Micronized Copper Preservative Systems

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What is Micronized Copper?

- **Alkaline Copper Quat (ACQ)**
  - Copper dissolved in an organic solvent, monoethanolamine (MEA), to form a water soluble amine copper complex ($Cu(MEA)_2^{2+}$)
  - 1 part Cu : 3.44 parts MEA (AWPA P5-08)
- **Micronized Copper**
  - Free of MEA
  - Fine sub-micron particles of copper compounds suspended in water
  - Quats or azoles as co-biocide

The Micronizing Technology

Large Particulate Copper Compounds

Micronizing Process with Proprietary Dispersants & Manufacturing Technology

Stable “Sub-Micron” size particles

Amine Copper vs. Micronized Copper

- **Size Comparison**
  - **Water Molecule (H2O): ~ 0.28nm**
  - **Copper ion (Cu^{2+}): ~ 0.26 nm**
  - **Amine copper complex($Cu(MEA)_2^{2+}$): <1.0nm**
  - **Micronized Copper Particle: 80nm – 1000nm**

- **Primary Skin Irritation in Rabbits**
  - **Cu-Amine Concentrate(9.0%Cu): Classified as corrosive to skin**
  - **MicroPro 200C Concentrate (33%Cu): Classified as slightly irritating to skin**

- **Acute Oral Toxicity for Male & Female Rats**
  - **Cu-Amine Concentrate(9.0%Cu): *LD_{50} 500-2000 mg/kg***
  - **MicroPro 200C Concentrate (33%Cu): *LD_{50} > 2000 mg/kg***

Benefits of the Micronized Copper System

- Reduced Cu leaching compared to ACQ
- Reduced corrosion of metal fasteners
- Improved mold inhibitor (Isothiazolones) stability in treating solutions
- Elimination of organic solvent – MEA

Questions?

- **Will micronized copper penetrate into wood cell walls? And be effective against soft rot?**
  - **Archer, 2007 (IRG 2007)**
- **Will micronized copper preservatives be effective against termites?**
- **Will micronized copper preservatives be effective against basidiomycete fungi including copper-tolerant brown-rot and white-rot?**
  - **Preston, et al. 2008 (IRG 08-30459)**

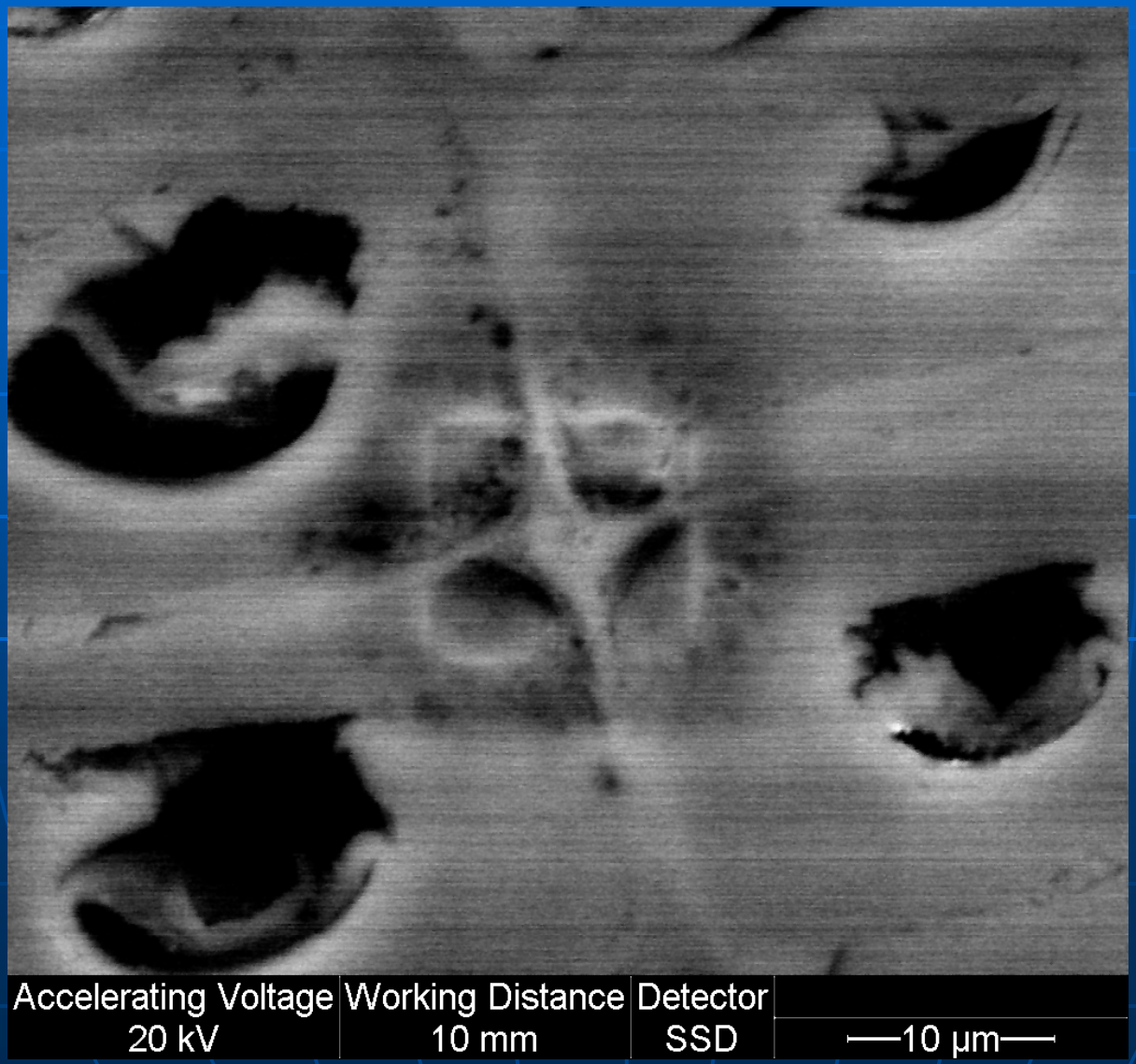
Cell-Wall Penetration and Efficacy against Soft-Rot

Independent scientific studies confirmed copper found in the cell wall:

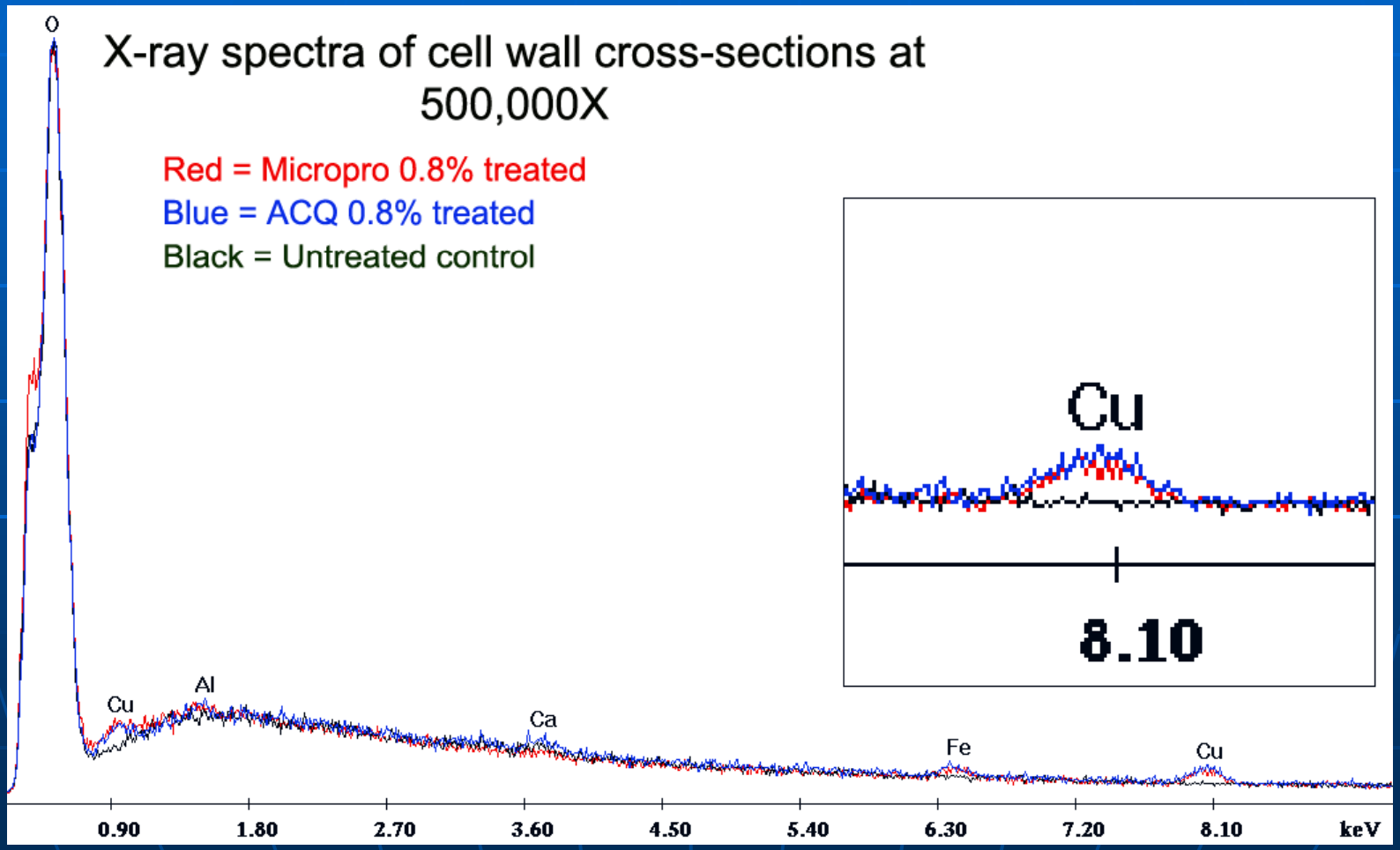
- **Matsunaga, et al. 2007 (IRG 07-40360)**
- **Matsunaga, et al. 2008 (J. Nanopart. Res.)**
- **Stirling, et al. 2008 (IRG 08-30479)**

