

2007 SAE Aircraft and Engine Icing International
Conference, Seville

Laboratory Testing of Aircraft Anti-Icing Fluid Rehydrated Gel Residues



Laboratoire international
des matériaux antigivre

LIMA  AMIL

Anti-icing Materials
International Laboratory

Problem

Thin (invisible) residues that rehydrate to form gels up to 600X their weight



Test Method

Rolf Buhler of Swiss Air developed
a test method to
compare the gel formation potential of fluids:
Successive Dry-out and Rehydration Test

Became Annex A of AMS 1428

Dry-out and Rehydration Test

1) Treat plates:
5min caustic soda
30sec nitric acid
Water rinse

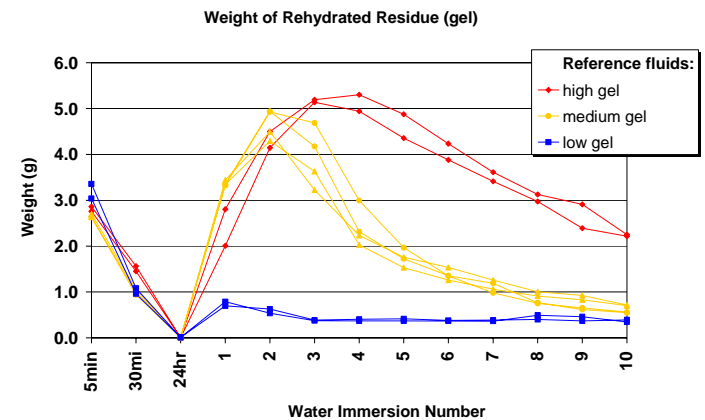


2) Dip in fluid
Dry 24 hrs
6x



3) Dip in water
Drip 1 minute
Weigh
10x

4) Plot data



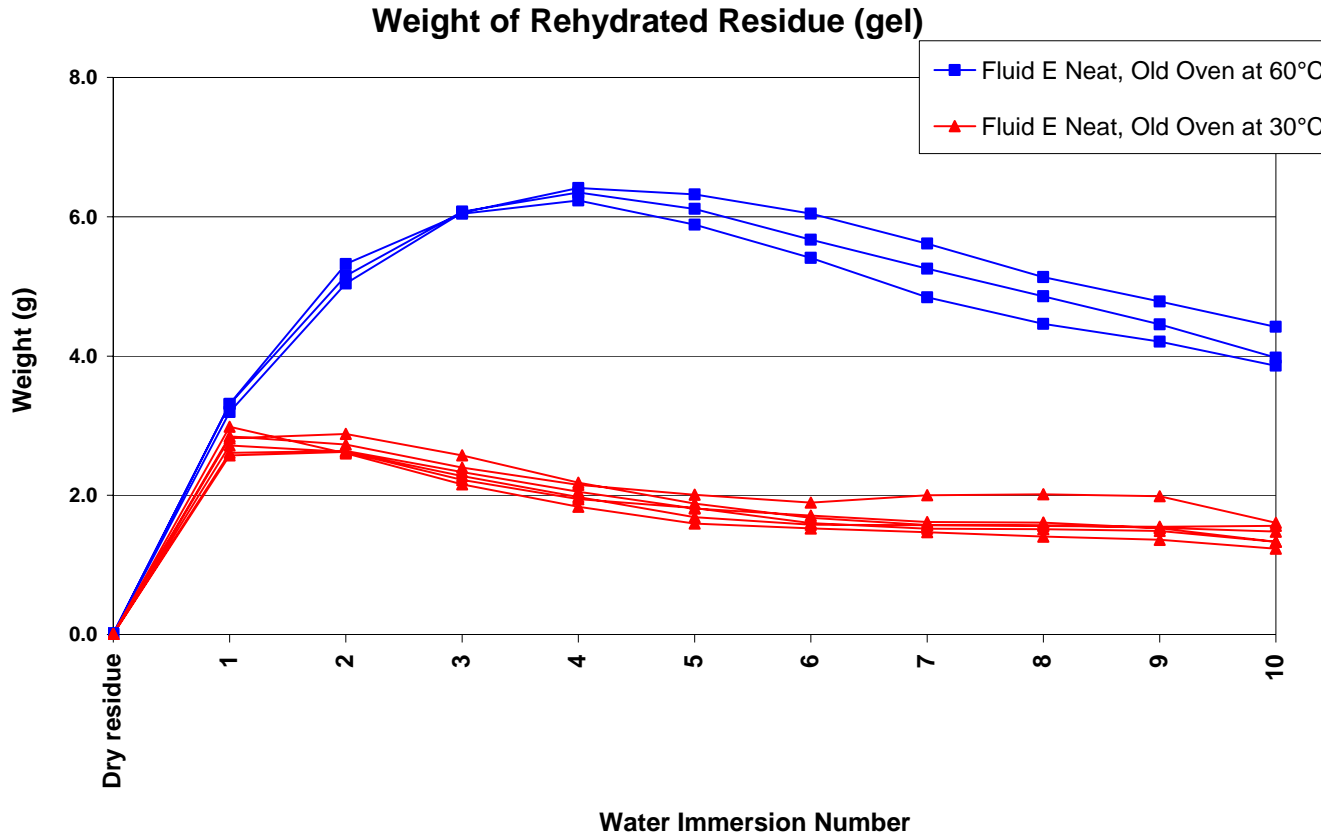
Questions

- with the reproducibility
(no interlab comparison)
- whether the test was representative
- fluid comparisons

