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Modelling of Timber Pyrolysis with FDS

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Read and approved,

Sabrina Spörri

(10th May 2022)

Abstract

Timber is experiencing a revival in the construction area. However, as a combustible material it poses a risk in case of fire. The understanding of how it burns in non-standardized fires is actually limited, but with the evolution towards performance-based designs, such knowledge is of huge importance.

Wood burning is a complex process because of its inhomogeneous structure and the interlinked processes of material decomposition and gas-phase combustion. Further, the burning products such as char influence the fire dynamics. Therefore, this work studies the charring properties during the burning of timber by a FDS (Fire Dynamics Simulator) simulation. The goal is to use the complex pyrolysis model in FDS with appropriated input parameters together with gas phase combustion in simulations with a non-standardized environment and analyse the simulation results in view of the charring properties as well as compare them to experimental data. Additionally, the study also changed some input parameters to assess their influence on the simulation results and the usefulness of such changes compared to the experimental results.

The main finding of this study was that an appropriated mesh resolution is needed inside the timber sample to perform theses simulations. The simulation outputs showed relatively good values for the charring rates and the surface temperatures of the timber compared with the experimental results. However, the charring depth was overestimated. The changed input parameters for the simulations did not result in huge differences compared to the experimental data.

To conclude, the ability of FDS to include different submodels and to be used with different complexities, makes it an interesting tool to study charring properties during the burning of timber, even if until now the setup of the FDS code needs a lot of input data and is relatively time-consuming.

Keywords: Pyrolysis; timber; simulation; FDS; charring rate; charring depth

Appendix A – List of graphs, tables, figures and equations

A.1 List of graphs

A.2 List of tables

A.3 List of figures

Appendix B – Mesh size study

This chapter describes the test series to define the mesh size for the fluid. This is done by studying the influence of the mesh size on the air velocity and on the length of the tunnel. The idea of the last point is that a shorter tunnel would allow to use a finer mesh, as it would take less computational time.

B.1 Simulation environment

Three mesh sizes were tested, 1.25 [cm], 1.0 [cm] and 0.625 [m], each of it in two simulation geometries. One of it was the whole FANCI tunnel with a length of 4.5 [m] and the second geometry was a shortened tunnel with a length of ca. 1.8 [m]. In this shortened tunnel, the timber sample was placed in the middle of the tunnel length.

During the tests, no burning was simulated but only the air flow through the tunnel, with an inlet velocity of 2.5 [m/s].

The simulations are named as shown in table 47.

Table 47: Simulation names of the performed simulations in this mesh size study

Simulation name	***Description***
T1-whole-1.25	Whole FANCI geometry, mesh size 1.25 [cm], only air flow
T2-whole-1.0	Whole FANCI geometry, mesh size 1.0 [cm], only air flow
T3-whole-0.625	Whole FANCI geometry, mesh size 0.625 [cm], only air flow
T4-short-1.25	Shortened FANCI geometry, mesh size 1.25 [cm], only air flow
T5-short-1.0	Shortened FANCI geometry, mesh size 1.0 [cm], only air flow
T6-short-0.625	Shortened FANCI geometry, mesh size 0.625 [cm], only air flow

B.2 Output parameters

There were three areas with air velocity measurement points. Nine measurement points were evenly distributed at the surface of the timber sample, nine others were positioned above the sample, in a parallel plan to it, and three were positioned at mid-height of the tunnel at the outlet.

Additionally, three cuts with animated velocity recordings were also recorded, one through the middle of each of the three axes in the tunnel.

The codes are shown under section B.4 FDS codes.

B.3 Results

The qualitative analysis of the simulation showed a similar flow field for all the simulations. Near the border of the tunnel, there was a range of lower air velocities compared to the middle of the tunnel. Additionally, variations in the air velocity measurements slightly increased along the tunnel (figure 18 & 19). Both geometries, the shorter and the longer tunnel, showed similar flow fields, but it seemed more stretched out for the longer tunnel (figure 18). Figure 18 shows the animated velocity outputs for the simulation with the whole FANCI geometry and a mesh size of 1.0 [cm] ("T2-whole-1.0"). The long tube is the tunnel, viewed from the side and with a vertical cut for the air velocity recordings. The flow direction is from left to right and the still is at 4.6 [min]. The scale for the velocity is from 0.0 – 3.83 [m/s]. The two grey rectangles are two areas which are enlarged in the smaller images below the tunnel. Figure 19 shows the same as figure 19 except this time, it is the result for the simulation with the shorter FANCI geometry ("T5-short-1.0"); the air velocity scale this time is from 0.0 – 3.63 [m/s].

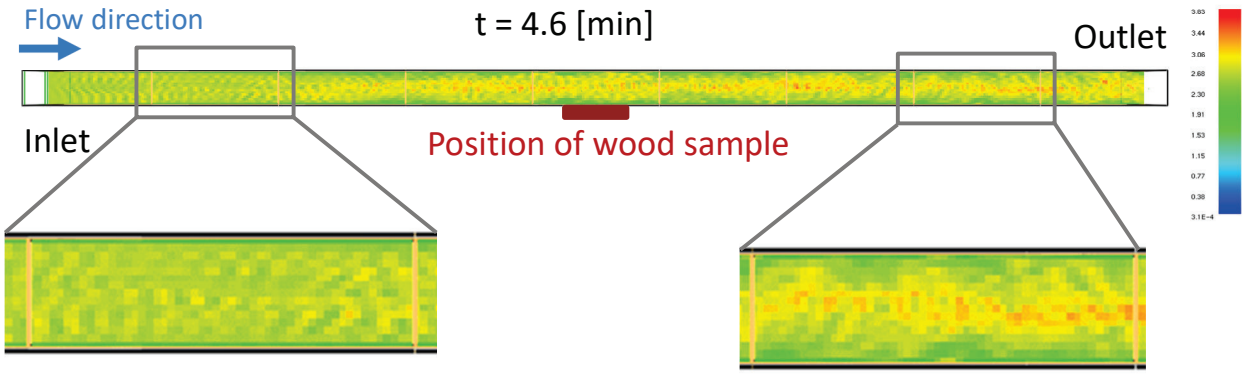


Figure 18: Result of the animated velocity output for simulation with the whole FANCI geometry and a mesh size of 1.0 [cm] ("T2-whole-1.0"); with a velocity scale of 0.0 - 3.83 [m/s] and a simulation time of the still of 4.6 [min]

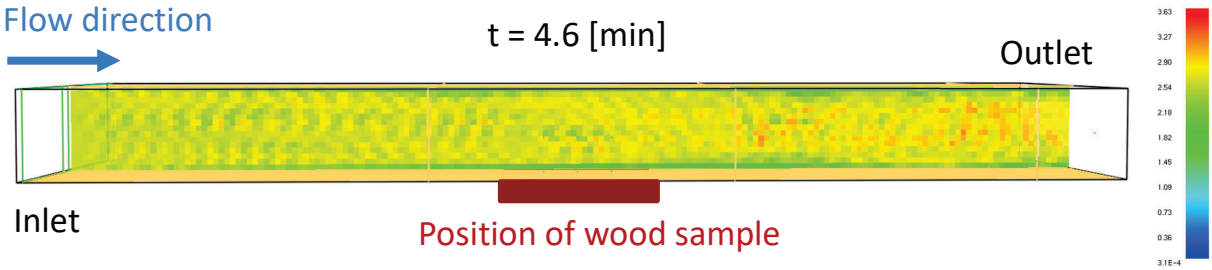


Figure 19: Result of the animated velocity output for simulation with the short FANCI geometry and a mesh size of 1.0 [cm] ("T5-short-1.0"); with a velocity scale of 0.0 - 3.63 [m/s] and a simulation time of the still of 4.6 [min]

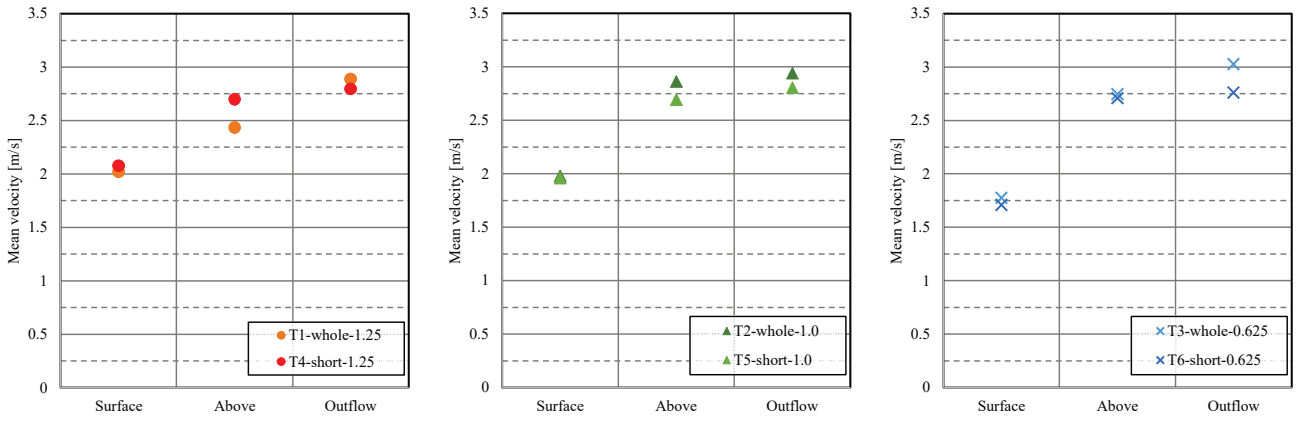
For the shorter geometry, all the three simulations had air velocities in the same range, between 0.0 – 3.6 [m/s]. However, for the longer tunnel, there was a slightly bigger difference for the simulation with the finest mesh size. There the range was between 0.0 – 4.2 [m/s]. For the mesh size of 1.0 [cm] it was between 0.0 – 3.8 [m/s] and for the one with 1.25 [cm] it was a slightly smaller range, between 0.0 – 3.7 [m/s]. But generally, the variations in the flow field were not huge and given that no burning is happening at both ends of the tunnel, shortening the geometry seems reasonable.

For the quantitative analysis of the results, the air velocities in each area, meaning on the timber sample, above it and at the outlet, were averaged in time and space. The results can be seen in table 48 and are compared in the following graphs.

Table 48: Mean velocity in different areas of the simulations for the six simulations of the test series

Simulation name	***Area of measurements for the mean air velocity [m/s]***		
	Timber sample surface	*Above wood sample*	*Outlet*
T1-whole-1.25	2.1	2.7	2.8
T2-whole-1.0	2.0	2.9	2.9
T3-whole-0.625	1.8	2.7	3.0
T4-short-1.25	2.0	2.4	2.9
T5-short-1.0	2.0	2.7	2.8
T6-short-0.625	1.7	2.7	2.8

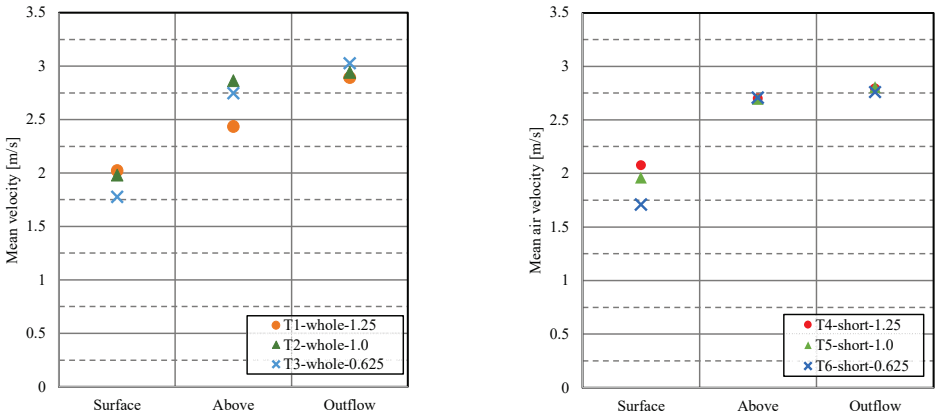
The following three graphs compare all the six simulations split by the mesh size, on the left side is the graph for a mesh size of 1.25 [cm], in the middle for 1.0 [cm] and on the right side for 0.625 [cm].



Graph 63: Mean velocities for the six simulations, in the three tested areas, split by mesh size; left for a mesh size of 1.25 [cm], middle for 1.0 [cm] and right for 0.625 [cm]

The comparison shows that there seems a small influence of the geometry on the air velocity. But on the surface of the timber sample, this influence is very small. It seems also that the finer mesh the smaller are the differences in the air velocity measurements.

The next two graphs compare the simulations split by the geometry.



Graph 64: Comparison of the six simulations, in the three areas, split by the geometry; left for the whole FANCI tunnel, right for the shortened tunnel

For the whole geometry, the mesh size of 1.25 [cm] and 0.625 [cm] result in different velocities. The mesh size of 1.0 [cm] range in-between and is a sort of compromise between the two others. For the shortened geometry, the results are much closer, except for the measurements at the surface of the timber sample which is very similar to the results from simulations with the whole geometry.

As a conclusion, the shortened geometry of the FANCI tunnel with a mesh size of 1.0 [cm] seems a reasonable compromise between accuracy and simulation time. It leads 15 cells along the height of the tunnel (table 49).

