



Brick Testing in Canada

Gerald R Genge
BUILDING CONSULTANTS INC.



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Test Procedures

- What are the Standards?
- What is Measured?
- What Should be Measured?
- How Should Results be Presented?
- Recommendations for Modifying Brick Testing?



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What are the Standards?

- CSA Standards (A82 Series) were adopted from an ASTM procedure developed decades ago when brick were manufactured using a wet mud process and slow firing.
- Today, most facilities have a finely ground, extruded brick fired quickly.
- Still, the basic pass/fail criteria is that brick do not fail under freeze-thaw conditions of the test developed over 50 years ago for brick made using a manufacturing process no longer in use.



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Code Requirements - General

- OBC 97 – 4.3.2 Plain and Reinforced Masonry
 - (1) Buildings and their structural members made of plain and reinforced masonry shall conform to
 - (a) CSA-S304, “Masonry Design for Buildings”
- OBC 97 – 5.1.4.2 Resistance to Deterioration
 - (1) Except as provided in Sentence (2), materials that comprise the building components and assemblies that separate dissimilar environments shall be
 - (a) compatible with adjoining materials, and
 - (b) resistant to any mechanism of deterioration which would be reasonably expected, given the nature function and exposure of the materials.



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CSA Requirements

- CSA S304.1 - 3.4.1 Materials used in construction shall conform to the requirements of CSA Standard A371.
- CSA A371 – 4.1.2 Clay or Shale Masonry Units
“Clay or shale masonry units shall conform to one or more of the following Standards:
 - CAN/CSA-A82.1 – Burned Clay Brick
- CAN/CSA-A82.1 – Burned Clay Brick says:
 - Originally published in 1935 as A36
 - Revised in 1944 as A82
 - Revised in 1954 to include facing brick
 - Revised in 1977
 - Revised in 1987 to SI Units and added “Weathering Index Map of Canada” *Important changes to 1987 version under 5.1 for Durability*
 - Technically identical to ASTM C216-1986



Grade Requirements

CSA A82 - Table 1:

- Two Classes MW and SW depending on F/T cycle-days/year and precipitation during F/T cycle days.

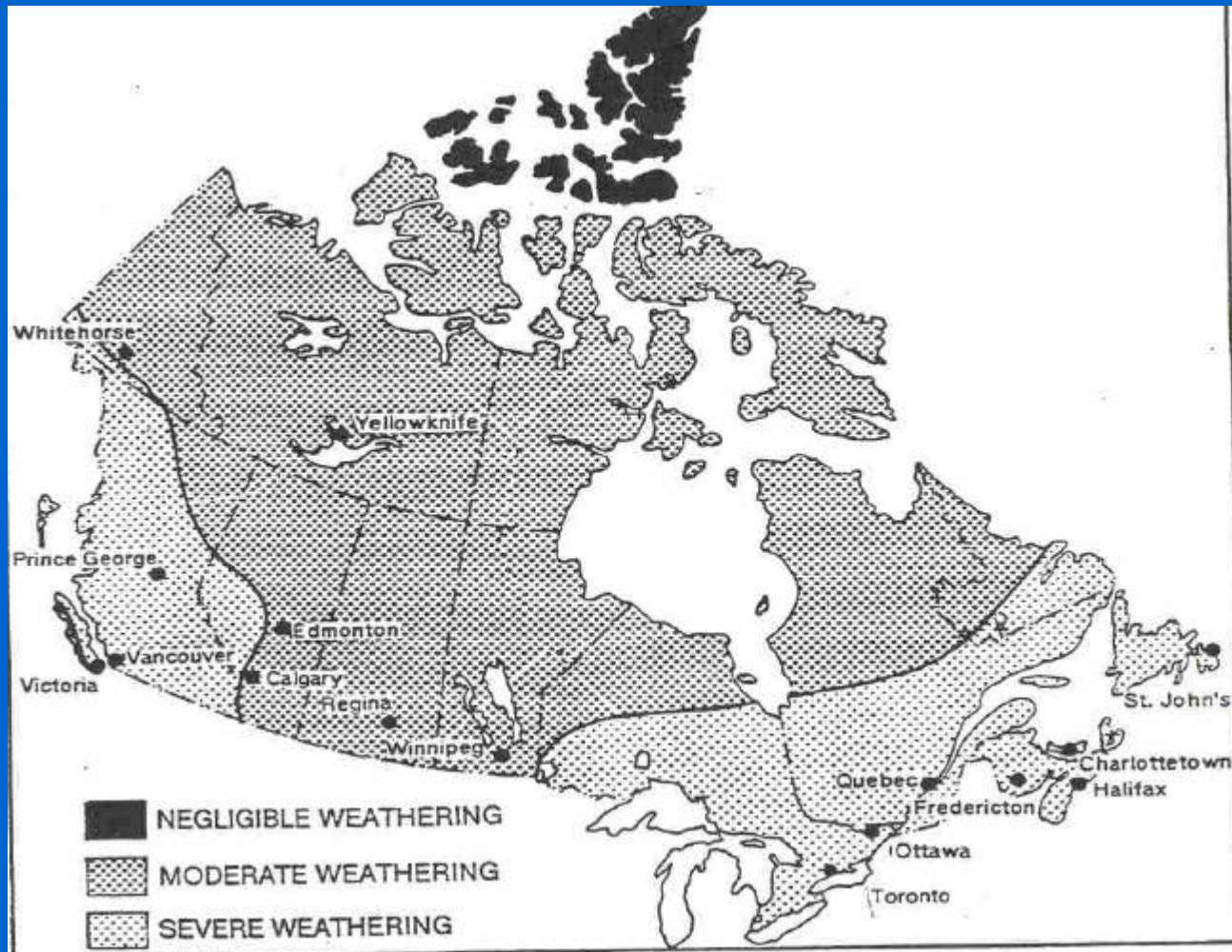
MW used if Weathering Index < 1500 cycle-mm

