	✓	✓	✓	✓
is this a common wall				

SKETCH PLAN OF HOUSE

Notes: Sketch the outside shell of the house. Mark the wall locations where moisture contents were obtained. Identify walls by number corresponding to the table opposite. If moisture contents were also obtained on the second floor, draw a separate outline sketch for that floor. Indicate North on the sketch.



RECORD OF MOISTURE CONTENT MEASUREMENTS

WALL NO.	STUD/PLATE	MOISTURE CONTENT		TEMPERATURE °C	GRADE STAMP INFORMATION		
		3/8-INCH	1-INCH		AGENCY	SPECIES	DRY/GRN GRADE
1	S	20	25	5	CFPA	SPF	S-GRN STUD
1	S	18.5	24	6	"	"	"
1	P	24	28	4	CLA	SPF	S-GRN No. 1
2	S	26	35	8			
2	S	18.2	24	9			
2	S	15.6	19.6	7			
2	P	14.4	16.3	11			
3	S	12.6	16.0	15			
3	S	15.5	18.2	16			
3	P	20	17.3	15			
4	S	15.2	18.0	10			
4	S	26	35	11			
4	S	18.3	21.0	9			
4	P	21	28	8			

all studs
plates

• Key the location (wall) number with the sketch of the house

MISCELLANEOUS INFORMATION

Ambient outdoor temperature 6 °CAmbient indoor temperature 8 °C

General Weather Conditions

snow	<u> </u>
sunny	<u>✓</u>
cloudy	<u> </u>
rainy	<u> </u>

INFORMATION ABOUT WOOD SAMPLES COLLECTED ON SITE

You will normally only need to fill this part out once for the visit to this building site.

Label the pieces with the house number on this data sheet. It will be assumed that they also apply to the other houses inspected at this site. If you pick up pieces at specific houses, code the information on the data sheets for those houses.

How many pieces were selected? 5How have you labelled them? 11-1 11-211-3 11-411-5

QUESTIONS FOR THE BUILDER OR SITE SUPERINTENDENT

Note: Complete this part only once per building site. For repeat visits to this site fill out only questions 1 and 2.

1. Start of framing - "date" or "how many days ago" 2

Note that some of the houses may have been started at different dates. What we would like to know is how soon after start of framing that the house is ready for installation of insulation and the vapour barrier.

2. Has the builder been using auxiliary heat to dry the building prior to your visit? Yes/No

3. How many housing starts were there in 1989 by this builder? 10

4. Is the framing lumber protected in any way on site? No
How?

5. Does the builder heat the interior during winter construction before installation of insulation and vapour barrier? YES

6. Does the site superintendent (builder) have any control over the quality of the lumber from a moisture point of view? Yes/No

7. Does the site superintendent (builder) have any problems with drywall cracking and nail popping associated with the drying out of lumber framing? Yes/No

8. If he had a choice, would he use drier lumber?

☒ Yes ☐ No

9. What is his estimate of the increase in cost that would result if kiln dried lumber were used instead of green lumber for a typical house? \$ 350

10. Do you have any other comments you would like to add about the builder's practices and problems he has encountered with moisture in wood?

He is interested in supplying quality
construction, he finds that it costs him
eat into profits. Foundation problems
are important issues too.

**IF YOU HAVE ANY QUESTIONS ABOUT THE
QUESTIONNAIRE OR, IF YOU NEED ANY ASSISTANCE**

Phone (613)-744-0963 or FAX (613)-744-0903

ask for

DON ONYSKO, PETER GARRAHAN, OR DERRICK CANE

SEND SAMPLES AND QUESTIONNAIRES TO

**Derrick Cane
FORINTEK CANADA CORP.
800 Montreal Road
Ottawa, Ontario K1G 3Z5**

APPENDIX B
BUILDER SURVEY QUESTIONNAIRE

PREFACE

Throughout the questionnaire we make reference to a number of descriptive terms regarding purchased lumber and its use. So as to avoid possible confusion, a number of these terms are described below. Before filling out the survey, please spend a moment to refresh your memory with these terms.

Surfaced Dry Lumber: Construction grade lumber that has been seasoned to a moisture content of 19% or less prior to the planing of its surfaces. Such lumber has been either kiln or air-dried. It is grade mark stamped S-DRY, which stands for surfaced dry. See Figure 1.

Surfaced Green Lumber: Construction grade lumber which has not been seasoned in any way prior to the planing of its surfaces. It is grade mark stamped S-GRN, which stands for surfaced green. See Figure 2.

Moisture Content: Moisture is present in lumber whether green or dry. Excessive moisture in lumber, however, is conducive to fungal attack and may accelerate the decay of the house structure. In recognition of this possible problem, the National Building Code of Canada states that the moisture content of lumber used in housing shall not be greater than 19% at the time of installation.

Framing Lumber: Construction grade lumber commonly used to frame the walls of a house. Common dimensions of framing lumber are: 2"x4" and 2"x6" random length and stud length lumber. All reference to framing lumber (either dry (S-DRY) or green (S-GRN)) in the survey pertains to that lumber used in wall construction.



Figure 1. Surfaced Dry
Grade Stamp (S-DRY)



Figure 2. Surfaced Green
Grade Stamp (S-GRN)

**** General Company Information ****

#1 Would you describe your company as a: (please check ☒ one)

- ☐ tract builder/developer ☐ other (please specify)
☐ custom home builder
☐ framing contractor

What major urban centre is served from your location? _____

#2 Approximately how many housing starts was your firm responsible for in 1989?

	<u>No. of Starts</u>
single detached	_____
semi-detached	_____
row housing units	_____
multi-unit	_____
major framing additions	_____
other (please specify)	_____

**** Wall Framing Lumber Purchasing and Use Information ****

#3 Of the total wall framing lumber (2"x 4" and 2" x 6" random length and/or studs) purchased by your firm in 1989, approximately what percentage was:

grade stamped surfaced green (S-GRN) _____%
 grade stamped surfaced dry (S-DRY) _____% (includes kiln and air-dried framing lumber)

#4 To the best of your knowledge, which of the following statements best describes the use of dry framing lumber by your firm? (Please check one)

- ☐ always used ☐ only used when specified by customer
☐ rarely ever used ☐ only used during specific seasons
☐ never used

If you checked "only used during specific seasons", please indicate which building season(s): (check all that are applicable)

☐ spring ☐ summer ☐ fall ☐ winter

#5 How would you rate the availability of dry framing lumber from your regular local lumber suppliers? (Please check one)

- ☐ not available
- ☐ limited or seasonal availability
- ☐ available by placing a special order
- ☐ availability depends on size of order
- ☐ good, immediate availability

#6a For the following "lumber use decision factors", please rank their order of importance when making a decision to use surfaced green (S-GRN) framing lumber. A ranking of 5 indicates you believe that factor is a very important variable determining green lumber use, while a ranking of 0 indicates it is not an important variable in the green lumber use decision. (Please rank by circling a score)

	<u>NOT</u> <u>IMPORTANT</u>			<u>VERY</u> <u>IMPORTANT</u>		
- price	0	1	2	3	4	5
- workability/machinability	0	1	2	3	4	5
- availability	0	1	2	3	4	5
- its impact on the quality of the final wall assembly	0	1	2	3	4	5

#6b For the following "lumber use decision factors", please rank their order of importance when making a decision to use surfaced dry (S-DRY) framing lumber. A ranking of 5 indicates you believe that factor is a very important variable determining dry lumber use, while a ranking of 0 indicates the least important variable in the dry lumber use decision. (Please rank by circling a score)

	<u>NOT</u> <u>IMPORTANT</u>			<u>VERY</u> <u>IMPORTANT</u>		
- price	0	1	2	3	4	5
- workability/machinability	0	1	2	3	4	5
- availability	0	1	2	3	4	5
- its impact on the quality of the final wall assembly	0	1	2	3	4	5

**** Lumber Moisture Related Building Practices Information ****

- #7 When ordering dry lumber (joist or framing stock) how confident are you that the stamped dry lumber (S-DRY) arriving on your job site(s) is at or below the 19% moisture content? (Please check one)

☐ not at all confident ☐ confident
☐ somewhat confident ☐ very confident

Do you ever use a moisture meter to test lumber for its moisture content? (Please check appropriate column)

	<u>YES</u>	<u>NO</u>
• when it arrives at the job site	—	—
• just prior to closing in walls with the vapour barrier	—	—

- #8 Please estimate the average time taken to complete the operations listed below, in days including weekend days, when building a single detached home.