ESEM To Detect Copper in Cell Wall

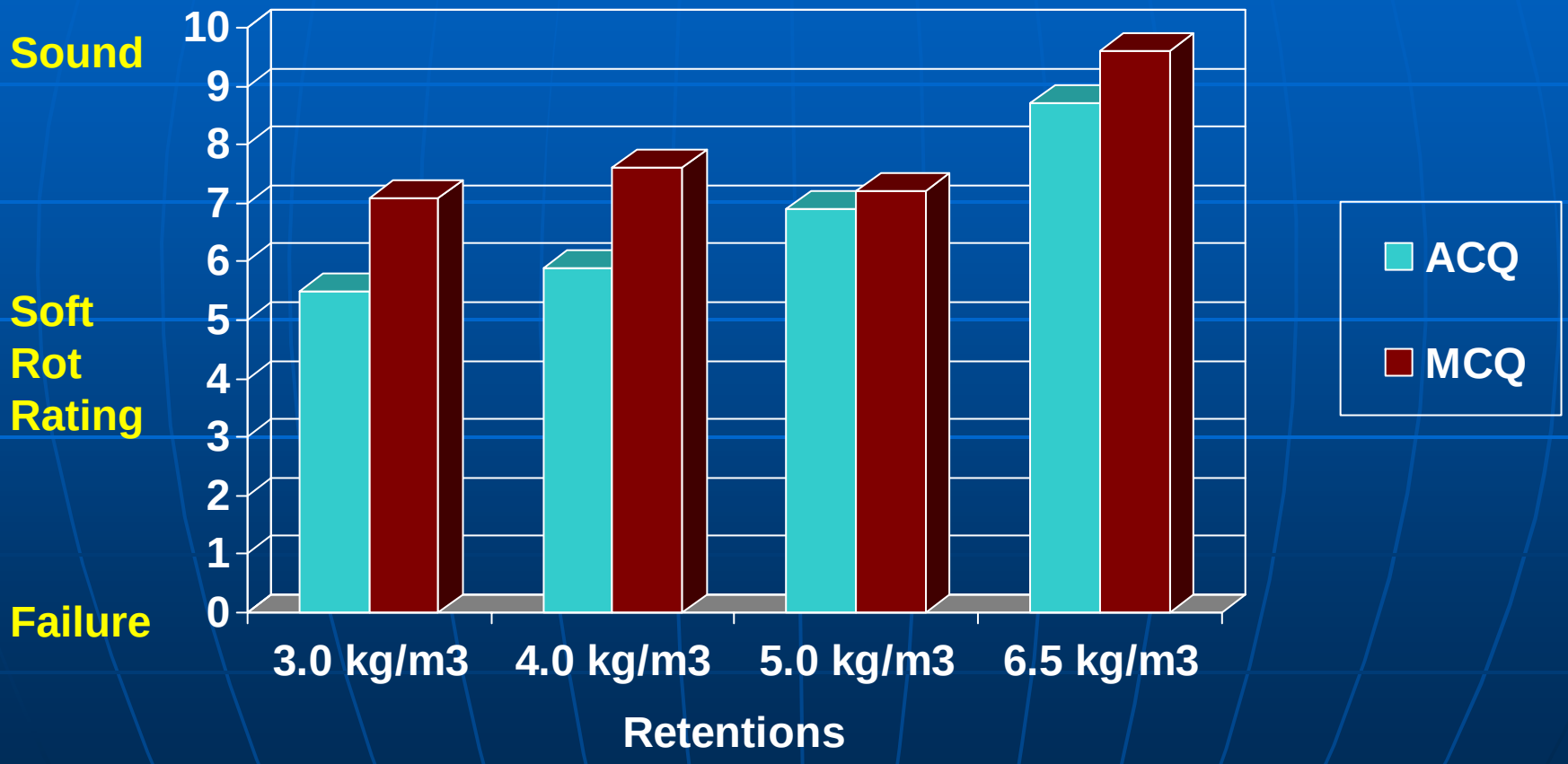
Copper Distribution – Cell Wall



X-Ray Analysis of Copper in Cell Wall Cross-Sections



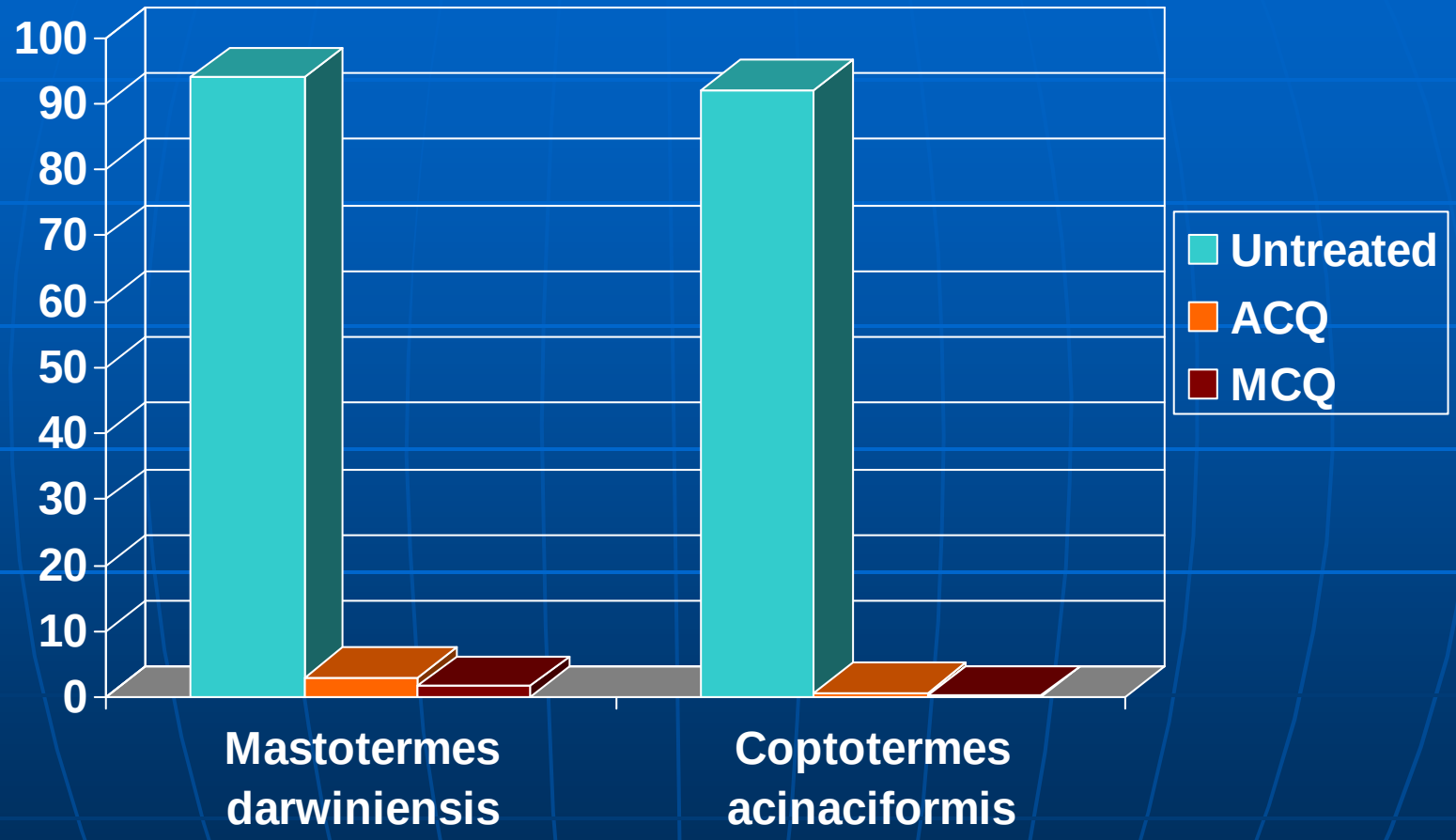
Fungal Cellar Test against Soft-Rot after 21-Months Exposure
(Soil Moisture: 100% Water Holding Capacity;
Soil Temperature: 25ºC – 27ºC)
Independently Conducted by Scion, New Zealand



