

*International Aircraft Materials Fire Test
Working Group Meeting*

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Small Scale Burn-Through Test Set-up

Comparison study

Teclu burner versus 2 - and 6 - gallon
oil burner

Agenda

- Motivation
- History
- Test set up principles
- Modification
- Test results
- Comparison to state of the art
- Future activities



Teclu burner



Teclu burner, modified



Cargo penetration test set up



Teclu test set up



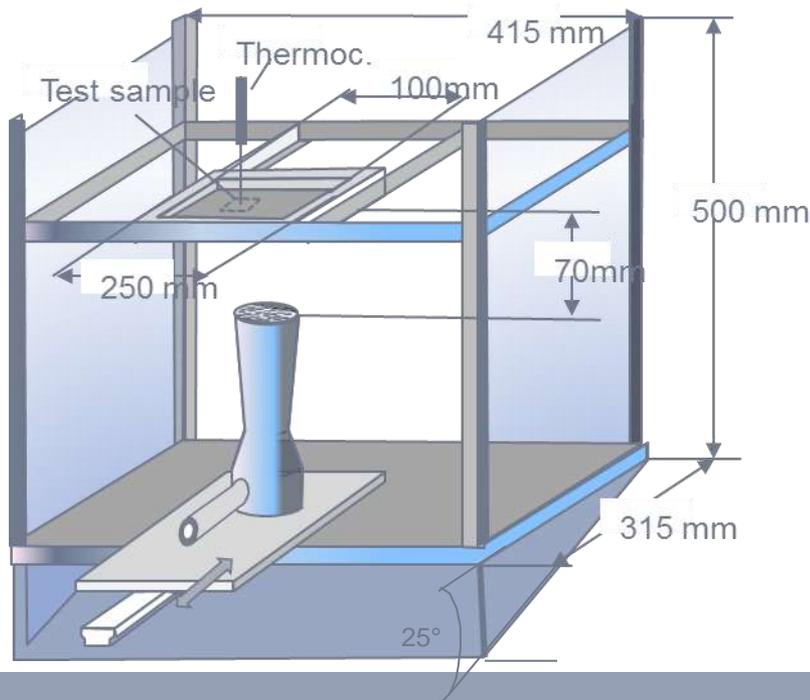
Fuselage burn through test set up

Motivation

- **To offer the industry a robust, simple and small test tool for material investigation with the certification test methods of CS/FAR 25.855 Appendix F, Part III (cargo flame penetration) and CS/FAR 25.856 Appendix F, Part VII (fuselage burn through) in mind.**
 - The tool shall be able to generate reproducible test results
 - Test results shall be comparable to the existing lab scale test methods
 - CS/FAR 25.855(c)
 - CS/FAR 25.856(b)
 - It shall be operable easily without big infrastructure

History

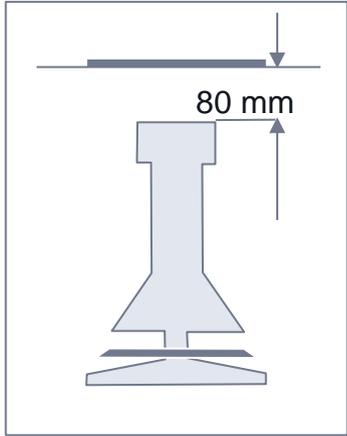
- During the intumescent paint material development Airbus was looking for a simple test tool for material screening. Airbus aimed for a flame penetration test with small sample sizes that are assessable and comparable to the certification test method CS/FAR 25.855(c).
- The test method screening ended in the first development step with the implementation of the unmodified Teclu burner and a simple test rig.



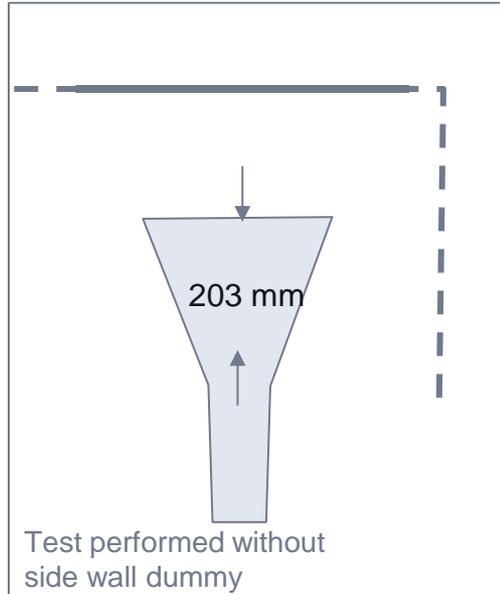
Test parameter:

Flame Temp.:	1200°C
Sample size:	100 mm x 100 mm
Sample inst.:	horizontal
Distance burner/sample:	80 mm
Gas pressure:	0.5 bar
Air supply:	no limitation to self-feed of burner

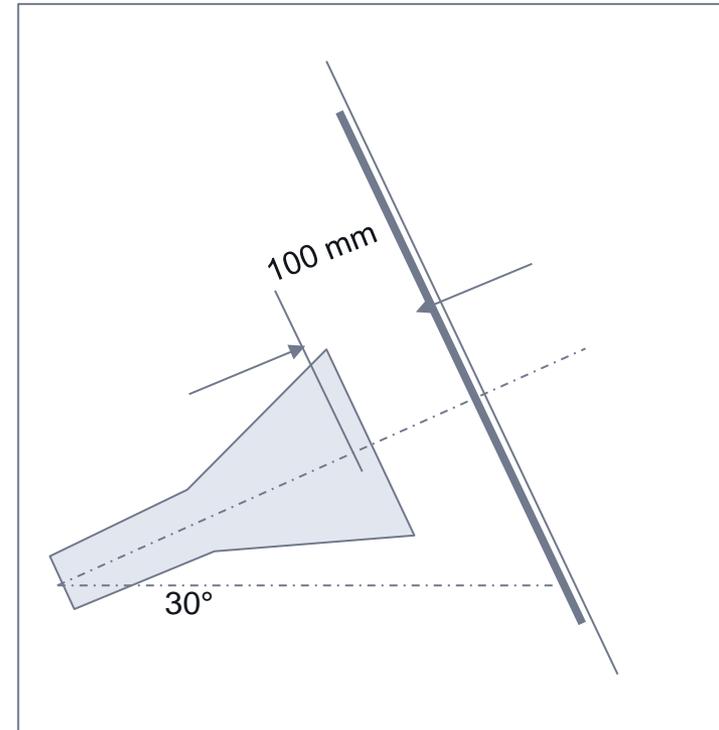
Test set up principles by comparison



Teclu set up,
 Propane-gas burner
 1200°C, app.190 kW/m²
 Self-fed with air
 Sample size 100 x 100