- between the arrival of wall framing lumber on the job site and exterior wall framing commences: _____ days.
- to frame the house and sheath the roof: _____ days.
- from completion of the roof sheathing to the closing in of exterior walls with the vapour barrier: _____ days.

- #9 Some builders believe they need to take extra steps to adequately protect wall framing lumber from wetting/rewetting (snow and rain) on the job site. Some also believe they need to use other practices to allow wall framing lumber to dry out satisfactorily before closing in the walls. Of the listed actions below which, if any, do you practice? (Check all that are applicable and state if the practice is carried out seasonally or year-round by writing one or a combination of spring, summer, fall, winter or year-round in the right most column.)

Season(s) Practiced

- | | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| (i) <input type="checkbox"/> keep unwrapped, green lumber under protective cover from weather | _____ |
| (ii) leave wrapped dry stamped lumber:
<input type="checkbox"/> in wrapping until needed
<input type="checkbox"/> in wrapping and under cover until needed | _____
_____ |
| (iii) <input type="checkbox"/> leave exterior sheathed framing exposed for a period of time after roof sheathing has been installed | _____ |
| (iv) <input type="checkbox"/> heat or dehumidify home prior to installing vapour barrier and drywall | _____ |
| (v) <input type="checkbox"/> other (specify practice and season employed)
_____ | _____ |

...#9 Continued

- | | YES | NO | N/A* |
|----------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|------|
| - Do you believe that, at the time of vapour barrier installation, stamped <u>green</u> (S-GRN) framing lumber is at or below 19% moisture content | — | — | — |
| - Do you believe that, at the time of vapour barrier installation, stamped <u>dry</u> (S-DRY) framing lumber is at or below 19% moisture content | — | — | — |
| • not applicable | | | |

#10(a) What are the most common new home buyer complaints about walls received by your firm or subcontractor to your firm? (Please rank the following list of common complaints about walls by their frequency of occurrence. A ranking of 1 indicates the complaint most often heard, a ranking of 5 or 6 indicates the least often heard complaint.)

- | | |
|--------------------|---------------------------------------------------|
| — nail popping | — condensation damage to drywall |
| — drywall cracking | — other (specify) _____ |
| — wall bowing | — none of these problems occur with our new homes |
| — baseboard drafts | |

#10(b) What are the most common new home buyer complaints about walls reported in your general operating area? (Please rank the following list of common complaints about walls by their frequency of occurrence. A ranking of 1 indicates the complaint most often heard, a ranking of 5 or 6 indicates the least often heard complaint.)

- | | |
|--------------------|----------------------------------------------------|
| — nail popping | — condensation damage to drywall |
| — drywall cracking | — other (specify) _____ |
| — wall bowing | — none of these problems occur in my building area |
| — baseboard drafts | - go to Question #12 |

#11 In your opinion, is there any correlation between the occurrence of complaints listed in #10 and the season in which the house was built? (Please check appropriate Yes/No column, and if you answered Yes please indicate the building season(s) (spring, summer, fall, winter) that this problem item predominately occurs in.)

- | | YES | NO | SEASON |
|----------------------------------|-----|----|--------|
| - nail popping | — | — | _____ |
| - drywall cracking | — | — | _____ |
| - wall bowing | — | — | _____ |
| - condensation damage to drywall | — | — | _____ |
| - baseboard drafts | — | — | _____ |
| - other (specify) _____ | — | — | _____ |

#12 In your opinion, and regardless of whether the complaint items listed in question #10 occur in your area or not, most common complaints about walls can be primarily attributed to: (Please check one)

- ☐ home/foundation settling over time
- ☐ poor ventilation/humidity control in home
- ☐ incorrect installation of wall components
- ☐ moisture in framing lumber
- ☐ season house was built in
- ☐ other (please specify) _____

#13 Some builders believe that although the initial purchase price of dry framing lumber is generally higher than that of green framing lumber (estimated to be up to \$300 per single family home), it is worth the extra cost because they receive fewer and less costly callback complaints. What do you think of this statement? (Please check one)

- ☐ I agree with the statement in its entirety
- ☐ I agree that using dry framing lumber reduces the number of callbacks concerning walls
- ☐ I agree that using dry framing lumber results in less costly callbacks concerning walls
- ☐ I disagree with the statement in its entirety
- ☐ I am undecided about my opinion on this statement

#14 In the future, how will your firm ensure that framing lumber used in the homes you build is at or below 19% moisture content? (Please check one)

- ☐ We would not make any changes to our operations, because we are confident that the homes we build would meet the 19% lumber moisture content regulation as stipulated in the Code
- ☐ We would change our lumber purchasing habits by only purchasing stamped dry framing lumber:
 - ☐ even if it cost \$300 more per single family house we build
 - ☐ even if it cost \$600 more per single family house we build
- ☐ We would change our building practices to ensure that any green framing lumber used did not have a moisture content above 19% at the time wall closing
- ☐ Other (please specify) _____

#15 What type of information do you think the residential building industry needs to build more moisture stable homes? (Please rank the following information types as to the industry's need for them. A ranking of 1 indicates the information type most needed. A ranking of 6 or 7 indicates the information type least needed.)

- ☐ results from technical research on the subject
- ☐ educational literature to increase industry awareness
- ☐ short technical briefs on how to minimize moisture problems using alternative building practices
- ☐ region/climate specific building practices that lower the moisture content of green framing lumber to within the 19% moisture content regulation
- ☐ region/climate specific technical reports demonstrating that dry framing lumber use reduces moisture related problems
- ☐ dry framing lumber capacity, prices and availability information
- ☐ other (please specify and rank) _____

#16 For the communication formats listed below, check those which you think would be most effective for transferring information to the industry.

- technical bulletins sent to builders/trades people
- provide an accessible national information data base on the subject (via the HBA regional offices, for instance)
- hold a national technical case study workshop for builders/trades people
- hold regional technical case study workshops for builders/trades people
- make a technical case study manual available to the industry
- provide an accessible education/information/building methods video series
- other (please specify)

Comments: Your comments are most welcome. Please note below any comments you may have on the moisture content issue or this survey.

To receive a summary of the national survey results and desired issues of CMHC's "BUILDER" booklets, please fill in the following information and check (✓) the appropriate spaces below.

Your Name: _____ Date: _____

Company Name: _____ Phone: () _____

Mailing Address: _____

National survey results summary _____

CMHC's "BUILDER" booklet series subject areas:

Preserved wood foundations _____	Ventilation _____
Drywall applications _____	Concrete foundation _____
Windows and doors _____	Moisture problems _____
Soundproofing _____	Wood-frame construction _____
Siding problems _____	

**** Thank-you, The End ****

APPENDIX C
SUPPLIER SURVEY QUESTIONNAIRE

**** General Firm Information ****

#1 How would you classify your firm? (Please check (✓) one)

- | | |
|------------------------------------------------|----------------------------------------------------|
| <input type="checkbox"/> lumber wholesaler | <input type="checkbox"/> general building products |
| <input type="checkbox"/> retail outlet selling | <input type="checkbox"/> wholesaler |
| <input type="checkbox"/> lumber at wholesale | <input type="checkbox"/> other (please specify) |
| <input type="checkbox"/> prices to builders | _____ |

What major urban area is served from your location? _____

#2 Approximately how much surfaced green framing lumber (specifically S-GRN stamped 2"x4" and 2"x6" random length and stud lumber) did your outlet sell in 1989? Please provide an estimate by checking one of the volume level categories below. (Note: Mbf is an abbreviation for thousand board feet)

- | | |
|------------------------------------------------|-------------------------------------------------|
| <input type="checkbox"/> 100 Mbf or less | <input type="checkbox"/> between 501 - 700 Mbf |
| <input type="checkbox"/> between 101 - 300 Mbf | <input type="checkbox"/> between 701 - 1000 Mbf |
| <input type="checkbox"/> between 301 - 500 Mbf | <input type="checkbox"/> 1001 Mbf or more |

Please "estimate" the percentage of your total 1989 surfaced green framing lumber sales volume that was sold to new home builders.