Fungal Cellar Test by Michigan Tech. Univ. demonstrates similar efficacy against soft rot fungi.

Weight Loss against Subterranean Termites

(20-Week Field Exposure in Darwin, Northern Territories, Australia)
Independent Tests Conducted by CSIRO-Australia



AWPA E-1 Studies by Mississippi St. Univ. and Louisiana St. Univ. indicated that MCQ performs at least as well as ACQ vs Reticulitermes & Formosan Termites

Soil Block Test Results by CSIRO

Treatment % m/m		Mean Mass Loss, %					
		Brown-Rot				White-Rot	
		*C. Olivacea	F.lilacino-gilva	G. abietinum	*S. lacrymans	P. tephropora	L. crassa
Water	---	**37.5**	**62.1**	**54.6**	**47.5**	**16.3**	**40.0**
MCQ (19/24)	0.23	25.5	39.6	2.5	21.8	2.1	2.9
	0.45	13.7	1.5	0.3	6.1	0.5	0.2
	0.75	0.0	0.0	0.0	1.6	0.4	0.2
	1.21	0.0	0.0	0.0	0.0	0.1	0.1
ACQ (15/24)	0.23	35.9	34.0	0.6	25.7	4.6	13.8
	0.45	23.5	1.6	0.0	9.1	3.1	5.8
	0.75	1.9	0.0	0.1	2.0	2.2	0.9
	1.21	0.2	0.0	0.0	0.0	0.7	0.0

*Copper Tolerant Brown Rot Fungi

AWPA E-10 Soil Block Test Study by Mississippi State and Forintek

Demonstrated that MCQ performs comparably to ACQ

19mm Field Stake Test in Hawaii – AWPA E-7

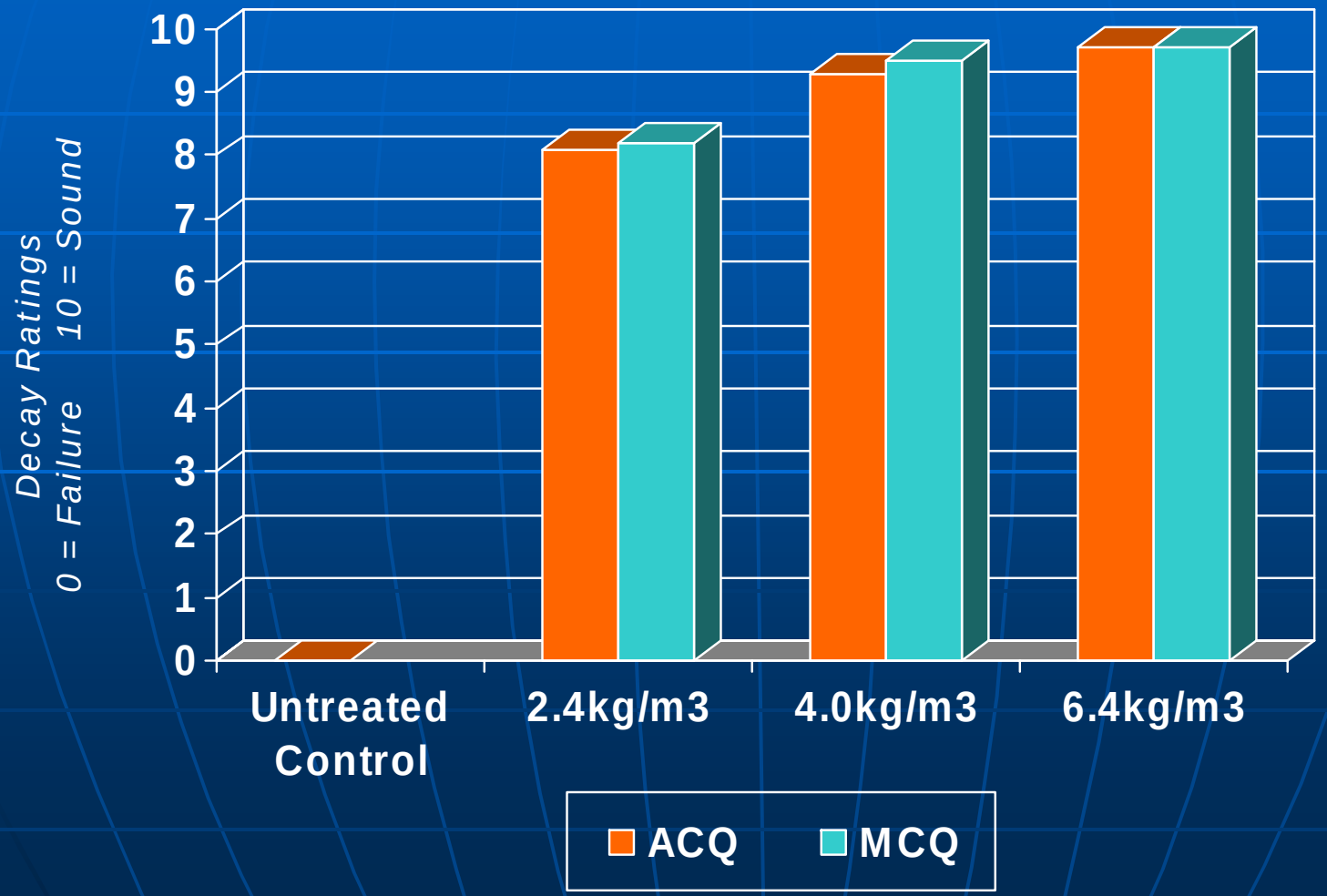
(Stakes were treated, installed and inspected by Michigan Technological University)

	Site 1 – 21 months	Site 2 – 19 months
Location	Keaau, HI	Maunawili, HI
Mean temperature	23°C	23°C
Average precipitation	322 cm	228 cm
Scheffer Index	350	300
Soil	Silty clay loam	Silty clay