Table 49: Mesh sizes and corresponding number of cells per height and width of the tunnel

	Mesh size		
	1.25 [cm]	**1.0 [cm]**	**0.625 [cm]**
Nb of cells along the height of the tunnel	12	15	24
Nb of cells along the width of the tunnel	40	50	80

B.4 FDS codes

B.4.1 T1-whole-1.25

This is the FDS code for the simulation with the whole FANCI geometry and a mesh size of 1.25 [cm].

```
-------Simulation name-------
&HEAD CHID='Fanci_5_2_nohf'/
-------Simulation time-------
&TIME T_END=300.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=108,40,12, XB=0.0,1.35,0.0,0.5,0.0,0.15, MPI_Process = 0/
&MESH ID='Mesh_02', IJK=144,40,12, XB=1.35,3.15,0.0,0.5,0.0,0.15, MPI_Process = 1/
&MESH ID='Mesh_03', IJK=109,40,12, XB=3.15,4.5125,0.0,0.5,0.0,0.15, MPI_Process = 2/
-------Spruce-------
&MATL ID = 'SPRUCE',
        EMISSIVITY = 0.9,
        CONDUCTIVITY = 0.09,
        SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
        DENSITY = 408.0,
        N_REACTIONS = 1.0,
        A(1) = 4.69E13,
        E(1) = 190500,
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14000.0,
        ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.92 /
&RAMP ID='c_ramp_spruce', T=230, F=1.8 /
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
        SPECIFIC_HEAT=0.46,
        CONDUCTIVITY=45.8,
        DENSITY=7850.0,
        EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
        MATL_ID(1,1)='STEEL',
        MATL_MASS_FRACTION(1,1)=1.0,
        THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
```

```
        RGB=26,204,26,
        VEL=-2.5/
-------Wood sample-------
&SURF ID='SAMPLE',
        RGB=200,100,0,
        BACKING='INSULATED',
        MATL_ID='SPRUCE',
        THICKNESS=0.12/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=0.0,2.1125,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.375,4.5125,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.112,2.38,0.0,0.1375,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.112,2.38,0.3625,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top', XB=0.0,4.5125,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=0.0,4.5125,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=0.0,4.5125,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
-------Position air inflow-------
&OBST ID='Side_Inlet', XB=4.5,4.5125,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Position wood sample-------
&OBST ID='WOOD_SAMPLE', XB=2.1125,2.375,0.1375,0.3625,0.0,0.0, SURF_ID='SAMPLE'/
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN', XB=4.5125,4.5125,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=0.0,0.0,0.0,0.5,0.0,0.15/
-------Output air velocity surface of wood sample -------
&DEVC ID='CM-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.25,0.0/
&DEVC ID='CM-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.25,0.0/
&DEVC ID='CM-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.25,0.0/
&DEVC ID='CM', QUANTITY='VELOCITY', XYZ=2.2375,0.25,0.0/

&DEVC ID='CF-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.1875,0.0/
&DEVC ID='CF-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.1875,0.0/
&DEVC ID='CF-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.1875,0.0/
&DEVC ID='CF', QUANTITY='VELOCITY', XYZ=2.2375,0.1875,0.0/

&DEVC ID='CB-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.3,0.0/
&DEVC ID='CB-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.3,0.0/
&DEVC ID='CB-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.3,0.0/
&DEVC ID='CB', QUANTITY='VELOCITY', XYZ=2.2375,0.3,0.0/

&DEVC ID='OM-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.25,0.0/
&DEVC ID='OM-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.25,0.0/
&DEVC ID='OM-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.25,0.0/
&DEVC ID='OM', QUANTITY='VELOCITY', XYZ=2.175,0.25,0.0/
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```
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&DEVC ID='OF-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.1875,0.0/
&DEVC ID='OF-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.1875,0.0/
&DEVC ID='OF', QUANTITY='VELOCITY', XYZ=2.175,0.1875,0.0/

&DEVC ID='OB-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.3,0.0/
&DEVC ID='OB-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.3,0.0/
&DEVC ID='OB-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.3,0.0/
&DEVC ID='OB', QUANTITY='VELOCITY', XYZ=2.175,0.3,0.0/

&DEVC ID='IM-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.25,0.0/
&DEVC ID='IM-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.25,0.0/
&DEVC ID='IM-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.25,0.0/
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&DEVC ID='IF-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.1875,0.0/
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&DEVC ID='IF-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.1875,0.0/
&DEVC ID='IF', QUANTITY='VELOCITY', XYZ=2.3,0.1875,0.0/

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&DEVC ID='IB-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.3,0.0/
&DEVC ID='IB-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.3,0.0/
&DEVC ID='IB', QUANTITY='VELOCITY', XYZ=2.3,0.3,0.0/
-------Output air velocity area above wood sample -------
&DEVC ID='CM-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.25,0.0125/
&DEVC ID='CM-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.25,0.0125/
&DEVC ID='CM-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.25,0.0125/
&DEVC ID='CM-1', QUANTITY='VELOCITY', XYZ=2.2375,0.25,0.0125/

&DEVC ID='CF-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.125,0.0125/
&DEVC ID='CF-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.125,0.0125/
&DEVC ID='CF-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.125,0.0125/
&DEVC ID='CF-1', QUANTITY='VELOCITY', XYZ=2.2375,0.125,0.0125/

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&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.375,0.0125/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.375,0.0125/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.2375,0.375,0.0125/

&DEVC ID='OM-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.25,0.0125/
&DEVC ID='OM-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.25,0.0125/
&DEVC ID='OM-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.25,0.0125/
&DEVC ID='OM-1', QUANTITY='VELOCITY', XYZ=2.175,0.25,0.0125/
```

```
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&DEVC ID='OF-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.125,0.0125/
&DEVC ID='OF-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.125,0.0125/
&DEVC ID='OF-1', QUANTITY='VELOCITY', XYZ=2.175,0.125,0.0125/

&DEVC ID='CB-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.375,0.0125/
&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.375,0.0125/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.375,0.0125/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.175,0.375,0.0125/

&DEVC ID='IM-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.25,0.0125/
&DEVC ID='IM-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.25,0.0125/
&DEVC ID='IM-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.25,0.0125/
&DEVC ID='IM-1', QUANTITY='VELOCITY', XYZ=2.3,0.25,0.0125/

&DEVC ID='IF-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.125,0.0125/
&DEVC ID='IF-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.125,0.0125/
&DEVC ID='IF-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.125,0.0125/
&DEVC ID='IF-1', QUANTITY='VELOCITY', XYZ=2.3,0.125,0.0125/

&DEVC ID='IB-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.375,0.0125/
&DEVC ID='IB-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.375,0.0125/
&DEVC ID='IB-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.375,0.0125/
&DEVC ID='IB-1', QUANTITY='VELOCITY', XYZ=2.3,0.375,0.0125/
-------Output air velocity at outlet-------
&DEVC ID='O-M-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M', QUANTITY='VELOCITY', XYZ=1.35,0.25,0.075/

&DEVC ID='O-F-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F', QUANTITY='VELOCITY', XYZ=1.35,0.125,0.075/

&DEVC ID='O-B-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B', QUANTITY='VELOCITY', XYZ=1.35,0.375,0.075/
-------Animated output velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.2375/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.075/
```

```
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBZ=0.075/

&TAIL /
```

B.4.2 T2-whole-1.0

This is the FDS code for the simulation with the whole FANCI geometry and a mesh size of 1.0 [cm].

```
-------Simulation name-------
&HEAD CHID='Fanci_7_1_1_nohf'/
-------Simulation time-------
&TIME T_END=300.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=50,27,15, XB=0.0,0.5,0.0,0.27,0.0,0.15, MPI_Process = 0/
&MESH ID='Mesh_02', IJK=50,23,15, XB=0.0,0.5,0.27,0.5,0.0,0.15, MPI_Process = 1/
&MESH ID='Mesh_03', IJK=50,27,15, XB=0.5,1.0,0.0,0.27,0.0,0.15, MPI_Process = 2/
&MESH ID='Mesh_04', IJK=50,23,15, XB=0.5,1.0,0.27,0.5,0.0,0.15, MPI_Process = 3/
&MESH ID='Mesh_05', IJK=50,27,15, XB=1.0,1.5,0.0,0.27,0.0,0.15, MPI_Process = 4/
&MESH ID='Mesh_06', IJK=50,23,15, XB=1.0,1.5,0.27,0.5,0.0,0.15, MPI_Process = 5/
&MESH ID='Mesh_07', IJK=50,27,15, XB=1.5,2.0,0.0,0.27,0.0,0.15, MPI_Process = 6/
&MESH ID='Mesh_08', IJK=50,23,15, XB=1.5,2.0,0.27,0.5,0.0,0.15, MPI_Process = 7/
&MESH ID='Mesh_09', IJK=50,27,15, XB=2.0,2.5,0.0,0.27,0.0,0.15, MPI_Process = 8/
&MESH ID='Mesh_10', IJK=50,23,15, XB=2.0,2.5,0.27,0.5,0.0,0.15, MPI_Process = 9/
&MESH ID='Mesh_11', IJK=50,27,15, XB=2.5,3.0,0.0,0.27,0.0,0.15, MPI_Process = 10/
&MESH ID='Mesh_12', IJK=50,23,15, XB=2.5,3.0,0.27,0.5,0.0,0.15, MPI_Process = 11/
&MESH ID='Mesh_13', IJK=50,27,15, XB=3.0,3.5,0.0,0.27,0.0,0.15, MPI_Process = 12/
&MESH ID='Mesh_14', IJK=50,23,15, XB=3.0,3.5,0.27,0.5,0.0,0.15, MPI_Process = 13/
&MESH ID='Mesh_15', IJK=50,27,15, XB=3.5,4.0,0.0,0.27,0.0,0.15, MPI_Process = 14/
&MESH ID='Mesh_16', IJK=50,23,15, XB=3.5,4.0,0.27,0.5,0.0,0.15, MPI_Process = 15/
&MESH ID='Mesh_17', IJK=51,27,15, XB=4.0,4.51,0.0,0.27,0.0,0.15, MPI_Process = 16/
&MESH ID='Mesh_18', IJK=51,23,15, XB=4.0,4.51,0.27,0.5,0.0,0.15, MPI_Process = 17/
-------Spruce-------
&MATL ID = 'SPRUCE',
        EMISSIVITY = 0.9,
        CONDUCTIVITY = 0.09,
        SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
        DENSITY = 408.0,
        N_REACTIONS = 1.0,
        A(1) = 4.69E13,
        E(1) = 190500,
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
```

```
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14000.0,
        ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.92 /
&RAMP ID='c_ramp_spruce', T=230, F=1.8 /
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
        SPECIFIC_HEAT=0.46,
        CONDUCTIVITY=45.8,
        DENSITY=7850.0,
        EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
        MATL_ID(1,1)='STEEL',
        MATL_MASS_FRACTION(1,1)=1.0,
        THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
        RGB=26,204,26,
        VEL=-2.5/
-------Wood sample-------
&SURF ID='SAMPLE',
        RGB=200,100,0,
        BACKING='INSULATED',
        MATL_ID='SPRUCE',
        THICKNESS=0.12/
 -------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=0.0,2.12,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.38,4.51,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.115,2.385,0.0,0.14,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.115,2.385,0.36,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top', XB=0.0,4.51,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=0.0,4.51,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=0.0,4.51,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
-------Position air inflow-------
&OBST ID='Side_Inlet', XB=4.5,4.51,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Position wood sample-------
&OBST ID='WOOD_SAMPLE', XB=2.12,2.38,0.14,0.36,0.0,0.0, SURF_ID='SAMPLE'/
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN', XB=4.51,4.51,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=0.0,0.0,0.0,0.5,0.0,0.15/
-------Output air velocity surface of wood sample -------
&DEVC ID='CM-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.25,0.0/
```

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&DEVC ID='CM-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.25,0.0/
&DEVC ID='CM-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.25,0.0/
&DEVC ID='CM', QUANTITY='VELOCITY', XYZ=2.25,0.25,0.0/

&DEVC ID='CF-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.20,0.0/
&DEVC ID='CF-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.20,0.0/
&DEVC ID='CF-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.20,0.0/
&DEVC ID='CF', QUANTITY='VELOCITY', XYZ=2.25,0.20,0.0/

&DEVC ID='CB-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.31,0.0/
&DEVC ID='CB-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.31,0.0/
&DEVC ID='CB-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.31,0.0/
&DEVC ID='CB', QUANTITY='VELOCITY', XYZ=2.25,0.31,0.0/

&DEVC ID='OM-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.25,0.0/
&DEVC ID='OM-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.25,0.0/
&DEVC ID='OM-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.25,0.0/
&DEVC ID='OM', QUANTITY='VELOCITY', XYZ=2.19,0.25,0.0/

&DEVC ID='OF-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.20,0.0/
&DEVC ID='OF-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.20,0.0/
&DEVC ID='OF-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.20,0.0/
&DEVC ID='OF', QUANTITY='VELOCITY', XYZ=2.19,0.20,0.0/

&DEVC ID='OB-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.31,0.0/
&DEVC ID='OB-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.31,0.0/
&DEVC ID='OB-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.31,0.0/
&DEVC ID='OB', QUANTITY='VELOCITY', XYZ=2.19,0.31,0.0/

&DEVC ID='IM-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.25,0.0/
&DEVC ID='IM-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.25,0.0/
&DEVC ID='IM-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.25,0.0/
&DEVC ID='IM', QUANTITY='VELOCITY', XYZ=2.31,0.25,0.0/

&DEVC ID='IF-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.20,0.0/
&DEVC ID='IF-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.20,0.0/
&DEVC ID='IF-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.20,0.0/
&DEVC ID='IF', QUANTITY='VELOCITY', XYZ=2.31,0.20,0.0/

&DEVC ID='IB-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.31,0.0/
&DEVC ID='IB-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.31,0.0/
&DEVC ID='IB-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.31,0.0/
&DEVC ID='IB', QUANTITY='VELOCITY', XYZ=2.31,0.31,0.0/
-------Output air velocity area above wood sample -------
&DEVC ID='CM-1-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.25,0.06/
```

```
&DEVC ID='CM-1-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.25,0.06/
&DEVC ID='CM-1-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.25,0.06/
&DEVC ID='CM-1', QUANTITY='VELOCITY', XYZ=2.25,0.25,0.06/

&DEVC ID='CF-1-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.20,0.06/
&DEVC ID='CF-1-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.20,0.06/
&DEVC ID='CF-1-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.20,0.06/
&DEVC ID='CF-1', QUANTITY='VELOCITY', XYZ=2.25,0.20,0.06/

&DEVC ID='CB-1-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.31,0.06/
&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.31,0.06/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.31,0.06/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.25,0.31,0.06/