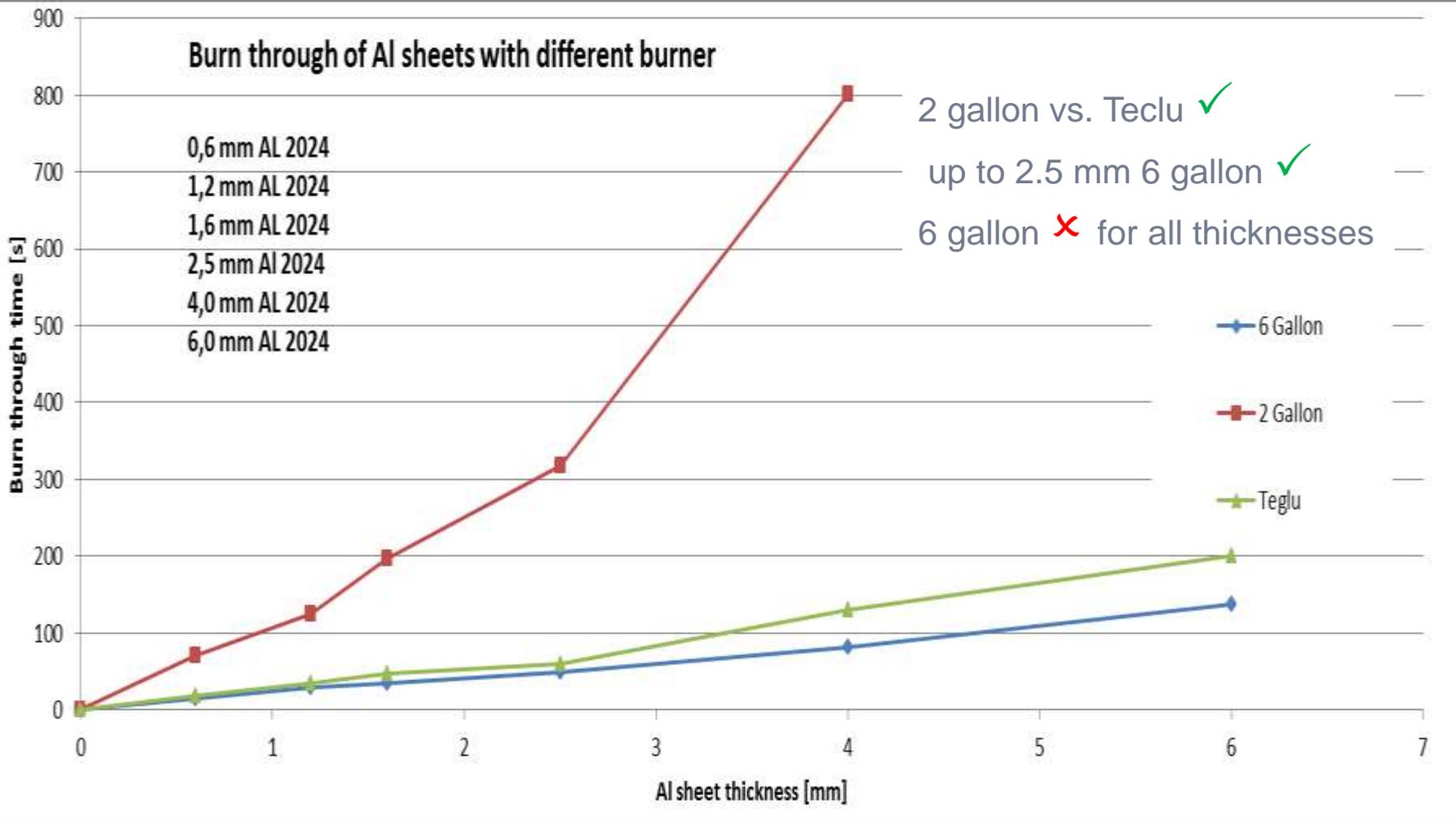
Test performed without side wall dummy
 Cargo penetration test,
 2 gallon oil burner
 960°C, 96 KW/m²
 Force-fed with air
 Sample size: 610 x 406



Fuselage burn through test,
 6 gallon oil burner
 1050°C, 182 KW/m²
 Force-fed with air
 Sample size: 930 x 930

Burn-through results of Al-sheets

Burn through of Al sheets with different burner



- 0,6 mm AL 2024
- 1,2 mm AL 2024
- 1,6 mm AL 2024
- 2,5 mm AL 2024
- 4,0 mm AL 2024
- 6,0 mm AL 2024

2 gallon vs. Teclu ✓
 up to 2.5 mm 6 gallon ✓
 6 gallon ✗ for all thicknesses

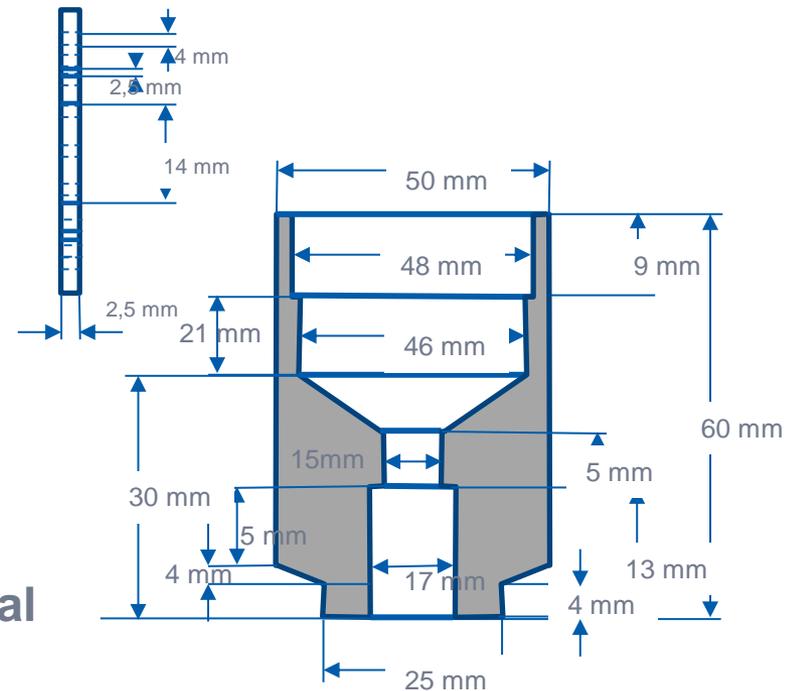
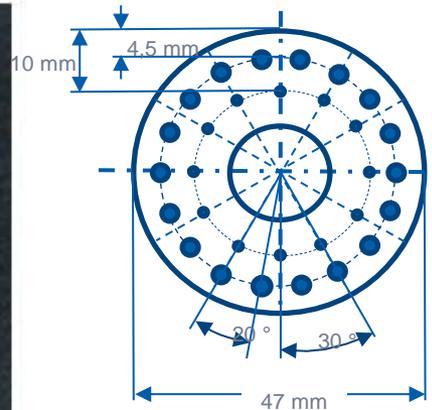
- ◆ 6 Gallon
- 2 Gallon
- ▲ Teglu

Modifications

- The aim of the modifications is to find parameter settings to reach the same or equivalent burn through times of different Al sheet thicknesses compared to both certification burn through test methods.
- Therefore the following parameters have been changed
 - Burner flame characteristic (flame size, gas/air mixture)
 - Sample size
 - Distance between burner and sample
 - Test rig housing (closed or open housing)
- In the first investigation step, Al sheets, in a thickness range of 0,6 mm up to 6 mm have been tested.

Telcu burner modifications for cargo flame penetration

- To have a bigger flame the burner outlet was changed.
- Four different burner discs have been tested to find an optimal temperature profile within the flame.
- Final design featured twice the size (area) of the original Teclu



