

## Fire resistance tests at SP



- Three sets of tests were conducted
  - Mock-up chassi, varying fuel, pre-heating time, direct exposure time and indirect exposure time. Tests were conducted to evaluate different procedures.
  - Temperature and Heat Release Rate depending on fuel (winter and summer 98 octane petrol and Heptane). Tests were conducted to assess different fuels.
  - Temperature as a function of height above fuel. Tests were conducted to establish suitable placement for a RESS in a component test.



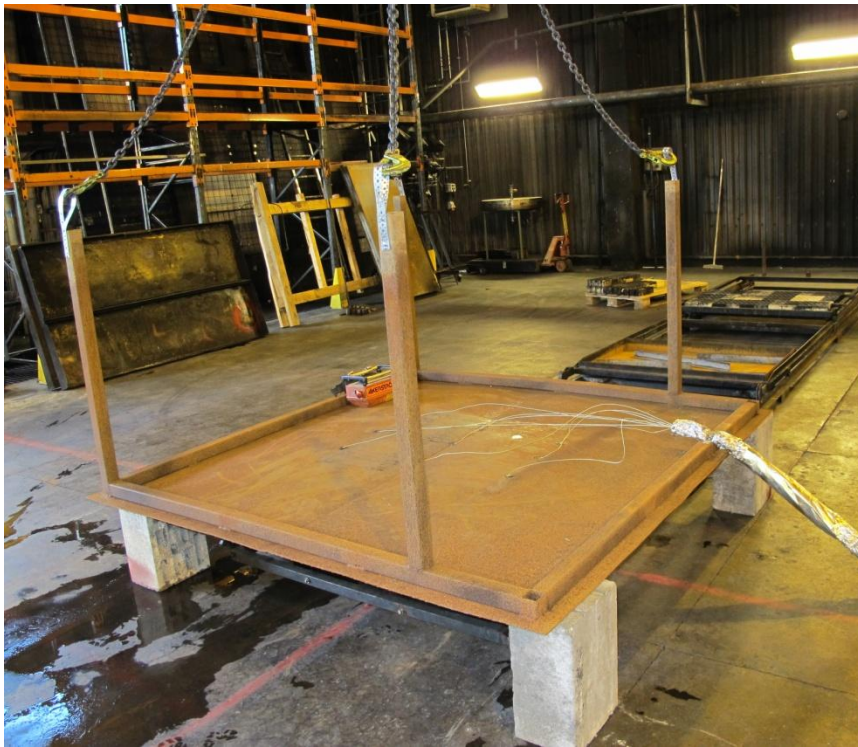