SW used if Weathering Index > 1500 cycle-mm and $< 15,000$ cycle-mm

SW used if Weathering Index $> 15,000$ cycle-mm



Weathering Index



Physical Requirements....for SW Brick

Property/ Test Duration	Average (5)	No Individual	& if Failure
Compressive Strength (24 h)	> 20.7 MPa	< 17 MPa	N/A Typically >> 20 MPa
Cold Absorption (CA) (24 h)	≤ 8%	≤ 10%	Do C/B test
Boil Absorption (BA) (5 h)	≤ 17%	≤ 20%	Do C/B test
Saturation Coefficient (C/B) (0 h)	0.78	0.80	Do F/T test



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CSA Freeze-Thaw Test Requirements

Property/ Test Duration	Criteria		& if Failure
CSA/ASTM Freeze-Thaw (<10 weeks)	No breakage &	< 0.5% mass loss	Don't use.

What is 0.5%? Consider 1 mm deep spalls. Then 0.5%....

= ~20 cm² or an area roughly the size of 4 Loonies, or

= ~ 2-in. diam circle, or

= 4 mm all around the perimeter of the exposed face



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Freeze-Thaw Test Procedure

CAN3-A82.2-M78 (reaffirmed in 1992)

- Purchaser or his representative is to sample 10 whole brick from each lot of 250,000 (or part) production representing the full range of colours, size, and texture.

Problem: *Often the supplier provides results of test performed by their own agent as proof of compliance.*

- Five ½ brick selected from separate brick for use in test using freeze-thaw chamber that can reduce air temperature to –9 deg C within 1-h..

Problem: *Very few commercial freezers can perform to this level unless surcharged with frozen materials. And...where is the temperature measured?*



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Freeze-Thaw Test Procedure (Cont'd)

One set of 5 cycles involves....

- **Step 1**- Bricks oven dried and weighed
- **Step 2**- Initially soak/submerge for 4-h
- **Step 3**- Then freeze face-down in shallow tray in 10 mm water for 20 h
- **Step 4**- Remove from freezer and thaw submerged for 4 h
- **Step 5**- Steps 3) and 4) repeated 5 times = 5 days
- **Step 6**- On 6th day air dry samples for 40 h
- **Step 7**- On 8th day inspect brick and weigh.

Repeat Steps 2) to 7) 10 times.

Problem 1: *Ideally the test is started at 8:00 a.m on a Monday. This requires work on Saturday until 12:00 noon. For 10 weeks.*

Problem 2: *The brick are allowed to dry for 40 hours every 5 cycle set. (How does this relate to actual exposure conditions?)*



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Research Findings

- 1990 CBAC/IRC Industrial Fellowship report found:
 - (a) 24h cold water absorption (CA) vs. saturation coefficient (C/B) identifies a characteristic fingerprint for a particular brick (constituent materials and manufacturing process)
 - (b) Water content increases to the 10th cycle then decreases with each drying cycle but increases again at end of every 5 cycles of freezing and thawing. Maximum water content achieved is approximately that for 5 to 15 days submersion and slightly above the 24h CA value.