40-Month Average Decay Ratings

Michigan Tech. University

Ground Stake Testing in Hawaii – AWPA E7



19mm Stakes at 6.4kg/m3 after 40 months in-ground exposure in Hawaii

19mm Stakes at 6.4kg/m3 after 52 months in-ground exposure in Hawaii

19mm Field Stake Test in Gainesville, Florida AWPA – E7

Stakes were treated and installed by Osmose and independently inspected by TPI

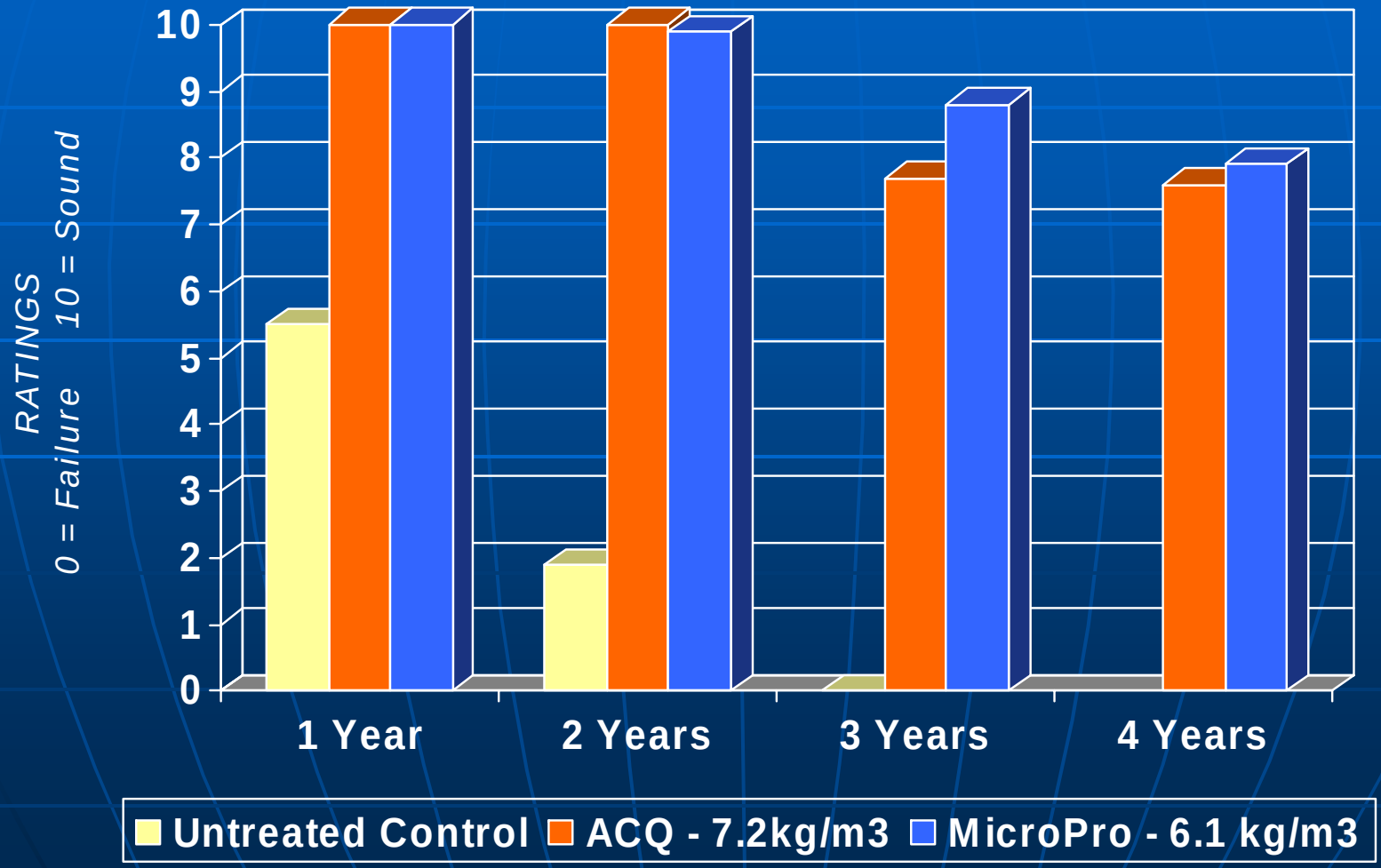
Location	Austin Cary Forest (near Gainesville, FL)
Mean temperature	20°C
Avg. precipitation	128 cm
Scheffer Index	110
Soil	Sandy (Pomona Series)

ACQ-D and MCQ Efficacy Comparison

4-Year Average Decay Ratings

Independent Evaluation by Timber Products Inspection

Fahlstrom Stake Tests, Gainesville, Florida



Summary of Field Stake Testing

- **17 independent field stake standard tests are in progress in several global testing sites including Florida, Hawaii, Mississippi, New Zealand, Australia, and China. Testing at Canadian sites is being initiated.**

- **All existing standard test results have shown that MicroPro treated stakes provide excellent protection against fungal decay and termite attack, and perform at least as well as ACQ.**

Questions Concerning Canadian Wood Preservation Industry?

- **Will micronized copper treat Canadian species?**
  - **Surface Appearance**
  - **Copper Penetration**
- **How effective will micronized copper be as a shell treatment?**
  - **Availability of mobile copper to protect checks?**

Hem-fir treated with MicroPro after 6-hour pressure cycle

Treatability Trials with MCQ

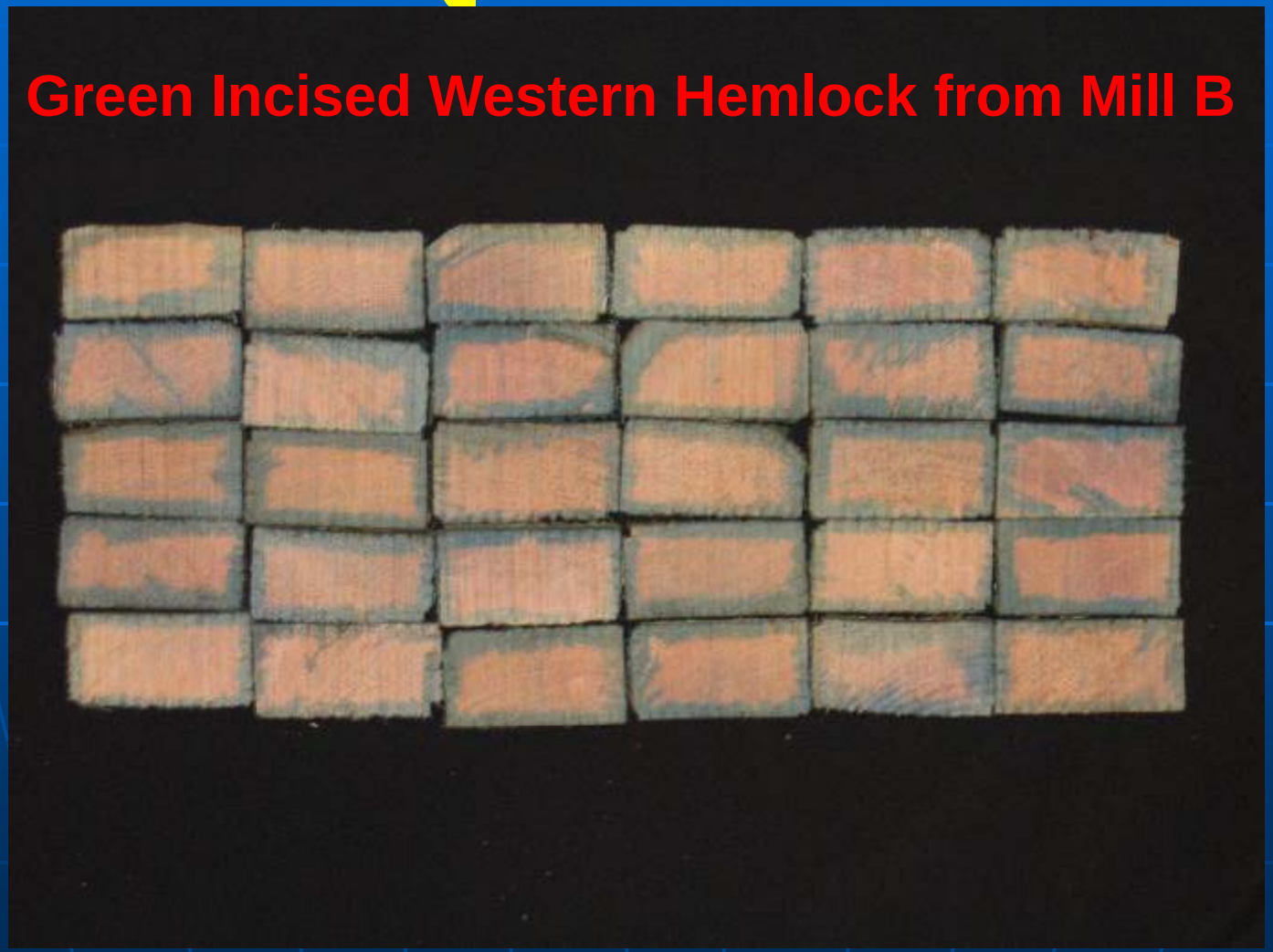
Project funded by Forest Innovation Investment Ltd. BC