Test Factors Examined

1. Dry-out Temperature
2. Steady Immersion
3. Centrifuging and bubbles
4. Plate treatment
5. Plate replacement
6. Dilutions
7. Mixed fluids
8. Longer wait times

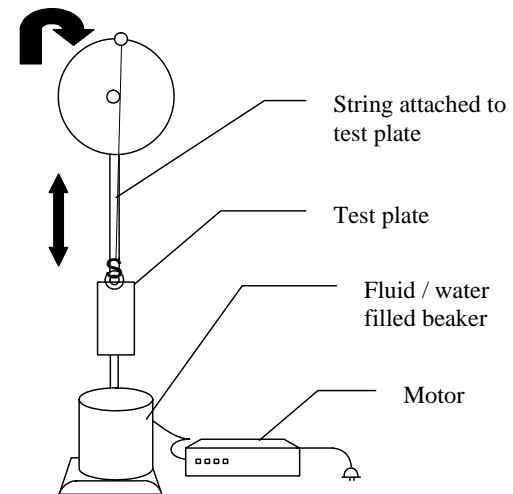
Dry-out Temperature



➔ Important factor

Steady Immersion

Suggested by Rolf Buhler
in Lisbon 2006 to improve
reproducibility



Centrifuging and Bubbles



➔ Little or no effect

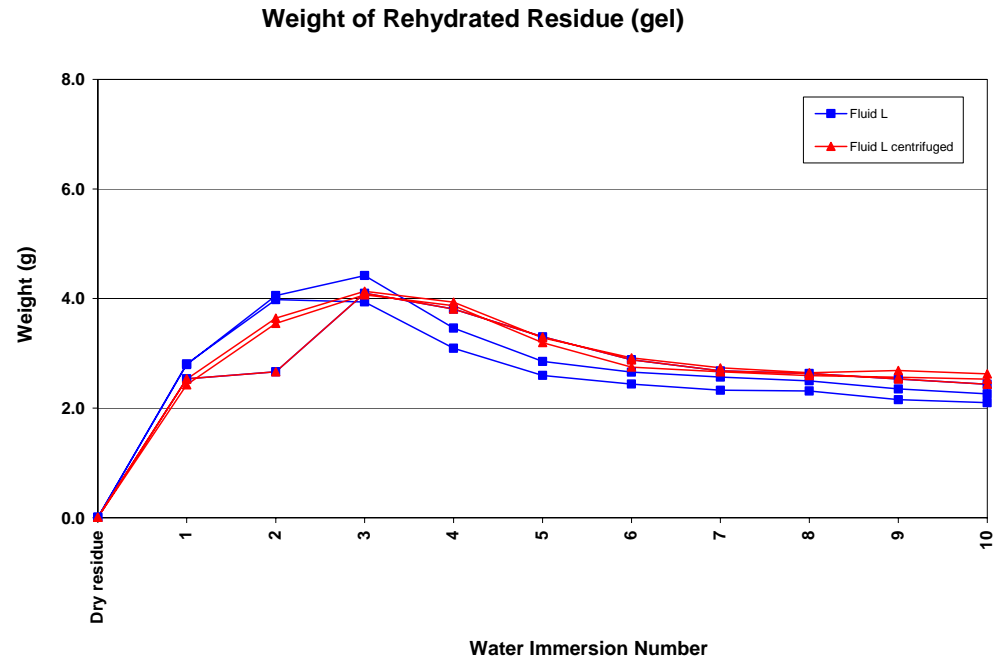
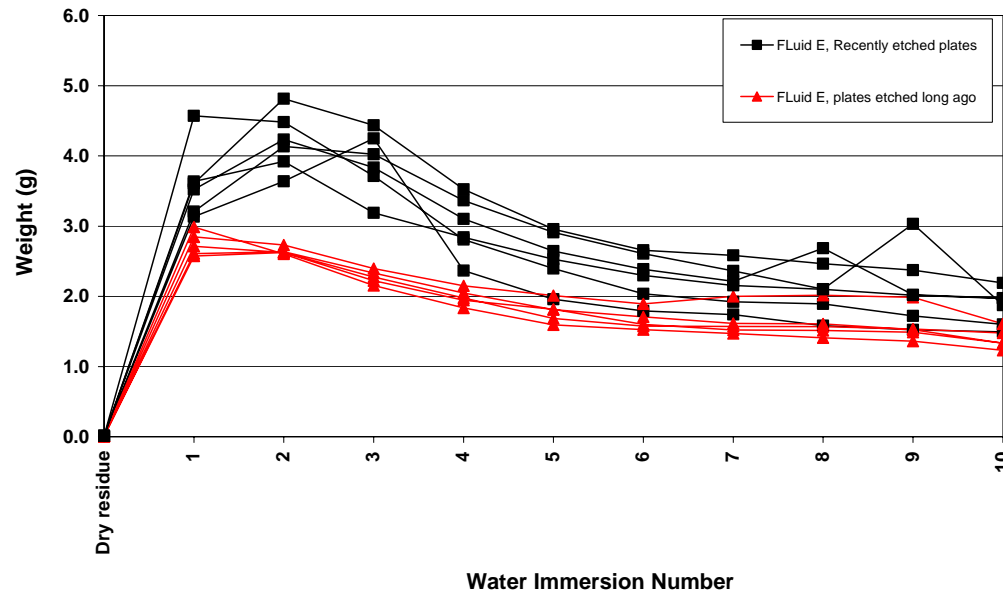