&DEVC ID='OM-1-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.25,0.06/
&DEVC ID='OM-1-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.25,0.06/
&DEVC ID='OM-1-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.25,0.06/
&DEVC ID='OM-1', QUANTITY='VELOCITY', XYZ=2.19,0.25,0.06/

&DEVC ID='OF-1-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.20,0.06/
&DEVC ID='OF-1-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.20,0.06/
&DEVC ID='OF-1-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.20,0.06/
&DEVC ID='OF-1', QUANTITY='VELOCITY', XYZ=2.19,0.20,0.06/

&DEVC ID='OB-1-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.31,0.06/
&DEVC ID='OB-1-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.31,0.06/
&DEVC ID='OB-1-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.31,0.06/
&DEVC ID='OB-1', QUANTITY='VELOCITY', XYZ=2.19,0.31,0.06/

&DEVC ID='IM-1-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.25,0.06/
&DEVC ID='IM-1-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.25,0.06/
&DEVC ID='IM-1-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.25,0.06/
&DEVC ID='IM-1', QUANTITY='VELOCITY', XYZ=2.31,0.25,0.06/

&DEVC ID='IF-1-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.20,0.06/
&DEVC ID='IF-1-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.20,0.06/
&DEVC ID='IF-1-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.20,0.06/
&DEVC ID='IF-1', QUANTITY='VELOCITY', XYZ=2.31,0.20,0.06/

&DEVC ID='IB-1-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.31,0.06/
&DEVC ID='IB-1-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.31,0.06/
&DEVC ID='IB-1-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.31,0.06/
&DEVC ID='IB-1', QUANTITY='VELOCITY', XYZ=2.31,0.31,0.06/
-------Output air velocity at outlet -------
&DEVC ID='O-M-U', QUANTITY='U-VELOCITY', XYZ=0.0,0.25,0.07/
```

```
&DEVC ID='O-M-V', QUANTITY='V-VELOCITY', XYZ=0.0,0.25,0.07/
&DEVC ID='O-M-W', QUANTITY='W-VELOCITY', XYZ=0.0,0.25,0.07/
&DEVC ID='O-M', QUANTITY='VELOCITY', XYZ=0.0,0.25,0.07/

&DEVC ID='O-F-U', QUANTITY='U-VELOCITY', XYZ=0.0,0.20,0.07/
&DEVC ID='O-F-V', QUANTITY='V-VELOCITY', XYZ=0.0,0.20,0.07/
&DEVC ID='O-F-W', QUANTITY='W-VELOCITY', XYZ=0.0,0.20,0.07/
&DEVC ID='O-F', QUANTITY='VELOCITY', XYZ=0.0,0.20,0.07/

&DEVC ID='O-B-U', QUANTITY='U-VELOCITY', XYZ=0.0,0.31,0.07/
&DEVC ID='O-B-V', QUANTITY='V-VELOCITY', XYZ=0.0,0.31,0.07/
&DEVC ID='O-B-W', QUANTITY='W-VELOCITY', XYZ=0.0,0.31,0.07/
&DEVC ID='O-B', QUANTITY='VELOCITY', XYZ=0.0,0.31,0.07/
-------Animated output velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.07/
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBZ=0.07/

&TAIL /
```

B.4.3 T3-whole-0.625

This is the FDS code for the simulation with the whole FANCI geometry and a mesh size of 0.625 [cm].

```
-------Simulation name-------
&HEAD CHID='Fanci_6_2_1_nohf'/
-------Simulation time-------
&TIME T_END=300.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=80,42,24, XB=0.0,0.5,0.0,0.2625,0.0,0.15, MPI_Process = 0/
&MESH ID='Mesh_02', IJK=80,38,24, XB=0.0,0.5,0.2625,0.5,0.0,0.15, MPI_Process = 1/
&MESH ID='Mesh_03', IJK=80,42,24, XB=0.5,1.0,0.0,0.2625,0.0,0.15, MPI_Process = 2/
&MESH ID='Mesh_04', IJK=80,38,24, XB=0.5,1.0,0.2625,0.5,0.0,0.15, MPI_Process = 3/
&MESH ID='Mesh_05', IJK=80,42,24, XB=1.0,1.5,0.0,0.2625,0.0,0.15, MPI_Process = 4/
&MESH ID='Mesh_06', IJK=80,38,24, XB=1.0,1.5,0.2625,0.5,0.0,0.15, MPI_Process = 5/
&MESH ID='Mesh_07', IJK=80,42,24, XB=1.5,2.0,0.0,0.2625,0.0,0.15, MPI_Process = 6/
&MESH ID='Mesh_08', IJK=80,38,24, XB=1.5,2.0,0.2625,0.5,0.0,0.15, MPI_Process = 7/
&MESH ID='Mesh_09', IJK=80,42,24, XB=2.0,2.5,0.0,0.2625,0.0,0.15, MPI_Process = 8/
&MESH ID='Mesh_10', IJK=80,38,24, XB=2.0,2.5,0.2625,0.5,0.0,0.15, MPI_Process = 9/
&MESH ID='Mesh_11', IJK=80,42,24, XB=2.5,3.0,0.0,0.2625,0.0,0.15, MPI_Process = 10/
&MESH ID='Mesh_12', IJK=80,38,24, XB=2.5,3.0,0.2625,0.5,0.0,0.15, MPI_Process = 11/
```

```
&MESH ID='Mesh_13', IJK=80,42,24, XB=3.0,3.5,0.0,0.2625,0.0,0.15, MPI_Process = 12/
&MESH ID='Mesh_14', IJK=80,38,24, XB=3.0,3.5,0.2625,0.5,0.0,0.15, MPI_Process = 13/
&MESH ID='Mesh_15', IJK=80,42,24, XB=3.5,4.0,0.0,0.2625,0.0,0.15, MPI_Process = 14/
&MESH ID='Mesh_16', IJK=80,38,24, XB=3.5,4.0,0.2625,0.5,0.0,0.15, MPI_Process = 15/
&MESH ID='Mesh_17', IJK=81,42,24, XB=4.0,4.50625,0.0,0.2625,0.0,0.15, MPI_Process = 16/
&MESH ID='Mesh_18', IJK=81,38,24, XB=4.0,4.50625,0.2625,0.5,0.0,0.15, MPI_Process = 17/
-------Spruce-------
&MATL ID = 'SPRUCE',
        EMISSIVITY = 0.9,
        CONDUCTIVITY = 0.09,
        SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
        DENSITY = 408.0,
        N_REACTIONS = 1.0,
        A(1) = 4.69E13,
        E(1) = 190500,
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14000.0,
        ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.92 /
&RAMP ID='c_ramp_spruce', T=230, F=1.8 /
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
        SPECIFIC_HEAT=0.46,
        CONDUCTIVITY=45.8,
        DENSITY=7850.0,
        EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
        MATL_ID(1,1)='STEEL',
        MATL_MASS_FRACTION(1,1)=1.0,
        THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
        RGB=26,204,26,
        VEL=-2.5/
-------Wood sample-------
&SURF ID='SAMPLE',
        RGB=200,100,0,
        BACKING='INSULATED',
        MATL_ID='SPRUCE',
```

```
        THICKNESS=0.12/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=0.0,2.11875,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.375,4.50625,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.1156,2.378,0.0,0.1375,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.1156,2.378,0.3625,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top', XB=0.0,4.50625,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=0.0,4.50625,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=0.0,4.50625,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
-------Position air inflow-------
&OBST ID='Side_Inlet', XB=4.5,4.50625,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Position wood sample-------
&OBST ID='WOOD_SAMPLE', XB=2.11875,2.375,0.1375,0.3625,0.0,0.0, SURF_ID='SAMPLE'/
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN',
XB=4.50625,4.50625,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=0.0,0.0,0.0,0.5,0.0,0.15/
-------Output air velocity surface of wood sample -------
&DEVC ID='CM-U', QUANTITY='U-VELOCITY', XYZ=2.24375,0.25,0.0/
&DEVC ID='CM-V', QUANTITY='V-VELOCITY', XYZ=2.24375,0.25,0.0/
&DEVC ID='CM-W', QUANTITY='W-VELOCITY', XYZ=2.24375,0.25,0.0/
&DEVC ID='CM', QUANTITY='VELOCITY', XYZ=2.24375,0.25,0.0/

&DEVC ID='CF-U', QUANTITY='U-VELOCITY', XYZ=2.24375,0.19375,0.0/
&DEVC ID='CF-V', QUANTITY='V-VELOCITY', XYZ=2.24375,0.19375,0.0/
&DEVC ID='CF-W', QUANTITY='W-VELOCITY', XYZ=2.24375,0.19375,0.0/
&DEVC ID='CF', QUANTITY='VELOCITY', XYZ=2.24375,0.19375,0.0/

&DEVC ID='CB-U', QUANTITY='U-VELOCITY', XYZ=2.24375,0.3,0.0/
&DEVC ID='CB-V', QUANTITY='V-VELOCITY', XYZ=2.24375,0.3,0.0/
&DEVC ID='CB-W', QUANTITY='W-VELOCITY', XYZ=2.24375,0.3,0.0/
&DEVC ID='CB', QUANTITY='VELOCITY', XYZ=2.24375,0.3,0.0/

&DEVC ID='OM-U', QUANTITY='U-VELOCITY', XYZ=2.18125,0.25,0.0/
&DEVC ID='OM-V', QUANTITY='V-VELOCITY', XYZ=2.18125,0.25,0.0/
&DEVC ID='OM-W', QUANTITY='W-VELOCITY', XYZ=2.18125,0.25,0.0/
&DEVC ID='OM', QUANTITY='VELOCITY', XYZ=2.1825,0.25,0.0/

&DEVC ID='OF-U', QUANTITY='U-VELOCITY', XYZ=2.18125,0.19375,0.0/
&DEVC ID='OF-V', QUANTITY='V-VELOCITY', XYZ=2.18125,0.19375,0.0/
&DEVC ID='OF-W', QUANTITY='W-VELOCITY', XYZ=2.18125,0.19375,0.0/
&DEVC ID='OF', QUANTITY='VELOCITY', XYZ=2.18125,0.19375,0.0/

&DEVC ID='OB-U', QUANTITY='U-VELOCITY', XYZ=2.18125,0.30625,0.0/
&DEVC ID='OB-V', QUANTITY='V-VELOCITY', XYZ=2.18125,0.30625,0.0/
```

```
&DEVC ID='OB-W', QUANTITY='W-VELOCITY', XYZ=2.18125,0.30625,0.0/
&DEVC ID='OB', QUANTITY='VELOCITY', XYZ=2.18125,0.30625,0.0/

&DEVC ID='IM-U', QUANTITY='U-VELOCITY', XYZ=2.30625,0.25,0.0/
&DEVC ID='IM-V', QUANTITY='V-VELOCITY', XYZ=2.30625,0.25,0.0/
&DEVC ID='IM-W', QUANTITY='W-VELOCITY', XYZ=2.30625,0.25,0.0/
&DEVC ID='IM', QUANTITY='VELOCITY', XYZ=2.30625,0.25,0.0/

&DEVC ID='IF-U', QUANTITY='U-VELOCITY', XYZ=2.30625,0.19375,0.0/
&DEVC ID='IF-V', QUANTITY='V-VELOCITY', XYZ=2.30625,0.19375,0.0/
&DEVC ID='IF-W', QUANTITY='W-VELOCITY', XYZ=2.30625,0.19375,0.0/
&DEVC ID='IF', QUANTITY='VELOCITY', XYZ=2.30625,0.19375,0.0/

&DEVC ID='IB-U', QUANTITY='U-VELOCITY', XYZ=2.30625,0.30625,0.0/
&DEVC ID='IB-V', QUANTITY='V-VELOCITY', XYZ=2.30625,0.30625,0.0/
&DEVC ID='IB-W', QUANTITY='W-VELOCITY', XYZ=2.30625,0.30625,0.0/
&DEVC ID='IB', QUANTITY='VELOCITY', XYZ=2.30625,0.30625,0.0/
-------Output air velocity area above wood sample -------
&DEVC ID='CM-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.25,0.0375/
&DEVC ID='CM-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.25,0.0375/
&DEVC ID='CM-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.25,0.0375/
&DEVC ID='CM-1', QUANTITY='VELOCITY', XYZ=2.2375,0.25,0.0375/

&DEVC ID='CF-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.125,0.0375/
&DEVC ID='CF-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.125,0.0375/
&DEVC ID='CF-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.125,0.0375/
&DEVC ID='CF-1', QUANTITY='VELOCITY', XYZ=2.2375,0.125,0.0375/

&DEVC ID='CB-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.375,0.0375/
&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.375,0.0375/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.375,0.0375/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.2375,0.375,0.0375/

&DEVC ID='OM-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.25,0.0375/
&DEVC ID='OM-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.25,0.0375/
&DEVC ID='OM-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.25,0.0375/
&DEVC ID='OM-1', QUANTITY='VELOCITY', XYZ=2.175,0.25,0.0375/

&DEVC ID='OF-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.125,0.0375/
&DEVC ID='OF-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.125,0.0375/
&DEVC ID='OF-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.125,0.0375/
&DEVC ID='OF-1', QUANTITY='VELOCITY', XYZ=2.175,0.125,0.0375/

&DEVC ID='OB-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.375,0.0375/
&DEVC ID='OB-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.375,0.0375/
```

```
&DEVC ID='OB-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.375,0.0375/
&DEVC ID='OB-1', QUANTITY='VELOCITY', XYZ=2.175,0.375,0.0375/

&DEVC ID='IM-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.25,0.0375/
&DEVC ID='IM-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.25,0.0375/
&DEVC ID='IM-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.25,0.0375/
&DEVC ID='IM-1', QUANTITY='VELOCITY', XYZ=2.3,0.25,0.0375/

&DEVC ID='IF-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.125,0.0375/
&DEVC ID='IF-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.125,0.0375/
&DEVC ID='IF-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.125,0.0375/
&DEVC ID='IF-1', QUANTITY='VELOCITY', XYZ=2.3,0.125,0.0375/

&DEVC ID='IB-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.375,0.0375/
&DEVC ID='IB-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.375,0.0375/
&DEVC ID='IB-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.375,0.0375/
&DEVC ID='IB-1', QUANTITY='VELOCITY', XYZ=2.3,0.375,0.0375/
-------Output air velocity at outlet -------
&DEVC ID='O-M-U', QUANTITY='U-VELOCITY', XYZ=0.0,0.25,0.075/
&DEVC ID='O-M-V', QUANTITY='V-VELOCITY', XYZ=0.0,0.25,0.075/
&DEVC ID='O-M-W', QUANTITY='W-VELOCITY', XYZ=0.0,0.25,0.075/
&DEVC ID='O-M', QUANTITY='VELOCITY', XYZ=0.0,0.25,0.075/

&DEVC ID='O-F-U', QUANTITY='U-VELOCITY', XYZ=0.0,0.125,0.075/
&DEVC ID='O-F-V', QUANTITY='V-VELOCITY', XYZ=0.0,0.125,0.075/
&DEVC ID='O-F-W', QUANTITY='W-VELOCITY', XYZ=0.0,0.125,0.075/
&DEVC ID='O-F', QUANTITY='VELOCITY', XYZ=0.0,0.125,0.075/

&DEVC ID='O-B-U', QUANTITY='U-VELOCITY', XYZ=0.0,0.375,0.075/
&DEVC ID='O-B-V', QUANTITY='V-VELOCITY', XYZ=0.0,0.375,0.075/
&DEVC ID='O-B-W', QUANTITY='W-VELOCITY', XYZ=0.0,0.375,0.075/
&DEVC ID='O-B', QUANTITY='VELOCITY', XYZ=0.0,0.375,0.075/
-------Animated output velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.2375/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.075/
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBZ=0.075/

&TAIL /
```

B.4.4 T4-short-1.25

This is the FDS code for the simulation with the shortened FANCI geometry and a mesh size of 1.25 [cm].

