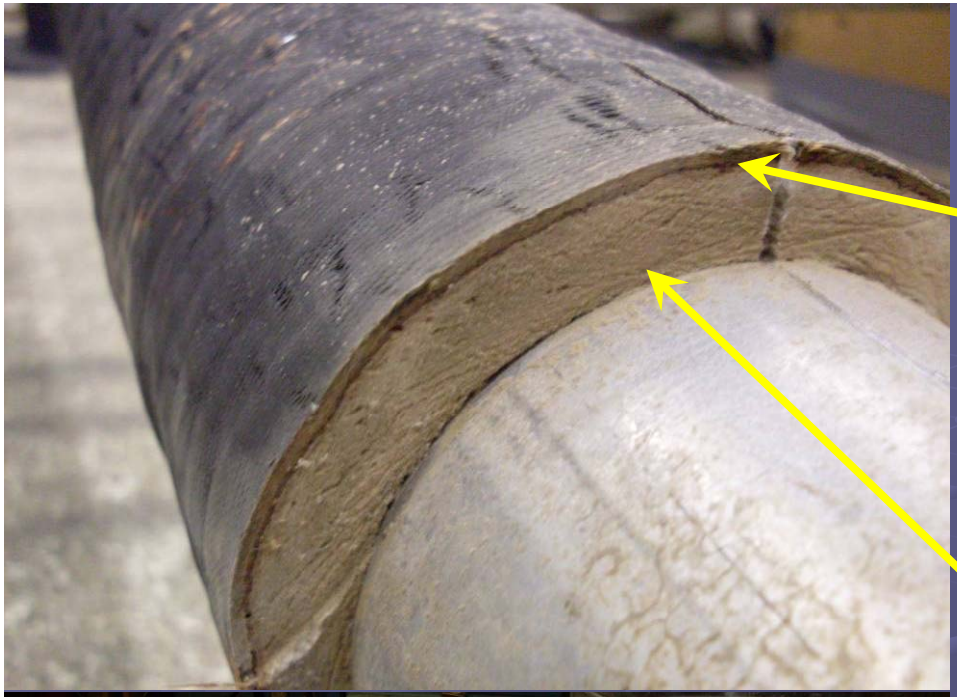
Performance Evaluation of Firwin Hard Coat Insulation

Based on Independent Study conducted by
Catalytic Exhaust Products Limited
MDEC Presentation
October 2009

Abstract

In this study, Firwin Hard Coat insulation was installed onto a 33 kW diesel generator set and was evaluated based on ISO 8497. The insulation was installed onto an engine exhaust pipe which was instrumented with 6 thermocouples attached to an 8 channel Omega TC-08 datalogger. The thermal insulation performance, heat transfer, insulation surface temperatures and rock impact damage to the surface of insulation were tested and reported. In addition the sound attenuation was tested and evaluated.

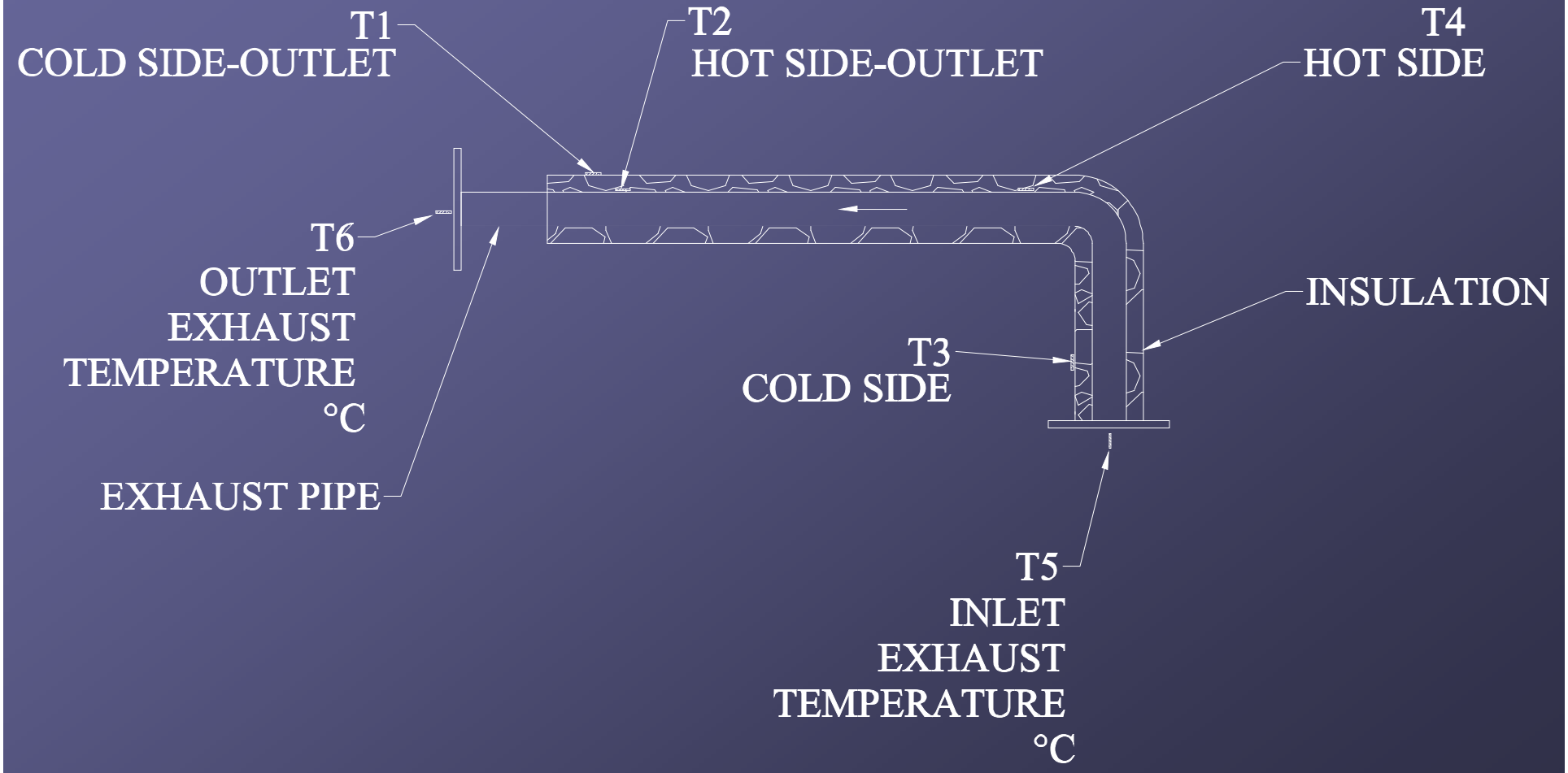


- Insulation type Firwin Hard Coat (HC):

- Outer layer
- Black color
- Composite fiber

- Inner layer
- High alumina ceramic fiber
- Temperature limit of 2300 ºF (1260 ºC).