Plate Treatment



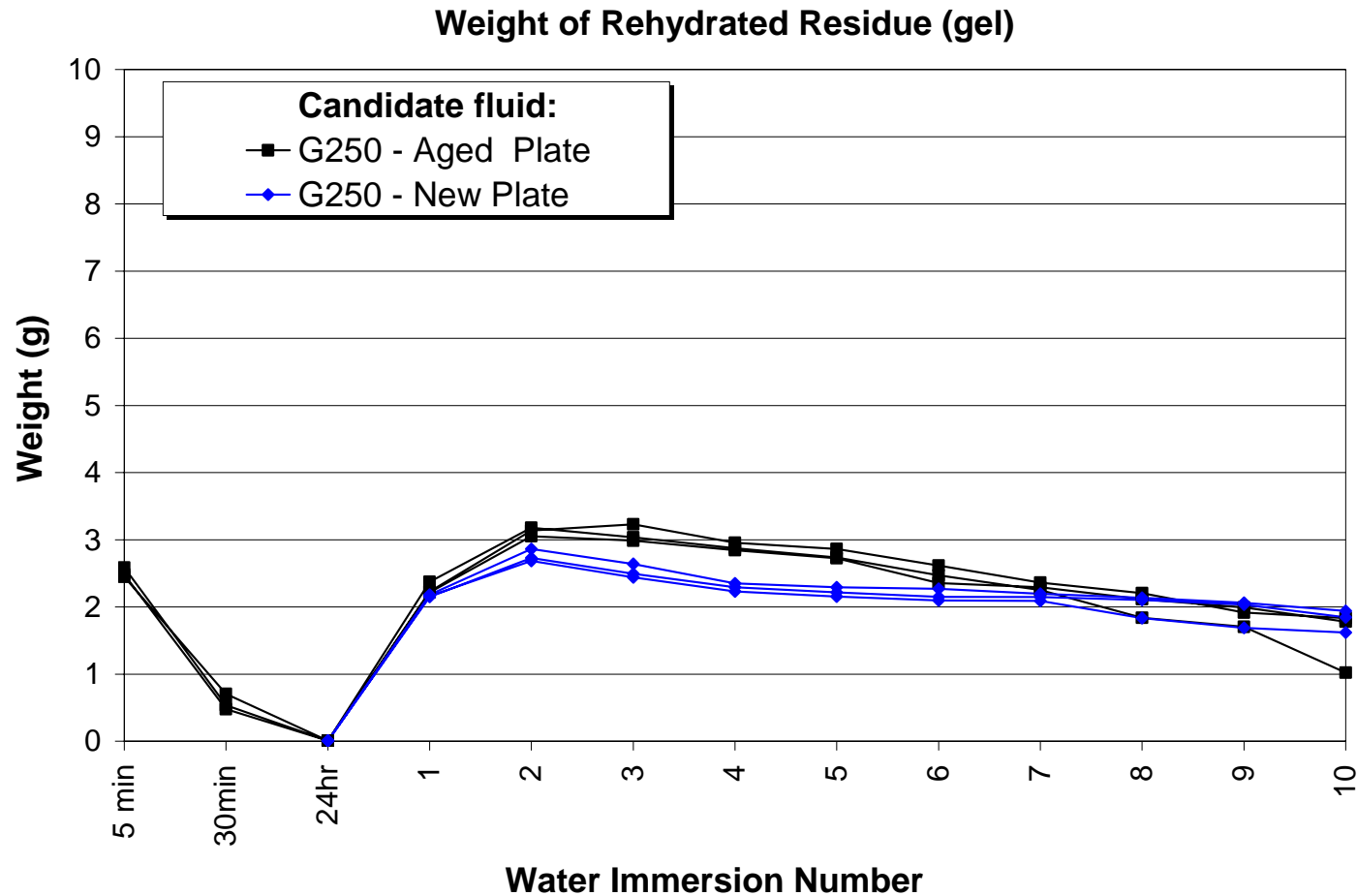
5 min in
NaOH
30 sec in
nitric
acid
(HNO₃)

Weight of Rehydrated Residue (gel)