```
-------Simulation name-------
&HEAD CHID='Fanci_5_0_nohf_2'/
-------Simulation time-------
&TIME T_END=300.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=145,40,12, XB=1.35,3.1625,0.0,0.5,0.0,0.15/
-------Spruce-------
&MATL ID = 'SPRUCE',
      EMISSIVITY = 0.9,
      CONDUCTIVITY = 0.09,
      SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
      DENSITY = 408.0,
      N_REACTIONS = 1.0,
      A(1) = 4.69E13,
      E(1) = 190500,
      N_S(1) = 1.0,
      MATL_ID(1,1) = 'CHAR',
      NU_MATL(1,1) = 0.16,
      SPEC_ID(1,1) = 'PYROLYZATE',
      NU_SPEC(1,1) = 0.84,
      HEAT_OF_REACTION(1) = 430.0,
      HEAT_OF_COMBUSTION= 14000.0,
      ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.92 /
&RAMP ID='c_ramp_spruce', T=230, F=1.8 /
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
      SPECIFIC_HEAT=0.46,
      CONDUCTIVITY=45.8,
      DENSITY=7850.0,
      EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
      MATL_ID(1,1)='STEEL',
      MATL_MASS_FRACTION(1,1)=1.0,
      THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
      RGB=26,204,26,
      VEL=-2.5/
```

```
-------Wood sample-------
&SURF ID='SAMPLE',
      RGB=200,100,0,
      BACKING='INSULATED',
      MATL_ID='SPRUCE',
      THICKNESS=0.12/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=1.35,2.1125,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.375,3.15,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.112,2.38,0.0,0.1375,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.112,2.38,0.3625,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top', XB=1.35,3.15,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=1.35,3.15,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=1.35,3.15,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
-------Geometry of tunnel-------
&OBST ID='Side_Inlet', XB=3.15,3.1625,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Position wood sample-------
&OBST ID='WOOD_SAMPLE', XB=2.1125,2.375,0.1375,0.3625,0.0,0.0, SURF_ID='SAMPLE'/
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN', XB=3.1625,3.1625,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=1.35,1.35,0.0,0.5,0.0,0.15/
-------Output air velocity surface of wood sample -------
&DEVC ID='CM-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.25,0.0/
&DEVC ID='CM-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.25,0.0/
&DEVC ID='CM-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.25,0.0/
&DEVC ID='CM', QUANTITY='VELOCITY', XYZ=2.2375,0.25,0.0/

&DEVC ID='CF-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.1875,0.0/
&DEVC ID='CF-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.1875,0.0/
&DEVC ID='CF-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.1875,0.0/
&DEVC ID='CF', QUANTITY='VELOCITY', XYZ=2.2375,0.1875,0.0/

&DEVC ID='CB-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.3,0.0/
&DEVC ID='CB-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.3,0.0/
&DEVC ID='CB-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.3,0.0/
&DEVC ID='CB', QUANTITY='VELOCITY', XYZ=2.2375,0.3,0.0/

&DEVC ID='OM-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.25,0.0/
&DEVC ID='OM-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.25,0.0/
&DEVC ID='OM-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.25,0.0/
&DEVC ID='OM', QUANTITY='VELOCITY', XYZ=2.175,0.25,0.0/

&DEVC ID='OF-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.1875,0.0/
&DEVC ID='OF-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.1875,0.0/
```

```
&DEVC ID='OF-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.1875,0.0/
&DEVC ID='OF', QUANTITY='VELOCITY', XYZ=2.175,0.1875,0.0/

&DEVC ID='OB-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.3,0.0/
&DEVC ID='OB-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.3,0.0/
&DEVC ID='OB-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.3,0.0/
&DEVC ID='OB', QUANTITY='VELOCITY', XYZ=2.175,0.3,0.0/

&DEVC ID='IM-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.25,0.0/
&DEVC ID='IM-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.25,0.0/
&DEVC ID='IM-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.25,0.0/
&DEVC ID='IM', QUANTITY='VELOCITY', XYZ=2.3,0.25,0.0/

&DEVC ID='IF-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.1875,0.0/
&DEVC ID='IF-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.1875,0.0/
&DEVC ID='IF-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.1875,0.0/
&DEVC ID='IF', QUANTITY='VELOCITY', XYZ=2.3,0.1875,0.0/

&DEVC ID='IB-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.3,0.0/
&DEVC ID='IB-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.3,0.0/
&DEVC ID='IB-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.3,0.0/
&DEVC ID='IB', QUANTITY='VELOCITY', XYZ=2.3,0.3,0.0/
-------Output air velocity area above the wood sample -------
&DEVC ID='CM-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.25,0.075/
&DEVC ID='CM-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.25,0.075/
&DEVC ID='CM-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.25,0.075/
&DEVC ID='CM-1', QUANTITY='VELOCITY', XYZ=2.2375,0.25,0.075/

&DEVC ID='CF-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.125,0.075/
&DEVC ID='CF-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.125,0.075/
&DEVC ID='CF-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.125,0.075/
&DEVC ID='CF-1', QUANTITY='VELOCITY', XYZ=2.2375,0.125,0.075/

&DEVC ID='CB-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.375,0.075/
&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.375,0.075/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.375,0.075/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.2375,0.375,0.075/

&DEVC ID='OM-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.25,0.075/
&DEVC ID='OM-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.25,0.075/
&DEVC ID='OM-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.25,0.075/
&DEVC ID='OM-1', QUANTITY='VELOCITY', XYZ=2.175,0.25,0.075/

&DEVC ID='OF-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.125,0.075/
&DEVC ID='OF-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.125,0.075/
```

```
&DEVC ID='OF-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.125,0.075/
&DEVC ID='OF-1', QUANTITY='VELOCITY', XYZ=2.175,0.125,0.075/

&DEVC ID='CB-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.375,0.075/
&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.375,0.075/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.375,0.075/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.175,0.375,0.075/

&DEVC ID='IM-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.25,0.075/
&DEVC ID='IM-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.25,0.075/
&DEVC ID='IM-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.25,0.075/
&DEVC ID='IM-1', QUANTITY='VELOCITY', XYZ=2.3,0.25,0.075/

&DEVC ID='IF-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.125,0.075/
&DEVC ID='IF-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.125,0.075/
&DEVC ID='IF-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.125,0.075/
&DEVC ID='IF-1', QUANTITY='VELOCITY', XYZ=2.3,0.125,0.075/

&DEVC ID='IB-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.375,0.075/
&DEVC ID='IB-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.375,0.075/
&DEVC ID='IB-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.375,0.075/
&DEVC ID='IB-1', QUANTITY='VELOCITY', XYZ=2.3,0.375,0.075/
-------Output air velocity surface of wood sample -------
&DEVC ID='O-M-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M', QUANTITY='VELOCITY', XYZ=1.35,0.25,0.075/

&DEVC ID='O-F-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F', QUANTITY='VELOCITY', XYZ=1.35,0.125,0.075/

&DEVC ID='O-B-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B', QUANTITY='VELOCITY', XYZ=1.35,0.375,0.075/
-------Animated output velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.2375/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.075/
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBZ=0.075/

&TAIL /
```

B.4.5 T5-short-1.0

This is the FDS code for the simulation with the shortened FANCI geometry and a mesh size of 1.0 [cm].

```
-------Simulation name-------
&HEAD CHID='Fanci_7_0_1_nohf'/
-------Simulation time-------
&TIME T_END=300.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=14,27,15, XB=1.35,1.5,0.0,0.27,0.0,0.15, MPI_Process = 0/
&MESH ID='Mesh_02', IJK=14,23,15, XB=1.35,1.5,0.27,0.5,0.0,0.15, MPI_Process = 1/
&MESH ID='Mesh_03', IJK=50,27,15, XB=1.5,2.0,0.0,0.27,0.0,0.15, MPI_Process = 2/
&MESH ID='Mesh_04', IJK=50,23,15, XB=1.5,2.0,0.27,0.5,0.0,0.15, MPI_Process = 3/
&MESH ID='Mesh_05', IJK=50,27,15, XB=2.0,2.5,0.0,0.27,0.0,0.15, MPI_Process = 4/
&MESH ID='Mesh_06', IJK=50,23,15, XB=2.0,2.5,0.27,0.5,0.0,0.15, MPI_Process = 5/
&MESH ID='Mesh_07', IJK=66,27,15, XB=2.5,3.16,0.0,0.27,0.0,0.15, MPI_Process = 6/
&MESH ID='Mesh_08', IJK=66,23,15, XB=2.5,3.16,0.27,0.5,0.0,0.15, MPI_Process = 7/
-------Spruce-------
&MATL ID = 'SPRUCE',
        EMISSIVITY = 0.9,
        CONDUCTIVITY = 0.09,
        SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
        DENSITY = 408.0,
        N_REACTIONS = 1.0,
        A(1) = 4.69E13,
        E(1) = 190500,
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14000.0,
        ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.92 /
&RAMP ID='c_ramp_spruce', T=230, F=1.8 /
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
        SPECIFIC_HEAT=0.46,
        CONDUCTIVITY=45.8,
        DENSITY=7850.0,
        EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
        MATL_ID(1,1)='STEEL',
```

```
        MATL_MASS_FRACTION(1,1)=1.0,
        THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
        RGB=26,204,26,
        VEL=-2.5/
-------Wood sample-------
&SURF ID='SAMPLE',
        RGB=200,100,0,
        BACKING='INSULATED',
        MATL_ID='SPRUCE',
        THICKNESS=0.12/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=1.35,2.12,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.38,3.16,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.115,2.385,0.0,0.14,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.115,2.385,0.36,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top', XB=1.35,3.16,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=1.35,3.16,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=1.35,3.16,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
-------Position air inflow-------
&OBST ID='Side_Inlet', XB=3.15,3.16,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Position wood sample-------
&OBST ID='WOOD_SAMPLE', XB=2.12,2.38,0.14,0.36,0.0,0.0, SURF_ID='SAMPLE'/
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN', XB=3.16,3.16,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=1.35,1.35,0.0,0.5,0.0,0.15/
-------Output air velocity surface of wood sample -------
&DEVC ID='CM-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.25,0.0/
&DEVC ID='CM-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.25,0.0/
&DEVC ID='CM-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.25,0.0/
&DEVC ID='CM', QUANTITY='VELOCITY', XYZ=2.25,0.25,0.0/

&DEVC ID='CF-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.20,0.0/
&DEVC ID='CF-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.20,0.0/
&DEVC ID='CF-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.20,0.0/
&DEVC ID='CF', QUANTITY='VELOCITY', XYZ=2.25,0.20,0.0/

&DEVC ID='CB-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.31,0.0/
&DEVC ID='CB-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.31,0.0/
&DEVC ID='CB-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.31,0.0/
&DEVC ID='CB', QUANTITY='VELOCITY', XYZ=2.25,0.31,0.0/

&DEVC ID='OM-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.25,0.0/
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&DEVC ID='OM-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.25,0.0/
&DEVC ID='OM-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.25,0.0/
&DEVC ID='OM', QUANTITY='VELOCITY', XYZ=2.19,0.25,0.0/

&DEVC ID='OF-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.20,0.0/
&DEVC ID='OF-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.20,0.0/
&DEVC ID='OF-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.20,0.0/
&DEVC ID='OF', QUANTITY='VELOCITY', XYZ=2.19,0.20,0.0/

&DEVC ID='OB-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.31,0.0/
&DEVC ID='OB-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.31,0.0/
&DEVC ID='OB-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.31,0.0/
&DEVC ID='OB', QUANTITY='VELOCITY', XYZ=2.19,0.31,0.0/

&DEVC ID='IM-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.25,0.0/
&DEVC ID='IM-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.25,0.0/
&DEVC ID='IM-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.25,0.0/
&DEVC ID='IM', QUANTITY='VELOCITY', XYZ=2.31,0.25,0.0/

&DEVC ID='IF-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.20,0.0/
&DEVC ID='IF-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.20,0.0/
&DEVC ID='IF-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.20,0.0/
&DEVC ID='IF', QUANTITY='VELOCITY', XYZ=2.31,0.20,0.0/