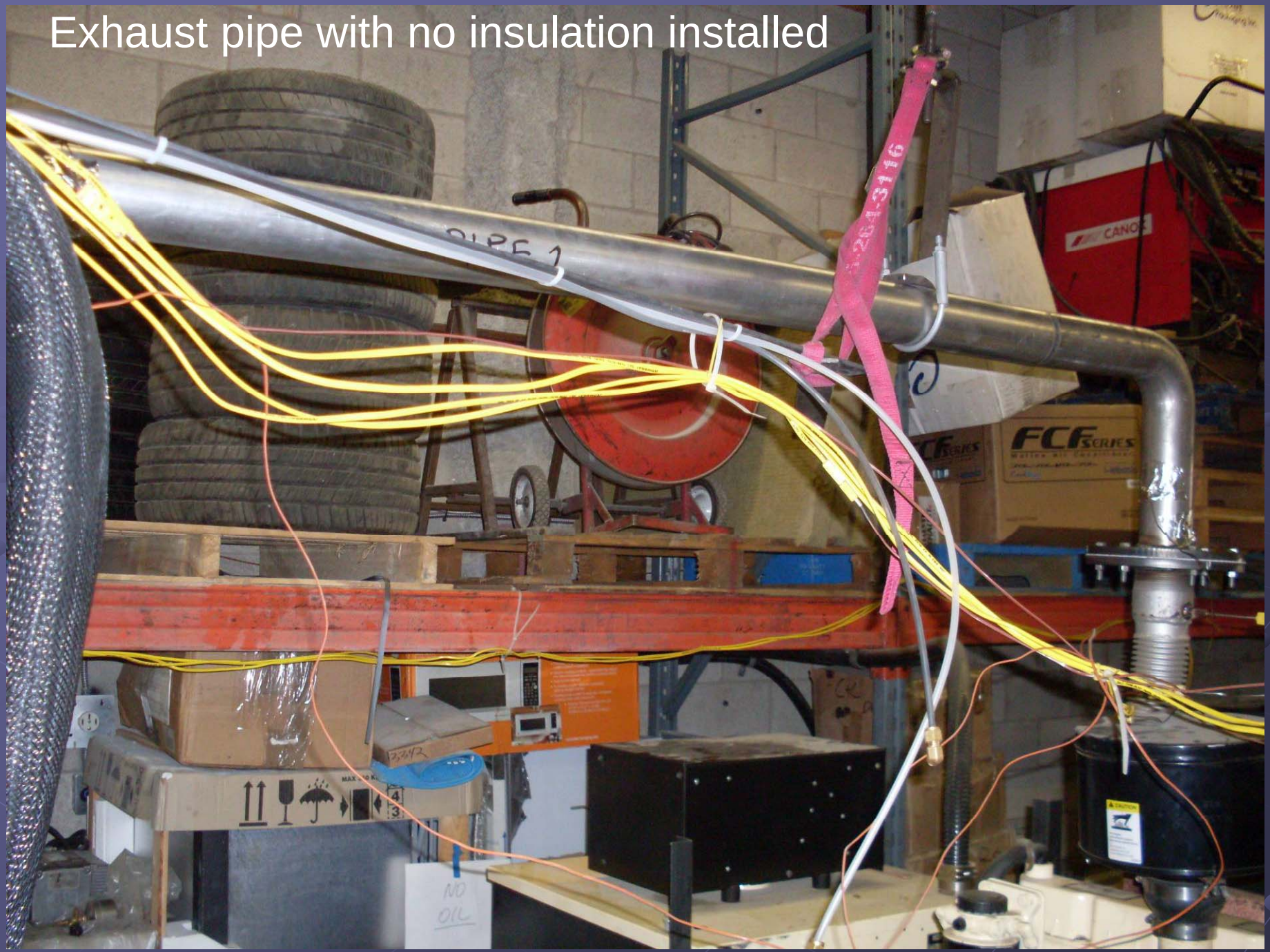
Exhaust Pipe Insulation Test Layout

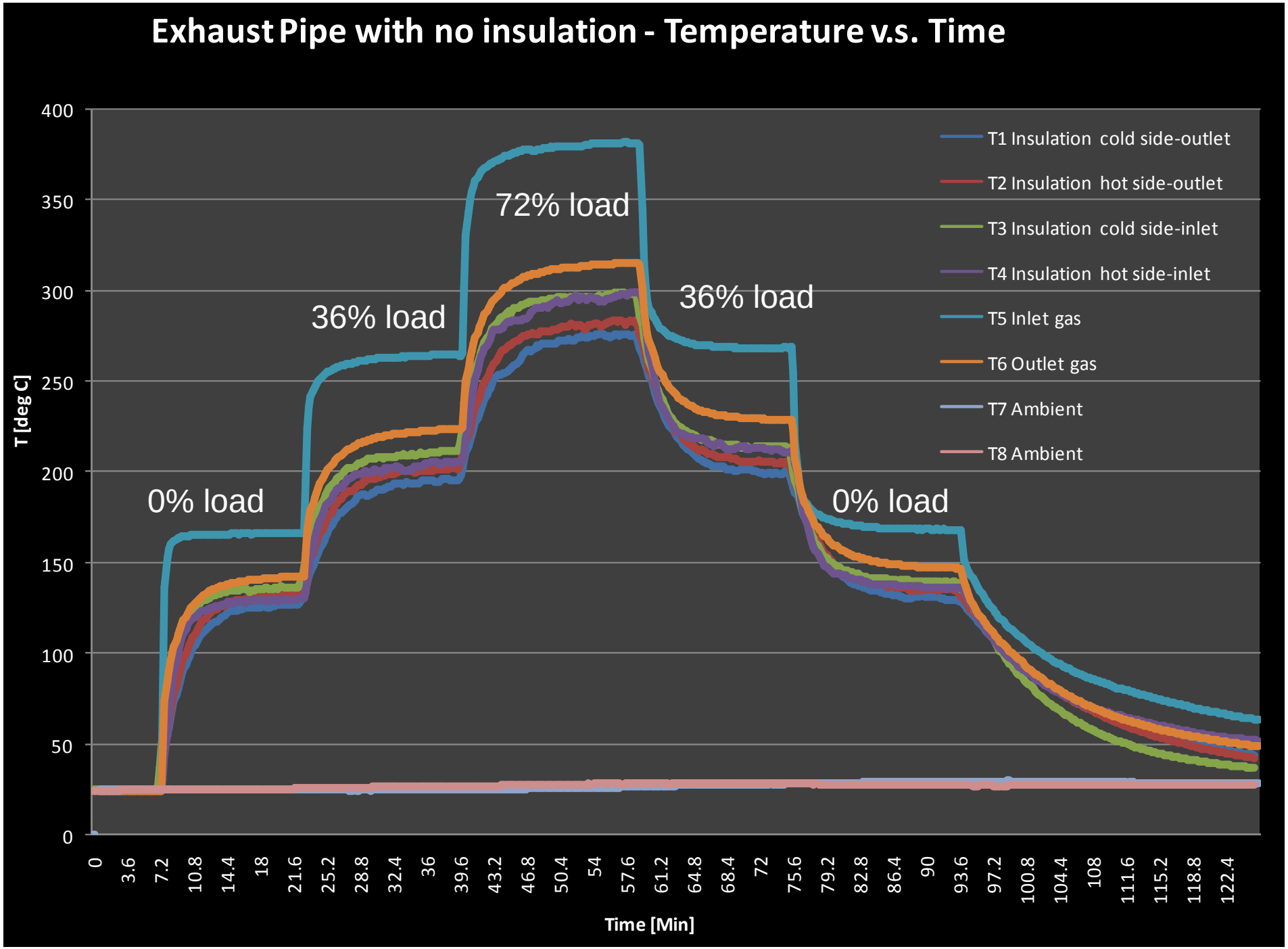


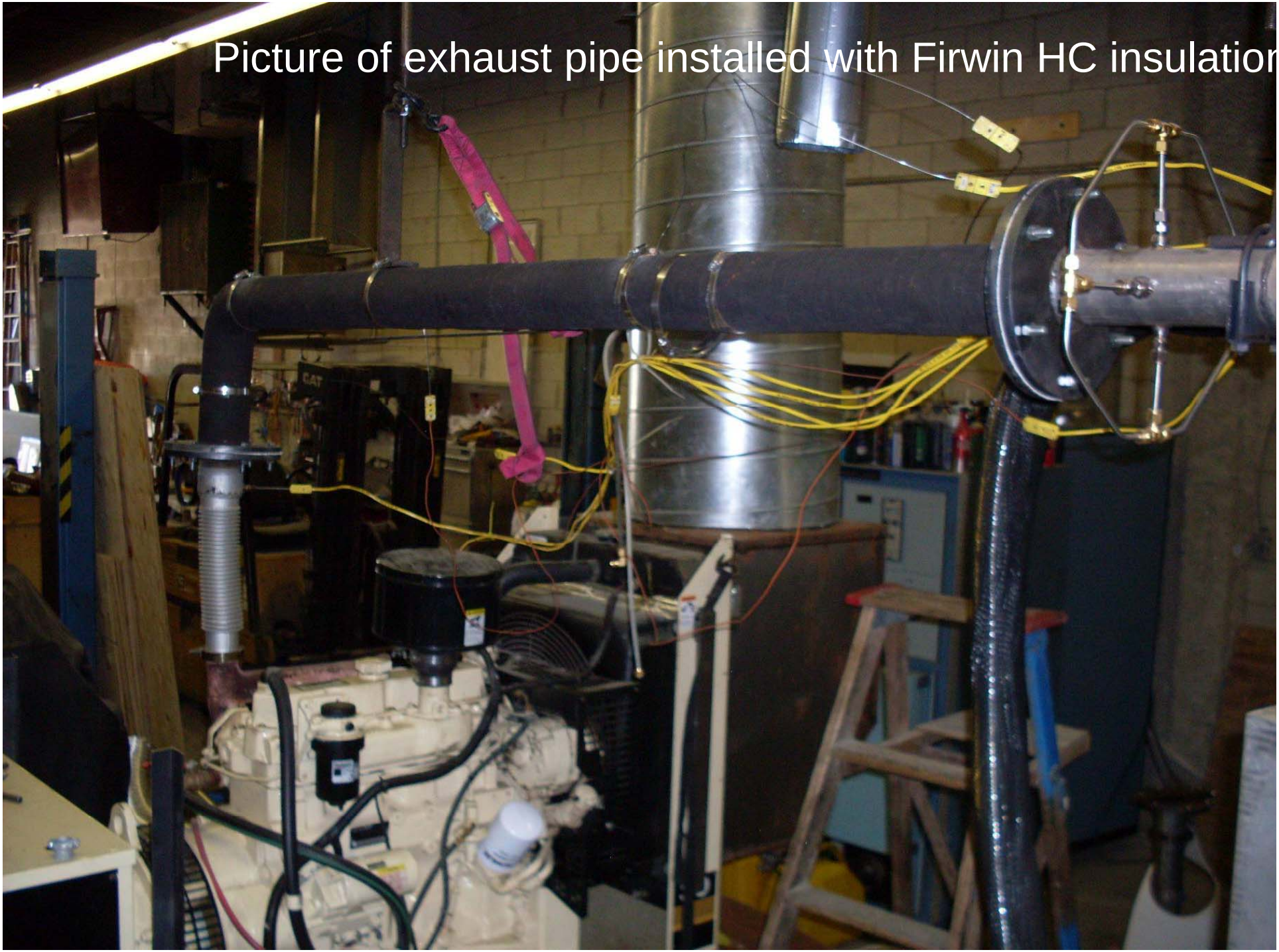
Procedure

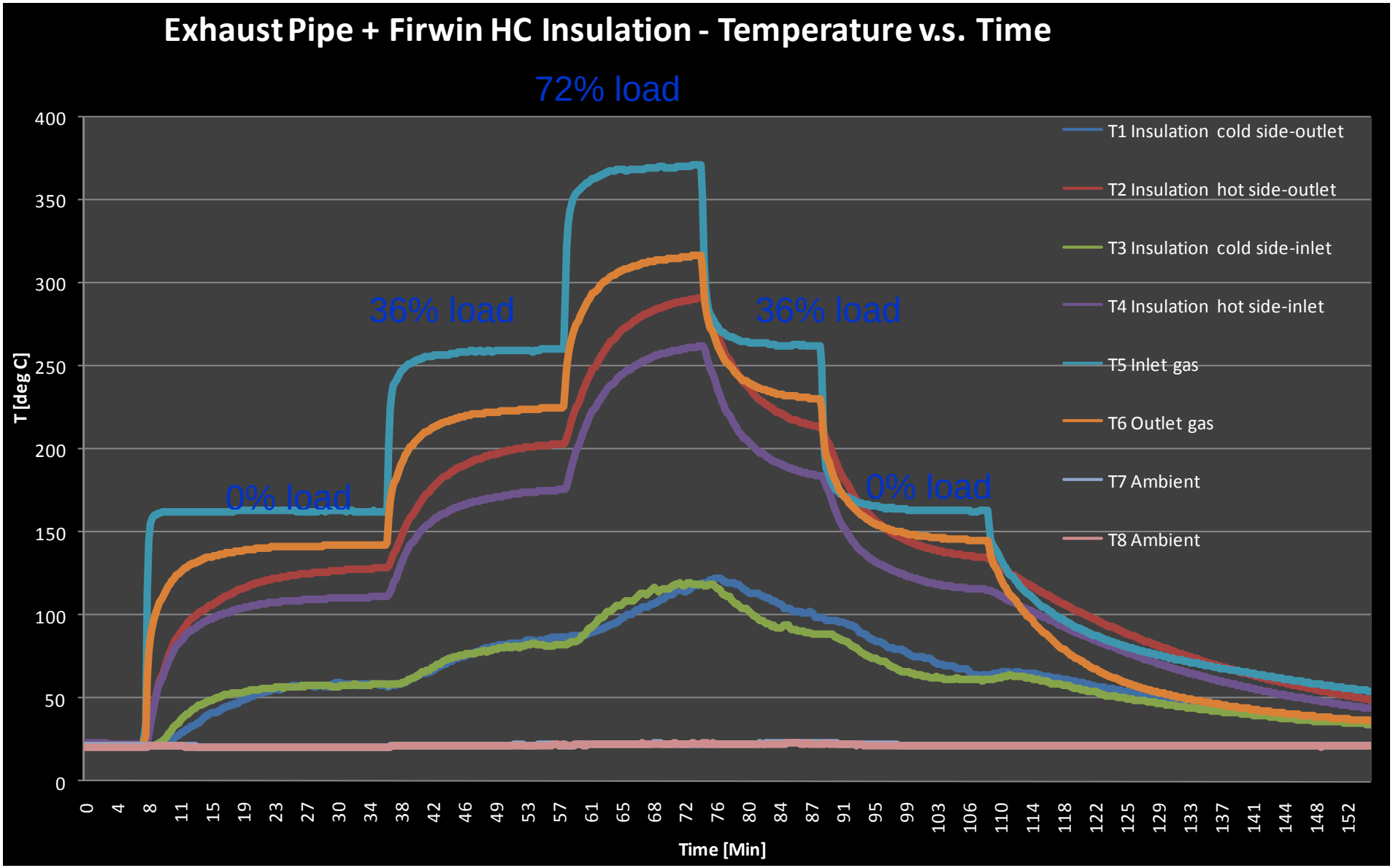
- Six sensors were installed on an exhaust pipe insulation.
- Two extra sensors (T7 &T8) were set to measure ambient temperature.
- Temperatures measured in following steps: with engine off, while engine running with zero load, load increased to 36%, then 72% and back to 36%, zero load, and finally measurement continued for the last stage after engine turned off. The temperature of exhaust gas inside the pipe was measured at Inlet (T5) and outlet (T6) and subtracted to find the heat loss. The temperature of insulation inner layer (T2 , hot side) and outer layer (T1, cold side) were measured and subtracted to evaluate heat retention.