_____ %

#3 Approximately how much surfaced dry (includes kiln and air dried) framing lumber (S-DRY stamped 2"x4" and 2"x6" random length and stud lumber) did you sell at your location in 1989? Please provide an estimate by checking one of the volume level categories below.

- | | |
|------------------------------------------------|-------------------------------------------------|
| <input type="checkbox"/> 100 Mbf or less | <input type="checkbox"/> between 501 - 700 Mbf |
| <input type="checkbox"/> between 101 - 300 Mbf | <input type="checkbox"/> between 701 - 1000 Mbf |
| <input type="checkbox"/> between 301 - 500 Mbf | <input type="checkbox"/> 1001 Mbf or more |

Please "estimate" the percentage of your total 1989 surfaced dry framing lumber sales volume that was sold to new home builders.

_____ %

- #4 From what major softwood lumber producing region do you primarily source your green and dry framing lumber stock? Please check one geographical area below which best describes your source region for each product.

	<u>Dry Lumber</u>	<u>Green Lumber</u>
<input type="checkbox"/> Atlantic Region	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Quebec	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Ontario	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Prairie Provinces	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> British Columbia	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> other (specify) _____	<input type="checkbox"/>	<input type="checkbox"/>

- #5 For the lumber products listed below that you carry, please provide average 1989 quoted prices to new home builders at your location. (Estimates are acceptable)

	<u>Surfaced Green</u>	<u>Surfaced Dry</u>
2"x4" random length No.2&Btr	\$____/Mbf	\$____/Mbf
2"x4" stud grade	\$____/Mbf	\$____/Mbf
2"x6" random length No.2&Btr.	\$____/Mbf	\$____/Mbf
2"x6" stud grade	\$____/Mbf	\$____/Mbf

Presently, how much higher is your quoted wholesale price to new home builders for dry 2"x4" studs over green 2"x4" studs?

\$____/Mbf

- #6a To the best of your knowledge, which of the following statements best describes the use pattern of dry framing lumber by new home builders in your operating area? (Please check one)

☐ always used ☐ only used when specified by customer
☐ rarely ever used ☐ only used during specific seasons

- #6b If you checked "only used during specific seasons", please indicate which building season(s). (Check all that are applicable)

☐ spring ☐ summer ☐ fall ☐ winter

#6c If you checked "rarely ever used", which of the following statements best describes the reason why builders do not use dry framing lumber? (Please check one)

- ☐ dry framing lumber is not readily available
- ☐ builders are unwilling to pay the extra price premium
- ☐ builders dislike working with dry framing lumber
- ☐ other (please specify) _____

#7 The following is a list of some common builder complaints about framing lumber they purchase. Please rank these complaints. (A ranking of 1 indicates the most often heard complaint from builders, while a ranking of 8 or 9 indicates the least often voiced complaint by builders.)

- ☐ too much grade variation within a lumber package
- ☐ poor lumber sizing accuracy within a lumber package
- ☐ too much of one species within a lumber package
- ☐ too many species within a lumber package
- ☐ too much moisture variation within a lumber package
- ☐ too many warped or twisted pieces in a lumber package
- ☐ dry lumber splits too easily when nailed
- ☐ green lumber twists and bows too much after it dries out in the frame of the house
- ☐ other (specify) _____

#8 Rate your impression of general builder's awareness of the negative effects of using green lumber in wall construction. (Please circle a score on the scale below)

0 1 2 3 4 5

not at all
aware

very
aware

#9a How would you rate the availability of stamped dry framing lumber from sawmills located in your own province? (Please check one)

- ☐ not at all available
- ☐ limited or seasonal availability
- ☐ available by placing a special order
- ☐ good, immediate availability
- ☐ other (specify and comment) _____

#9b When you purchase and receive dry (S-DRY) stamped lumber (joist or framing stock) at your location, how is it packaged? (Check all that are appropriate)

- ☐ dry lumber is end painted
- ☐ dry lumber is wrapped three or more sides
- ☐ dry lumber packages have a plastic sheet insert placed below the top or second row of each bundle
- ☐ dry lumber arrives with no protective covering
- ☐ other (specify) _____

#10 When stamped dry (S-DRY) lumber (joist or framing stock) arrives at your yard gate how confident are you that it is at or below 19% moisture content (MC)? (Please check one)

- | | |
|-----------------------------------------------|-----------------------------------------|
| <input type="checkbox"/> not at all confident | <input type="checkbox"/> confident |
| <input type="checkbox"/> somewhat confident | <input type="checkbox"/> very confident |

Do you ever test dry lumber for its MC using a moisture meter (Please check one)

Often _____ Ocassionally _____ Never _____

#11 What measures do you practice to protect dry framing lumber from excessive rewetting while in inventory? (Check all that are applicable from the list below)

- i) ☐ store unwrapped lumber under protective cover from weather
- ii) Leave wrapped lumber:
 - ☐ in wrapping outdoors
 - ☐ in wrapping under cover outdoors
- iii) ☐ keep lumber in warehouse
- iv) ☐ other (specify) _____

#12 If the 19% moisture content regulation for framing lumber, as described in the National Building Code of Canada, was fully enforced, which of the following demand and/or price effects would you most likely experience? (Please check one)

- ☐ demand for, and the price of, dry framing lumber would increase both in the short-term (2 years) and the long-term
- ☐ demand for dry framing lumber would increase, but its price premium would eventually decline in the long-term once new kiln drying capacity was put in place to meet this increased demand
- ☐ demand for green framing lumber would increase because builders would adopt alternative building practices that allowed green lumber to dry to the enforced levels
- ☐ demand levels would not change due to enforcement of the 19% MC regulation
- ☐ other (specify) _____

Comments: Please note below any comments you may have on the supply, demand or prices of dry and green framing stock sold to new home builders or on any of the survey questions.

To receive a summary of the national survey results and desired issues of CMHC's "BUILDER" booklets, please fill in the mailing information and check (✓) the appropriate spaces below.

Your Name: _____ Date: _____

Firm Name: _____ Phone: () _____

Mailing Address: _____

National survey results summary _____

CMHC's "BUILDER" booklet series subject areas:

Preserved wood foundations	_____	Ventilation	_____	Concrete	_____
Drywall applications	_____	Moisture	_____	Soundproofing	_____
Windows and doors	_____	Siding problem	_____		
Wood-frame construction	_____				

**** Thank-you, The End ****

APPENDIX D
SAWMILL TELEPHONE SURVEY QUESTIONNAIRE

CMHC MOISTURE IN FRAMING LUMBER SURVEY**** SAWMILL TELEPHONE SURVEY ****

Hello, My name is _____

Our company, Forintek Canada Corp., is conducting a brief study on behalf of Canada Mortgage and Housing Corporation and the Canadian Home Builders Association to determine the availability of kiln dried framing lumber to Canadian home builders.

Your mill has been selected for inclusion in this survey and your participation would be appreciated. All your responses to our questions will be kept strictly confidential. We estimate it will take about 20 minutes to complete the questionnaire by phone

Can you spare 20 minutes now to answer our questions?

Yes _____
No _____

If No, when would it be convenient to call you again to participate in our survey

Date _____
Time _____

If Yes, continue with questions

I would first like to ask you some questions about your mills production

#1a Approximately how much lumber does your mill produce annually?
_____ MBM/Year

#1b Approximately what percentage of your mills total production is construction framing lumber? That is, 2x4 and 2x6 random length and stud length lumber. _____%.

#1c Does your mill kiln dry framing lumber?
If YES _____ Continue with #1d
If No _____ go to #13

#1d About how much of your annual kiln dried lumber production is framing lumber? That is, 2x4 and 2x6 random length and stud length construction lumber.
_____ K.D. MBM/YEAR

Now I would like to ask you some general questions about where your lumber is shipped

#2 Approximately what percentage of your kiln-dried framing lumber is destined for export markets?

_____ % If greater than 20% ask why it is sold on export markets and not domestic markets.

— DO NOT READ, CODE ONLY —

- (a) Domestic demand is minimal for KD material
- (b) A higher price is paid for KD material on export markets
- (c) Domestic buyers find the price premium for KD lumber too high relative to green lumber
- (d) Other _____

#3 What is the primary provincial market for your KD framing lumber?