&DEVC ID='IB-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.31,0.0/
&DEVC ID='IB-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.31,0.0/
&DEVC ID='IB-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.31,0.0/
&DEVC ID='IB', QUANTITY='VELOCITY', XYZ=2.31,0.31,0.0/
-------Output air velocity area above wood sample -------
&DEVC ID='CM-1-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.25,0.06/
&DEVC ID='CM-1-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.25,0.06/
&DEVC ID='CM-1-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.25,0.06/
&DEVC ID='CM-1', QUANTITY='VELOCITY', XYZ=2.25,0.25,0.06/

&DEVC ID='CF-1-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.20,0.06/
&DEVC ID='CF-1-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.20,0.06/
&DEVC ID='CF-1-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.20,0.06/
&DEVC ID='CF-1', QUANTITY='VELOCITY', XYZ=2.25,0.20,0.06/

&DEVC ID='CB-1-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.31,0.06/
&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.31,0.06/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.31,0.06/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.25,0.31,0.06/

&DEVC ID='OM-1-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.25,0.06/
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&DEVC ID='OM-1-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.25,0.06/
&DEVC ID='OM-1-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.25,0.06/
&DEVC ID='OM-1', QUANTITY='VELOCITY', XYZ=2.19,0.25,0.06/

&DEVC ID='OF-1-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.20,0.06/
&DEVC ID='OF-1-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.20,0.06/
&DEVC ID='OF-1-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.20,0.06/
&DEVC ID='OF-1', QUANTITY='VELOCITY', XYZ=2.19,0.20,0.06/

&DEVC ID='OB-1-U', QUANTITY='U-VELOCITY', XYZ=2.19,0.31,0.06/
&DEVC ID='OB-1-V', QUANTITY='V-VELOCITY', XYZ=2.19,0.31,0.06/
&DEVC ID='OB-1-W', QUANTITY='W-VELOCITY', XYZ=2.19,0.31,0.06/
&DEVC ID='OB-1', QUANTITY='VELOCITY', XYZ=2.19,0.31,0.06/

&DEVC ID='IM-1-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.25,0.06/
&DEVC ID='IM-1-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.25,0.06/
&DEVC ID='IM-1-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.25,0.06/
&DEVC ID='IM-1', QUANTITY='VELOCITY', XYZ=2.31,0.25,0.06/

&DEVC ID='IF-1-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.20,0.06/
&DEVC ID='IF-1-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.20,0.06/
&DEVC ID='IF-1-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.20,0.06/
&DEVC ID='IF-1', QUANTITY='VELOCITY', XYZ=2.31,0.20,0.06/

&DEVC ID='IB-1-U', QUANTITY='U-VELOCITY', XYZ=2.31,0.31,0.06/
&DEVC ID='IB-1-V', QUANTITY='V-VELOCITY', XYZ=2.31,0.31,0.06/
&DEVC ID='IB-1-W', QUANTITY='W-VELOCITY', XYZ=2.31,0.31,0.06/
&DEVC ID='IB-1', QUANTITY='VELOCITY', XYZ=2.31,0.31,0.06/
-------Output air velocity at outlet-------
&DEVC ID='O-M-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.25,0.07/
&DEVC ID='O-M-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.25,0.07/
&DEVC ID='O-M-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.25,0.07/
&DEVC ID='O-M', QUANTITY='VELOCITY', XYZ=1.35,0.25,0.07/

&DEVC ID='O-F-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.12,0.07/
&DEVC ID='O-F-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.12,0.07/
&DEVC ID='O-F-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.12,0.07/
&DEVC ID='O-F', QUANTITY='VELOCITY', XYZ=1.35,0.12,0.07/

&DEVC ID='O-B-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.37,0.07/
&DEVC ID='O-B-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.37,0.07/
&DEVC ID='O-B-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.37,0.07/
&DEVC ID='O-B', QUANTITY='VELOCITY', XYZ=1.35,0.37,0.07/
-------Animated output velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
```

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&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.07/
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBZ=0.07/

&TAIL /
```

B.4.6 T6-short-0.625

This is the FDS code for the simulation with the shortened FANCI geometry and a mesh size of 0.625 [cm].

```
-------Simulation name-------
&HEAD CHID='Fanci_6_0_1_nohf'/
-------Simulation time-------
&TIME T_END=300.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=24,80,24, XB=1.35,1.5,0.0,0.5,0.0,0.15, MPI_Process = 0/
&MESH ID='Mesh_02', IJK=80,42,24, XB=1.5,2.0,0.0,0.2625,0.0,0.15, MPI_Process = 1/
&MESH ID='Mesh_03', IJK=40,38,24, XB=1.5,2.0,0.2625,0.5,0.0,0.15, MPI_Process = 2/
&MESH ID='Mesh_04', IJK=80,42,24, XB=2.0,2.5,0.0,0.2625,0.0,0.15, MPI_Process = 3/
&MESH ID='Mesh_05', IJK=80,38,24, XB=2.0,2.5,0.2625,0.5,0.0,0.15, MPI_Process = 4/
&MESH ID='Mesh_06', IJK=80,42,24, XB=2.5,3.0,0.0,0.2625,0.0,0.15, MPI_Process = 5/
&MESH ID='Mesh_07', IJK=80,38,24, XB=2.5,3.0,0.2625,0.50,0.0,0.15, MPI_Process = 6/
&MESH ID='Mesh_08', IJK=25,80,24, XB=3.0,3.15625,0.0,0.5,0.0,0.15, MPI_Process = 7/
-------Spruce-------
&MATL ID = 'SPRUCE',
        EMISSIVITY = 0.9,
        CONDUCTIVITY = 0.09,
        SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
        DENSITY = 408.0,
        N_REACTIONS = 1.0,
        A(1) = 4.69E13,
        E(1) = 190500,
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14000.0,
        ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.92 /
&RAMP ID='c_ramp_spruce', T=230, F=1.8 /
```

```
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
      SPECIFIC_HEAT=0.46,
      CONDUCTIVITY=45.8,
      DENSITY=7850.0,
      EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
      MATL_ID(1,1)='STEEL',
      MATL_MASS_FRACTION(1,1)=1.0,
      THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
      RGB=26,204,26,
      VEL=-2.5/
-------Wood sample-------
&SURF ID='SAMPLE',
      RGB=200,100,0,
      BACKING='INSULATED',
      MATL_ID='SPRUCE',
      THICKNESS=0.12/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=1.35,2.11875,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.375,3.15625,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.1156,2.378,0.0,0.1375,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.1156,2.378,0.3625,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top', XB=1.35,3.15625,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=1.35,3.15625,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=1.35,3.15625,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
-------Position air inflow-------
&OBST ID='Side_Inlet', XB=3.15,3.15625,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Position wood sample-------
&OBST ID='WOOD_SAMPLE', XB=2.11875,2.375,0.1375,0.3625,0.0,0.0, SURF_ID='SAMPLE'/
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN',
XB=3.15625,3.15625,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=1.35,1.35,0.0,0.5,0.0,0.15/
-------Output air velocity surface of wood sample -------
&DEVC ID='CM-U', QUANTITY='U-VELOCITY', XYZ=2.24375,0.25,0.0/
&DEVC ID='CM-V', QUANTITY='V-VELOCITY', XYZ=2.24375,0.25,0.0/
&DEVC ID='CM-W', QUANTITY='W-VELOCITY', XYZ=2.24375,0.25,0.0/
&DEVC ID='CM', QUANTITY='VELOCITY', XYZ=2.24375,0.25,0.0/

&DEVC ID='CF-U', QUANTITY='U-VELOCITY', XYZ=2.24375,0.19375,0.0/
&DEVC ID='CF-V', QUANTITY='V-VELOCITY', XYZ=2.24375,0.19375,0.0/
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&DEVC ID='CF-W', QUANTITY='W-VELOCITY', XYZ=2.24375,0.19375,0.0/
&DEVC ID='CF', QUANTITY='VELOCITY', XYZ=2.24375,0.19375,0.0/

&DEVC ID='CB-U', QUANTITY='U-VELOCITY', XYZ=2.24375,0.3,0.0/
&DEVC ID='CB-V', QUANTITY='V-VELOCITY', XYZ=2.24375,0.3,0.0/
&DEVC ID='CB-W', QUANTITY='W-VELOCITY', XYZ=2.24375,0.3,0.0/
&DEVC ID='CB', QUANTITY='VELOCITY', XYZ=2.24375,0.3,0.0/

&DEVC ID='OM-U', QUANTITY='U-VELOCITY', XYZ=2.18125,0.25,0.0/
&DEVC ID='OM-V', QUANTITY='V-VELOCITY', XYZ=2.18125,0.25,0.0/
&DEVC ID='OM-W', QUANTITY='W-VELOCITY', XYZ=2.18125,0.25,0.0/
&DEVC ID='OM', QUANTITY='VELOCITY', XYZ=2.1825,0.25,0.0/

&DEVC ID='OF-U', QUANTITY='U-VELOCITY', XYZ=2.18125,0.19375,0.0/
&DEVC ID='OF-V', QUANTITY='V-VELOCITY', XYZ=2.18125,0.19375,0.0/
&DEVC ID='OF-W', QUANTITY='W-VELOCITY', XYZ=2.18125,0.19375,0.0/
&DEVC ID='OF', QUANTITY='VELOCITY', XYZ=2.18125,0.19375,0.0/

&DEVC ID='OB-U', QUANTITY='U-VELOCITY', XYZ=2.18125,0.30625,0.0/
&DEVC ID='OB-V', QUANTITY='V-VELOCITY', XYZ=2.18125,0.30625,0.0/
&DEVC ID='OB-W', QUANTITY='W-VELOCITY', XYZ=2.18125,0.30625,0.0/
&DEVC ID='OB', QUANTITY='VELOCITY', XYZ=2.18125,0.30625,0.0/

&DEVC ID='IM-U', QUANTITY='U-VELOCITY', XYZ=2.30625,0.25,0.0/
&DEVC ID='IM-V', QUANTITY='V-VELOCITY', XYZ=2.30625,0.25,0.0/
&DEVC ID='IM-W', QUANTITY='W-VELOCITY', XYZ=2.30625,0.25,0.0/
&DEVC ID='IM', QUANTITY='VELOCITY', XYZ=2.30625,0.25,0.0/

&DEVC ID='IF-U', QUANTITY='U-VELOCITY', XYZ=2.30625,0.19375,0.0/
&DEVC ID='IF-V', QUANTITY='V-VELOCITY', XYZ=2.30625,0.19375,0.0/
&DEVC ID='IF-W', QUANTITY='W-VELOCITY', XYZ=2.30625,0.19375,0.0/
&DEVC ID='IF', QUANTITY='VELOCITY', XYZ=2.30625,0.19375,0.0/

&DEVC ID='IB-U', QUANTITY='U-VELOCITY', XYZ=2.30625,0.30625,0.0/
&DEVC ID='IB-V', QUANTITY='V-VELOCITY', XYZ=2.30625,0.30625,0.0/
&DEVC ID='IB-W', QUANTITY='W-VELOCITY', XYZ=2.30625,0.30625,0.0/
&DEVC ID='IB', QUANTITY='VELOCITY', XYZ=2.30625,0.30625,0.0/
-------Output air velocity area above wood sample -------
&DEVC ID='CM-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.25,0.0375/
&DEVC ID='CM-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.25,0.0375/
&DEVC ID='CM-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.25,0.0375/
&DEVC ID='CM-1', QUANTITY='VELOCITY', XYZ=2.2375,0.25,0.0375/

&DEVC ID='CF-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.125,0.0375/
&DEVC ID='CF-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.125,0.0375/
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&DEVC ID='CF-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.125,0.0375/
&DEVC ID='CF-1', QUANTITY='VELOCITY', XYZ=2.2375,0.125,0.0375/

&DEVC ID='CB-1-U', QUANTITY='U-VELOCITY', XYZ=2.2375,0.375,0.0375/
&DEVC ID='CB-1-V', QUANTITY='V-VELOCITY', XYZ=2.2375,0.375,0.0375/
&DEVC ID='CB-1-W', QUANTITY='W-VELOCITY', XYZ=2.2375,0.375,0.0375/
&DEVC ID='CB-1', QUANTITY='VELOCITY', XYZ=2.2375,0.375,0.0375/

&DEVC ID='OM-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.25,0.0375/
&DEVC ID='OM-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.25,0.0375/
&DEVC ID='OM-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.25,0.0375/
&DEVC ID='OM-1', QUANTITY='VELOCITY', XYZ=2.175,0.25,0.0375/

&DEVC ID='OF-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.125,0.0375/
&DEVC ID='OF-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.125,0.0375/
&DEVC ID='OF-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.125,0.0375/
&DEVC ID='OF-1', QUANTITY='VELOCITY', XYZ=2.175,0.125,0.0375/

&DEVC ID='OB-1-U', QUANTITY='U-VELOCITY', XYZ=2.175,0.375,0.0375/
&DEVC ID='OB-1-V', QUANTITY='V-VELOCITY', XYZ=2.175,0.375,0.0375/
&DEVC ID='OB-1-W', QUANTITY='W-VELOCITY', XYZ=2.175,0.375,0.0375/
&DEVC ID='OB-1', QUANTITY='VELOCITY', XYZ=2.175,0.375,0.0375/

&DEVC ID='IM-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.25,0.0375/
&DEVC ID='IM-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.25,0.0375/
&DEVC ID='IM-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.25,0.0375/
&DEVC ID='IM-1', QUANTITY='VELOCITY', XYZ=2.3,0.25,0.0375/

&DEVC ID='IF-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.125,0.0375/
&DEVC ID='IF-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.125,0.0375/
&DEVC ID='IF-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.125,0.0375/
&DEVC ID='IF-1', QUANTITY='VELOCITY', XYZ=2.3,0.125,0.0375/

&DEVC ID='IB-1-U', QUANTITY='U-VELOCITY', XYZ=2.3,0.375,0.0375/
&DEVC ID='IB-1-V', QUANTITY='V-VELOCITY', XYZ=2.3,0.375,0.0375/
&DEVC ID='IB-1-W', QUANTITY='W-VELOCITY', XYZ=2.3,0.375,0.0375/
&DEVC ID='IB-1', QUANTITY='VELOCITY', XYZ=2.3,0.375,0.0375/
-------Output air velocity at outlet-------
&DEVC ID='O-M-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.25,0.075/
&DEVC ID='O-M', QUANTITY='VELOCITY', XYZ=1.35,0.25,0.075/

&DEVC ID='O-F-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.125,0.075/
```

```
&DEVC ID='O-F-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.125,0.075/
&DEVC ID='O-F', QUANTITY='VELOCITY', XYZ=1.35,0.125,0.075/

&DEVC ID='O-B-U', QUANTITY='U-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B-V', QUANTITY='V-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B-W', QUANTITY='W-VELOCITY', XYZ=1.35,0.375,0.075/
&DEVC ID='O-B', QUANTITY='VELOCITY', XYZ=1.35,0.375,0.075/
-------Animated output velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.2375/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.075/
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBZ=0.075/

&TAIL /
```

Appendix C – Calculation of Reynolds number

The Reynolds number Re can be calculated by the following equation [37]:

$$Re = \frac{u*D_h}{v} \quad (22)$$

Where:

- u Air velocity, 2.0 [m/s]
- D_h Hydraulic diameter of tunnel, [m]
- v Kinematic viscosity of air, at 20 [°C], 15.06*10^{-6} [m^2/s] [38]

The hydraulic diameter can be calculated with equation 23 and is 0.23 [m].

$$D_h = \frac{4*\mathrm{A}}{P} \quad (23)$$

Where:

- A Cross-section of tunnel, 0.075 [m^2]
- P Perimeter of tunnel, 1.3 [m]

By that, the Reynolds number becomes 30544 which is higher than 5000 and therefore is characterize as a turbulent flow.