Finally, this modification was chosen for 2 gal cargo flame penetration test

Telcu burner modifications for cargo penetration test

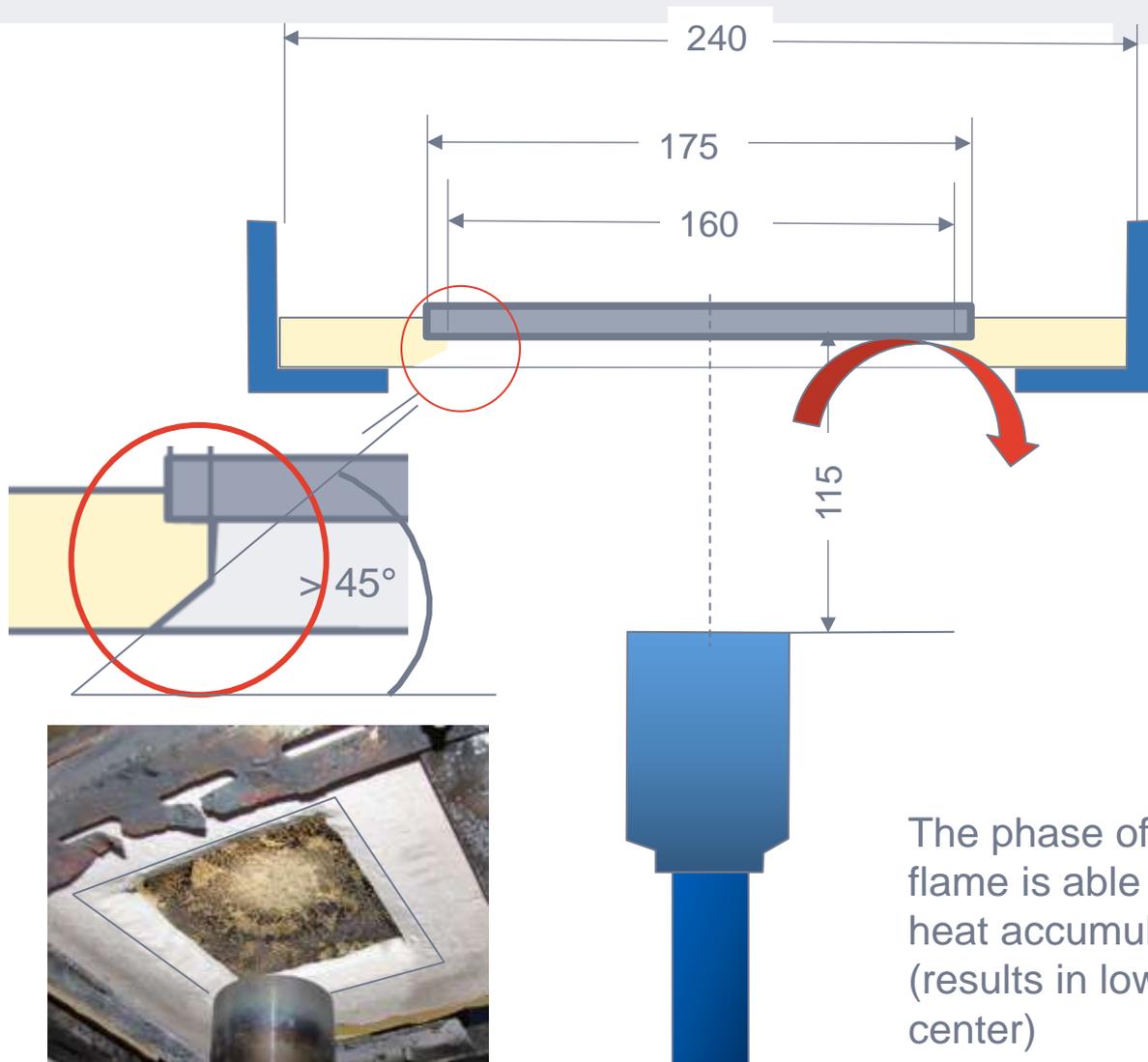


The pre-screening results showed that the flame was too aggressive to provide equivalent flame penetration times compared to the CS/FAR 25.855, App. F, Part III test method (2 gal).

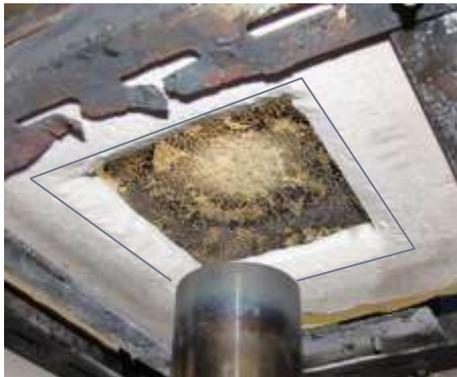
To be more comparable to the cargo test the air / propane gas mixture has to be adjusted.

- Propane gas via pressure regulator to 0,5 bar
- The air via a metal ring (\varnothing 32 mm) with 12 drill holes (\varnothing 3,4 mm) providing a fixed opening and therefore constant and reproducible flame parameters
 - Temperature $1000\text{ }^{\circ}\text{C} \pm 20\text{ }^{\circ}\text{C}$
 - Heat flux 98 kW/m^2
 - Gas support 392 g/h Propane