Exhaust pipe with no insulation installed



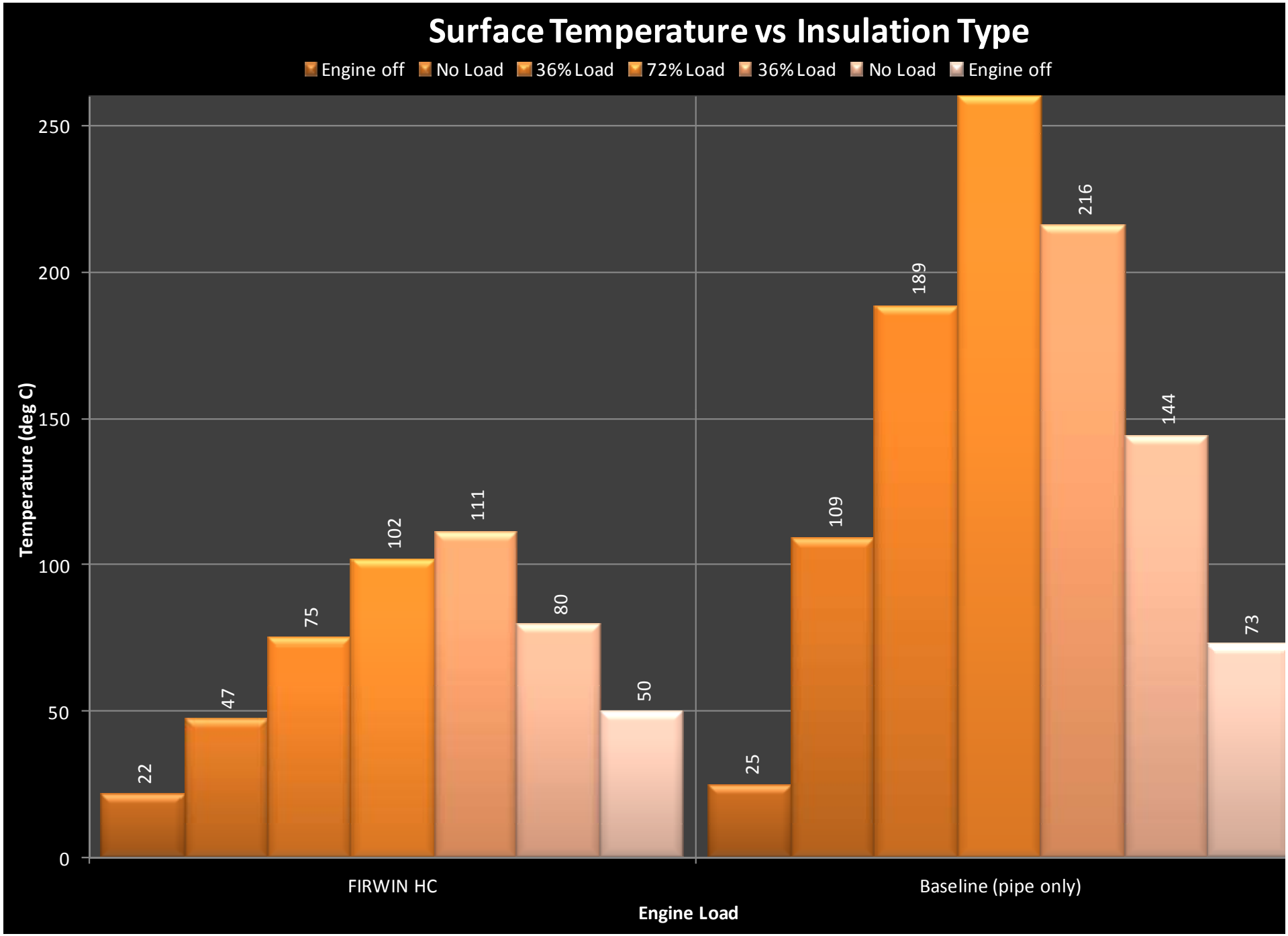

Exhaust Pipe with no insulation - Temperature v.s. Time
T [deg C]
Time [Min]
0% load
36% load
72% load
36% load
0% load
T1 Insulation cold side-outlet
T2 Insulation hot side-outlet
T3 Insulation cold side-inlet
T4 Insulation hot side-inlet
T5 Inlet gas
T6 Outlet gas
T7 Ambient
T8 Ambient

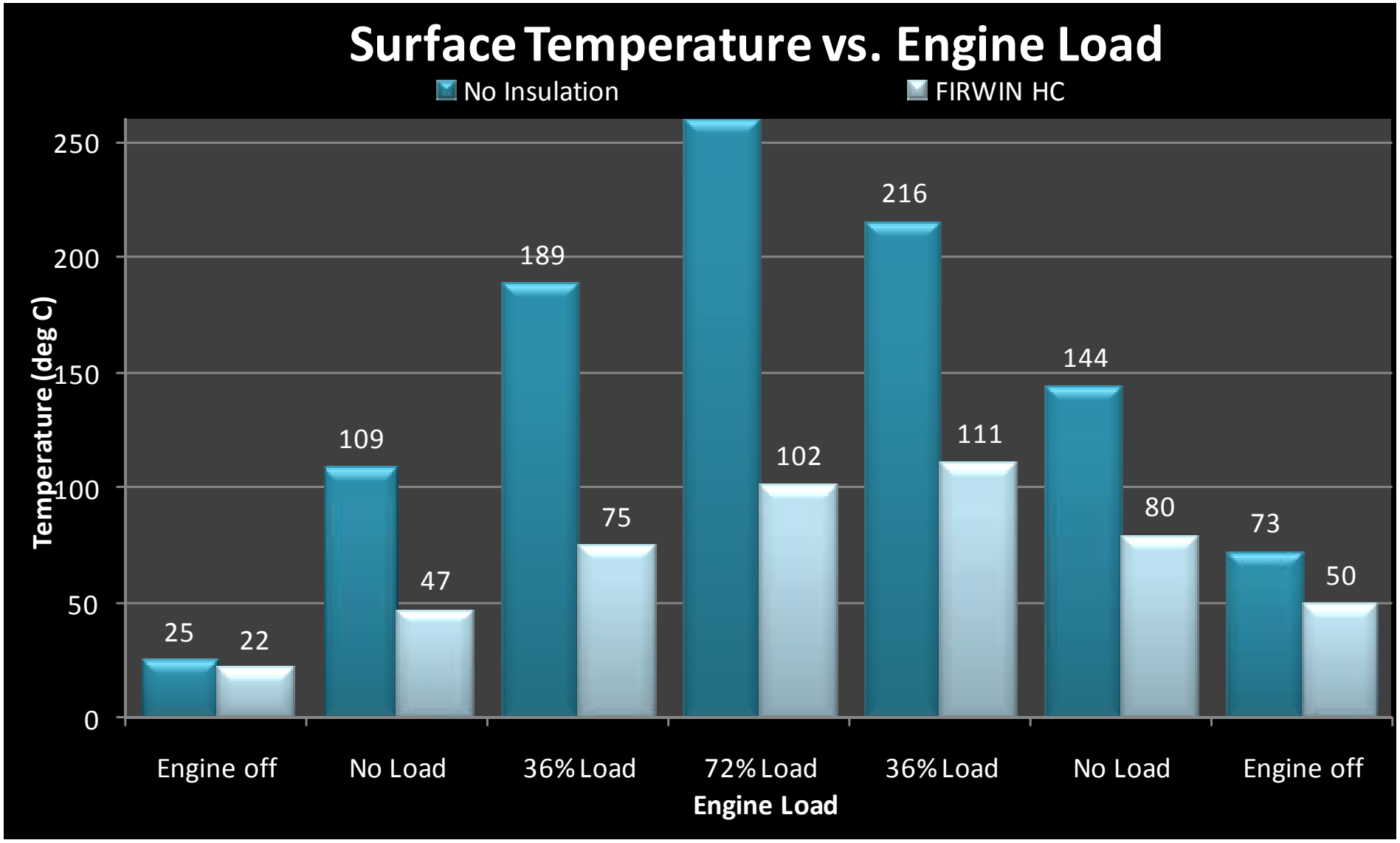

Picture of exhaust pipe installed with Firwin HC insulation


Exhaust Pipe + Firwin HC Insulation - Temperature v.s. Time
72% load
36% load
36% load
0% load
0% load
T [deg C]
Time [Min]
T1 Insulation cold side-outlet
T2 Insulation hot side-outlet
T3 Insulation cold side-inlet
T4 Insulation hot side-inlet
T5 Inlet gas
T6 Outlet gas
T7 Ambient
T8 Ambient

Surface temperature Insulation evaluation

The chart for surface temperature (measured with T1 sensor) is shown on the next two slides. Note that the Values lag behind load change due to insulation resistance. It has a delay in reaching to the maximum temperature during loading of the engine, and it has a delay in cooling off during unloading of the engine, therefore as shown in the chart 36% load shows higher heat than 72%.