# Tests with mock-up chassi

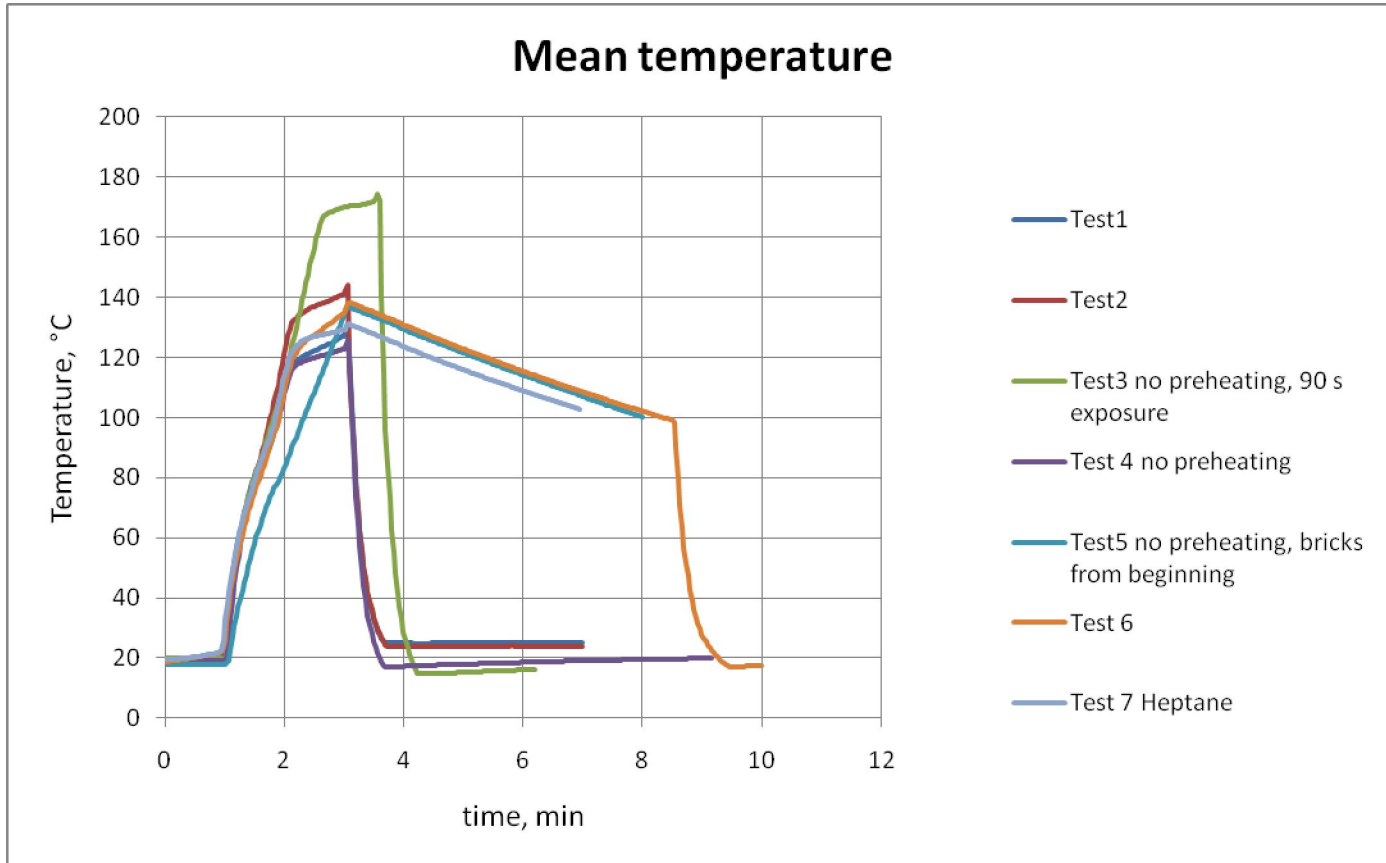
- Test 1 swedish winter petrol, normal R34 procedure
- Test 2 same as test 1
- Test 3 winter petrol, no pre-heating, 90 s direct exposure (without bricks), 60 s indirect exposure (with bricks)
- Test 4 winter petrol, no pre-heating 60 s direct exposure, 60 s indirect exposure
- Test 5 winter petrol, no pre-heating, 120s indirect exposure with bricks in place entire time, no cooling afterwards
- Test 6 repetition of test 1
- Test 7, Heptane, normal R34 procedure