Test rig modification for cargo penetration test

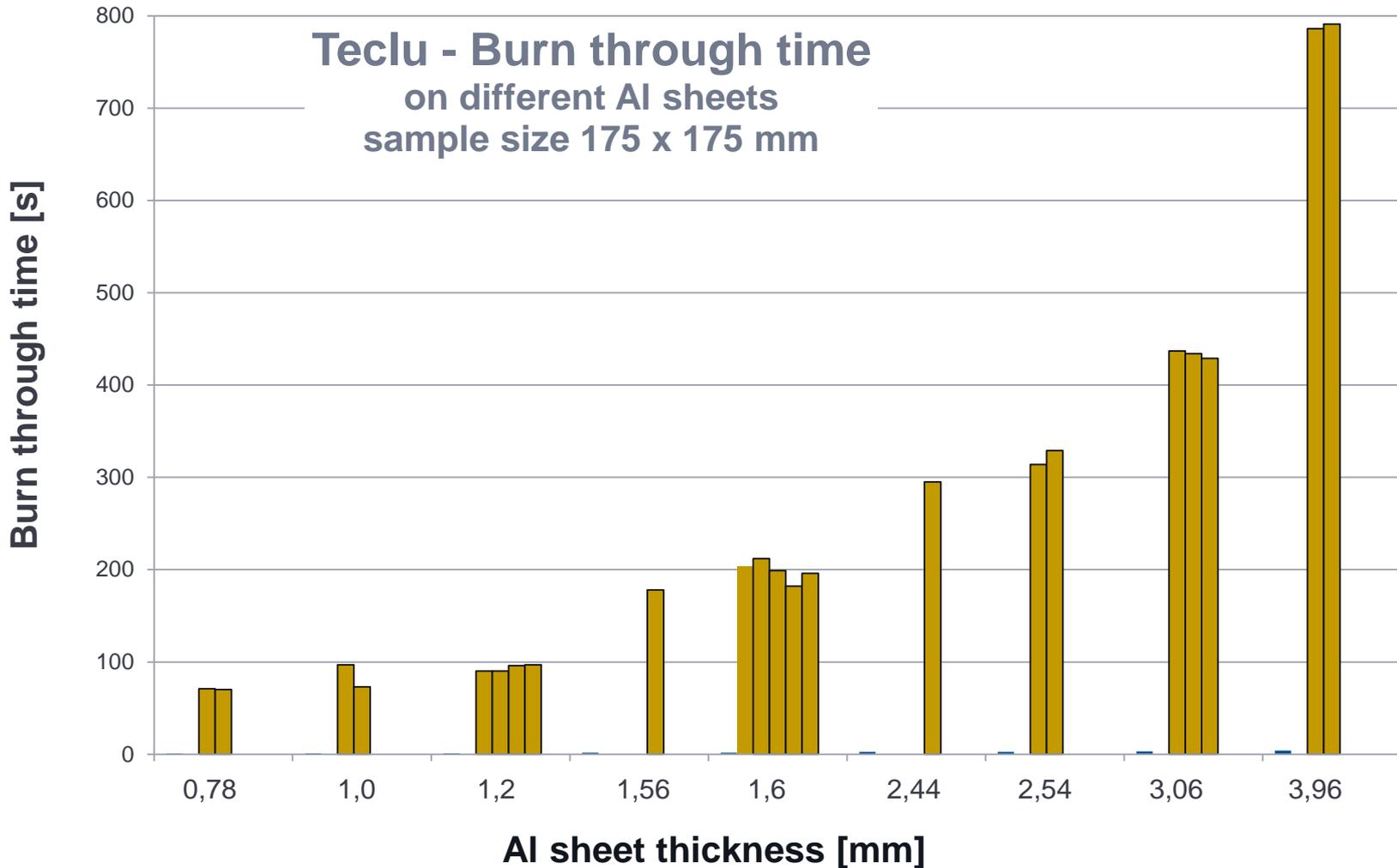


Test without 45° phase
Heat accumulations

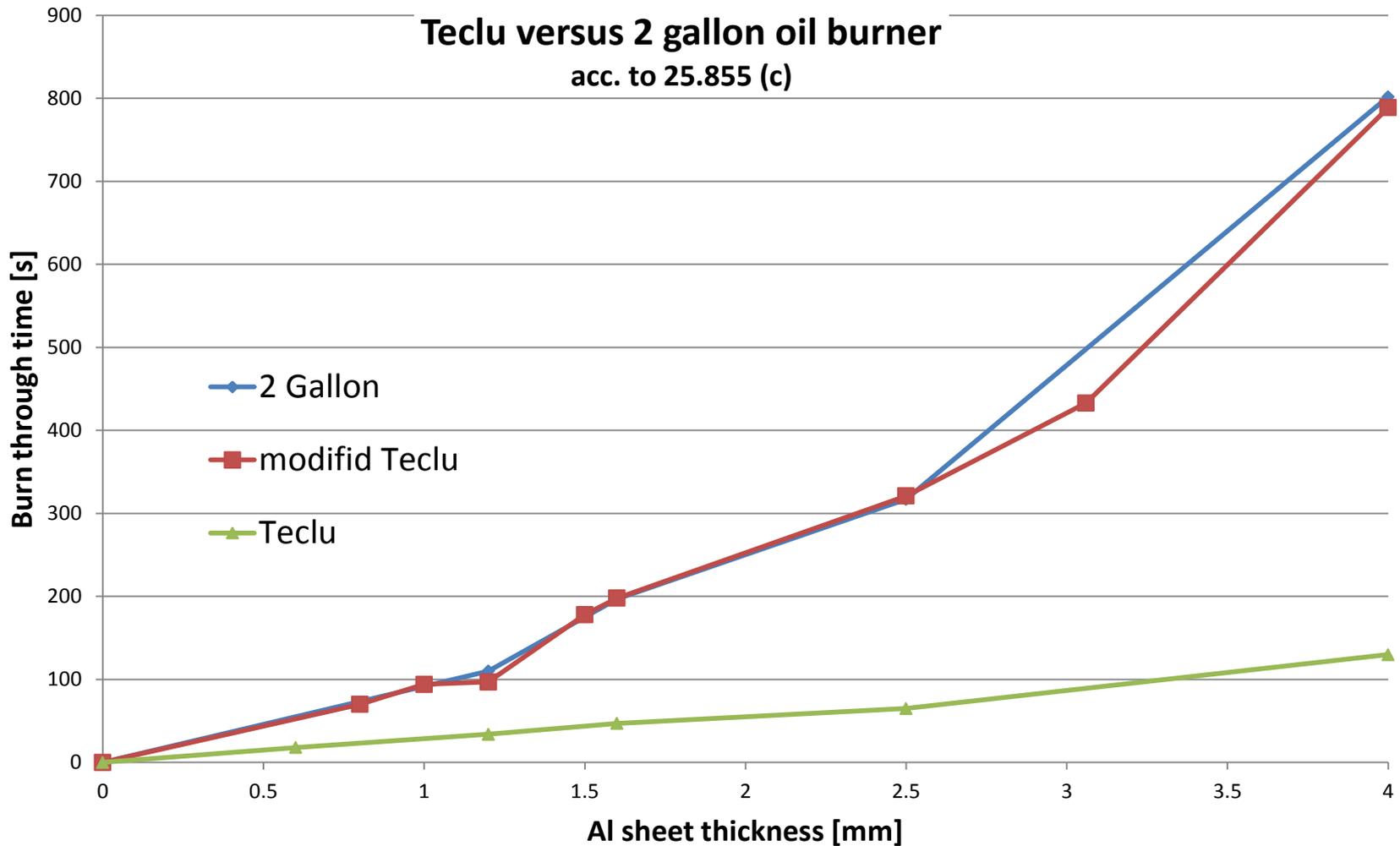


The phase of min 45° is necessary that the flame is able to glide sideward and to avoid heat accumulations in the edge areas (results in lower burn-through times in the center)

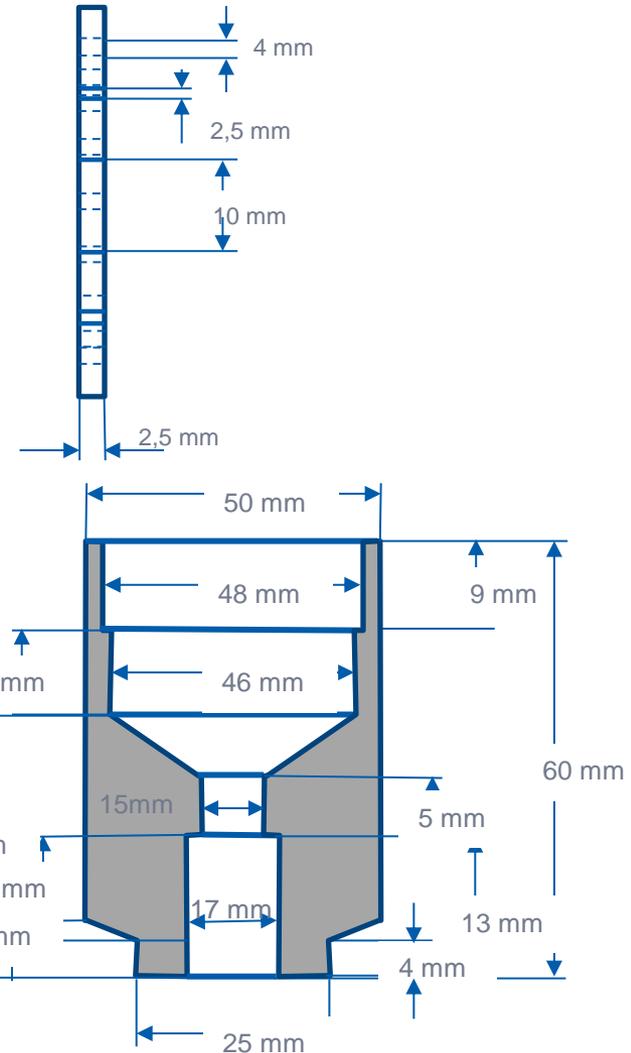
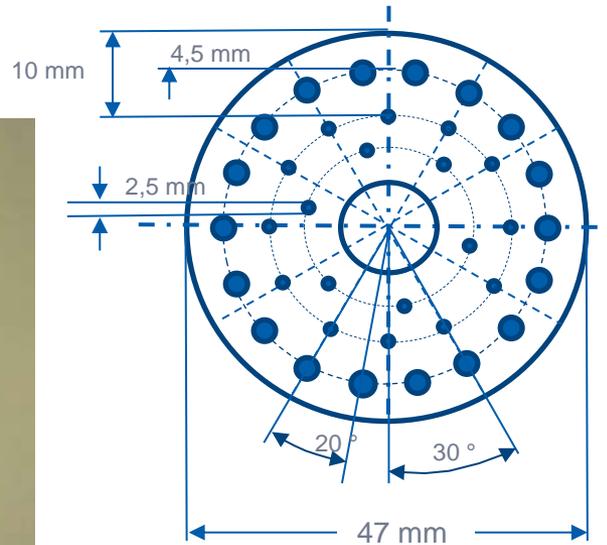
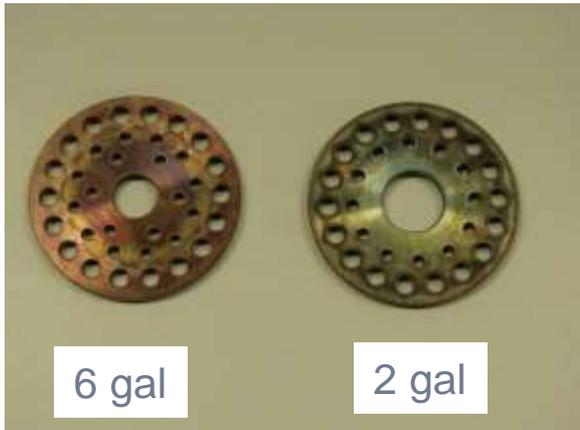
Teclu results with cargo penetration parameter setting