W. Hemlock and Pacific Silver Fir

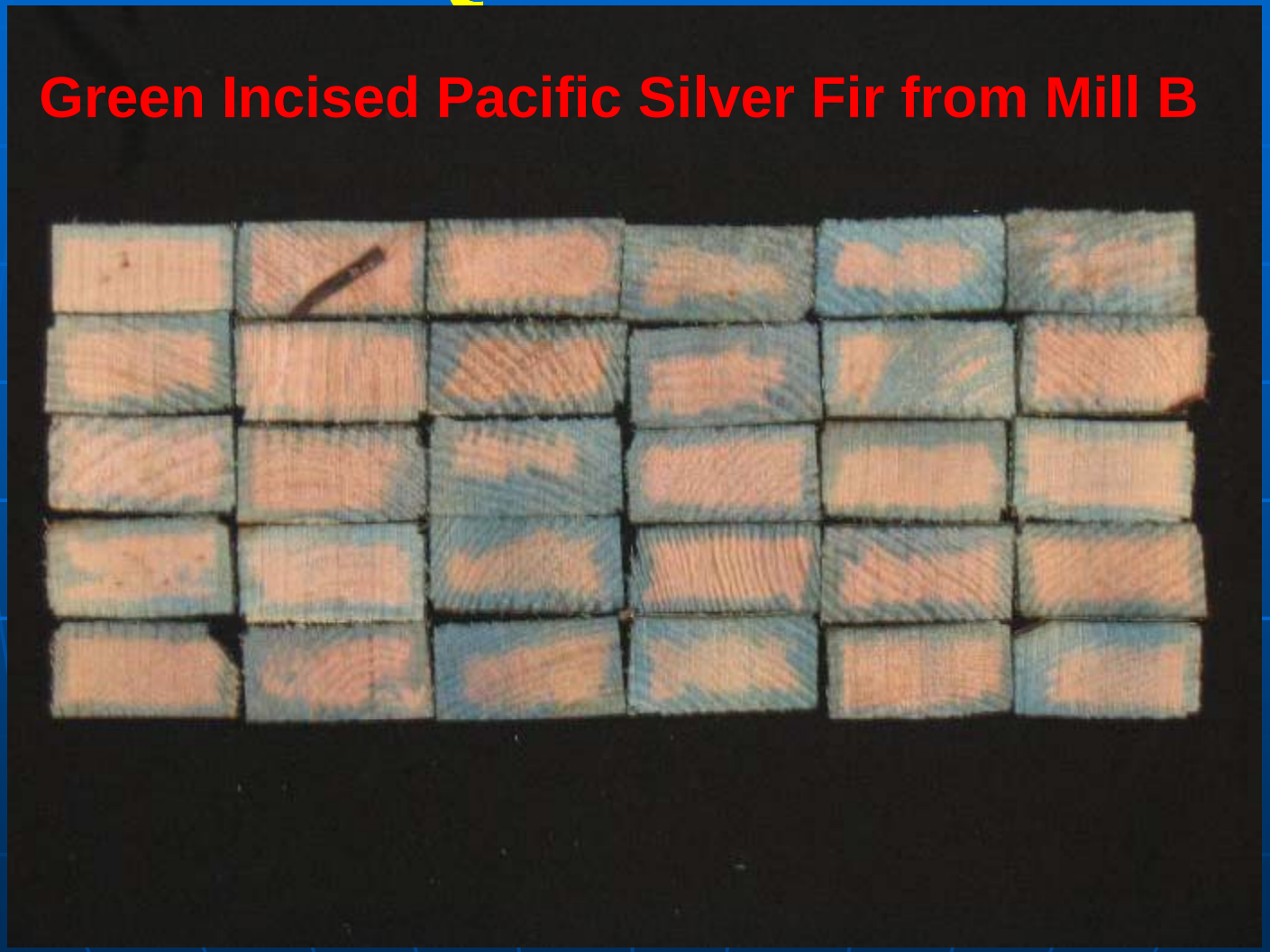
Mainland and Island mills

Green and kiln dried

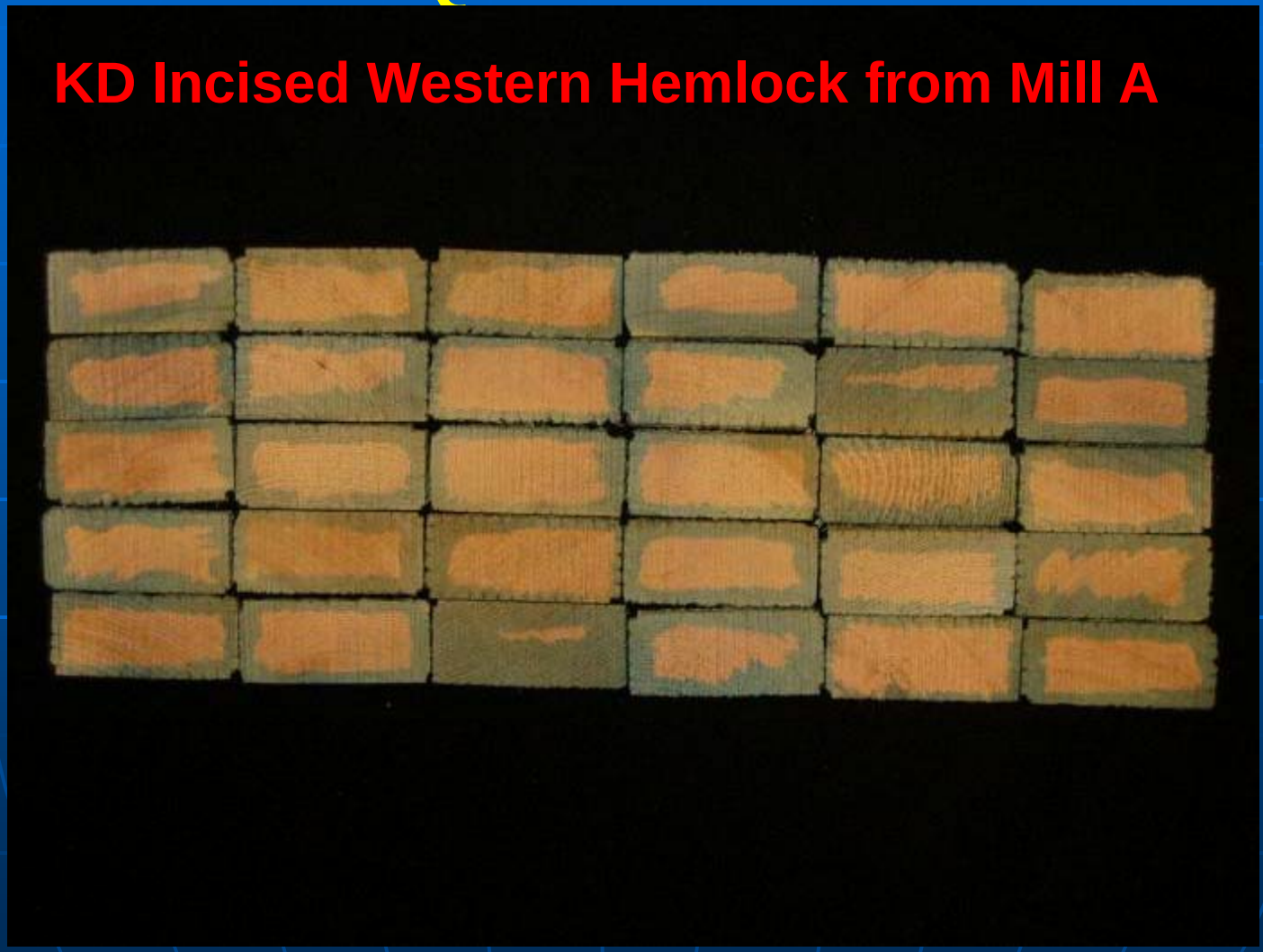
MCQ Treatment



MCQ Treatment



MCQ Treatment

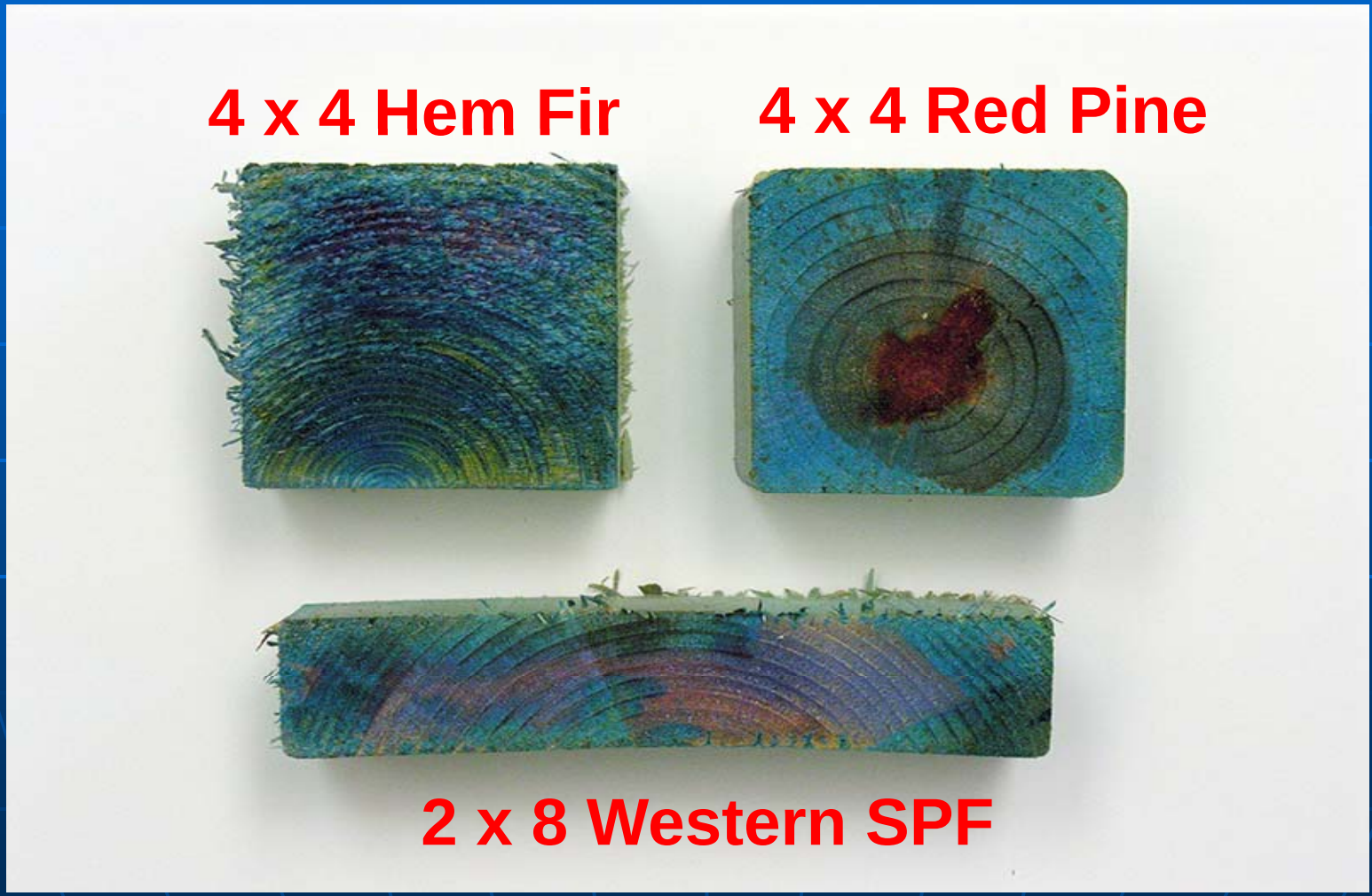


MCQ Treatment

Treating Canadian Species with MCQ at Osmose Griffin Facility

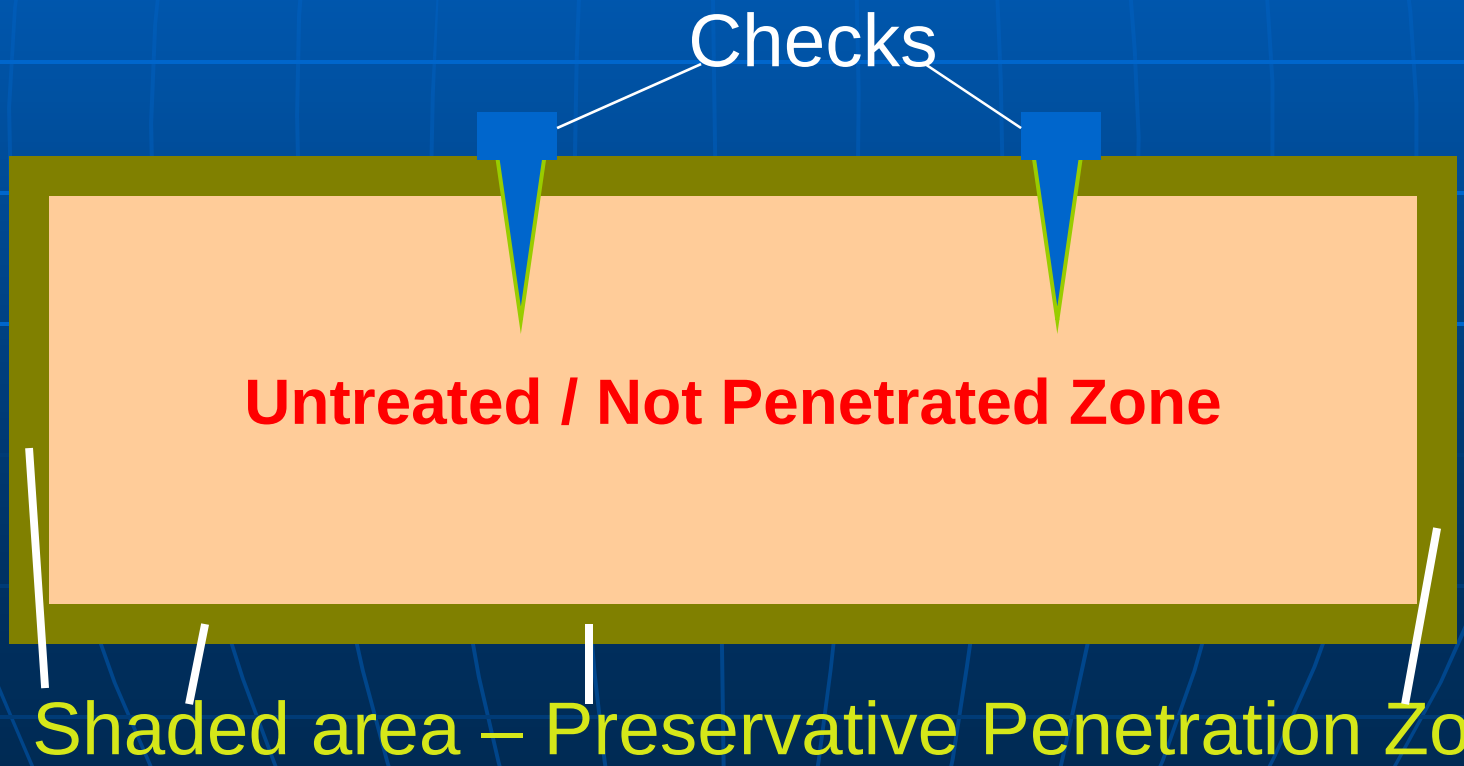
Species	Average Penetration (mm) & % Sapwood Penetrated Pines	Passing Rate
Lodge Pine Wides, #1	9.2 and 100%	93%
Lodge Pine Wides, #2	7.0 and 100%	86%
Western Spruce Wides, #1	14.7	93%
Western Spruce Wides, #2	9.9	93%
Hem-Fir Squares, #1	16.6	83%
Hem-Fir Squares, #2	33.5	100%
Red Pine Squares, #1	8.9 and 99.7%	58%
Red Pine Squares, #2	20.6 and 100%	83%