➔ important

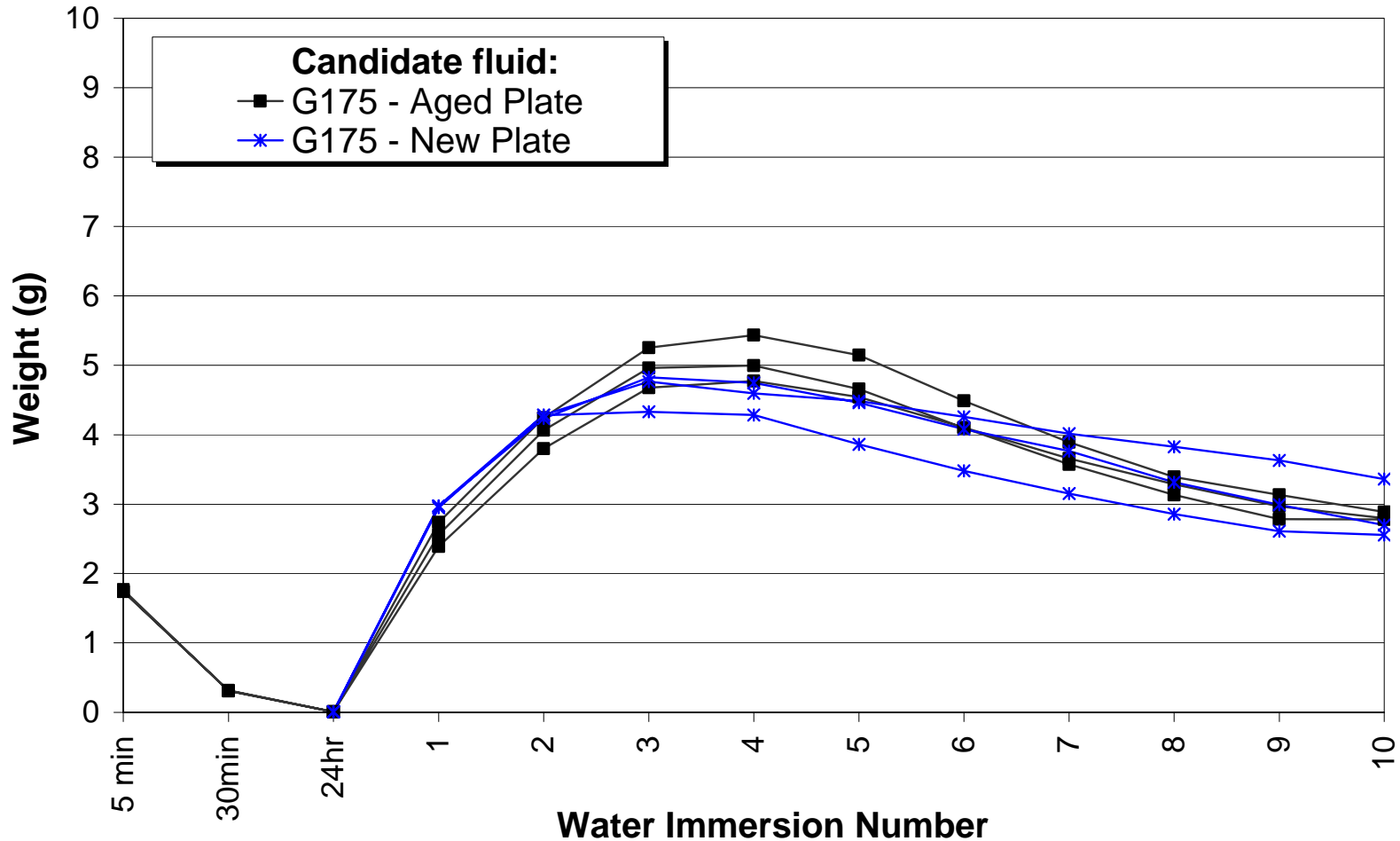
Plate Replacement – Example 1



➔ More gel with aged plate

Old Etched vs. New Etched Plates - #2

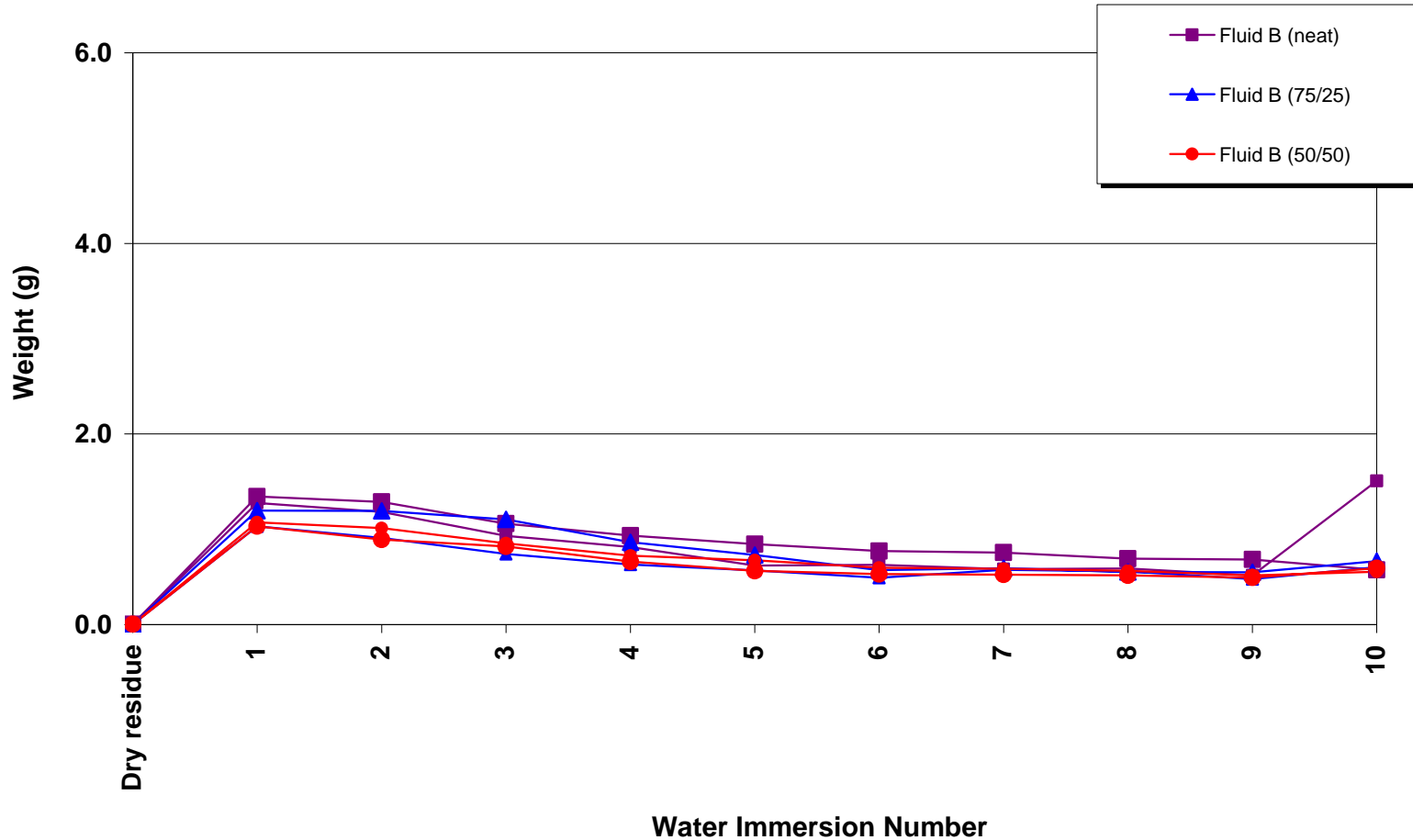
Weight of Rehydrated Residue (gel)