Modified Teclu results with cargo penetration by comparison



Telcu burner modifications for fuselage burn-through

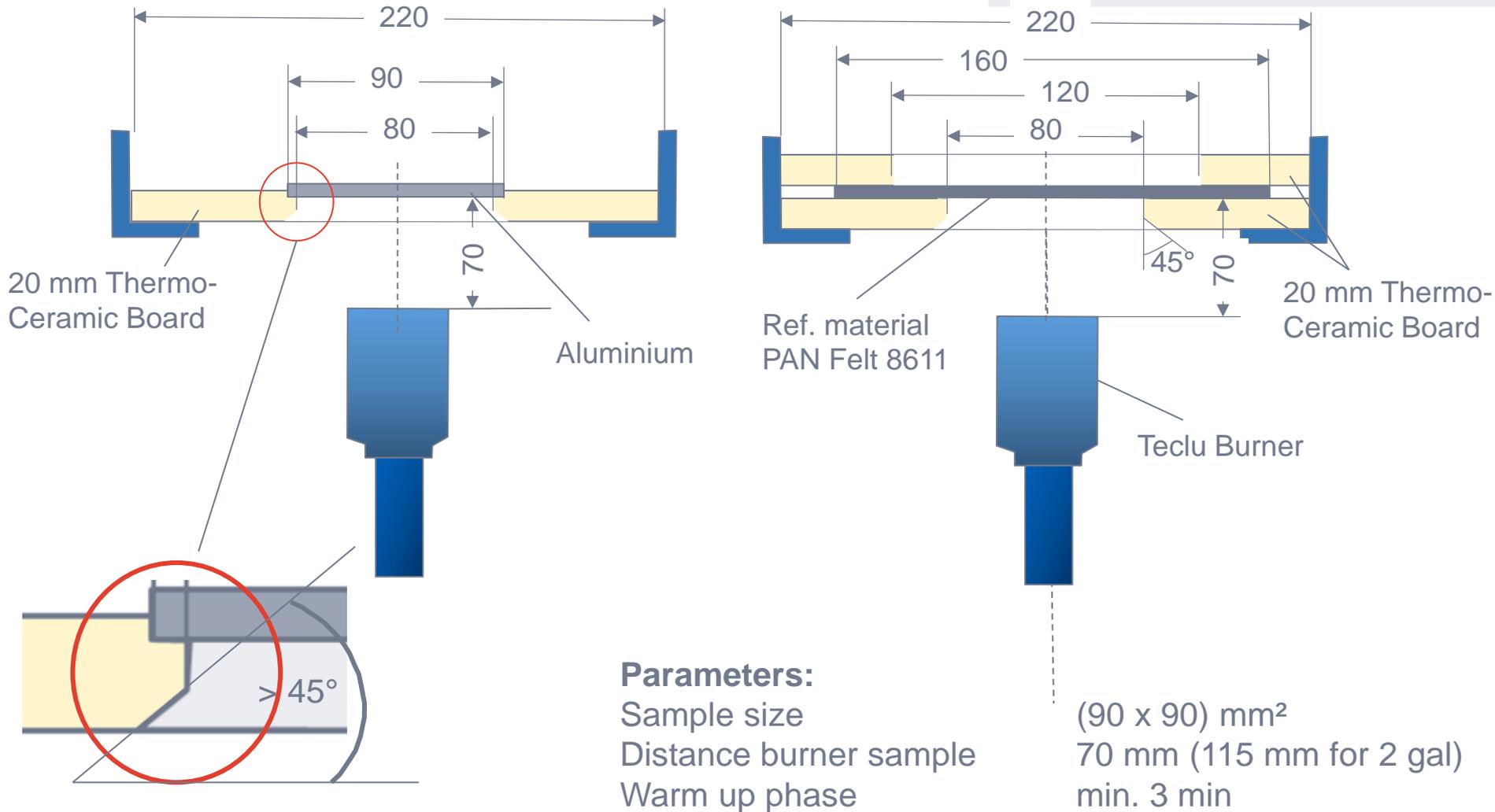


New burner disc modification

To reach equivalent burn through times compared to the 6 gallon oil burner a lot of parameters had to be changed.

Based on the modified 2 gal Teclu burner, the hole pattern of the disc was changed to provide a more evenly distributed flame.

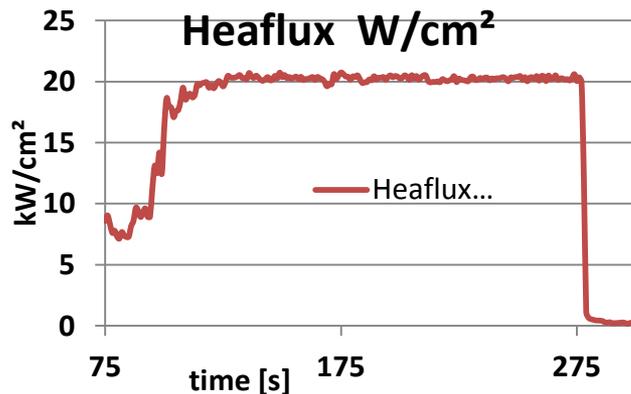
Test set up principles for fuselage burn through



Test set up principles for fuselage burn through



Air supply fully open



The pre-screening results showed that the flame was not aggressive enough to provide equivalent flame penetration times compare to the CS/FAR 25.856(b), App. F, Part VII test method when testing Al sheets.