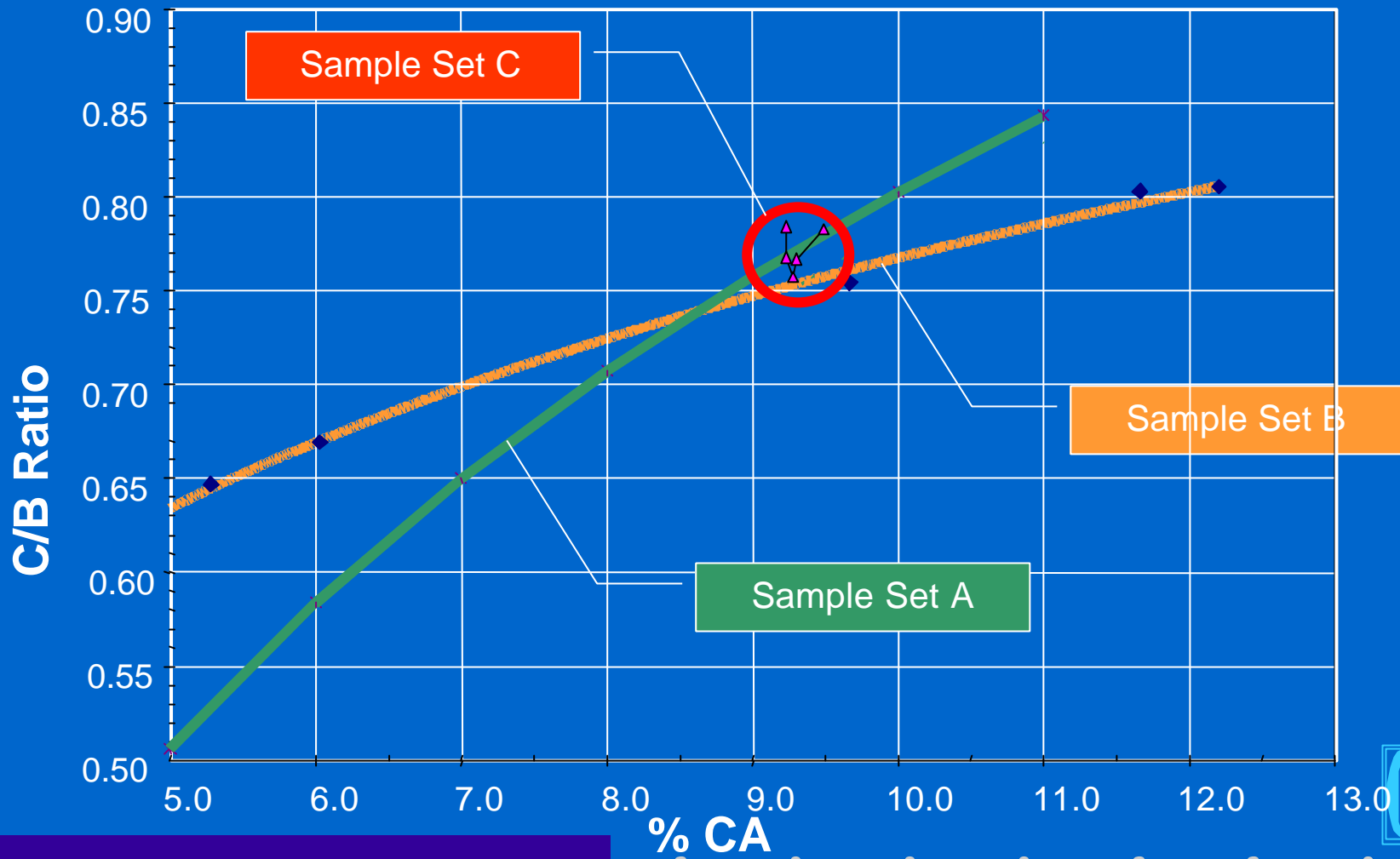


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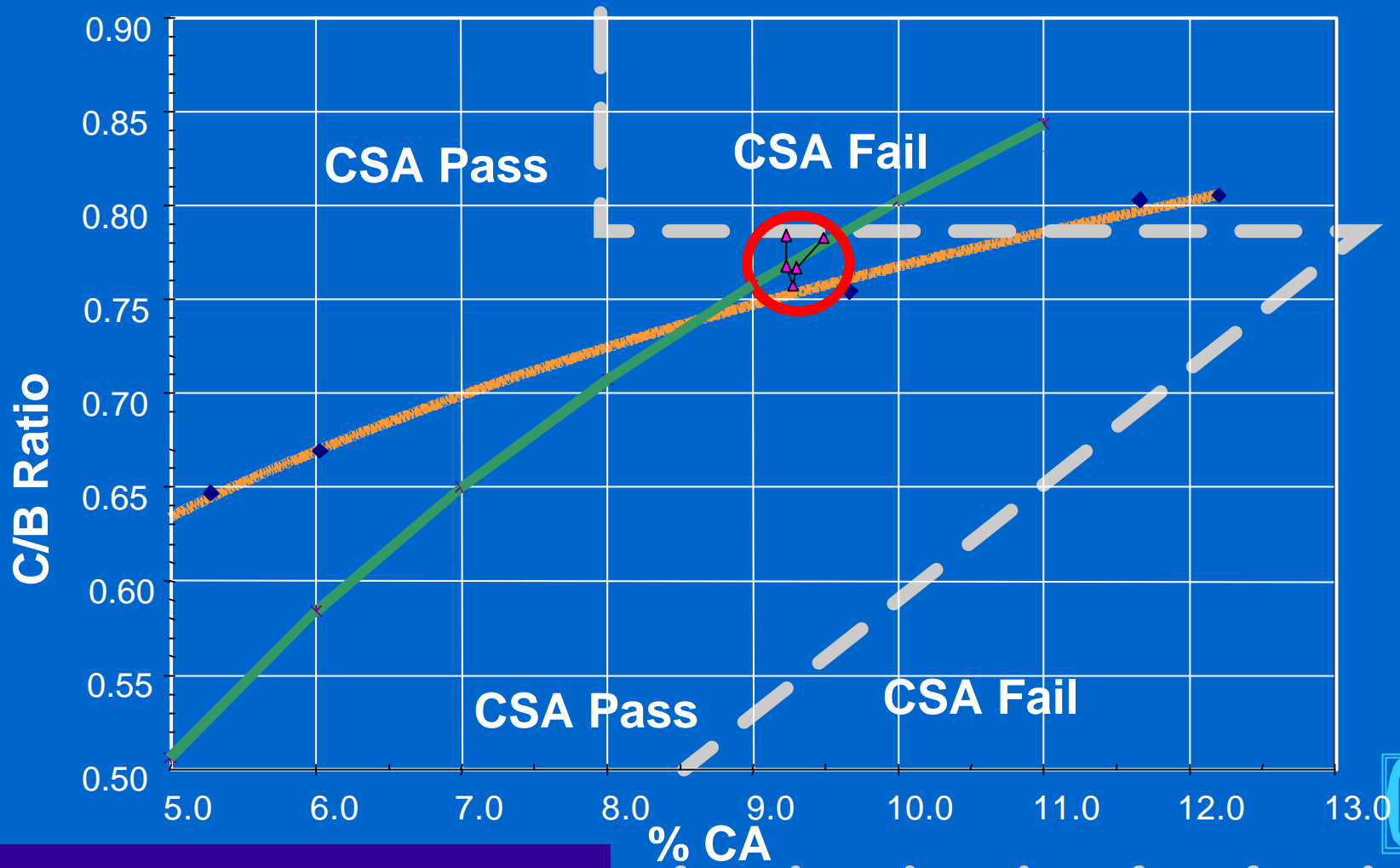
Fingerprinting Brick

(a) 24h cold water absorption (CA) vs. saturation coefficient (C/B) identifies a characteristic fingerprint for a particular brick (constituent materials and manufacturing process)