Appendix D – Calibration of the heat panel ("S2-HP")

D.1 Estimation of heat flux from the heat panel

To get a rough idea of the emitting heat flux from the heat panel, an estimation of it is done by the following equations. The incident heat flux I [kW/m^2] on a surface by a radiative panel can be calculated by [39, p. 30]

$$I = \varphi * \alpha * I_{EC} \quad (24)$$

Where:

- I Receiving heat flux on a surface, [kW/m^2]
- φ Configuration factor, [-]
- α Ratio of radiant surface divided by area of enclosed rectangle, [-]
- I_{EC} Emitted heat flux from a heating source, [kW/m^2]

For the simulation situation, the receiving heat flux on a surface is known but the emitted heat flux is to calculate, therefore:

$$I_{EC} = \frac{I}{\varphi * \alpha} \quad (25)$$

The receiving heat flux I is equal to the estimated incident heat flux in the experiment which is 96.4 [kW/m^2] and α is equal to 1. The configuration factor is estimated by the following equation which is for emitting rectangle positioned opposite a receiving point [38, p. 30].

$$\varphi_1 = \frac{1}{2\pi}\left[\frac{X}{\sqrt{X^2+Z^2}}\arctan\left(\frac{Y}{\sqrt{X^2+Z^2}}\right) + \frac{Y}{\sqrt{Y^2+Z^2}}\arctan\left(\frac{Z}{\sqrt{X^2+Y^2}}\right)\right] \quad (26)$$

Where:

- X Longer side of emitting surface, 0.56 [m]
- Y Distance between the emitting surface and the receiving point, 0.15 [m]
- Z Shorter side from emitting surface, 0.139 [m]

Given that in the equation for configuration factor above the receiving point is positioned at a corner of the emitting surface, the total configuration factor φ is equal to $4 * \varphi_1$. With the above given numbers, $\varphi = 4 * 0.182 = 0.727$. Therefore, the estimated emitting heat flux is 132.6 [kW/m^2].

D.2 Test simulations

The estimated emitting heat flux from the heat panel was tested in the simulation environment of the FANCI experiment as described under chapter 3.5.1 “Implementation” except for one modification. The timber surface was replaced by an inert material (“INERT”) and no burning took place. The incident heat flux at the position of the timber sample surface is measured by the output quantity “NET_HEAT_FLUX”. Three measuring points are positioned on the surface, one in the center of the surface, one closer to the back side wall and one closer to the front side wall. A heat panel was added on the ceiling opposite and centered above the timber sample with dimensions 0.56 [m] by 0.39 [m]. The estimated heat flux was placed as a heating source on that heat panel by the code “NET_HEAT_FLUX”. This forces FDS to keep the combination of radiative and convective heat flux from the heat panel equal to the specified value [21, p. 87].

The first test simulation with a heat panel at 132 [kW/m^2] resulted in a too high incident heat flux on the timber sample. Therefore, heat fluxes at 120 and 125 [kW/m^2] were tested. The FDS codes are displayed under D.3.

The mean of the three recorded positions of the incident heat fluxes on the timber sample surface are shown in table 50.

Table 50: Mean heat flux on the surface depending on the emitting heat flux on the heat panel as well as the corresponding values from the experiment

Emitting heat flux	120 [kW/m^2]	125 [kW/m^2]	Experiment
Mean heat flux on wood surface	98.3	102.8	96.4

The simulation with a heat panel at 120 [kW/m^2] resulted in a very similar incident heat flux as the one from the experiment. Therefore, that value was chosen as the heat flux for the simulation with a heat panel.

D.3 FDS code for testing a heat panel

D.3.1 FDS code for a heat flux of 120 [kW/m^2]

```
Fanci_11_3_nb_1206s_120_20.fds
&HEAD CHID='Fanci_11_3_nb_1206s_120_20'/
&TIME T_END=1206.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=40,27,15, XB=1.6,2.0,0.0,0.27,0.0,0.15, MPI_Process = 0/
&MESH ID='Mesh_02', IJK=40,23,15, XB=1.6,2.0,0.27,0.5,0.0,0.15, MPI_Process = 1/
&MESH ID='Mesh_03', IJK=50,27,15, XB=2.0,2.5,0.0,0.27,0.0,0.15, MPI_Process = 2/
&MESH ID='Mesh_04', IJK=50,23,15, XB=2.0,2.5,0.27,0.5,0.0,0.15, MPI_Process = 3/
&MESH ID='Mesh_05', IJK=50,27,15, XB=2.5,3.0,0.0,0.27,0.0,0.15, MPI_Process = 4/
&MESH ID='Mesh_06', IJK=50,23,15, XB=2.5,3.0,0.27,0.5,0.0,0.15, MPI_Process = 5/
```

```
&MESH ID='Mesh_07', IJK=50,27,15, XB=3.0,3.5,0.0,0.27,0.0,0.15, MPI_Process = 6/
&MESH ID='Mesh_08', IJK=50,23,15, XB=3.0,3.5,0.27,0.5,0.0,0.15, MPI_Process = 7/
&MESH ID='Mesh_09', IJK=31,27,15, XB=3.5,3.81,0.0,0.27,0.0,0.15, MPI_Process = 8/
&MESH ID='Mesh_10', IJK=31,23,15, XB=3.5,3.81,0.27,0.5,0.0,0.15, MPI_Process = 9/
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
      SPECIFIC_HEAT=0.46,
      CONDUCTIVITY=45.8,
      DENSITY=7850.0,
      EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
      MATL_ID(1,1)='STEEL',
      MATL_MASS_FRACTION(1,1)=1.0,
      THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
      RGB=26,204,26,
      VEL=-2.0/
-------Heat panel-------
&SURF ID='HEAT_PANEL_SURFACE',
      COLOR='RED',
      NET_HEAT_FLUX=120/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=1.6,2.12,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.38,3.81,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.115,2.385,0.0,0.14,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.115,2.385,0.36,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_outlet', XB=1.6,1.97,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_inlet', XB=2.53,3.81,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_front', XB=1.965,2.535,0.0,0.05,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_back', XB=1.965,2.535,0.44,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=1.6,3.81,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=1.6,3.81,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Inlet', XB=3.8,3.81,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Wood sample turned inert-------
&OBST ID='WOOD_SAMPLE', XB=2.12,2.38,0.14,0.36,0.0,0.0, SURF_ID='INERT'/
-------Position of heat panel-------
&VENT ID='HEAT_PANEL_FLOW', XB=1.97,2.53,0.05,0.44,0.15,0.15,
SURF_ID='HEAT_PANEL_SURFACE', IOR=-3 /
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN', XB=3.81,3.81,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=1.6,1.6,0.0,0.5,0.0,0.15/
-------Recording NET_HEAT_FLUX-------
&DEVC ID='HF_M', QUANTITY='NET HEAT FLUX', XYZ=2.25,0.25,0.0, IOR=3/
```

```
&DEVC ID='HF_B', QUANTITY='NET HEAT FLUX', XYZ=2.25,0.31,0.0, IOR=3/
&DEVC ID='HF_F', QUANTITY='NET HEAT FLUX', XYZ=2.25,0.20,0.0, IOR=3/
-------Other heat flux recording on wood surface-------
&DEVC ID='IHF_M', QUANTITY='INCIDENT HEAT FLUX', XYZ=2.25,0.25,0.0, IOR=3/
&DEVC ID='IHF_B', QUANTITY='INCIDENT HEAT FLUX', XYZ=2.25,0.31,0.0, IOR=3/
&DEVC ID='IHF_F', QUANTITY='INCIDENT HEAT FLUX', XYZ=2.25,0.20,0.0, IOR=3/
&DEVC ID='GHF_M', QUANTITY='GAUGE HEAT FLUX', XYZ=2.25,0.25,0.0, IOR=3/
&DEVC ID='GHF_B', QUANTITY='GAUGE HEAT FLUX', XYZ=2.25,0.31,0.0, IOR=3/
&DEVC ID='GHF_F', QUANTITY='GAUGE HEAT FLUX', XYZ=2.25,0.20,0.0, IOR=3/
-------Temperature recording on wood surface-------
&DEVC ID='T_M', QUANTITY='TEMPERATURE', XYZ=2.25,0.25,0.0, IOR=3/
&DEVC ID='T_B', QUANTITY='TEMPERATURE', XYZ=2.25,0.31,0.0, IOR=3/
&DEVC ID='T_F', QUANTITY='TEMPERATURE', XYZ=2.25,0.20,0.0, IOR=3/
-------Animated output air velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.07/
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBZ=0.07/

&TAIL /
```

D.3.2 FDS code for a heat flux of 125 [kW/m^2]

This is the same code as in the subsection before, except for the following subchapter:

```
-------Heat panel-------
&SURF ID='HEAT_PANEL_SURFACE',
      COLOR='RED',
      NET_HEAT_FLUX=125/
```

D.3.2 FDS code for a heat flux of 132 [kW/m^2]

This is the same code as in the subsection before, except for the following subchapter:

```
-------Heat panel-------
&SURF ID='HEAT_PANEL_SURFACE',
      COLOR='RED',
      NET_HEAT_FLUX=132/
```

Appendix E – FDS codes

The following sections describe the different simulation codes in FDS. The first section summarizes the codes with ignition by an external heat flux and the second section the codes for ignition by a heat panel.

E.1 "S1-exHF-fine"

The following code is for the standard case with ignition by an external heat flux over the timber sample.