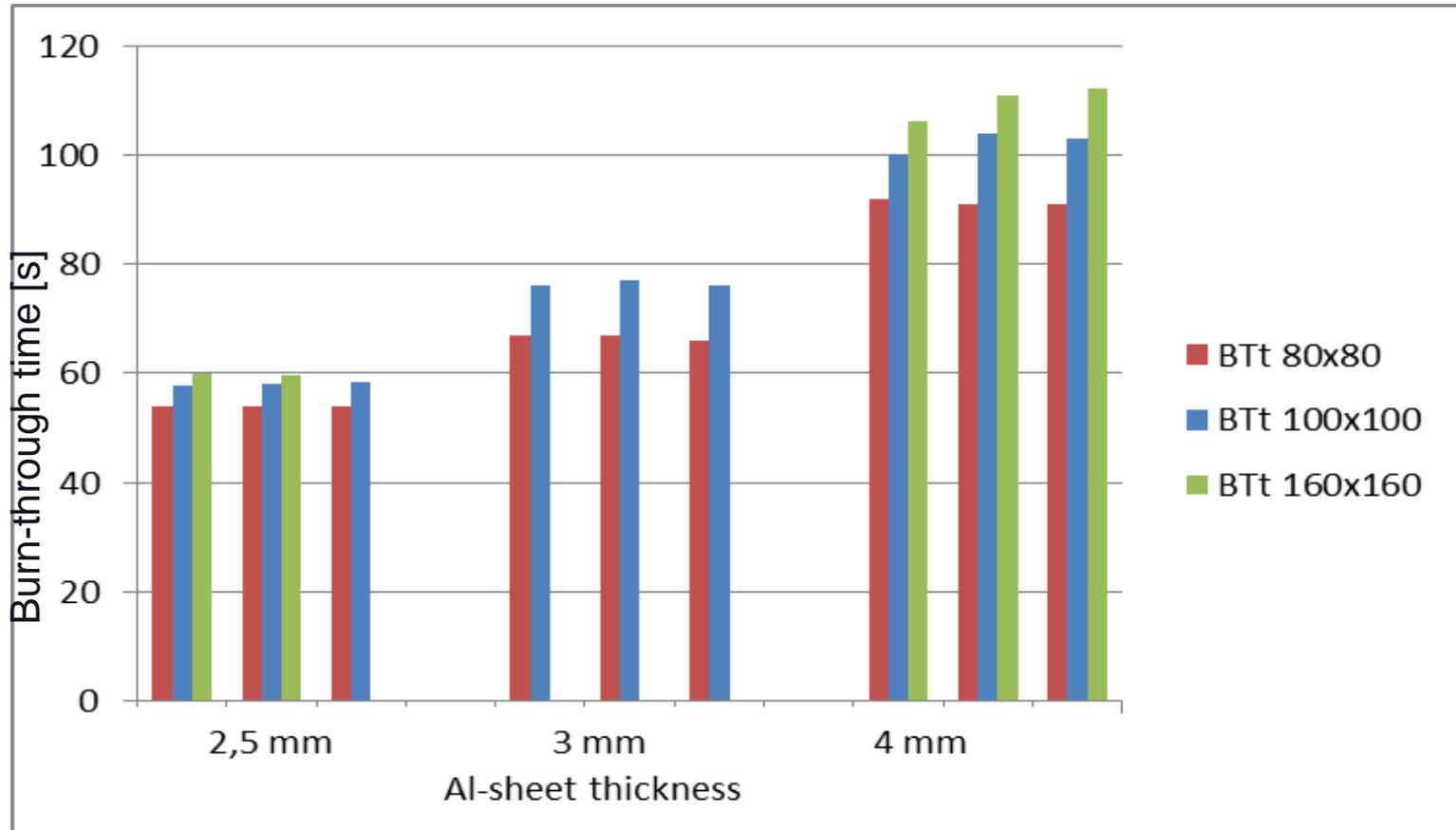
To be more comparable to the 6 gallon burner, the air/propane gas mixture has to be readjusted.

- Propane gas via pressure regulator has been set to 1,5 bar.
- The air supply was turned to max. opening.

This changes lead to

- | | |
|---------------|-----------------------|
| - Temperature | 1220 °C ± 20 °C |
| - Heat flux | 200 kW/m ² |
| - Gas support | 1040 g/h Propane |

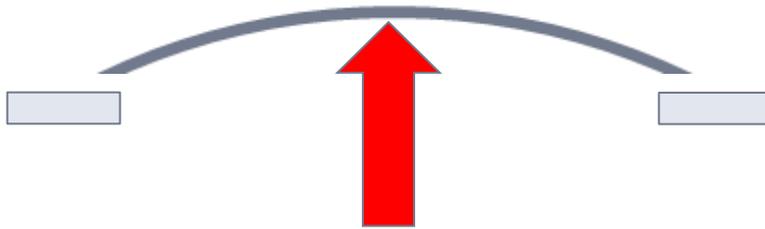
Teclu test set up - Sample size influence on Al sheets



The influence of the sample size increase with larger sample thickness

Teclu test set up - Sample direction influence

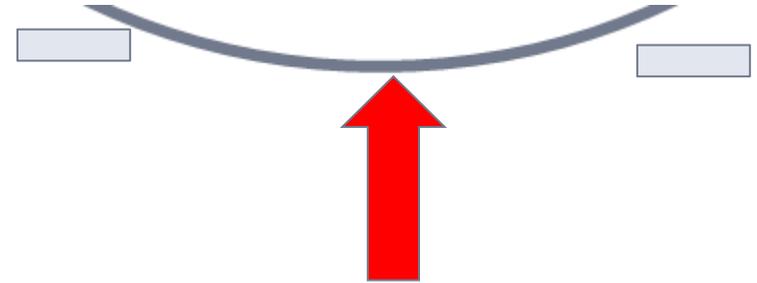
Flat samples warped during the test!