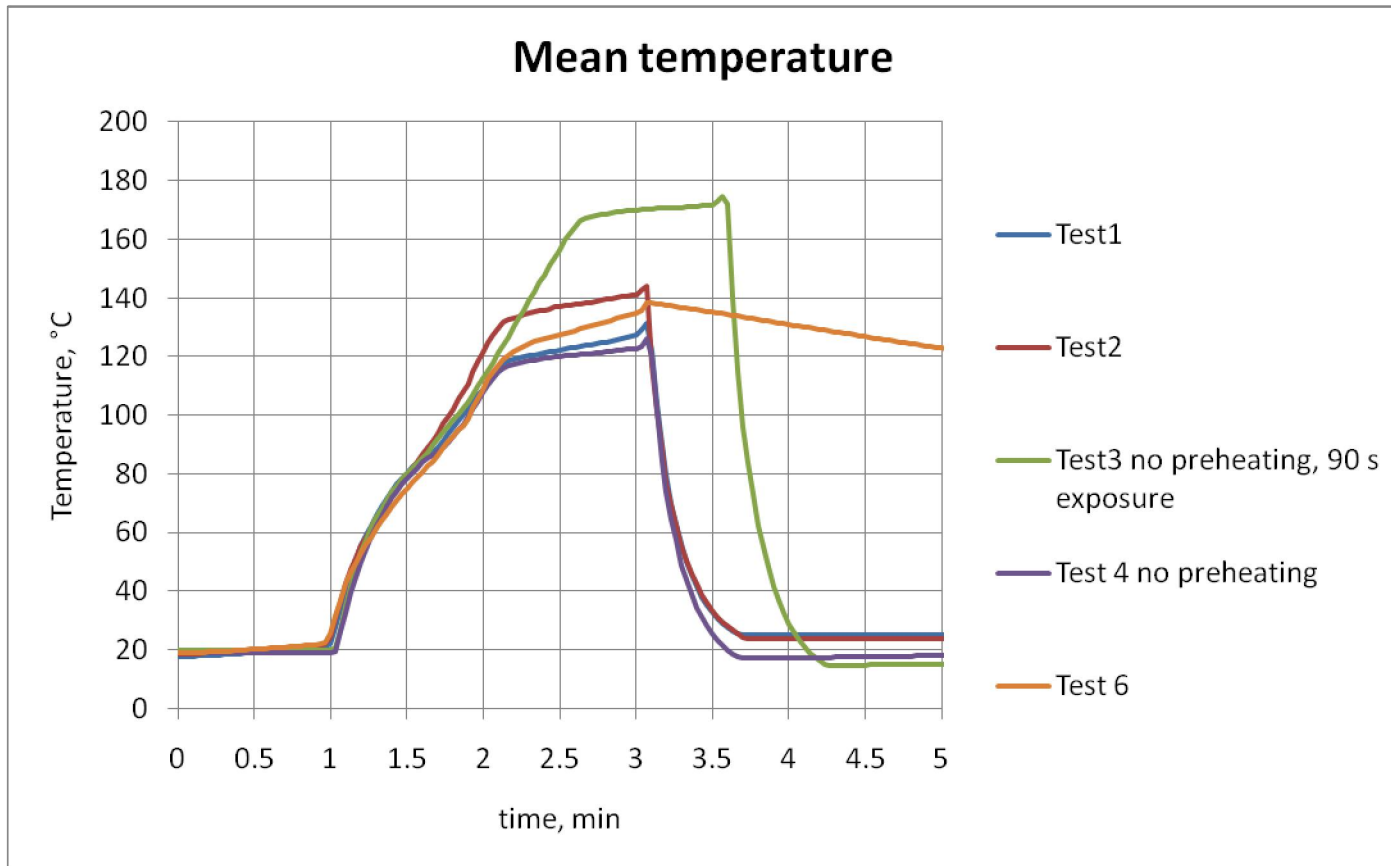


# Tests with mock-up chassi

- The temperature was measured at 5 places on the "chassi"
- Heat Release Rate was also measured









# Conclusions test 1-7

- Preheating makes some difference, the influence might be larger if the fuel is not kept at RT before ignition
- There is a stochastic variation in exposure, suggest to increase direct exposure by 10 s to compensate for this and the exclusion of preheating
- Cooling afterwards influences the result, but is not a realistic scenario – suggested that it be removed based on this
- Having the bricks in place from the beginning, i.e indirect exposure during entire time, results in a slower heating but the end temperature is about the same as in the normal procedure, suggested to retain heating with and without screen



# Different Fuels

- Test 8 Swedish Winter Petrol
- Test 9 Same as test 8
- Test 10 Heptane
- Test 11 Swedish Summer Petrol