➔ More gel with aged plate

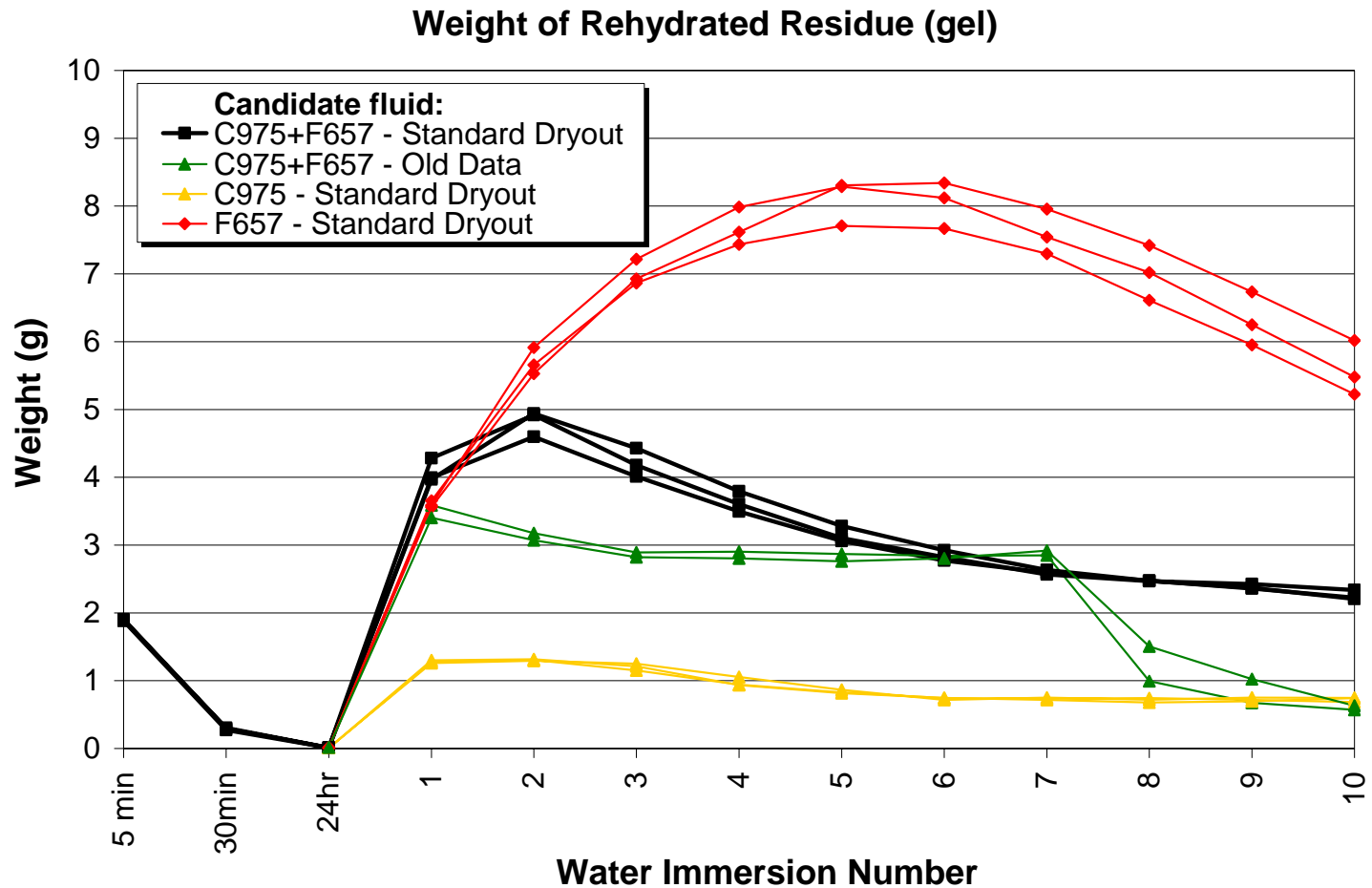
Dilutions

Weight of Rehydrated Residue (gel)



➔ Less effect

Mixed fluids



➔ **No proof that a mixed fluid residue would be any greater than the residue of the fluids alone**

Longer Wait Times