Fingerprinting Brick



Fingerprinting Brick

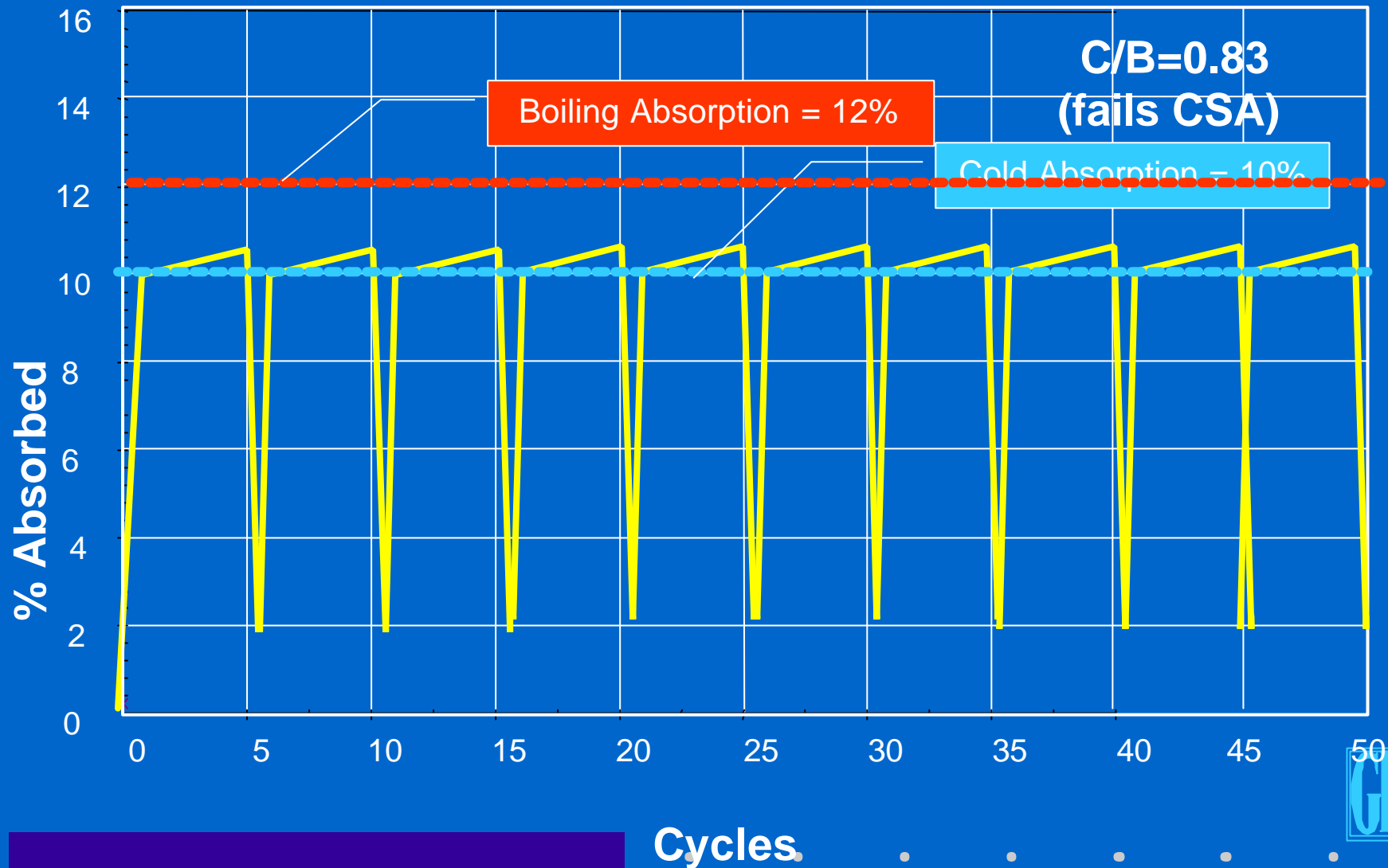


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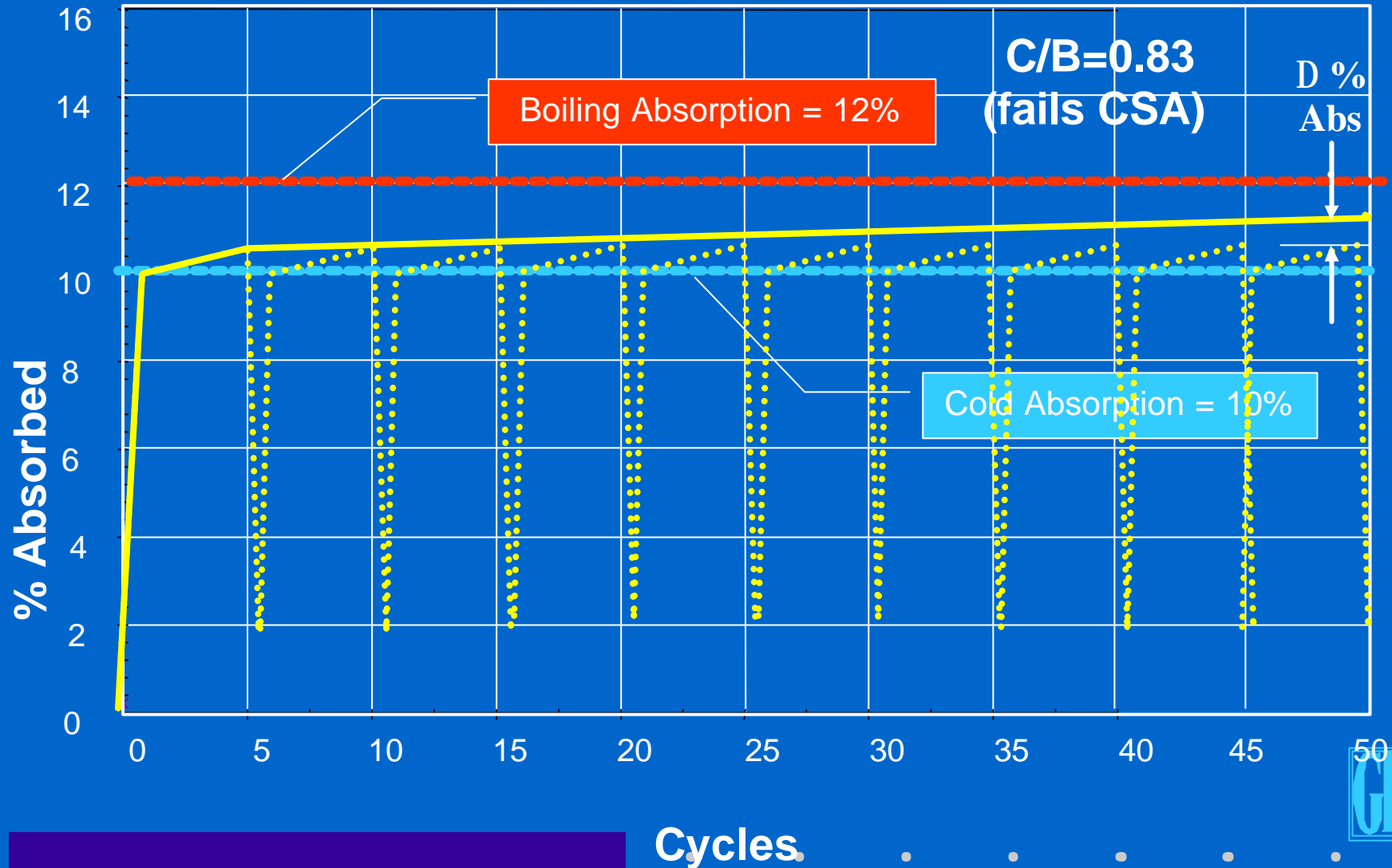
Freeze-Thaw Cycles