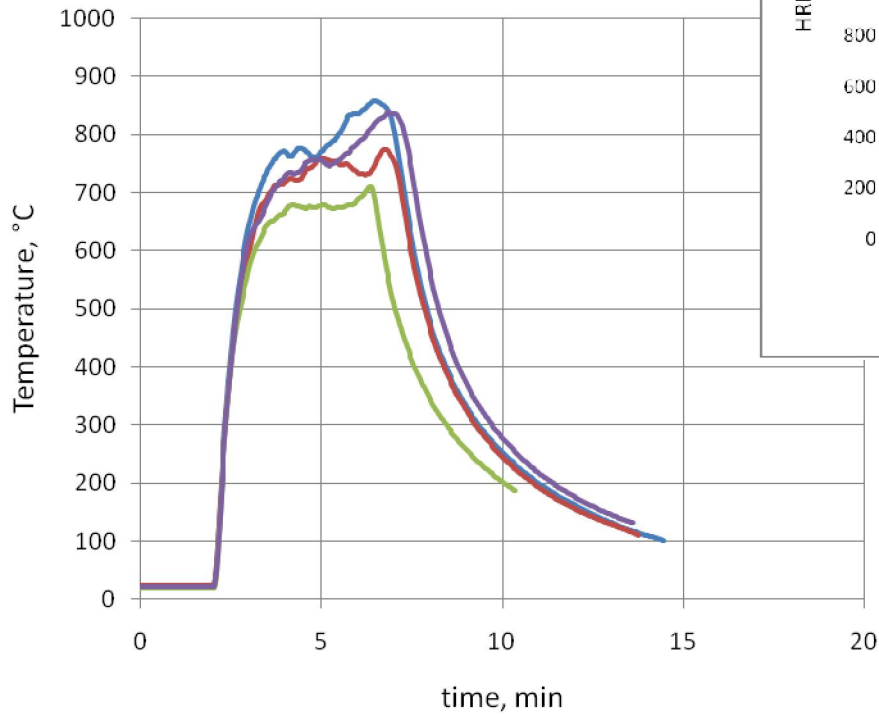
- Three Plate thermometers (measures thermal impact) were mounted above the fuel surface
- Heat Release Rate was measured



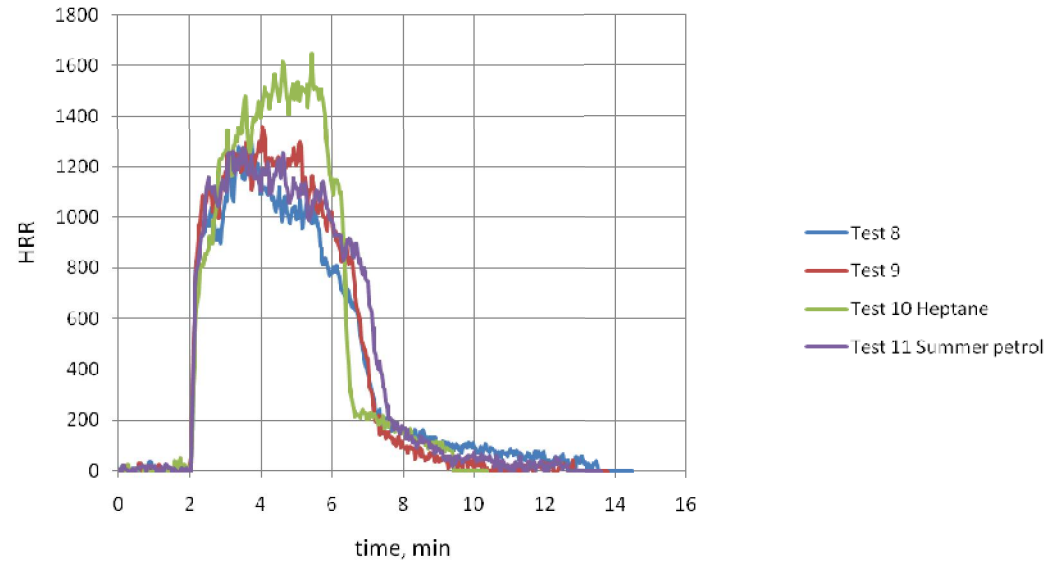


# Different Fuels

### Mean temperature Test8-11



### HRR Test8-11



- Test 8 Mean TC 1-3
- Test 9 Mean TC 1-3
- Test 10 Heptane Mean TC1-3
- Test 11 Summer petrol Mean TC1-3