MCQ Treatment on Canadian Species



Shell Treatment and Its Effectiveness against Decay

- **The heartwood of Canadian wood species is refractory**



Historical CCA Studies on Shell Treatment

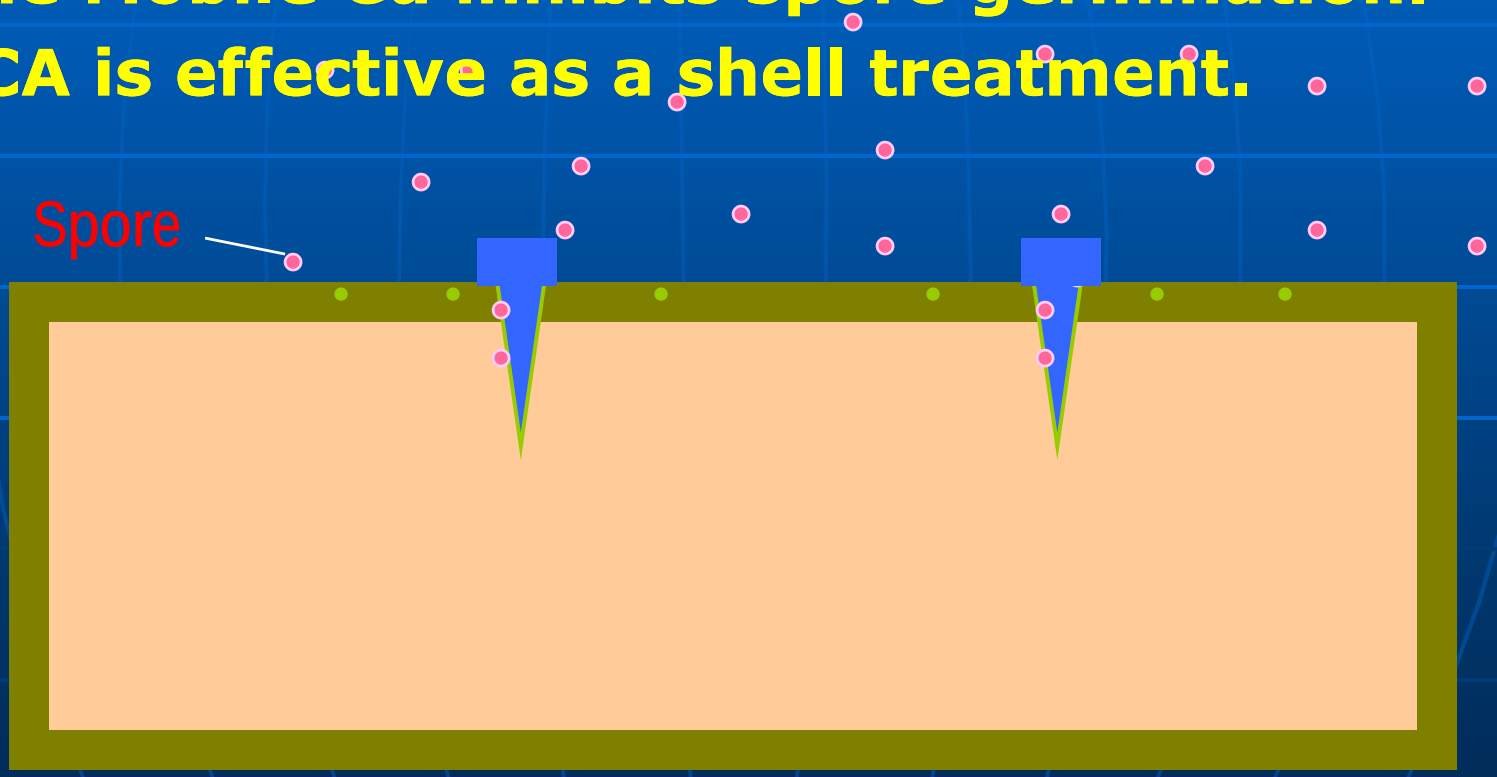
- **Ruddick, 1991 (Forest Prod. J.)**
  - **Lower requirement of 5mm penetration could provide comparable performance as 10mm penetration.**
- **Richards & McNamara, 1997 (IRG)**
  - **Refractory softwoods with non-conforming penetration have shown excellent performance in a 8 years above ground and ground contact field exposure at two sites in North America.**
- **Morris & Ingram, 2000 (Forintek Report)**
  - **CCA treatment with limited penetration performed surprisingly well in a 9 year field test.**

Historical CCA Studies on Shell Treatment cont'd

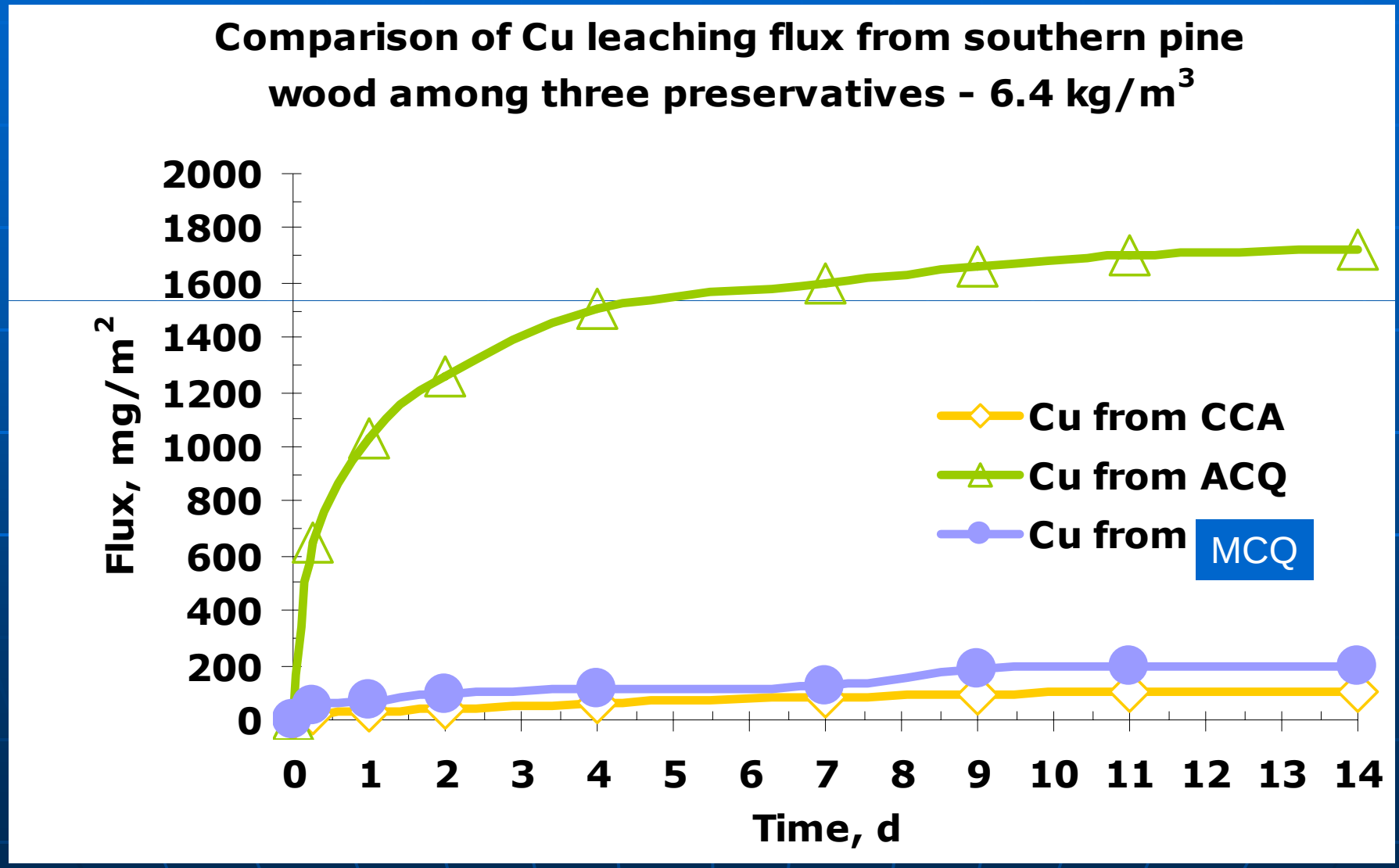
- **Choi, Ruddick & Morris, 2001 (IRG)**
  - **CCA with ≤ 5mm penetration performed well after 9-19 years exposure, and most boards were deeply checked with untreated surfaces exposed.**
  - **Copper was found on the exposed checks.**
- **Choi, Ruddick & Morris, 2004 (Forest Prod. J.)**
  - **Mobile copper redistributed to the checked area.**
- **Morris, Ingram, Ruddick & Choi, 2004 (Forest Prod. J)**
  - **Low levels of copper readily migrate during service and such movement can protect untreated wood exposed during checking from colonization by wood-rotting basidiomycetes.**

Availability of Soluble Copper to Protect Checks

- Cu from CCA moves into checks.
- The Mobile Cu inhibits spore germination.
- CCA is effective as a shell treatment.