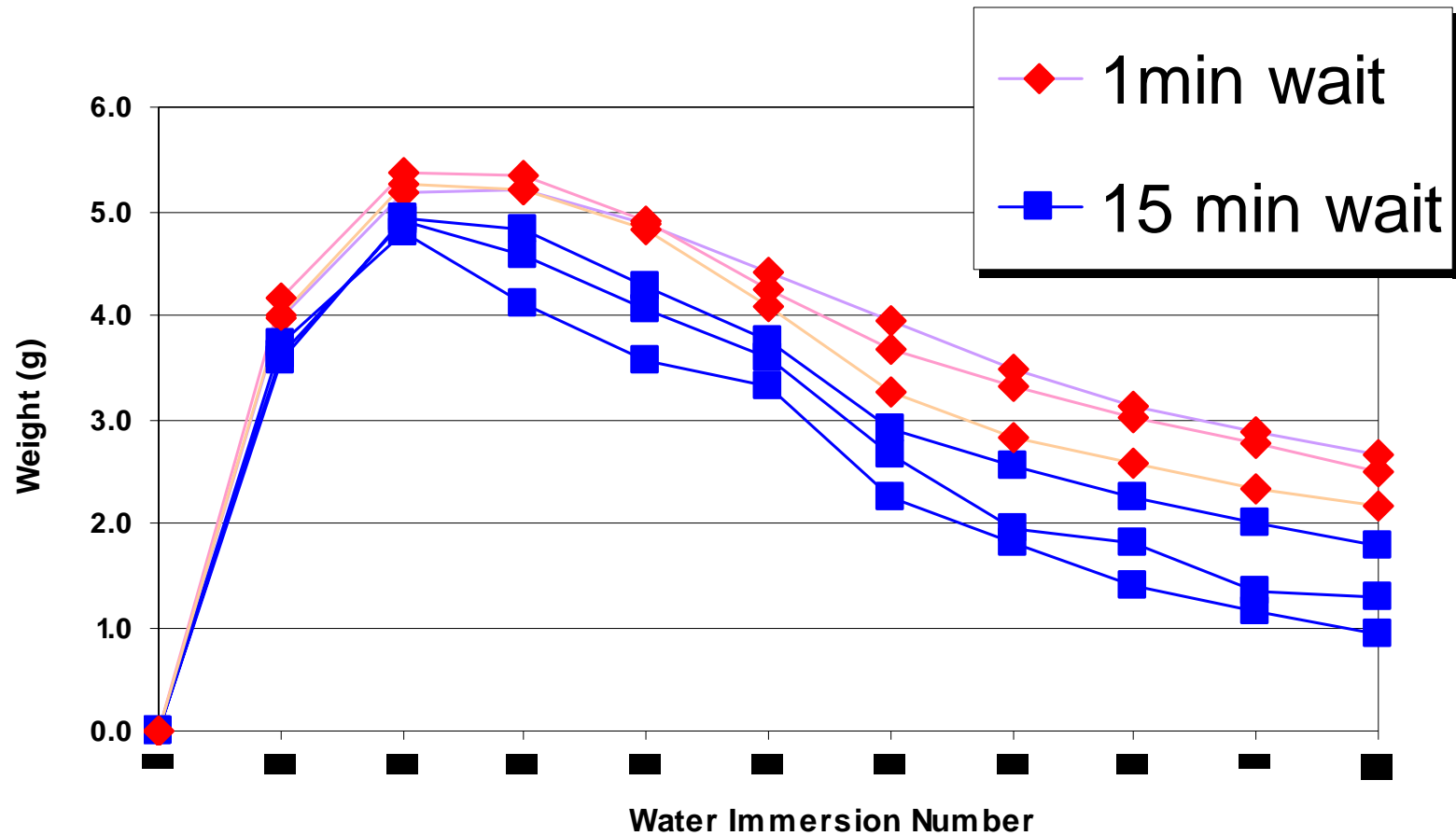


1 min wait



15 min wait

Longer Wait Times



Longer Wait Times

By waiting a longer time, there was less water dripping all over the place, but much gel dripping. This led less gel being measured, but more variation in the results.