Fanci_12_5_1206s_20_outputs1.fds

```
-------Simulation name-------
&HEAD CHID=' Fanci_12_5_1206s_20_outputs1/
-------Simulation time-------
&TIME T_END=1206.0/
-------Mesh-------
&MESH ID='Mesh_01', IJK=40,27,15, XB=1.6,2.0,0.0,0.27,0.0,0.15, MPI_Process = 0/
&MESH ID='Mesh_02', IJK=40,23,15, XB=1.6,2.0,0.27,0.5,0.0,0.15, MPI_Process = 1/
&MESH ID='Mesh_03', IJK=50,27,15, XB=2.0,2.5,0.0,0.27,0.0,0.15, MPI_Process = 2/
&MESH ID='Mesh_04', IJK=50,23,15, XB=2.0,2.5,0.27,0.5,0.0,0.15, MPI_Process = 3/
&MESH ID='Mesh_05', IJK=50,27,15, XB=2.5,3.0,0.0,0.27,0.0,0.15, MPI_Process = 4/
&MESH ID='Mesh_06', IJK=50,23,15, XB=2.5,3.0,0.27,0.5,0.0,0.15, MPI_Process = 5/
&MESH ID='Mesh_07', IJK=50,27,15, XB=3.0,3.5,0.0,0.27,0.0,0.15, MPI_Process = 6/
&MESH ID='Mesh_08', IJK=50,23,15, XB=3.0,3.5,0.27,0.5,0.0,0.15, MPI_Process = 7/
&MESH ID='Mesh_09', IJK=31,27,15, XB=3.5,3.81,0.0,0.27,0.0,0.15, MPI_Process = 8/
&MESH ID='Mesh_10', IJK=31,23,15, XB=3.5,3.81,0.27,0.5,0.0,0.15, MPI_Process = 9/
-------Gas combustion-------
&REAC FUEL='PYROLYZATE', C=1, H=3.584, O=1.55, N=0, SOOT_YIELD=0.015,
HEAT_OF_COMBUSTION= 14000 /
-------Fuel (gaseous)-------
&SPEC ID = 'PYROLYZATE',
      FORMULA='C1H3.584O1.55',
      CONDUCTIVITY= 0.09,
      DIFFUSIVITY=4.30E-7,
      VISCOSITY=0.00059,
      RADCAL_ID='METHANOL' /
-------Spruce-------
&MATL ID = 'SPRUCE',
      EMISSIVITY = 0.9,
      CONDUCTIVITY = 0.09,
      SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
      DENSITY = 408.0,
      N_REACTIONS = 1.0,
      A(1) = 4.69E13,
      E(1) = 190500,
```

```
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14000.0,
        ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.92 /
&RAMP ID='c_ramp_spruce', T=230, F=1.8 /
-------Char-------
&MATL ID='CHAR',
        EMISSIVITY = 0.85,
        DENSITY = 59,
        CONDUCTIVITY = 0.22,
        SPECIFIC_HEAT_RAMP = 'c_ramp_char'/
&RAMP ID='c_ramp_char', T=20, F=0.682 /
&RAMP ID='c_ramp_char', T=60, F=0.889 /
&RAMP ID='c_ramp_char', T=100, F=1.037 /
&RAMP ID='c_ramp_char', T=140, F=1.148 /
&RAMP ID='c_ramp_char', T=180, F=1.234 /
&RAMP ID='c_ramp_char', T=220, F=1.304 /
&RAMP ID='c_ramp_char', T=260, F=1.362 /
&RAMP ID='c_ramp_char', T=300, F=1.411 /
&RAMP ID='c_ramp_char', T=350, F=1.462 /
&RAMP ID='c_ramp_char', T=400, F=1.507 /
&RAMP ID='c_ramp_char', T=450, F=1.547 /
-------Steel (walls of tunnel)-------
&MATL ID='STEEL',
        SPECIFIC_HEAT=0.46,
        CONDUCTIVITY=45.8,
        DENSITY=7850.0,
        EMISSIVITY=0.7/
&SURF ID='STEEL_SURFACE',
        MATL_ID(1,1)='STEEL',
        MATL_MASS_FRACTION(1,1)=1.0,
        THICKNESS(1)=3.0E-3/
-------Inlet air flow-------
&SURF ID='INFLOW',
        RGB=26,204,26,
        VEL=-2.0/
-------Wood sample-------
&SURF ID='SAMPLE',
        RGB=200,100,0,
```

```
        BACKING='INSULATED',
        MATL_ID='SPRUCE',
        THICKNESS=0.12,
        STRETCH_FACTOR(1)=1,
        EXTERNAL_FLUX = 96.3963/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=1.6,2.12,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.38,3.81,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.115,2.385,0.0,0.14,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.115,2.385,0.36,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top', XB=1.6,3.81,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=1.6,3.81,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=1.6,3.81,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
-------Position air inflow-------
&OBST ID='Side_Inlet', XB=3.8,3.81,0.0,0.5,0.0,0.15, SURF_ID='INFLOW'/
-------Position wood sample-------
&OBST ID='WOOD_SAMPLE', XB=2.12,2.38,0.14,0.36,0.0,0.0, SURF_ID='SAMPLE'/
-------Tunnel openings-------
&VENT ID='Mesh Vent: Mesh_01 [XMAX]', SURF_ID='OPEN', XB=3.81,3.81,0.0,0.5,0.0,0.15/
&VENT ID='Mesh Vent: Mesh_01 [XMIN]', SURF_ID='OPEN', XB=1.6,1.6,0.0,0.5,0.0,0.15/
-------Output temperature inside wood sample-------
&PROF ID='Temp', XYZ=2.25, 0.25, 0.005, QUANTITY='TEMPERATURE', IOR=3 /
-------Output temperature on wood surface(1)-------
&DEVC XYZ=2.25, 0.25, 0.005, QUANTITY='WALL TEMPERATURE', IOR=3, ID='Wall_temp_devc' /
-------Output density inside wood sample-------
&PROF ID='Density', XYZ=2.25, 0.25, 0.005, QUANTITY='DENSITY', IOR=3 /
&PROF ID='Spruce_density', XYZ=2.25, 0.25, 0.005, QUANTITY='SPRUCE', IOR=3 /
&PROF ID='Char_density', XYZ=2.25, 0.25, 0.005, QUANTITY='CHAR', IOR=3 /
-------Output solid density on wood surface-------
&DEVC ID='Solid_density_spruce', XYZ=2.25, 0.25, 0.0, QUANTITY='SOLID DENSITY',
MATL_ID='SPRUCE', IOR=3 /
&DEVC ID='Solid_density_char', XYZ=2.25, 0.25, 0.0, QUANTITY='SOLID DENSITY',
MATL_ID='CHAR', IOR=3 /
-------Output surface density on wood surface-------
&DEVC ID='Surface_density', XYZ=2.25, 0.25, 0.0, IOR = 3, QUANTITY = 'SURFACE DENSITY' /
&DEVC ID='Surface_density_spruce', XYZ=2.25, 0.25, 0.0, IOR = 3, QUANTITY = 'SURFACE
DENSITY', MATL_ID='SPRUCE' /
&DEVC ID='Surface_density_char', XYZ=2.25, 0.25, 0.0, IOR = 3, QUANTITY = 'SURFACE DENSITY',
MATL_ID='CHAR' /
-------Output temperatures on wood surface(2)-------
&DEVC ID='CM-T', QUANTITY='TEMPERATURE', XYZ=2.25,0.25,0.0/
&DEVC ID='CF-T', QUANTITY='TEMPERATURE', XYZ=2.25,0.20,0.0/
&DEVC ID='CB-T', QUANTITY='TEMPERATURE', XYZ=2.25,0.30,0.0/
&DEVC ID='OM-T', QUANTITY='TEMPERATURE', XYZ=2.19,0.25,0.0/
```

```
&DEVC ID='OF-T', QUANTITY='TEMPERATURE', XYZ=2.19,0.20,0.0/
&DEVC ID='OB-T', QUANTITY='TEMPERATURE', XYZ=2.19,0.30,0.0/
&DEVC ID='IM-T', QUANTITY='TEMPERATURE', XYZ=2.31,0.25,0.0/
&DEVC ID='IF-T', QUANTITY='TEMPERATURE', XYZ=2.31,0.20,0.0/
&DEVC ID='IB-T', QUANTITY='TEMPERATURE', XYZ=2.31,0.30,0.0/
-------Output gas temperatures-------
&DEVC ID='C1-T', QUANTITY='TEMPERATURE', XYZ=2.0,0.25,0.07/ at end of fire chamber
&DEVC ID='C2-T', QUANTITY='TEMPERATURE', XYZ=1.8,0.25,0.07/ a little further away from fire
chamber
&DEVC ID='C3-T', QUANTITY='TEMPERATURE', XYZ=1.7,0.25,0.07/ a little further away from fire
chamber
&DEVC ID='C4-T', QUANTITY='TEMPERATURE', XYZ=1.6,0.25,0.07/ a little further away from fire
chamber
&DEVC ID='C01-T', QUANTITY='TEMPERATURE', XYZ=2.7,0.25,0.07/ before fire chamber
&DEVC ID='C02-T', QUANTITY='TEMPERATURE', XYZ=2.5,0.25,0.07/ before fire chamber
&DEVC ID='CM0-T', QUANTITY='TEMPERATURE', XYZ=2.25,0.25,0.07/ center of fire chamber
-------Output velocity-------
&DEVC ID='CIA-V-U', QUANTITY='U-VELOCITY', XYZ=3.70,0.25,0.07/
&DEVC ID='CIA-V-V', QUANTITY='V-VELOCITY', XYZ=3.70,0.25,0.07/
&DEVC ID='CIA-V-W', QUANTITY='W-VELOCITY', XYZ=3.70,0.25,0.07/
&DEVC ID='CIA-V', QUANTITY='VELOCITY', XYZ=3.70,0.25,0.07/

&DEVC ID='CIB-V-U', QUANTITY='U-VELOCITY', XYZ=3.50,0.25,0.07/
&DEVC ID='CIB-V-V', QUANTITY='V-VELOCITY', XYZ=3.50,0.25,0.07/
&DEVC ID='CIB-V-W', QUANTITY='W-VELOCITY', XYZ=3.50,0.25,0.07/
&DEVC ID='CIB-V', QUANTITY='VELOCITY', XYZ=3.50,0.25,0.07/

&DEVC ID='CIC-V-U', QUANTITY='U-VELOCITY', XYZ=3.30,0.25,0.07/
&DEVC ID='CIC-V-V', QUANTITY='V-VELOCITY', XYZ=3.30,0.25,0.07/
&DEVC ID='CIC-V-W', QUANTITY='W-VELOCITY', XYZ=3.30,0.25,0.07/
&DEVC ID='CIC-V', QUANTITY='VELOCITY', XYZ=3.30,0.25,0.07/

&DEVC ID='CI1-V-U', QUANTITY='U-VELOCITY', XYZ=3.10,0.25,0.07/
&DEVC ID='CI1-V-V', QUANTITY='V-VELOCITY', XYZ=3.10,0.25,0.07/
&DEVC ID='CI1-V-W', QUANTITY='W-VELOCITY', XYZ=3.10,0.25,0.07/
&DEVC ID='CI1-V', QUANTITY='VELOCITY', XYZ=3.10,0.25,0.07/

&DEVC ID='CI2-V-U', QUANTITY='U-VELOCITY', XYZ=2.90,0.25,0.07/
&DEVC ID='CI2-V-V', QUANTITY='V-VELOCITY', XYZ=2.90,0.25,0.07/
&DEVC ID='CI2-V-W', QUANTITY='W-VELOCITY', XYZ=2.90,0.25,0.07/
&DEVC ID='CI2-V', QUANTITY='VELOCITY', XYZ=2.90,0.25,0.07/

&DEVC ID='CI3-V-U', QUANTITY='U-VELOCITY', XYZ=2.70,0.25,0.07/
&DEVC ID='CI3-V-V', QUANTITY='V-VELOCITY', XYZ=2.70,0.25,0.07/
```

```
&DEVC ID='CI3-V-W', QUANTITY='W-VELOCITY', XYZ=2.70,0.25,0.07/
&DEVC ID='CI3-V', QUANTITY='VELOCITY', XYZ=2.70,0.25,0.07/

&DEVC ID='CI4-V-U', QUANTITY='U-VELOCITY', XYZ=2.50,0.25,0.07/
&DEVC ID='CI4-V-V', QUANTITY='V-VELOCITY', XYZ=2.50,0.25,0.07/
&DEVC ID='CI4-V-W', QUANTITY='W-VELOCITY', XYZ=2.50,0.25,0.07/
&DEVC ID='CI4-V', QUANTITY='VELOCITY', XYZ=2.50,0.25,0.07/

&DEVC ID='CM-V-U', QUANTITY='U-VELOCITY', XYZ=2.25,0.25,0.07/
&DEVC ID='CM-V-V', QUANTITY='V-VELOCITY', XYZ=2.25,0.25,0.07/
&DEVC ID='CM-V-W', QUANTITY='W-VELOCITY', XYZ=2.25,0.25,0.07/
&DEVC ID='CM-V', QUANTITY='VELOCITY', XYZ=2.25,0.25,0.07/

&DEVC ID='CO1-V-U', QUANTITY='U-VELOCITY', XYZ=2.0,0.25,0.07/
&DEVC ID='CO1-V-V', QUANTITY='V-VELOCITY', XYZ=2.0,0.25,0.07/
&DEVC ID='CO1-V-W', QUANTITY='W-VELOCITY', XYZ=2.0,0.25,0.07/
&DEVC ID='CO1-V', QUANTITY='VELOCITY', XYZ=2.0,0.25,0.07/

&DEVC ID='CO2-V-U', QUANTITY='U-VELOCITY', XYZ=1.8,0.25,0.07/
&DEVC ID='CO2-V-V', QUANTITY='V-VELOCITY', XYZ=1.8,0.25,0.07/
&DEVC ID='CO2-V-W', QUANTITY='W-VELOCITY', XYZ=1.8,0.25,0.07/
&DEVC ID='CO2-V', QUANTITY='VELOCITY', XYZ=1.8,0.25,0.07/

&DEVC ID='CO3-V-U', QUANTITY='U-VELOCITY', XYZ=1.6,0.25,0.07/
&DEVC ID='CO3-V-V', QUANTITY='V-VELOCITY', XYZ=1.6,0.25,0.07/
&DEVC ID='CO3-V-W', QUANTITY='W-VELOCITY', XYZ=1.6,0.25,0.07/
&DEVC ID='CO3-V', QUANTITY='VELOCITY', XYZ=1.6,0.25,0.07/
-------Output thickness-------
&DEVC XYZ=2.25, 0.25, 0.0, IOR=3, QUANTITY='WALL THICKNESS', ID='Thickness' /
-------Animated output velocity-------
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBY=0.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBX=2.25/
&SLCF QUANTITY='VELOCITY', VECTOR=.TRUE., CELL_CENTERED=.TRUE., PBZ=0.07/
-------Animated output temperature-------
&SLCF QUANTITY='TEMPERATURE', CELL_CENTERED=.TRUE., PBY=0.25/

&TAIL /
```

E.1.1 “S1-exHF-medium”

This is the code for the simulation with a moderate fine mesh resolution inside the timber sample. It is the same code as under D.1 “S1-exHF-fine” except for the following subchapter:

```
-------Wood sample-------
&SURF ID='SAMPLE',
      RGB=200,100,0,
      BACKING='INSULATED',
      MATL_ID='SPRUCE',
      THICKNESS=0.12,
      STRETCH_FACTOR(1)=1.05,
      EXTERNAL_FLUX = 96.3963/
```

E.1.2 “S1-exHF-coarse” // “S1-exHF”

This is the code for the simulation with a coarse mesh resolution inside the timber sample. It is the same code as under D.1 “S1-exHF-fine” except for the following subchapter:

```
-------Wood sample-------
&SURF ID='SAMPLE',
      RGB=200,100,0,
      BACKING='INSULATED',
      MATL_ID='SPRUCE',
      THICKNESS=0.12,
      EXTERNAL_FLUX = 96.3963/
```

E.1.3 “S1-exHF-moisture-fine”

This is the code for the simulation with moisture content. It is the same code as under D.1 “S1-exHF-fine” except for the following subchapters:

```
-------Gas combustion-------
&REAC FUEL='PYROLYZATE', C=1, H=3.584, O=1.55, N=0, SOOT_YIELD=0.015,
HEAT_OF_COMBUSTION= 14163.0 /
-------Spruce-------
&MATL ID = 'SPRUCE',
      EMISSIVITY = 0.9,
      CONDUCTIVITY = 0.2,
      SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
      DENSITY = 317.8,
      N_REACTIONS = 1.0,
      A(1) = 4.69E13,
```

```
        E(1) = 190500,
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14163.0,
        ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.792 /
&RAMP ID='c_ramp_spruce', T=70, F=0.857 /
&RAMP ID='c_ramp_spruce', T=110, F=0.912 /
&RAMP ID='c_ramp_spruce', T=150, F=0.959 /
&RAMP ID='c_ramp_spruce', T=190, F=0.999 /
&RAMP ID='c_ramp_spruce', T=230, F=1.035 /
-------Wood sample-------
&SURF ID='SAMPLE',
        RGB=200,100,0,
        BACKING='INSULATED',
        MATL_ID='SPRUCE',
        THICKNESS=0.12,
        MATL_ID(1,1) = 'SPRUCE',
        MATL_ID(1,2) = 'MOISTURE',
        MATL_MASS_FRACTION(1,:) = 0.88,0.12,
        STRETCH_FACTOR(1)=1,
        EXTERNAL_FLUX = 96.3963/
```