— DO NOT READ, CODE ONLY —

B.C. _____	Man. _____	N.B. _____	N.S. _____
Alta _____	Ont. _____	P.E.I. _____	Nfld _____
Sask _____	Que. _____		

#4 Does the fluctuation in the demand for KD framing lumber during the year follow the same pattern as the demand for green framing lumber?

Yes _____ No _____ (if NO, during what seasons does it differ and is demand for KD lumber higher or lower)

<u>Season(s)</u>	<u>Higher/Lower</u>
_____	_____
_____	_____

#5 From your mill location do you ever sell framing lumber directly to home builders?

Yes _____ No _____

If YES, is this lumber usually sold green _____ or dry _____.

#6 Approximately what is the average current price differential between similar KD and green framing lumber products? (For example, 2x4 and 2x6 stud grade lumber)

Price differential \$ _____ /MBM (FOB mill)

#7 Approximately what was this price differential last year?

Price Differential \$ _____ /MBM (FOB mill)

#8 Is the present price differential between similar green and dry lumber products sufficient to cover all the costs incurred with the drying of lumber?

Yes _____ No _____ (if NO, what does it cost to dry lumber \$ ____/MBM)

#9 What measures are taken by your mill to protect KD lumber from rewetting in storage?

— DO NOT READ, CODE ONLY —

- (a) wrap lumber 3 sides or more and store outside
- (b) wrap lumber 3 or more sides and store under cover
- (c) plastic sheet inserted one lumber row from top then stored outside
- (d) plastic sheet inserted one or more rows from top then stored under cover
- (e) none
- (f) Other _____

#10 How much more does the extra packaging of kiln dried lumber cost the eventual buyer? \$ _____ /MBM

#11 Does your company test KD lumber for its moisture content prior to shipping?

Always _____ Sometimes _____ Never _____

#12 Finally, has domestic demand for KD framing lumber -

increased _____
 decreased _____ , or remained
 unchanged _____ over the last five years?

#13 Why doesn't your firm kiln dry framing lumber?

— DO NOT READ, CODE ONLY —

- (a) no demand for KD framing lumber from our buyers
- (b) we do not have the kiln capacity to dry framing lumber
- (c) we do not have kilns at our sawmill location
- (d) the prevailing market price would not cover the cost of kiln drying lumber
- (e) other

Thank-you for spending the time to answer our questions

APPENDIX E
SUMMARY OF BUILDER COMMENTS

APPENDIX E

SUMMARY OF BUILDER COMMENTS

"Would like to see K.D. lumber use in housing mandatory under the building codes so that all builders compete on a level playing field. The housing business is very competitive". (Vancouver)

"Would prefer all lumber had to be dry so there would be no choice". (Fredericton).

"If no vapour barrier-type sheathing used, the lumber will dry in place".

"Most moisture problems are caused by trying too hard to save money by using the wrong materials in the wrong places in poor ventilated houses. The moisture content of lumber doesn't matter if you do two things".

1. Properly install a heat recovery ventilator
2. Use a good sealed vapour barrier under the drywall and be sure that all materials from there out are vapour permeable

"This will exclude many sheathing materials and upset many manufacturers - but it works. So don't use panel sheathing products, rigid insulations or hardboard sidings". (Halifax)

"Would use more dry lumber if it were available". (Fredericton)

"We would use dry lumber if it were available". (Dartmouth)

"Truss uplift, condensation from bottom plate, wet corners mildew biggest problem. Have to educate the public and rural builders about good building practices. Information is not directed at these two groups or it is not ready". (New Brunswick)

"Already enough information out there, it won't stop sloppy building practices - survey is biased towards S-dry lumber." (Waterloo)

"Most lumber mills do not kiln dry their framing lumber, those that do ship to the U.S.A. market." (New Brunswick)

"We believe that using dry lumber will eliminate our problems." (Halifax)

"More information must be aimed at the consumer, problems definitely more prevalent now."
(Ottawa - pretest comment)

"Poor quality lumber." (Edmonton)

"Noticeable decrease in problems since we started using S-dry lumber and the quality of lumber has increased too."

"Believe nothing can be done and that you cannot get lumber with less than 19% moisture content." (Toronto)

"Clear off snow or water immediately, we have switched to kiln dry for all our material and have noticed reduced callbacks." (Toronto)

"Homeowner should be educated on how to maintain proper humidity levels especially during the first years." (Toronto)

"During construction period prior to closing lumber has an opportunity to dry out." (Toronto)

"Use moisture meters when they are available at a reasonable cost." (Toronto)

"Enforce 19% moisture content regulation." (Southern Ontario)

"Frame and drywall ASAP before lumber twists too much." (Sudbury)

"As much a quality of lumber problem as a moisture in lumber problem." (Edmonton)

"I think many builders here use kiln dry studs because it is a generally accepted practice at least in our area I think kiln dry studs are not specifically chosen so much for low moisture content, but for reasons of general quality. I think kiln dry studs generally warp less than lower grades while they wait to be installed. Because you have not separated general quality (straight grain, few knots, etc.) from the specific quality characteristics of moisture, you may get some inaccurate answers from the questionnaire." (Edmonton)

"Availability of kiln dry material should be greatly increased, present availability is limited."
(Vancouver)

"We have been using kiln dry spruce lumber for framing because kiln dry fir is not available."
(Vancouver)

"Ensure a dryout period. My experience has shown inconsistent amounts of shrinkage problems regarding wet or dry lumber. Homes framed in the summer sometimes shrink more even though the lumber is dryer. Framing technicians are also a problem. If we continue to seal homes to existing code requirements we will continue to have moisture problems and possibly more health problems." (Vancouver)

"Ensure lumber is less than 19% when it leaves the mill I hope this survey will result in a reduction of moisture at the source." (Vancouver)

"I sometimes think that S-dry lumber is wood that has been stacked 'near the kiln'. In other words, dry is a relative term." (Edmonton)

APPENDIX F
COMMENTS BY BUILDERS RECORDED ON-SITE BY CMHC FIELD STAFF

APPENDIX F

COMMENTS BY BUILDERS RECORDED ON SITE BY CMHC FIELD STAFF

The comments that follow were made by builders (or their site superintendents) when they were interviewed on site during the moisture measurement survey. The comments represent the intent provided to the CMHC field staff and have largely been reported as they were recorded by them. Repetitions of the same comment have been recorded only once, although some similar phrases appear more than once at each location and are reported here.

St. John's

- Many problems with truss uplift
- Builder states houses left 3-4 weeks after weathertight to dry, before insulation and vapour barrier - windows opened etc. for drying
- On site supervisor claims 2 x 4 interior studs are always wet and have a much higher moisture content than 2 x 6 exterior studs
- Has problems with truss uplift and bowed studs
- Kiln dried not available
- studs not graded
- Material is always wet
- Twisted studs
- Problems with bowed studs in many units now switched to board sheathing from plywood to help prevent this problem
- nail pops/twisted studs
- bowed studs after finish is applied
- Problems with bowed studs one unit had 60 bowed studs which had to be replaced
- no major problems
- Local lumber is always very wet - have no choice but to use it sometimes

Halifax

- It appears from framing time to drywall is too soon. If you build with green lumber let it dry out
- Buy kiln dry lumber
- Kiln dry studs are difficult to obtain
- Builder said it is cheaper to go back and repair problems than to use kiln dry
- considers it is cheaper to use green lumber and repair problems that are identified later

Fredericton

- Would use dry wood if it was available and (price right)
- Would use dry wood at the same price and if available
- Wish that kiln dry was available
- Always use dry when available

Montreal

- 2" x 4" travaille plus que le 2" x 4"
- Les teneurs en humidité dans cette maison sont basse compte term des resultat dans les autre maisons
- De temps à autre un coloubage cauchi, et il faut le replacer une fois la maison fumie
- Peu de problème sur environ 75 maison 110 maisons avec quelques joint de platue a reprendre

Toronto No comments

Sudbury

- Grading of lumber No 2 should be No 3 lots of knots
- Floor joists should be No. 3 not No 2 lots of knots