- (b) Water content increases to the 10th cycle then decreases with each drying cycle but increases again at end of every 5 cycles of freezing and thawing. Maximum water content achieved is approximately that for 5 to 15 days submersion and slightly above the 24h CA value.

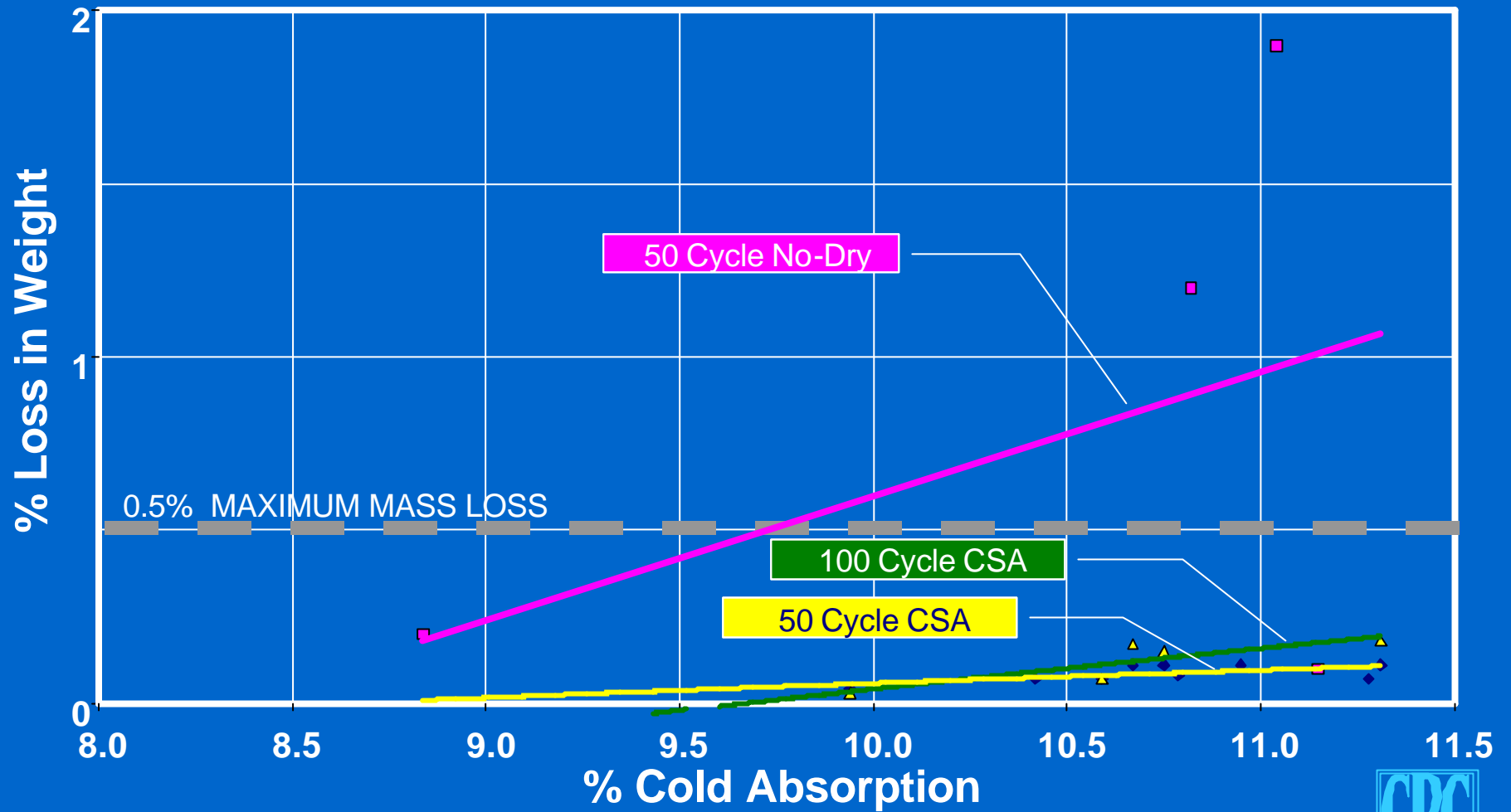
F-T Moisture Content CSA Test



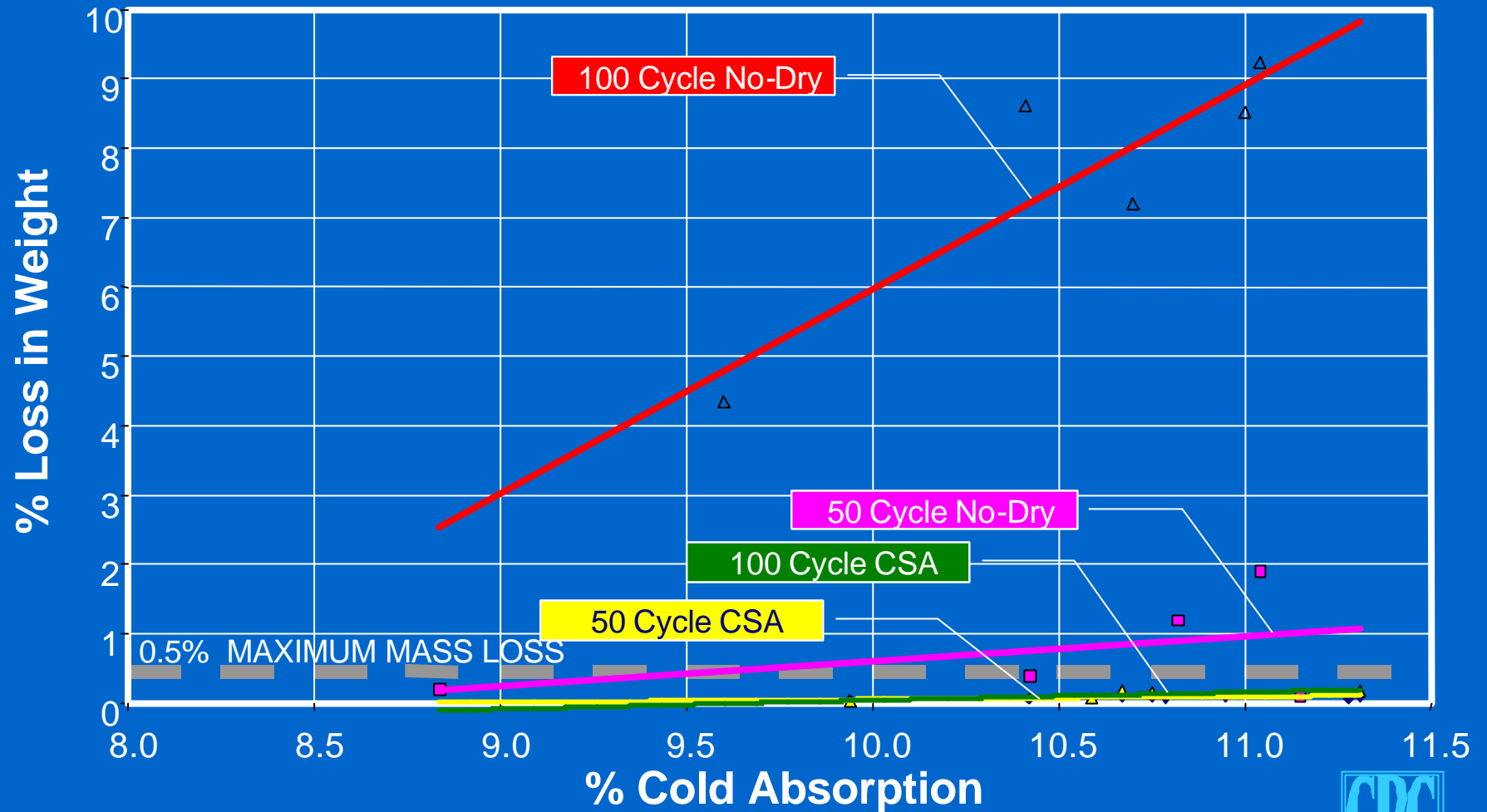
F-T Moisture Content No-Dry Test



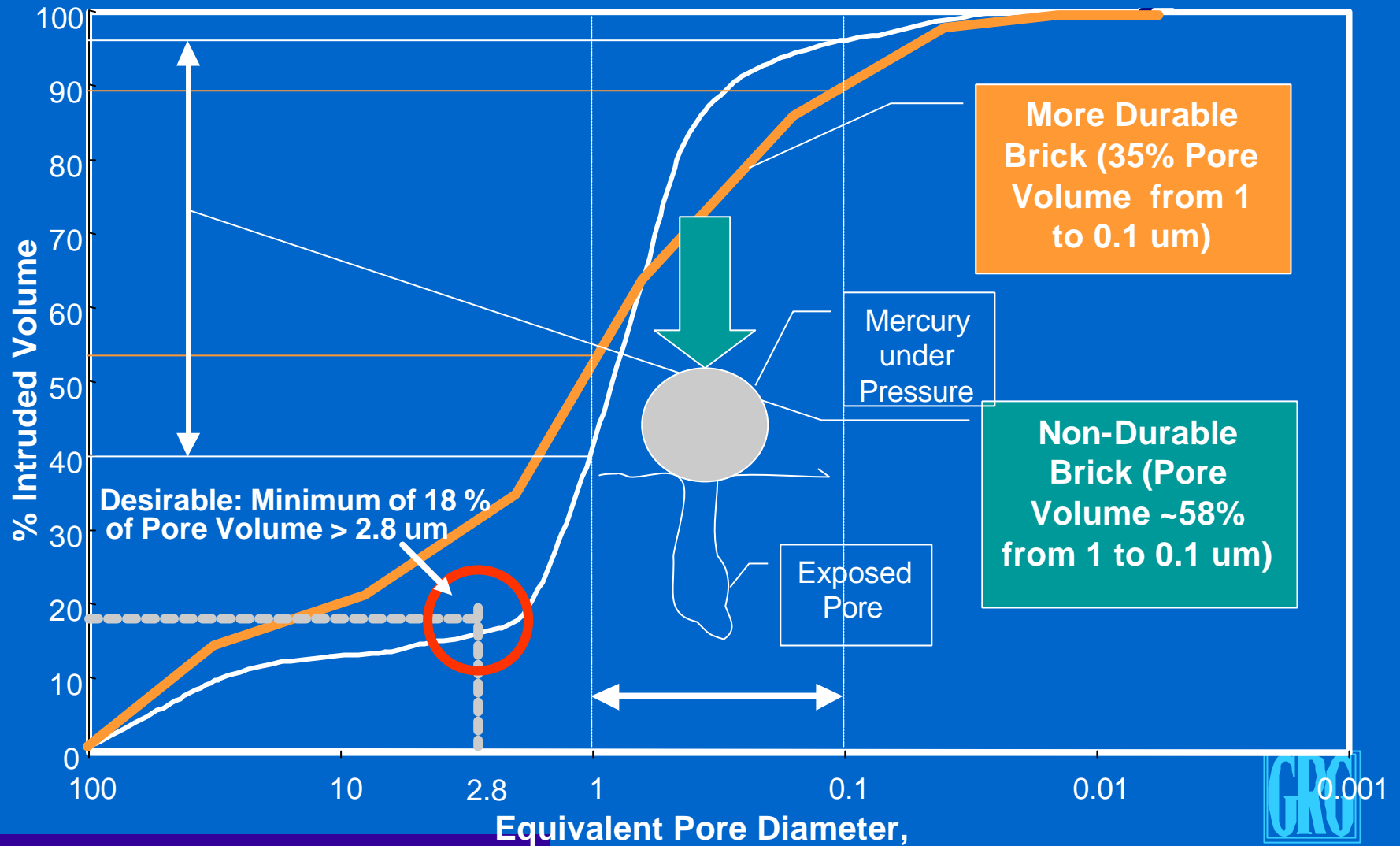
Weight Loss by F-T Test



Weight Loss by F-T Test



Pore Size Distribution



Summary

- CSA Standard Tests for Bricks were developed decades ago and applied to processes largely out of use. Lessons can be learned from European testing of brick which applies different methods more aligned with exposure.
- SW-Class brick based on +1500 cycle-mm should be reviewed and split to allow specifiers to call for:
 - More extreme building exposure conditions, e.g., parapets, wing walls, high corners, etc.
 - More extreme environments, e.g. south-central Ontario or Eastern Canada.