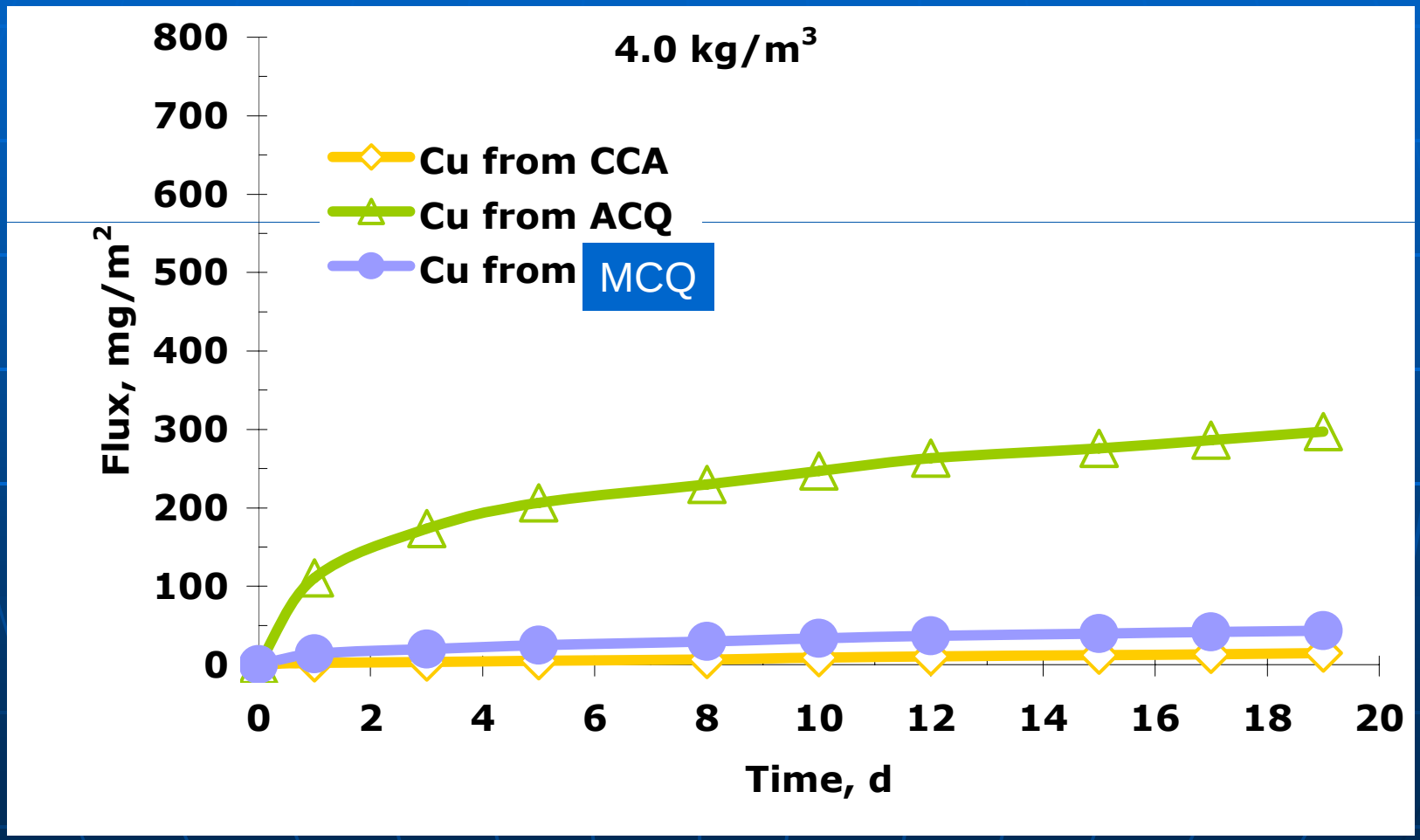


Copper Mobility by E-11

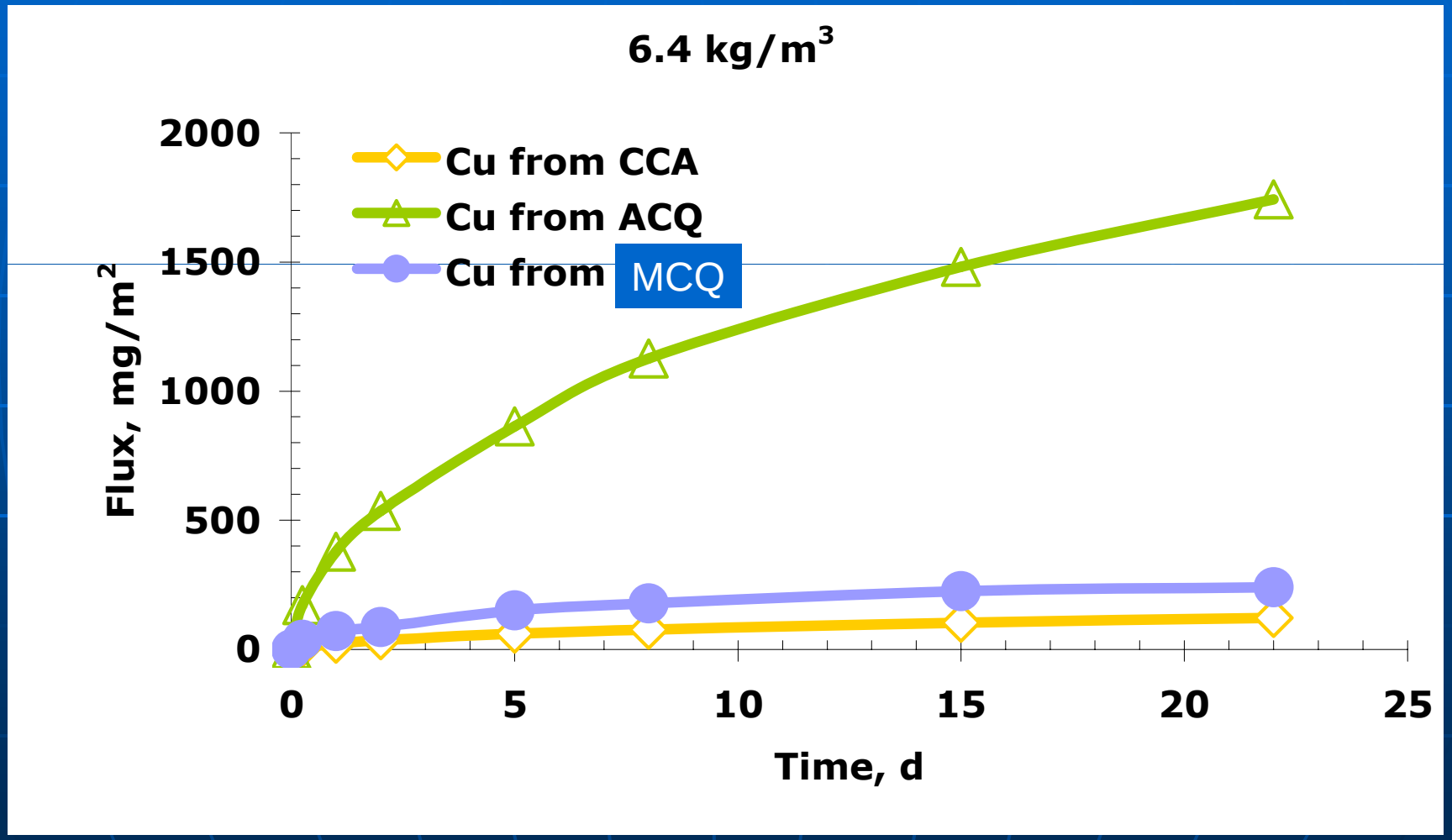


Copper Mobility by OECD Method 1 - SP

15X20X50mm
End sealed



Copper Mobility by OECD Method 2



Conclusions

- **Micronized Copper Preservative is effective in protecting wood from fungal decay and termite attack with comparable performance to ACQ.**
- **Micronized Copper Preservative can treat Canadian refractory species.**
- **The Cu mobility in the Micronized Copper system is similar to that in CCA.**
- **Therefore, we expect that MCQ will provide equivalent performance in Canadian species.**

Thank You