Winnipeg

- Less moisture content wood reduce drywall defects at 1 year warranty
- Any problems that do occur 1-year warranty, other than above no serious concerns
- No test method to determine moisture content of material delivered to site
- Availability of material with lower moisture content at times.
- Reduce screw pops and repair expenses
- Warped lumber and nail popping are of most concern
- Would like to see that manufacturers provide properly dried material
- Excessive shrinkage, warping and nail popping
- Mostly nail popping problems and warped lumber
- Dryer lumber would decrease problems later on
- Floor joists should be kiln dried, has experienced nail popping
- Problems with twisted studs, floor joists, nail popping
- Dryer lumber in general would cause less problems
- Encountered nail popping and 2 storey framing excessive shrinkage
- Would prefer to see fir lumber be kiln dried, encountered many problems with floor joist shrinkage

- Experienced common nail popping and excessive shrinkage between floors on 2 storey units.
- Lesser moisture content would decrease call backs on repairs

Saskatoon

- He buys only Kiln dried lumber
- concerns with exterior walls bowing out, especially in kitchen area
- special framing and exterior kitchen walls see detail below
- notices more nail popping in stairwell arch in 2 storey houses
- Note framing detail and exterior kitchen wall. This is the first year builder is trying this to eliminate wall separating front cabinets

Edmonton

- Would use drier lumber but feels price is not justified
- Satisfied with the lumber received

Vancouver

- Mostly using Kiln dried studs
- Already using Kiln dried studs and finger jointed materials to reduce warpage
- Presently using kiln dried material for studs
- Prefers to use Kiln dried D-fir loadbearing walls
- Already using kiln dried material
- Already using kiln dried studs in most situations and finger jointed material for the majority of studs
- nail popping, floor squeaks, and twisting
- floor squeaks, and twisting
- encountered twisting of joists and studs as they dry

APPENDIX G

ANALYSIS OF MOISTURE CONTENT OF WOOD SAMPLES

APPENDIX G
ANALYSIS OF MOISTURE CONTENT OF WOOD SAMPLES

Table G.1 provides a summary of the number of wood samples sent from the various regions of the country over the duration of the study. These provided data for a large number of species (at least 9) and a wide range of moisture contents.

Table G.1. Number of wood samples returned to the Forintek Laboratory for identification.

LOCATION	NUMBER OF SAMPLES	PERCENT OF TOTAL
ST. JOHN'S	73	15.7
HALIFAX	52	11.2
FREDERICTON	34	7.3
MONTREAL	41	8.8
TORONTO	64	13.8
SUDBURY	15	3.2
WINNIPEG	63	13.5
SASKATOON	54	11.6
EDMONTON	46	9.9
VANCOUVER	23	4.9
TOTAL	465	100

The species identified in the sample are summarized in Table G.2. It is not possible to accurately determine individual species within the spruce genus on the basis of wood anatomy alone. Therefore all spruce samples have been listed under a single category.

Table G.2. Species of wood samples sent in for identification

SPECIES	NUMBER OF SAMPLES	PERCENT OF TOTAL
Aspen	1	0.2
Fir	74	15.9
Douglas-Fir	10	2.1
Hemlock	1	0.2
Jack Pine	3	0.6
Lodgepole Pine	15	3.2
Red Pine	4	0.9
Spruce	314	67.5
White Pine	43	9.2
TOTAL	465	100

The work of Pfaff and Garrahan (1986) described a relationship correcting the meter readings of a DC type Delmhorst meter (calibrated for Douglas-fir) for the effects of wood temperature and species at moisture contents below fibre saturation. The relationship is

$$M_c = \left[\frac{M + 0.567 - 0.0260T + 0.000051T^2}{0.881 \cdot 1.0056^T} - b \right] \frac{1}{a}$$

where M_c is the corrected moisture content, M is the uncorrected meter reading, T is the wood temperature; a and b are constants dependent on the species.

The best fit constants for different species are to be found in a later paper, Garrahan (1989). This expression can be simplified somewhat by dropping second order terms and substituting the constants for individual species to produce a single species constant. An equation in the following form results

$$M_c = (S - 0.0081T)M + (0.57 - 0.043T)$$

in which S is a species constant (from van Rijn and Onysko, 1989). For example, the value for S for eastern white spruce is 1.617 while for balsam fir it is 1.261. The range of values of S for six species included in the Spruce-Pine-Fir marketing group yields an arithmetic mean of 1.50 for this constant. However, this does not account for the proportion of each species likely to be encountered in a broad-based field study. The distribution of species represented by the wood samples sent in for oven drying and identification in the present survey could be used for this purpose. For the purpose of this report, field meter readings were corrected using the more complex equation.

The average of constants for a group of species that will be marketed together does not necessarily lead to the best fitting average for uncertain mixtures of lumber. The distribution of species represented by the wood samples sent in for oven drying and identification in the present survey will be used for checking the adequacy of assumed coefficients.

An equally important issue concerns the interpretation of the two moisture readings at each stud for assessing its average moisture content. Moisture gradients complicate the issue and for this reason moisture readings were taken at two depths into the edge of each stud - 9.5 mm (3/8-inch) depth and 25 mm (1-inch) depth. Normal procedures, based on experience of dry kiln operators, is to use the moisture reading taken at a 9.5 depth from the face of a piece of lumber as this is the best estimate of the mean for the piece of lumber with a symmetrical moisture gradient. Since the moisture readings in this study had to be taken through the edge of the

lumber it was considered that some other assumption may be more appropriate. This is further complicated by the potential for non-uniform drying expected in lumber in a partially completed wall.

The difference between the readings at the two depths showed that those taken in the core were for the most part higher than those in the shell. This is logical since air drying or kiln drying of lumber leads to a drier outer shell compared with the core of the cross section. A few samples had higher moisture in the outer shells which suggested that they had been rained on or were re-wetted in some other manner. The differential moisture contents were smaller for the laboratory measurements than those taken in the field on the same pieces. This is due to equalization of moisture within the sample during transit in the plastic bags.

The oven-dried moisture content of each sample is an average moisture content for the piece. Individual moisture meter readings are point estimates which do not necessarily represent the average moisture content in a full cross section of lumber. To estimate the bulk moisture content of the lumber it was assumed that the 25 mm deep reading represents the moisture content of the core and that the 9.5 mm deep reading represents the moisture content of the outer shell of the cross section. The distribution of moisture from the core to the shell can be assumed to be parabolic, or linear.

The least squares regression between bulk oven-dry moisture content and both the field and laboratory moisture readings was examined. Different assumptions were made about the moisture gradients as described above. The data for spruce samples were examined first using composite species factors that gave the best one-to-one fit over a wide range of moisture contents; $a=0.76$, $b=1.13$. By restricting the examination to moisture measurements below fibre saturation, i.e., readings that were less than 28 percent after correction), it was found that neither the shell nor the core moisture readings alone related well to the oven-dried moisture content for either the field or laboratory measurements. It was found that the simple arithmetic mean of the two measurements provided a good estimate of the average moisture content of the piece regardless of whether the measurements were made in the field or in the laboratory. Estimates based on assumptions of linear or parabolic variation in moisture distribution did not show consistent improved correlation (depending on the moisture content range) to justify the additional computational complexity.

When moisture measurements over fibre saturation (over 28 percent) were included, the correlation was generally poorer because of the scatter in the data. The regressions did not suggest that different coefficients were needed for moisture readings above fibre saturation. Other research has suggested that there can be a different slope in the correlation between true moisture content and the meter reading above fibre saturation for Jack Pine (Pouyez and van Rijn, 1987). There are a sufficient number of samples here to demonstrate that a different

relationship is not needed for the spruces. The best fit regressions and the data are shown in Figure G.1 for material below about 30 percent moisture and in Figure G.2 for the entire range of moisture contents in spruce samples.