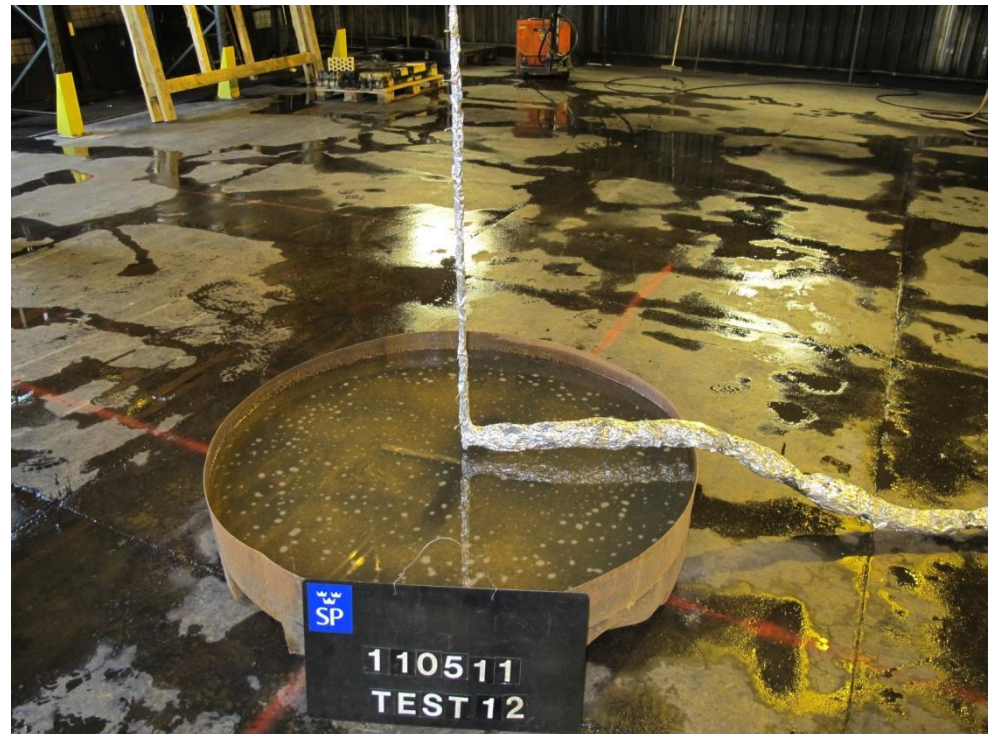
**CONCLUSION** → Keep commercial fuel



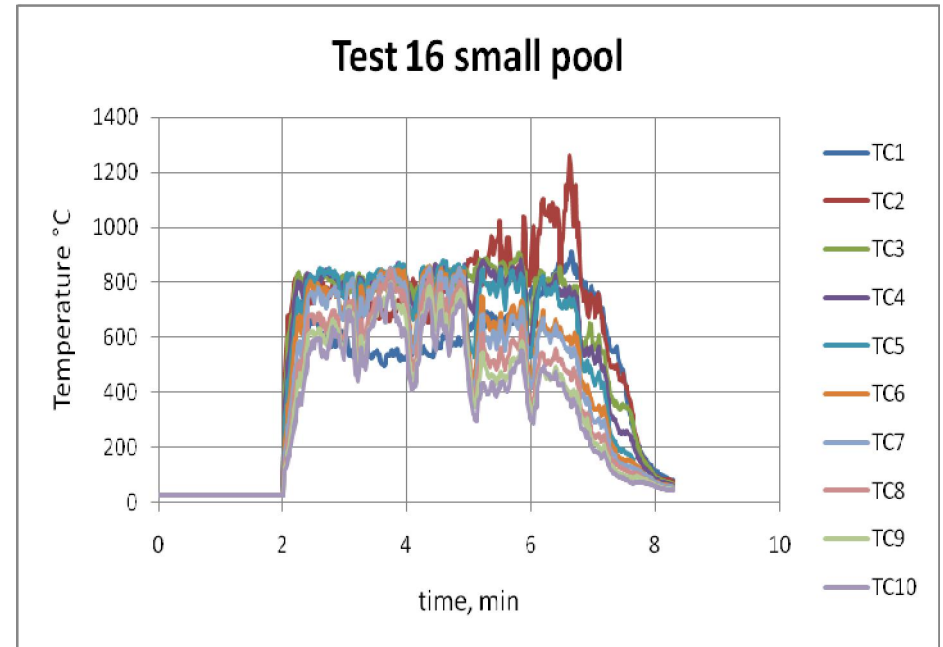
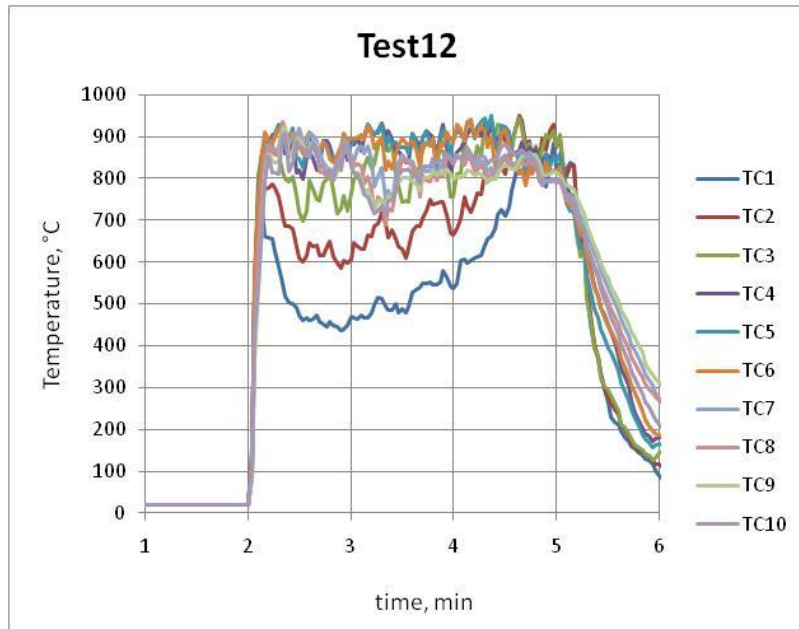
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# Component test