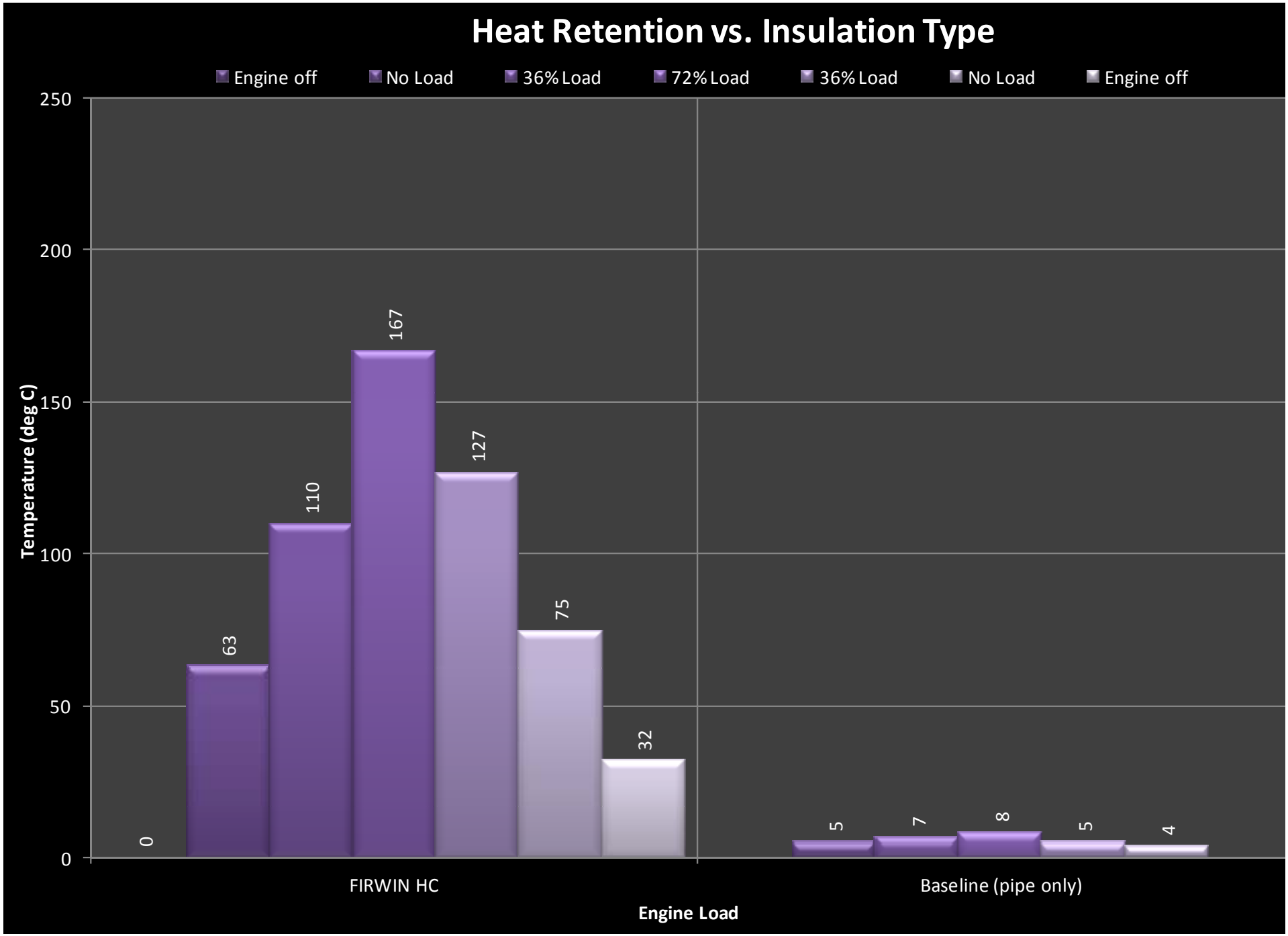

Surface Temperature vs Insulation Type
Engine off
No Load
36% Load
72% Load
36% Load
No Load
Engine off
Temperature (deg C)
250
200
150
100
50
0
22
47
75
102
111
80
50
25
109
189
216
144
73
FIRWIN HC
Baseline (pipe only)
Engine Load