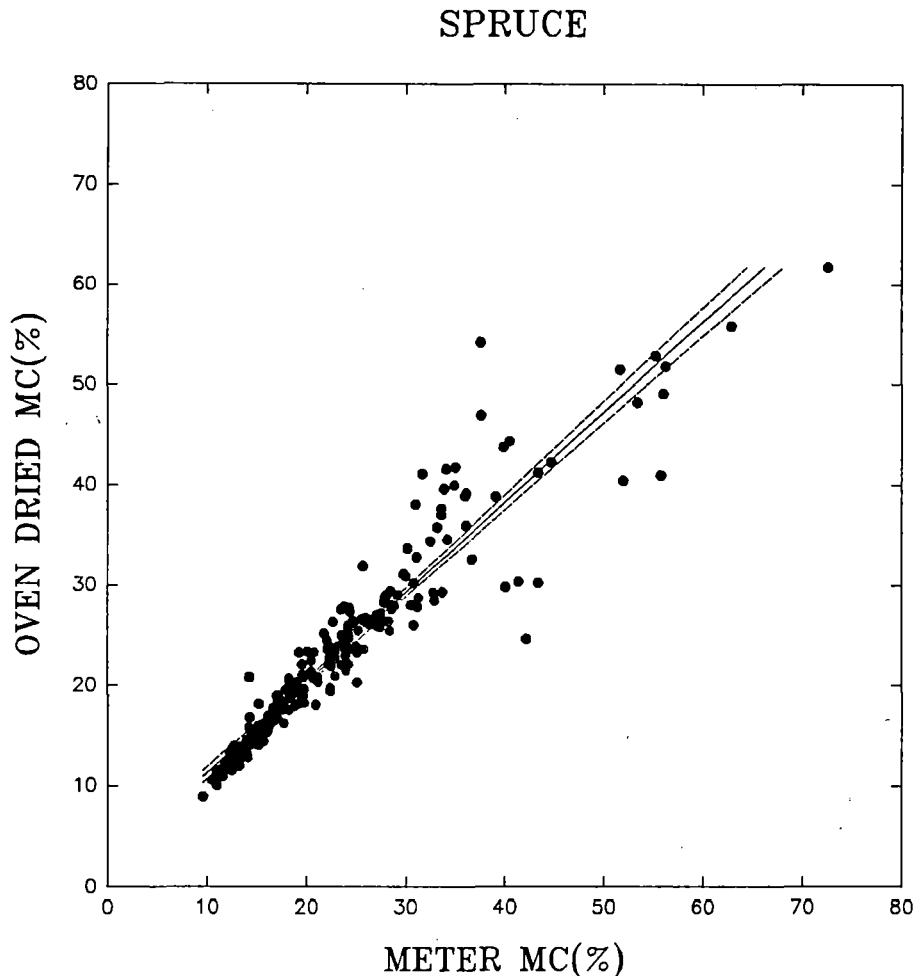


Figure G.1 Plot of moisture data for all spruce samples.

This approach was repeated for the pine samples using composite coefficients for those species represented in the sample from across the country. The best fit coefficients for this data set are $a=0.85$ and $b=0.25$. The two groups were then combined and the coefficients for spruce were found to provide the best fit over the full range of moisture encountered in these samples. The regressions are shown in Table G.3 but are not plotted here.

There were too few samples of Douglas-fir and hemlock ($N=11$) to attempt a calibration and the published values for this species grouping were used [$a=0.838$, $b=0.693$]. The firs ($N=65$) were more problematic because of the basic nature of the wood. Wet pockets can be the source

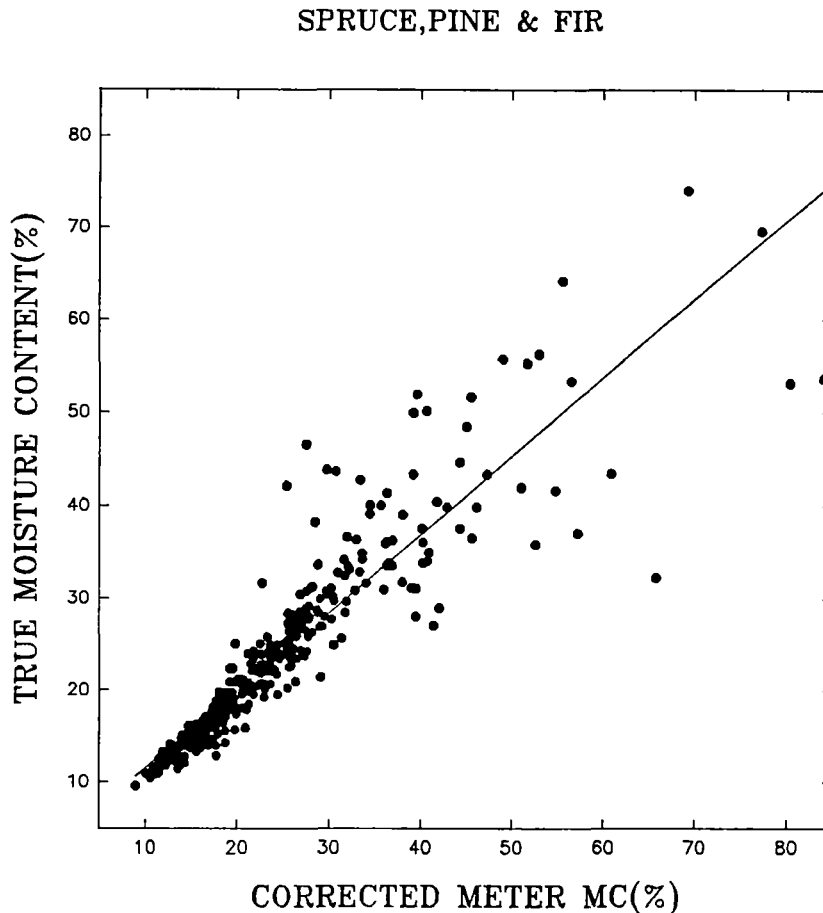


Figure G.2 Plot of all data for the SPF samples

of very

high meter readings which are not representative of the average moisture content in the piece. For example, published coefficients for balsam fir ($a=0.90$, $b=0.35$) and alpine fir ($a=1.07$, $b=2.95$) are sufficiently divergent from each other that means of the individual coefficients is not appropriate. Poor correlation was found for the firs because of the very large influence of wet pockets in the wood samples returned to the laboratory.

For the simplified prediction equation, composite species constants were found to be 1.45 for the spruces, 1.48 for the pines, 1.30 for Douglas-fir and hemlock, and 1.27 for the firs. These values are based on regressions of data for samples having moisture contents below fibre saturation.

A summary of some of the results are included in Table G.3. It was generally found that the correlations were poorer when the data above fibre saturation were included. A measure of the variation or distribution of the readings about the regression line is the root mean square error (RMSE) which is analogous to the standard deviation for normal distributions. It can be inferred

that approximately 68 percent of all measurements will fall in a range about the predicted value equal to twice the RMSE.

The results shown in Table G.3 for the spruce samples were considered quite adequate and generally agreed with individual species factors determined by Pfaff and Garrahan (1986). Individual spruce species or true firs cannot be identified by examining the anatomical structure alone. Other species are readily identifiable by persons familiar with their anatomical differences. However, CMHC field staff are not likely able to tell the spruces from the pines, or firs, so it is desirable to correct field measurements based on information available on the grade stamps. A S-P-F designation includes most of the species that have been sent to the laboratory from the field, except for the Douglas-fir and hemlock samples.

Table G.3 Summary of regressions relating true moisture content and corrected average moisture content based on moisture meter readings at two depths for different species and combinations of species.

SPECIES	SPECIES CONSTANTS	MOISTURE CONTENT	NUMBER OF SPECIMENS	RMSE	SLOPE	INT.	R-SQUARE
SPRUCE	a= 0.76 b= 1.13	<30	224	1.52	1.016	-0.181	0.927
		ALL	264	3.20	1.029	-0.362	0.899
PINE	a=0.85 b=0.25	< 30	60	1.52	1.049	-1.296	0.911
		ALL	64	2.49	1.031	-0.318	0.899
SPRUCE AND PINES	a= 0.76 b= 1.13	<30	277	1.51	0.987	0.030	0.910
		ALL	325	3.13	1.016	-0.443	0.893
FIR	a= 0.90 b= 0.35	< 40	43	6.46	1.031	2.545	0.564
		ALL	54	8.17	0.760	9.272	0.635
SPRUCE	a= 0.76 b= 1.13	< 30	313	2.42	1.037	-0.824	0.835
		ALL	391	4.58	0.843	3.127	0.815

After determining that the mean of two readings gave the best estimate of the bulk moisture content, the effect of adding the data for the pines was examined. The results for these regressions are included in Table G.3 and show that the correlation is not degraded in any important way. A plot showing all S-P-F samples corrected using the species factors for spruce only is shown in Figure G.2. This plot includes the fir samples for which relatively poor correlation was found.