Al 1,6 mm, sample size 175 x 175

Burn through time: 196 s; 198 s

Material designation print upwards



Al 1,6 mm, sample size 175 x 175

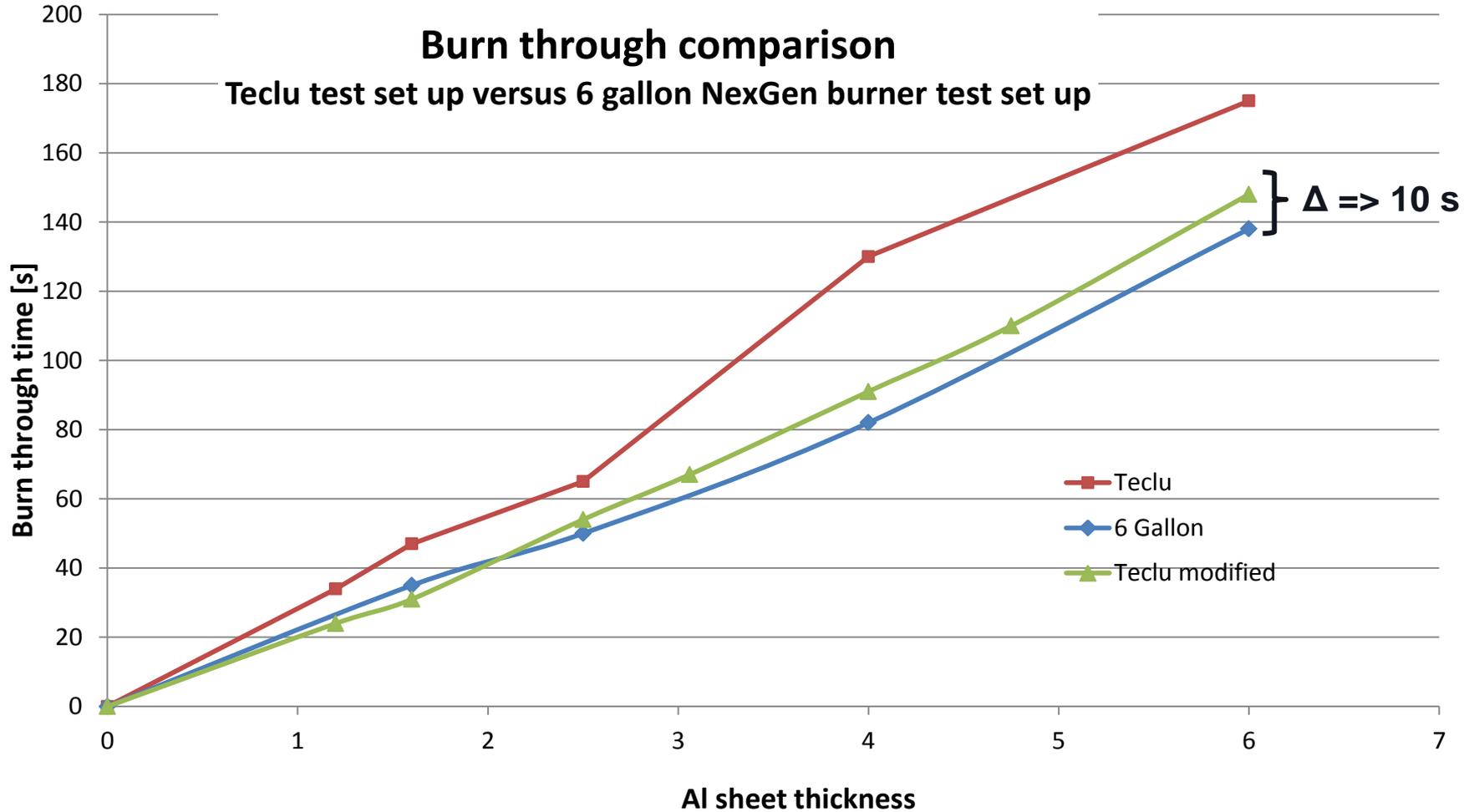
Burn through time: 220 s; 226 s

Material designation print downwards

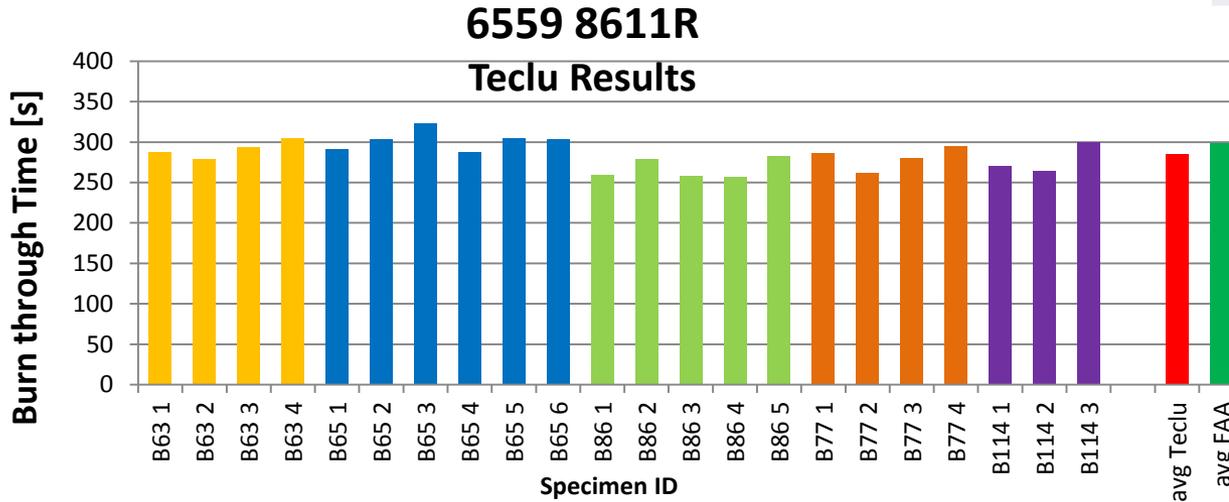
The sample direction, upper manufacturer side or lower manufacturer side of Al sheets influenced the burn through time.

The different increased with thinner Al- test samples.

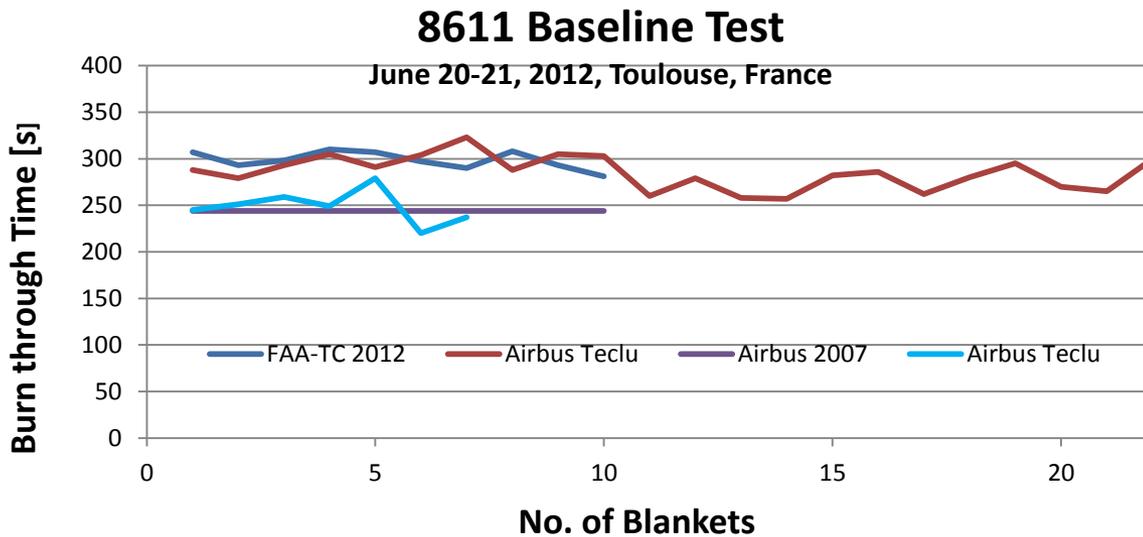
Teclu results with fuselage burn through parameter setting



Base line material (TexTech) test results

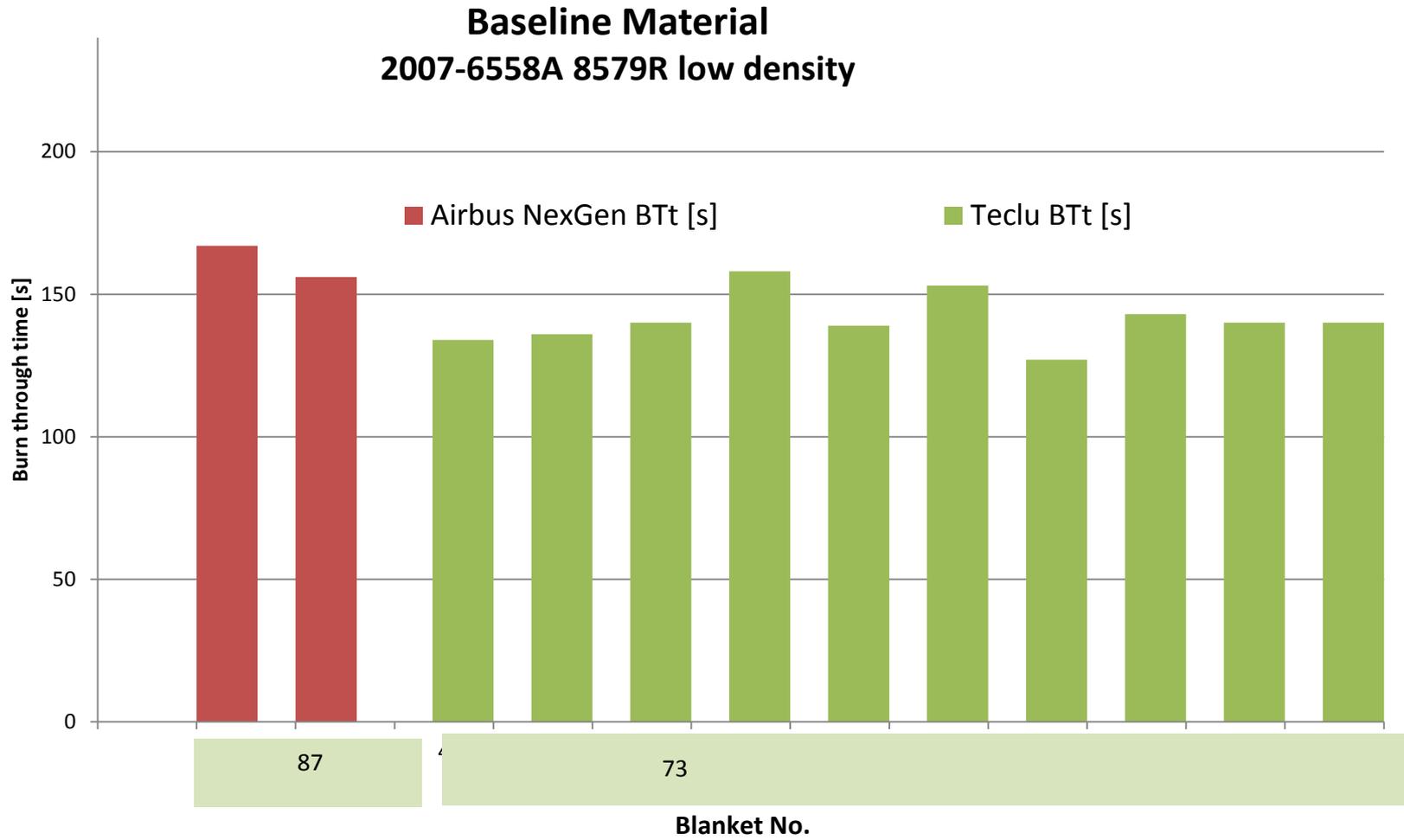


To base the comparable study not only on Al material with different thicknesses the TexTech Pan felt material has been tested in two different densities as well. These materials has been used to compare different 6 gallon NexGen oil burners during its implementation to replace the Park oil burner.