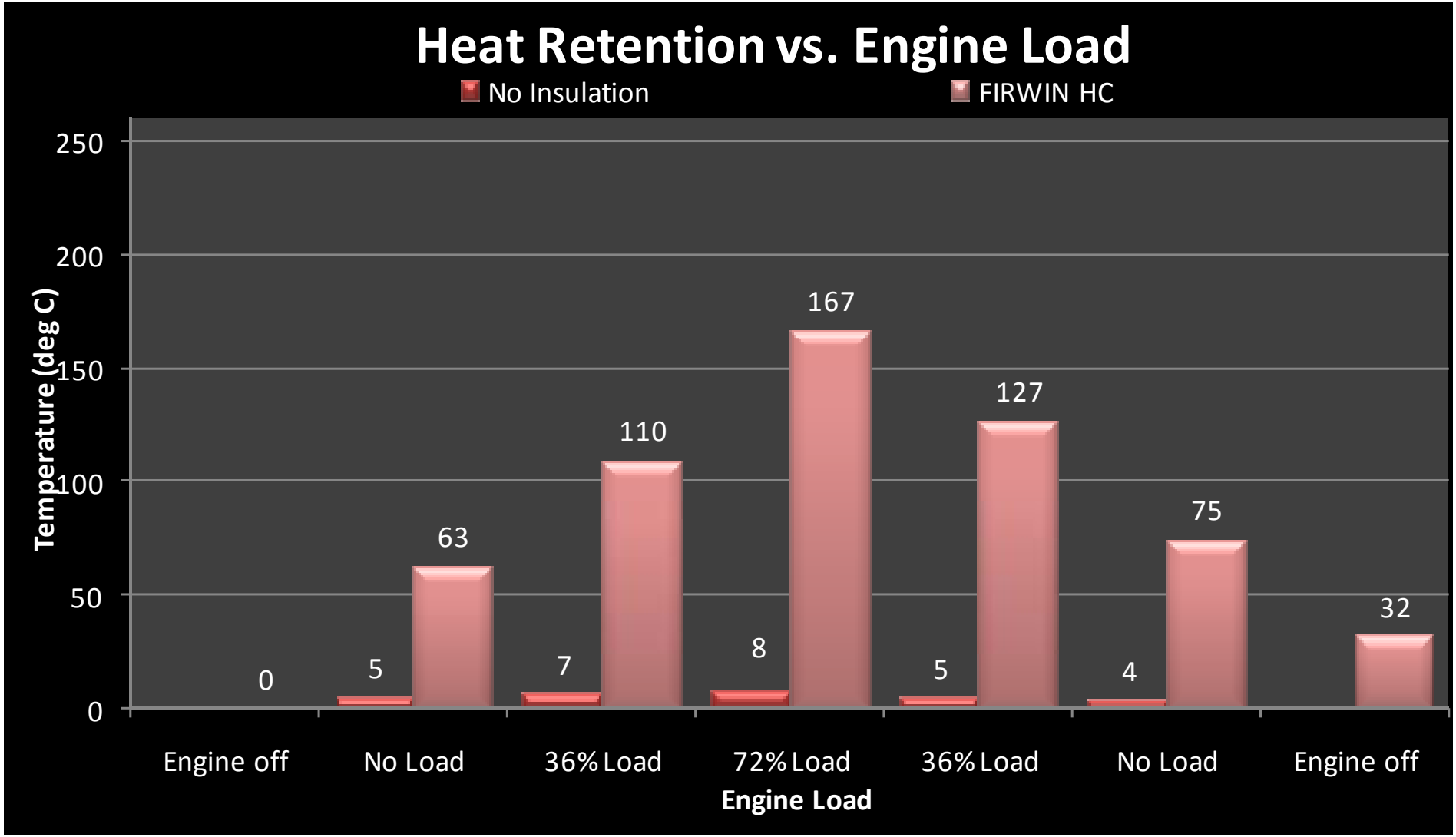

Surface Temperature vs. Engine Load
No Insulation
FIRWIN HC
Temperature (deg C)
250
200
150
100
50
0
25
22
109
47
189
75
216
102
111
144
80
73
50
Engine off
No Load
36% Load
72% Load
36% Load
No Load
Engine off
Engine Load

Insulation Heat Retention Evaluation

On the next two slides, the heat retention was calculated by subtracting T1 from T2.

It represents pipe surface temperature (hot side) minus insulation surface (cold side) temperature.

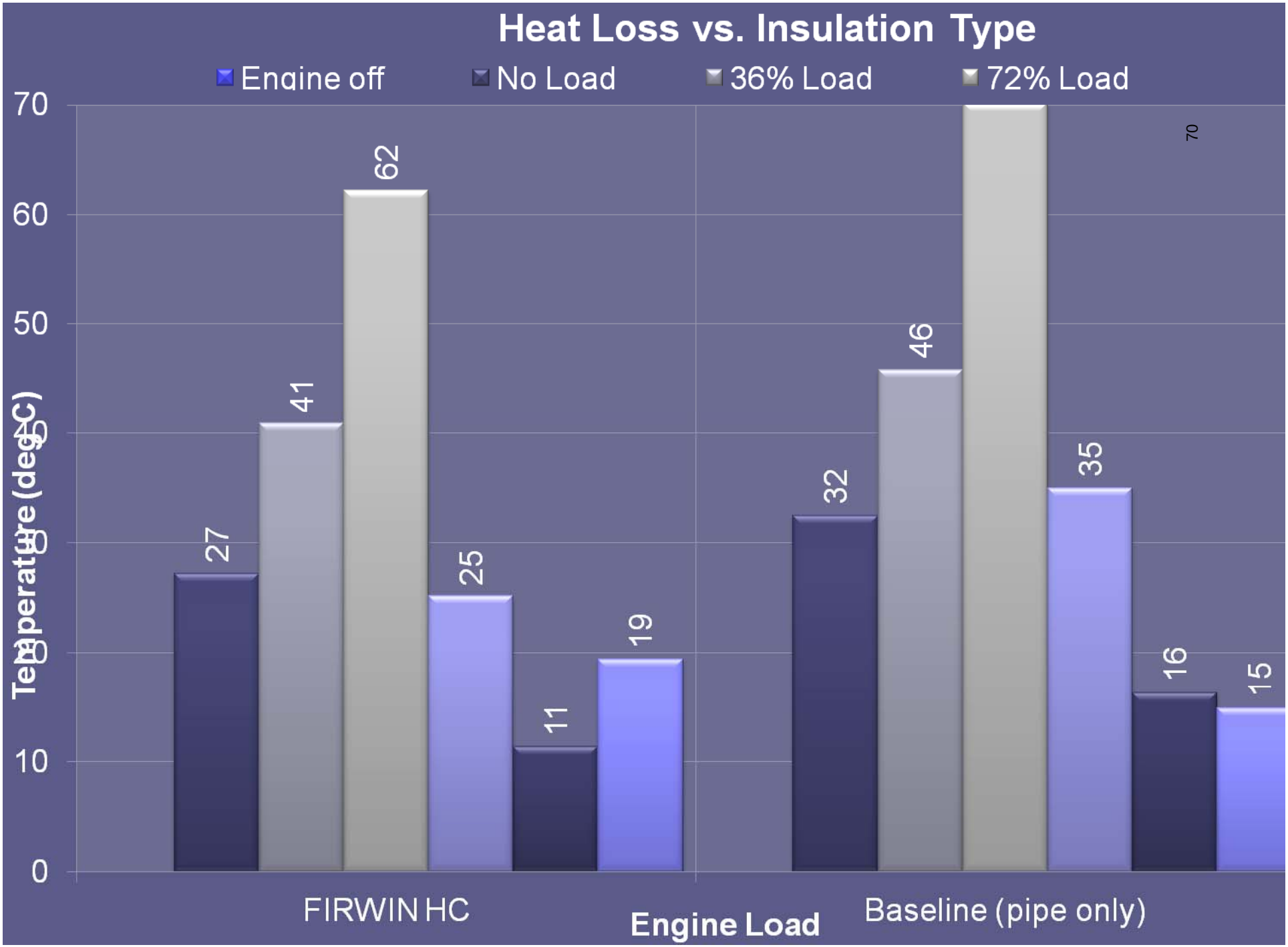

Heat Retention vs. Insulation Type
Engine off
No Load
36% Load
72% Load
36% Load
No Load
Engine off
250
200
150
100
50
0
Temperature (deg C)
0
63
110
167
127
75
32
5
7
8
5
4
FIRWIN HC
Baseline (pipe only)
Engine Load


Heat Retention vs. Engine Load
No Insulation
FIRWIN HC
Temperature (deg C)
250
200
150
100
50
0
0
5
63
7
110
8
167
5
127
4
75
32
Engine off
No Load
36% Load
72% Load
36% Load
No Load
Engine off
Engine Load

Heat loss inside exhaust pipe

On the next slide the heat lost was calculated by subtracting exhaust gas temperature inside the pipe at inlet from the value at the outlet side, or T5 minus T6.

The lower the value, means lower heat loss, and therefore a better insulation.