This rather more complex method of establishing a correlation between true mean moisture content and meter readings was necessary for several reasons. The history and application of the lumber which was measured is sufficiently varied to preclude the assumption of a specific moisture gradient. Since it was not possible to obtain species information for each piece of lumber framing in the walls, the resulting method for correcting meter readings had to be sufficiently robust to accommodate this lack of information. The accuracy of predicted moisture content of the spruces and pines in the SPF group will be greater for the spruces and firs.

Use of the average of the two moisture readings and a correction equation that involves composite species coefficients provided the best and simplest correlation with measured true values. This, of necessity, assumes that the moisture gradients are symmetric about the centerline of the member. Field measurements, particularly those involving wall plates, will probably not conform to this assumption.

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APPENDIX H
SUMMARY STATISTICS OF MOISTURE CONTENTS

APPENDIX H

The tables included in this Appendix provide details about the measured distributions in corrected moisture contents for S-DRY and S-GRN wall studs and plates in this field survey. The data has been sorted by **REGION** and by **SEASON** of construction, as defined in the main body of the report. Tables are provided for both the shallow moisture readings at a 3/8-inch depth (9.5 mm), and the moisture readings at a 1-inch depth (25 mm) into the inner edge of a stud or plate. Where no values have been provided, no data was available. The following statistics have been provided, with explanation for some of the terms that may not be familiar to the reader.

MEAN	The numeric average of the values in the group
MIN	Minimum value measured in the group
MAX	Maximum value measured in the group
STD. DEV.	Standard Deviation assuming a normal distribution
SKEW	Skewness - this is one measure of the shape of the distribution. If the distribution is not symmetrical, but has a perponderance to the left of the mean, the distribution is said to have a negative skewness. A distribution with positive skewness is the reverse of this. A skewness of zero represents a symmetrical distribution.
KURT.	Kurtosis - this is a measure of the peakedness or flatness of a symmetrical distribution. A flat distribution (platykurtic) has a negative kurtosis. A distribution that is more peaked than a normal distribution (leptokurtic) has positive values of kurtosis, while a symmetrical normal distribution has a kurtosis of zero.
NUM	Number of measurements in the group.

TABLE 1. Summary statistics for the moisture content at 9 to 10 mm depth [3/8-inch] for wall STUDS by REGION, SURFACE CONDITIONS and SEASON.

REGION	SURFACE	SEASON	SUMMARY STATISTICS FOR MOISTURE CONTENT DISTRIBUTIONS						
			MEAN	MIN	MAX	STD DEV	SKEW	KURT	NUM
ATLANTIC	S-GRN	WINTER	27.8	19.5	61.4	5.27	2.36	9.42	329
		SPRING	25.5	13.1	76.1	7.91	2.12	8.85	210
		SUMMER	22.4	13.9	81.7	6.93	3.35	20.29	288
		AUTUMN	29.7	15.6	110.0	12.15	3.37	14.79	195
	S-DRY	WINTER	21.3	16.2	29.4	3.68	0.73	0.23	17
		SPRING	11.2	10.0	12.7	0.94	0.09	-0.73	8
		SUMMER	17.7	13.6	28.7	4.01	1.36	1.08	33
		AUTUMN	20.4	17.7	22.9	1.44	-0.42	0.09	12
QUEBEC	S-GRN	WINTER	20.5	15.6	32.1	5.57	1.66	2.18	8
		SPRING	22.5	10.9	85.6	10.74	3.10	11.59	248
		SUMMER	26.7	17.7	67.9	11.70	2.79	6.99	32
		AUTUMN	29.2	14.0	64.9	11.96	1.60	1.69	56
	S-DRY	WINTER	—	—	—	—	—	—	—
		SPRING	22.2	11.9	53.0	10.98	2.02	3.76	16
		SUMMER	—	—	—	—	—	—	—
		AUTUMN	—	—	—	—	—	—	—
ONTARIO	S-GRN	WINTER	19.7	14.2	26.3	3.46	0.52	1.80	8
		SPRING	17.2	8.4	47.5	6.14	1.92	5.33	113
		SUMMER	19.2	11.1	52.0	5.20	1.95	8.13	203
		AUTUMN	24.4	7.0	68.1	7.00	3.06	17.20	86
	S-DRY	WINTER	23.4	14.0	39.7	5.04	0.62	0.78	64
		SPRING	14.2	9.4	28.8	2.92	3.07	12.57	100
		SUMMER	14.4	11.2	19.6	1.87	0.82	0.54	99
		AUTUMN	21.0	16.3	32.2	4.26	1.67	2.83	16
PRARIES	S-GRN	WINTER	—	—	—	—	—	—	—
		SPRING	—	—	—	—	—	—	—
		SUMMER	—	—	—	—	—	—	—
		AUTUMN	—	—	—	—	—	—	—
	S-DRY	WINTER	15.9	8.8	27.7	2.65	0.51	1.14	362
		SPRING	13.4	8.0	20.8	2.21	0.19	-0.04	346
		SUMMER	12.6	0.3	36.3	2.69	1.59	9.18	703
		AUTUMN	15.0	9.4	29.1	2.68	1.09	3.42	250
PACIFIC	S-GRN	WINTER	—	—	—	—	—	—	—
		SPRING	—	—	—	—	—	—	—
		SUMMER	14.2	12.2	15.9	0.87	0.14	-0.13	35
		AUTUMN	—	—	—	—	—	—	—
	S-DRY	WINTER	21.2	15.0	36.7	3.91	0.95	1.47	104
		SPRING	—	—	—	—	—	—	—
		SUMMER	14.5	10.6	21.2	2.85	0.90	-0.28	84
		AUTUMN	23.3	21.4	25.7	1.16	0.23	0.14	16

TABLE 2. Summary statistics for the moisture content at 25 mm depth [1-inch] for wall STUDS by REGION, SURFACE CONDITIONS and SEASON.

REGION	SURFACE	SEASON	SUMMARY STATISTICS FOR MOISTURE CONTENT DISTRIBUTIONS						
			MEAN	MIN	MAX	STD DEV	SKEW	KURT	NUM
ATLANTIC	S-GRN	WINTER	30.6	19.5	91.4	7.49	3.70	19.95	329
		SPRING	30.2	17.0	102.7	11.91	2.76	9.83	209
		SUMMER	25.0	12.3	109.3	9.85	4.25	25.83	288
		AUTUMN	32.9	15.1	110.0	14.48	2.70	8.29	195
	S-DRY	WINTER	22.0	14.8	37.0	5.25	1.46	3.13	17
		SPRING	16.6	14.5	18.6	1.55	- 0.27	- 1.15	8
		SUMMER	17.9	13.6	31.3	4.47	1.65	2.09	33
		AUTUMN	21.0	18.5	23.6	1.46	- 0.58	- 0.20	12
QUEBEC	S-GRN	WINTER	41.6	19.5	61.9	17.19	- 0.28	- 2.08	8
		SPRING	28.1	12.6	80.6	12.74	2.06	4.41	248
		SUMMER	30.5	21.0	81.7	15.91	2.59	5.78	32
		AUTUMN	34.3	20.8	76.6	15.84	1.41	0.59	56
	S-DRY	WINTER	—	—	—	—	—	—	—
		SPRING	25.8	14.0	64.9	11.76	2.68	8.65	16
		SUMMER	—	—	—	—	—	—	—
		AUTUMN	—	—	—	—	—	—	—
ONTARIO	S-GRN	WINTER	23.7	16.9	31.5	4.31	0.40	1.12	8
		SPRING	21.3	10.0	81.7	11.44	3.22	11.87	113
		SUMMER	21.8	12.2	81.0	9.24	3.42	16.21	203
		AUTUMN	27.8	18.8	54.9	7.96	1.89	3.39	86
	S-DRY	WINTER	26.3	14.4	75.7	8.09	3.76	21.77	64
		SPRING	16.9	11.5	59.2	5.21	6.09	45.43	100
		SUMMER	15.9	11.9	24.1	2.57	1.34	1.83	99
		AUTUMN	22.0	19.2	25.6	1.80	0.09	- 0.49	16
PRARIES	S-GRN	WINTER	—	—	—	—	—	—	—
		SPRING	—	—	—	—	—	—	—
		SUMMER	—	—	—	—	—	—	—
		AUTUMN	—	—	—	—	—	—	—
	S-DRY	WINTER	18.5	10.9	31.1	2.80	0.54	1.20	362
		SPRING	15.0	5.4	23.7	2.63	0.01	1.11	346
		SUMMER	14.0	0.7	60.0	3.10	5.19	69.50	703
		AUTUMN	17.7	8.9	36.8	3.72	1.50	5.89	250
PACIFIC	S-GRN	WINTER	—	—	—	—	—	—	—
		SPRING	—	—	—	—	—	—	—
		SUMMER	15.0	13.5	17.3	1.01	0.81	- 0.18	35
		AUTUMN	—	—	—	—	—	—	—
	S-DRY	WINTER	23.6	13.7	40.1	4.86	0.86	1.28	104
		SPRING	—	—	—	—	—	—	—
		SUMMER	15.8	11.2	24.6	3.49	1.09	0.02	84
		AUTUMN	24.3	22.3	26.4	1.23	- 0.07	- 0.92	16

TABLE 3. Summary statistics for the moisture content at 9 to 10 mm depth [3/8-inch] for wall PLATES by REGION, SURFACE CONDITIONS and SEASON.