- Test 12 pool 1.17 m diameter (1.1 m<sup>2</sup>) winter petrol
- Test 13 pool 1.48 m diameter (1.7 m<sup>2</sup>) winter petrol
- Test 14 pool 1.67 m diameter (2.2 m<sup>2</sup>) winter petrol
  
- Temperature measured every 10 cm above pool
- Heat Release Rate measured



# Component test

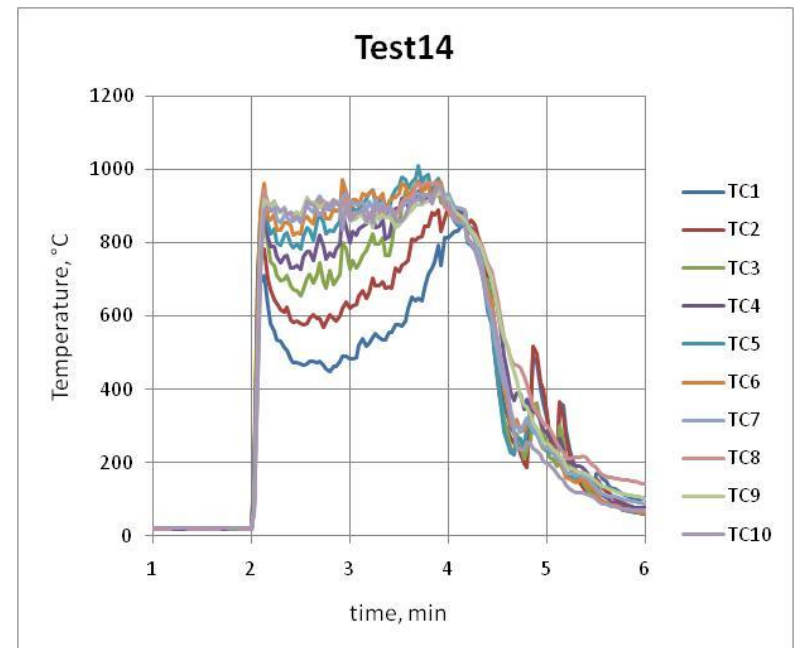


About the same temperature  
above 50 cm

**CONCLUSION** → place RESS at 50 cm



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### **3.5.2.3 Acceptance criteria**

During Phase A to D of the test, the RESS shall exhibit no evidence of fire, rupture or explosion, as defined in Table X of this document.

No dangerous voltages shall be available on the chassi or RESS.

### **3.5.3 Verification**

The fire, rupture and explosion criteria are verified by inspection.

Indicators of fire, rupture or explosion include, but are not limited to: sudden increase in flame intensity or size, emission of projectiles, loud noise.

Voltage levels towards ground shall be continuously measured during phase A to D.

If relevant after fire testing, isolation resistance shall be checked according to Annex 1.