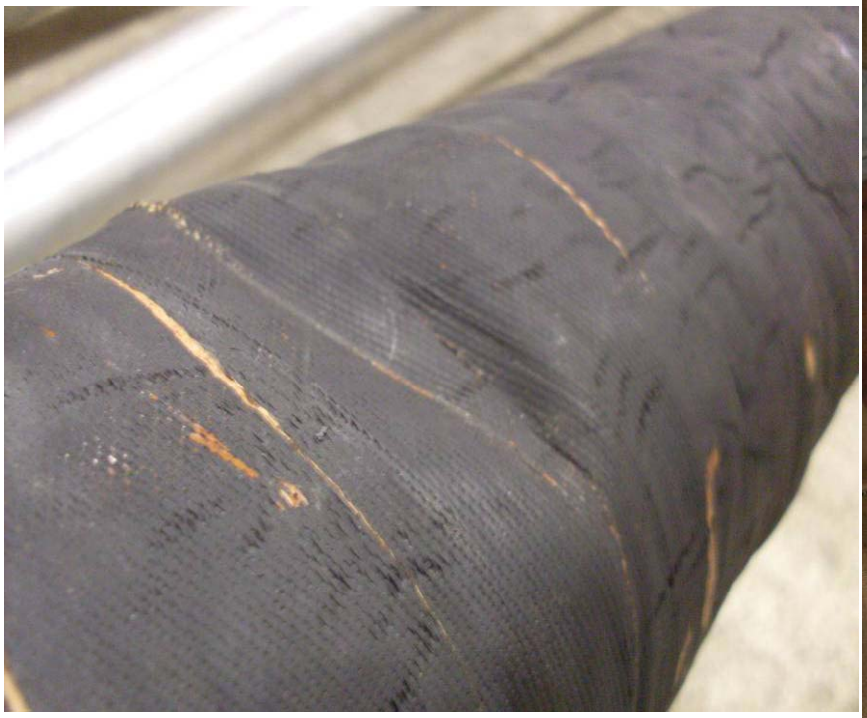

Heat Loss vs. Insulation Type
Engine off
No Load
36% Load
72% Load
70
60
50
40
30
20
10
0
Temperature (deg C)
27
41
62
25
11
19
32
46
70
35
16
15
FIRWIN HC
Baseline (pipe only)
Engine Load

Impact Test

In this test 15.87 kg weight was dropped from a height of 4 feet on each insulation while strapped to the exhaust pipe.

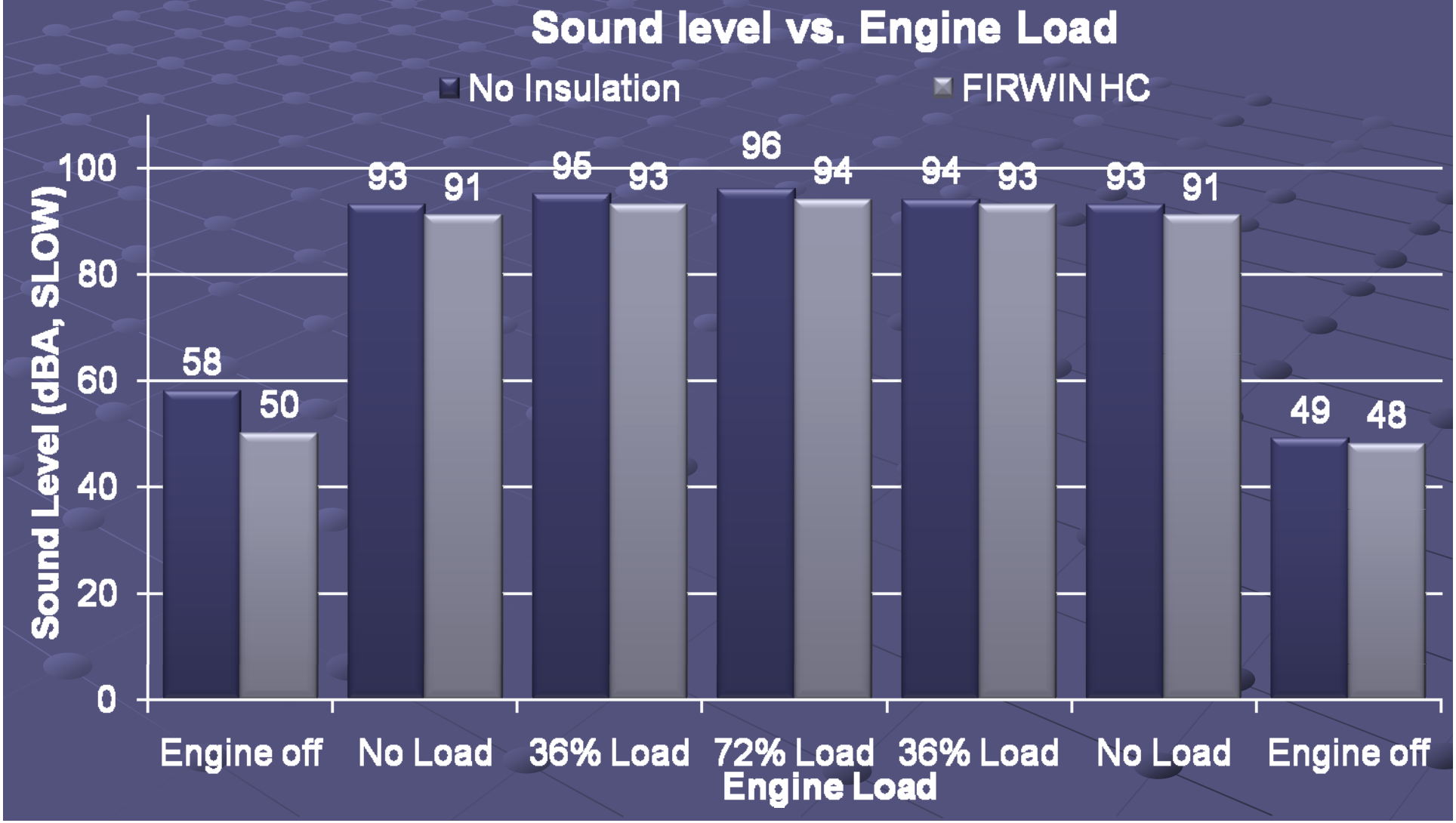
Firwin HC was dented about 0.25” deep.

CEP HC with dent after the impact



Sound Level Measurement

Sound level measured 26” away from the insulated exhaust pipe. It shows 1-3 dBA Improvement compare to pipe with no insulation. The sound measurement device was exposed to direct engine and other environmental noise.



Oil Absorption Test

- Firwin HC insulation, along with various models of Firwin's removable insulation blankets were submerged in oil for an hour and weight before and after, the result is shown as % gain over the original weight:
- Standard Insulation Blanket 75% (highest oil absorption)
- Mark II Insulation Blanket 71%
- Mark III Insulation Blanket 64%
- Firwin HC 33% (lowest oil absorption)