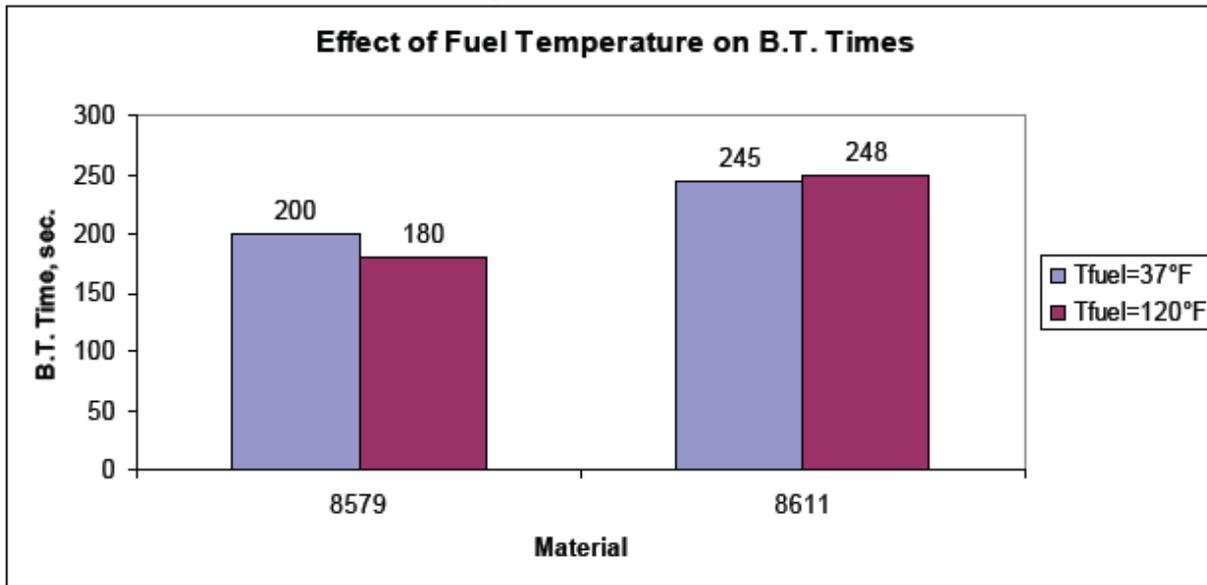


The Teclu test set up generates equivalent burn-through times for the 8611R TexTech material compare to the NexGen 6 gallon oil burner

Base line material (TexTech) test results



Effect of Fuel Temperature on B.T. Times

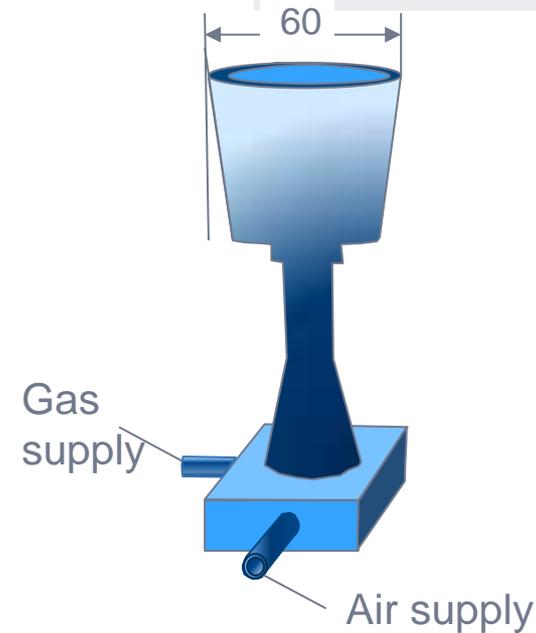


- **Material 8611 seems to be unaffected by changes in fuel temperature**
- **Material 8579 shows a significant change in b.t. time for varying fuel temperatures**
- **Material 8611 seems to be insensitive to minor changes, and will be useful for calibrating burners if an “absolute” b.t. time can be determined**
- **Material 8579 seems to be the more sensitive material to minor changes, will be useful as a diagnostic tool**

Improvements



Modified Teclu burner test rig



NexGen Teclu burner

- To accommodate the more sensitive material TexTech 8579 following changes will be made
- The burner outlet will be slightly conical to spread the flame a little bit.
 - The air as well as the gas will be controlled by mass flow controller to have a most stable flame and to set the flame parameters more sensitive and to be independent from environment air temperature and air moisture.
 - The test rig will also modified to change the distance burner – test sample quicker and to have more space for operating.

Conclusion

- The Teclu test set up in the configuration presented herein, shows equivalent results to the 2 gallon oil burner test acc. to CS/FAR 25.855(c).
- The comparability to the 6 gallon burner for fuselage burn-through is limited in this configuration only to metallic materials.
- Tests on the Pan Felt materials, - high density and low density- show that the Teclu burner react stronger compare to the 6 gallon oil burner.
- The low density material 8579 is also more sensitive in the Teclu test. The same material ranking as found during the 6 gallon NexGen oil burner.
- The next development step will integrate controlled air- and gas flow by using mass flow controller. This make a fine tuning of the flame possible and will lead to comparable burn through times of the 8579 material.

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Teglu gas burner- versus 2 and 6 gallon oil burner test set up



Test parameter:

Teglu: 1200°C; sample size 10 mm x 10 mm

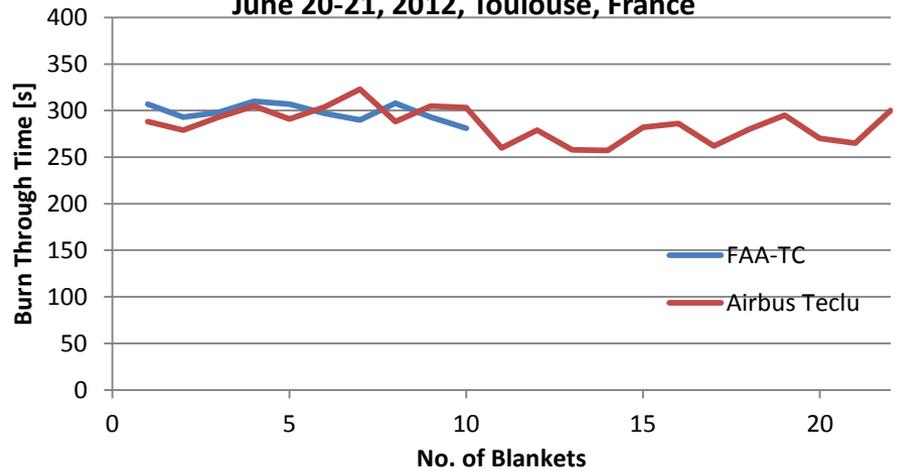
2 gallon: 960°C; sample size 610 mm x 406 mm

6 gallon: 1050°C; sample size 600 mm x 600 mm
up to 1200 mm 930 mm



8611 Baseline Test

June 20-21, 2012, Toulouse, France



8579 Baseline Tests