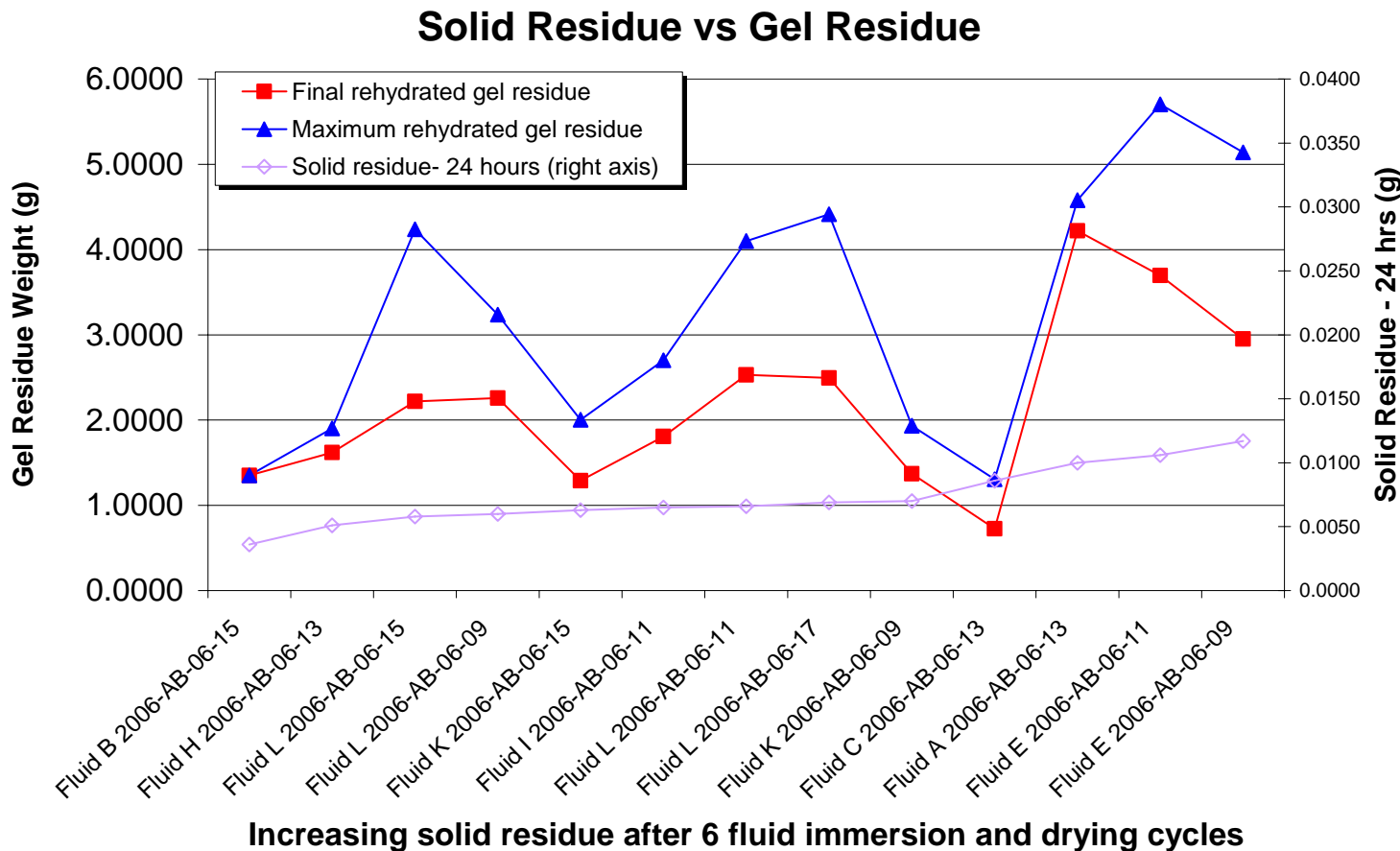
Conclusions

FACTOR INVESTIGATED	EFFECT
Complete dryout	<u>Important:</u> Fluid must completely dryout
Steady immersion	<u>Important:</u> Can be achieved with an automated dipping machine
Bubbles in fluid	Not necessary to centrifuge
Plate treatment (etching)	<u>Important:</u> Must be performed prior to each test
Plate replacement	<u>Important:</u> New (and etched) plates should be used
Fluid Dilutions	Little or none
Mixed fluid immersion	No more gel in the mixture than when the two fluids were tested separately
Longer wait times	More variation in results

Discussion

- Solid Residue Versus Rehydrated Residue
- Viscosity Versus Gel Residue
- Fluid Classifications
- Threshold or Minimum Weight

Solid Residue Versus Rehydrated Residue



➔ **No correlation**

Viscosity Versus Gel Residue

Because the relative viscosities of the fluids are well known,
can't present curves.