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Summary (Cont'd)

- Current F-T pass/fail criteria (0.5% mass loss) allows a rather high (4-loonie to 1 mm) face spall rate and should be reviewed.
- A certification or other quality management process for brick testing should be implemented to assure purchasers that brick testing and equipment used comply with standards.
- Testing agencies should consider providing graphical output to better visualize the results and isolate anomalies.



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Summary (Cont'd)

- The “Fellowship” report identified brick test precision errors that should be incorporated into the test method. These deal with:
 - 24 h is insufficient time to dry some low absorption brick.
 - Cooling after the 5 h boiling test should be standardized
 - Freezing chamber should not have thermal stratification and must cool sufficiently. Time/Temp records should be kept.



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Summary (Cont'd)

- F-T Testing from Monday to Friday requires Saturday morning work. Failure to meet precisely the test cycle times can result in over-drying.
- The orientation of the brick during drying (face-up or face-down) is not specified but will affect moisture content at the exposed face.
- The definition of F-T “failure” should be re-examined. Not only is a large area of spalling allowed but micro-cracking and strength loss will happen prior to actual spalling or weight loss.



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Summary (Cont'd)

- The F-T test should be updated, perhaps to the “No-Dry” procedure to better model Canadian wet-cold conditions.
- As an alternative to the CSA requirement that Purchasers select brick for testing and to expedite brick approval, brick manufacturers may consider a product certification program employing parameters that relate in-situ performance with material properties such as pore size, cold water absorption, and a modified freeze-thaw test.



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