REGION	SURFACE	SEASON	SUMMARY STATISTICS FOR MOISTURE CONTENT DISTRIBUTIONS						
			MEAN	MIN	MAX	STD DEV	SKEW	KURT	NUM
ATLANTIC	S-GRN	WINTER	31.7	23.3	117.4	10.46	5.19	33.63	165
		SPRING	29.6	10.3	118.1	14.42	3.00	13.53	134
		SUMMER	28.5	13.9	105.5	12.47	3.61	18.36	153
		AUTUMN	34.4	16.9	110.0	15.12	2.58	8.06	110
	S-DRY	WINTER	24.6	17.7	37.0	4.83	1.56	3.65	12
		SPRING	15.6	14.5	16.0	0.73	- 1.96	3.86	4
		SUMMER	18.1	14.6	23.6	2.68	0.59	- 0.66	29
		AUTUMN	20.3	18.5	21.4	1.27	- 1.42	2.59	4
QUEBEC	S-GRN	WINTER	30.8	20.6	43.3	9.37	0.74	1.78	4
		SPRING	25.2	13.2	82.2	11.59	2.97	10.80	124
		SUMMER	28.0	21.6	40.8	6.60	1.22	0.79	8
		AUTUMN	31.7	19.3	63.7	12.07	1.50	1.47	21
	S-DRY	WINTER	—	—	—	—	—	—	—
		SPRING	18.7	15.8	20.3	2.00	- 1.56	2.57	4
		SUMMER	—	—	—	—	—	—	—
		AUTUMN	—	—	—	—	—	—	—
ONTARIO	S-GRN	WINTER	17.6	13.7	24.9	3.59	1.15	1.97	8
		SPRING	18.6	10.3	30.8	4.85	0.74	0.19	55
		SUMMER	21.5	13.0	70.0	7.46	3.33	19.52	89
		AUTUMN	25.8	16.6	74.0	8.56	3.89	20.16	51
	S-DRY	WINTER	29.6	14.1	60.6	8.41	1.65	6.40	28
		SPRING	18.7	13.1	36.3	4.70	1.84	3.79	51
		SUMMER	15.6	11.9	23.5	2.42	0.96	1.36	46
		AUTUMN	—	—	—	—	—	—	—
PRARIES	S-GRN	WINTER	24.4	9.9	48.8	17.56	1.27	1.07	4
		SPRING	18.0	13.9	34.4	5.12	2.46	6.00	20
		SUMMER	21.6	16.1	31.9	5.00	1.33	1.99	8
		AUTUMN	—	—	—	—	—	—	—
	S-DRY	WINTER	16.3	8.7	26.7	3.03	0.42	0.61	177
		SPRING	14.9	7.7	30.2	3.67	1.48	2.77	153
		SUMMER	14.2	8.3	31.8	4.09	1.65	2.84	302
		AUTUMN	15.7	8.0	26.7	2.85	0.59	1.44	125
PACIFIC	S-GRN	WINTER	—	—	—	—	—	—	—
		SPRING	—	—	—	—	—	—	—
		SUMMER	15.6	12.2	19.3	1.44	0.41	0.17	50
		AUTUMN	30.7	25.5	35.2	3.21	- 0.01	- 0.29	8
	S-DRY	WINTER	35.1	19.8	85.5	13.14	2.09	5.44	52
		SPRING	—	—	—	—	—	—	—
		SUMMER	20.1	13.5	31.1	5.48	0.77	0.40	10
		AUTUMN	—	—	—	—	—	—	—

TABLE 4. Summary statistics for the moisture content at 25 mm depth [1-inch] for wall PLATES by REGION, SURFACE CONDITION and SEASON.

REGION	SURFACE	SEASON	SUMMARY STATISTICS FOR MOISTURE CONTENT DISTRIBUTIONS						
			MEAN	MIN	MAX	STD DEV	SKEW	KURT	NUM
ATLANTIC	S-GRN	WINTER	35.5	20.9	118.1	13.63	3.84	17.43	165
		SPRING	40.6	17.2	118.1	24.16	1.95	3.21	134
		SUMMER	34.3	14.9	106.7	16.65	2.55	7.65	153
		AUTUMN	38.7	20.5	110.0	16.71	1.95	4.11	110
	S-DRY	WINTER	24.6	19.7	38.5	5.43	1.70	3.11	12
		SPRING	19.1	18.7	20.1	0.69	1.94	3.78	4
		SUMMER	18.3	14.7	24.1	2.77	0.63	-0.69	29
		AUTUMN	20.8	19.2	21.4	1.08	-1.97	3.89	4
QUEBEC	S-GRN	WINTER	44.6	29.2	63.7	17.42	0.20	-4.79	4
		SPRING	31.3	15.9	112.7	15.24	2.91	9.83	124
		SUMMER	33.4	22.7	51.0	9.31	0.88	0.39	8
		AUTUMN	40.4	22.5	99.6	20.60	1.67	2.46	21
	S-DRY	WINTER	—	—	—	—	—	—	—
		SPRING	22.9	18.9	26.4	3.08	-0.44	1.02	4
		SUMMER	—	—	—	—	—	—	—
		AUTUMN	—	—	—	—	—	—	—
ONTARIO	S-GRN	WINTER	20.8	17.2	23.6	2.85	-0.43	-2.05	8
		SPRING	23.1	11.7	54.4	8.60	1.90	3.99	55
		SUMMER	25.0	12.7	71.5	10.66	2.16	6.04	89
		AUTUMN	30.4	17.7	81.5	10.65	2.73	10.38	51
	S-DRY	WINTER	30.8	7.6	53.1	8.66	-0.37	2.10	28
		SPRING	24.5	13.5	94.9	14.00	3.60	14.94	51
		SUMMER	17.4	7.8	25.4	3.98	0.42	0.03	46
		AUTUMN	—	—	—	—	—	—	—
PRARIES	S-GRN	WINTER	23.9	12.3	43.3	13.64	1.44	2.13	4
		SPRING	21.4	16.0	37.1	5.03	1.68	3.97	20
		SUMMER	23.3	16.4	34.4	5.25	1.30	3.08	8
		AUTUMN	—	—	—	—	—	—	—
	S-DRY	WINTER	18.9	11.3	29.0	3.20	0.61	0.90	177
		SPRING	17.5	10.5	27.9	3.46	0.45	-0.11	153
		SUMMER	16.2	9.1	34.4	4.36	1.53	2.53	302
		AUTUMN	18.2	10.6	29.4	3.47	0.50	0.30	125
PACIFIC	S-GRN	WINTER	—	—	—	—	—	—	—
		SPRING	—	—	—	—	—	—	—
		SUMMER	17.2	13.5	23.8	2.33	0.91	0.91	50
		AUTUMN	—	—	—	—	—	—	—
	S-DRY	WINTER	37.2	25.5	96.4	12.08	3.16	12.04	52
		SPRING	—	—	—	—	—	—	—
		SUMMER	23.5	15.7	31.1	5.17	0.00	-0.94	10
		AUTUMN	35.0	29.4	42.1	4.20	0.45	-0.31	8