But there is no relation

As seen by the dilutions with different viscosities and different residues

Fluid Classifications/Comparison

Under investigation:

for EASA all currently qualified thickened fluids

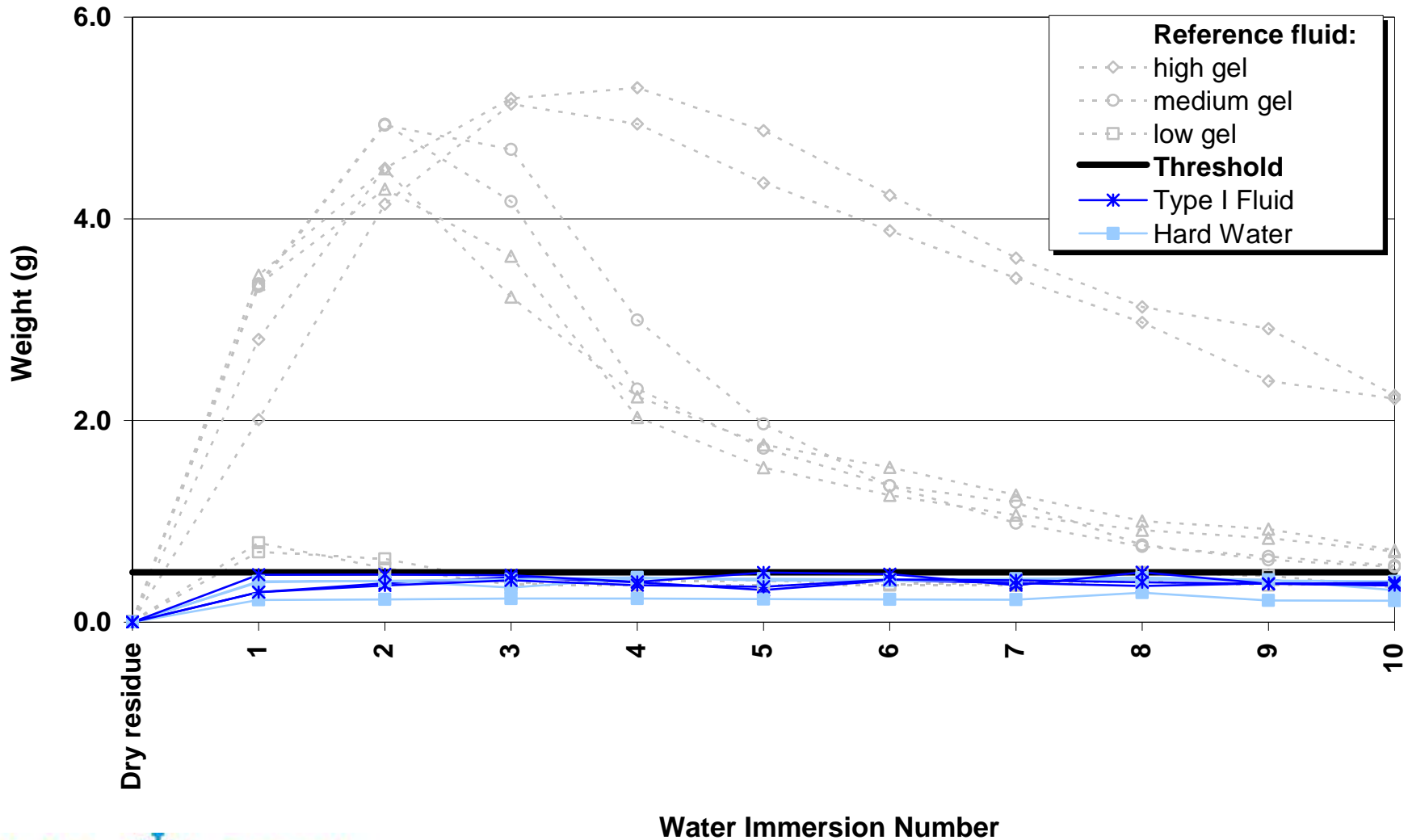
were tested this summer at AMIL

according to the same protocol

Data is currently being examined by the fluid manufacturers

Threshold or Minimum Weight

Weight of Rehydrated Residue (gel)



Future Research

- Effect of Runway Fluids
- Effect of Type I Rinses
- Gel Characterization
 - Measure gel adhesion to solid surfaces

Future

- I think we have, or will have, a repeatable test
- Need to compare the data of the fluids tested this summer
- Need to find out whether the test is representative of the issue
- Need to bring parts of an aircraft into the lab, cold rooms, spray fluids, make gels, freeze gels, analyze adhesion, rigidity...