And these new subchapters:

```
-------Water vapor-------
&SPEC ID='WATER VAPOR' /
-------Moisture-------
&MATL ID = 'MOISTURE'
        EMISSIVITY = 1.0
        DENSITY = 1000.
        CONDUCTIVITY = 0.6
        SPECIFIC_HEAT = 4.19
        N_REACTIONS = 1
        A = 1E13
        E = 1.0E5
        N_S = 1
        SPEC_ID = 'WATER VAPOR'
        NU_SPEC = 1.0
        HEAT_OF_REACTION = 2260. /
```

E.1.4 “S1-exHF-cp-fine”

This is the code for the simulation with constant specific heat for spruce and char. It is the same code as under D.1 “S1-exHF-fine” except for the following subchapters:

```
-------Spruce-------
&MATL ID = 'SPRUCE',
        EMISSIVITY = 0.9,
        CONDUCTIVITY = 0.09,
        SPECIFIC_HEAT = 1.8,
        DENSITY = 408.0,
        N_REACTIONS = 1.0,
        A(1) = 4.69E13,
        E(1) = 190500,
        N_S(1) = 1.0,
        MATL_ID(1,1) = 'CHAR',
        NU_MATL(1,1) = 0.16,
        SPEC_ID(1,1) = 'PYROLYZATE',
        NU_SPEC(1,1) = 0.84,
        HEAT_OF_REACTION(1) = 430.0,
        HEAT_OF_COMBUSTION= 14000.0,
        ABSORPTION_COEFFICIENT = 50000.0/
-------Char-------
&MATL ID='CHAR',
        EMISSIVITY = 0.85,
        DENSITY = 59,
        CONDUCTIVITY = 0.22,
        SPECIFIC_HEAT = 1.5/
```

E.2 “S2-HP-fine”

This is the standard code for the simulation with ignition by a heat panel. The code is the same as under D.1 “S1-exHF-fine” except for the following subchapters:

```
-------Wood sample-------
&SURF ID='SAMPLE',
      RGB=200,100,0,
      BACKING='INSULATED',
      MATL_ID='SPRUCE',
      THICKNESS=0.12,
      STRETCH_FACTOR(1)=1/
-------Geometry of tunnel-------
&OBST ID='Bottom_outlet', XB=1.6,2.12,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_inlet', XB=2.38,3.81,0.0,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_front', XB=2.115,2.385,0.0,0.14,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Bottom_back', XB=2.115,2.385,0.36,0.5,0.0,0.0, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_outlet', XB=1.6,1.97,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_inlet', XB=2.53,3.81,0.0,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_front', XB=1.965,2.535,0.0,0.05,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Top_back', XB=1.965,2.535,0.44,0.5,0.15,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Front', XB=1.6,3.81,0.0,0.0,0.0,0.15, SURF_ID='STEEL_SURFACE'/
&OBST ID='Side_Back', XB=1.6,3.81,0.5,0.5,0.0,0.15, SURF_ID='STEEL_SURFACE'/
```

And these new subchapters:

```
-------Heat panel-------
&SURF ID='HEAT_PANEL_SURFACE',
      COLOR='RED',
      NET_HEAT_FLUX=120/
-------Position of heat panel-------
&VENT ID='HEAT_PANEL_FLOW', XB=1.97,2.53,0.05,0.44,0.15,0.15,
SURF_ID='HEAT_PANEL_SURFACE', IOR=-3 /
```

E.2.1 “S2-HP-moisture-fine”

This is the code for the simulation with moisture content. The code is the same as under D.2 “S2-HP-fine” except for the following subchapters:

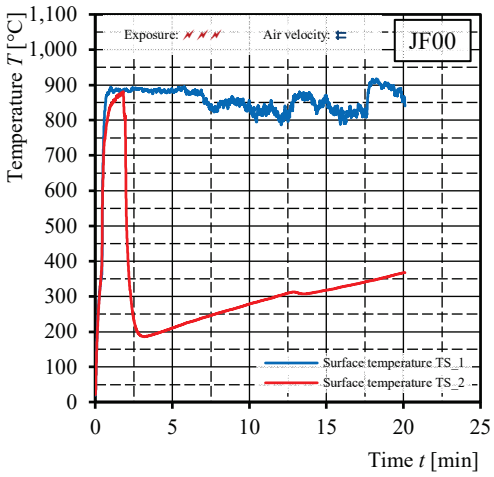
```
-------Gas combustion-------
&REAC FUEL='PYROLYZATE', C=1, H=3.584, O=1.55, N=0, SOOT_YIELD=0.015, HEAT_OF_COMBUSTION= 14163.0 /
-------Spruce-------
&MATL ID = 'SPRUCE',
      EMISSIVITY = 0.9,
      CONDUCTIVITY = 0.2,
      SPECIFIC_HEAT_RAMP = 'c_ramp_spruce',
      DENSITY = 317.8,
      N_REACTIONS = 1.0,
      A(1) = 4.69E13,
      E(1) = 190500,
      N_S(1) = 1.0,
      MATL_ID(1,1) = 'CHAR',
      NU_MATL(1,1) = 0.16,
      SPEC_ID(1,1) = 'PYROLYZATE',
      NU_SPEC(1,1) = 0.84,
      HEAT_OF_REACTION(1) = 430.0,
      HEAT_OF_COMBUSTION= 14163.0,
      ABSORPTION_COEFFICIENT = 50000.0/
&RAMP ID='c_ramp_spruce', T=30, F=0.792 /
&RAMP ID='c_ramp_spruce', T=70, F=0.857 /
&RAMP ID='c_ramp_spruce', T=110, F=0.912 /
&RAMP ID='c_ramp_spruce', T=150, F=0.959 /
&RAMP ID='c_ramp_spruce', T=190, F=0.999 /
&RAMP ID='c_ramp_spruce', T=230, F=1.035 /
-------Wood sample-------
&SURF ID='SAMPLE',
      RGB=200,100,0,
      BACKING='INSULATED',
      MATL_ID='SPRUCE',
      THICKNESS=0.12,
      MATL_ID(1,1) = 'SPRUCE',
      MATL_ID(1,2) = 'MOISTURE',
      MATL_MASS_FRACTION(1,:) = 0.88,0.12,
      STRETCH_FACTOR(1)=1/
```

And these new subchapters:

```
-------Water vapor-------
&SPEC ID='WATER VAPOR' /
-------Moisture-------
&MATL ID = 'MOISTURE'
      EMISSIVITY = 1.0
      DENSITY = 1000.
      CONDUCTIVITY = 0.6
      SPECIFIC_HEAT = 4.19
      N_REACTIONS = 1
      A = 1E13
      E = 1.0E5
      N_S = 1
      SPEC_ID = 'WATER VAPOR'
      NU_SPEC = 1.0
      HEAT_OF_REACTION = 2260. /
```

Appendix F – Surface temperature recordings from test JF00

The following graph shows the recorded temperature on the surface of the timber sample during the test JF00 with the FANCI apparatus [31, modified Fig. 5.2(a)]. The two lines show the two measuring points. It can be seen that for the red line measuring in TS_2, there was a problem during the recording. Given that, only the temperature measurements from TS_1 was used for the comparison with the simulation in this study.

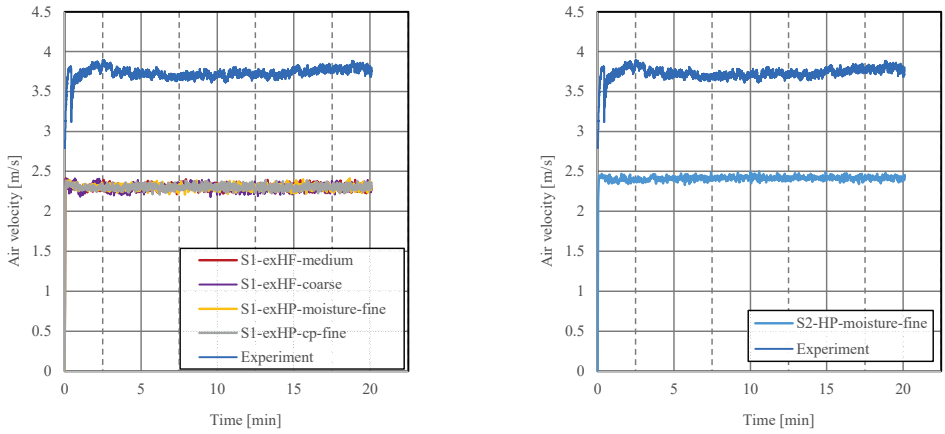


Graph 65: Surface temperature measurements from experiment JF00 [31, modified Fig. 5.2(a)]

Appendix G – Additional simulation results

G.1 Air velocity recordings above timber sample

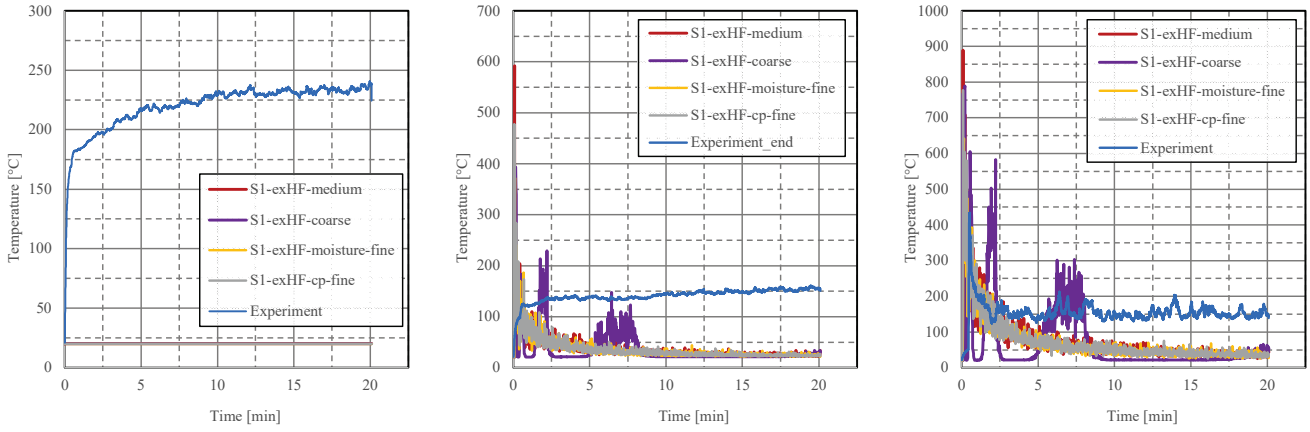
The first graph shows the air velocity recordings above the timber sample for the simulations with ignition by an external heat flux “S1-exHF-medium”, “S1-exHF-coarse”, “S1-exHF-moisture-fine” and “S1-exHF-cp-fine” together with the experimental results. The lines for the simulation results are overlapping. The second graph shows the results for the simulation with ignition by a heat panel including moisture “S2-HP-moisture-fine” and the experimental results.



Graph 66: Results from air velocity measurements above timber sample for different simulations and for the experiment

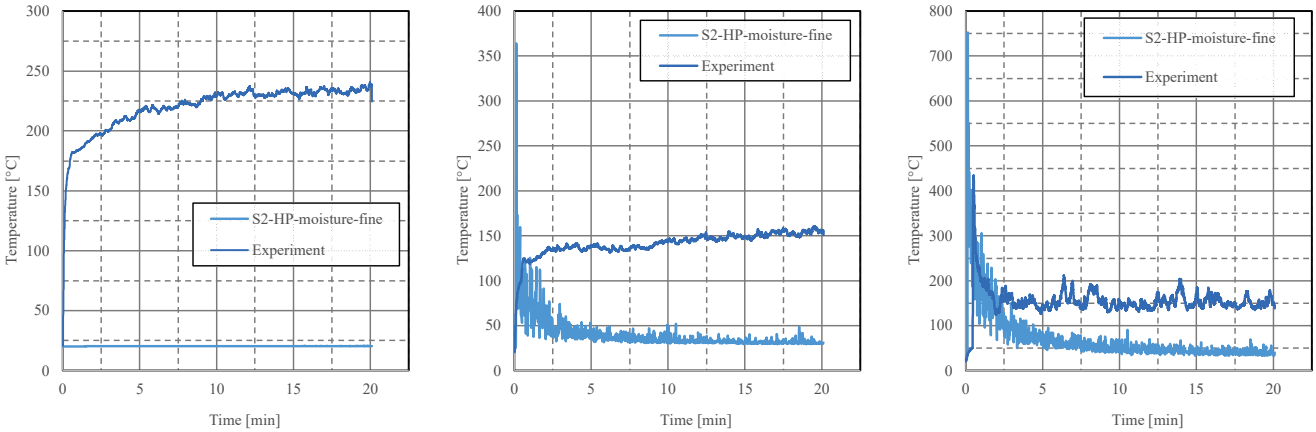
G.2 Gas temperature measurements at the start, the end and behind the fire chamber

The first three graphs show the gas temperature measurements at the start, the end and behind the fire chamber for the simulations with ignition by an external heat flux “S1-exHF-medium”, “S1-exHF-coarse”, “S1-exHF-moisture-fine” and “S1-exHF-cp-fine” and the next three the same results for the simulation with ignition by a heat panel “S2-HP-moisture-fine”, together with the experimental results.



Graph 67: Gas temperature measurements at the start (left), at the end (middle) and behind the fire chamber (left) for simulations with ignition by an external heat flux and the experiment

The results for the simulations “S1-exHF-medium”, “S1-exHF-moisture-fine” and “S1-exHF-cp-fine” are overlapping in all three graphs, and in the results for the position at the start of the fire chamber, also the simulation “S1-exHF-coarse”.

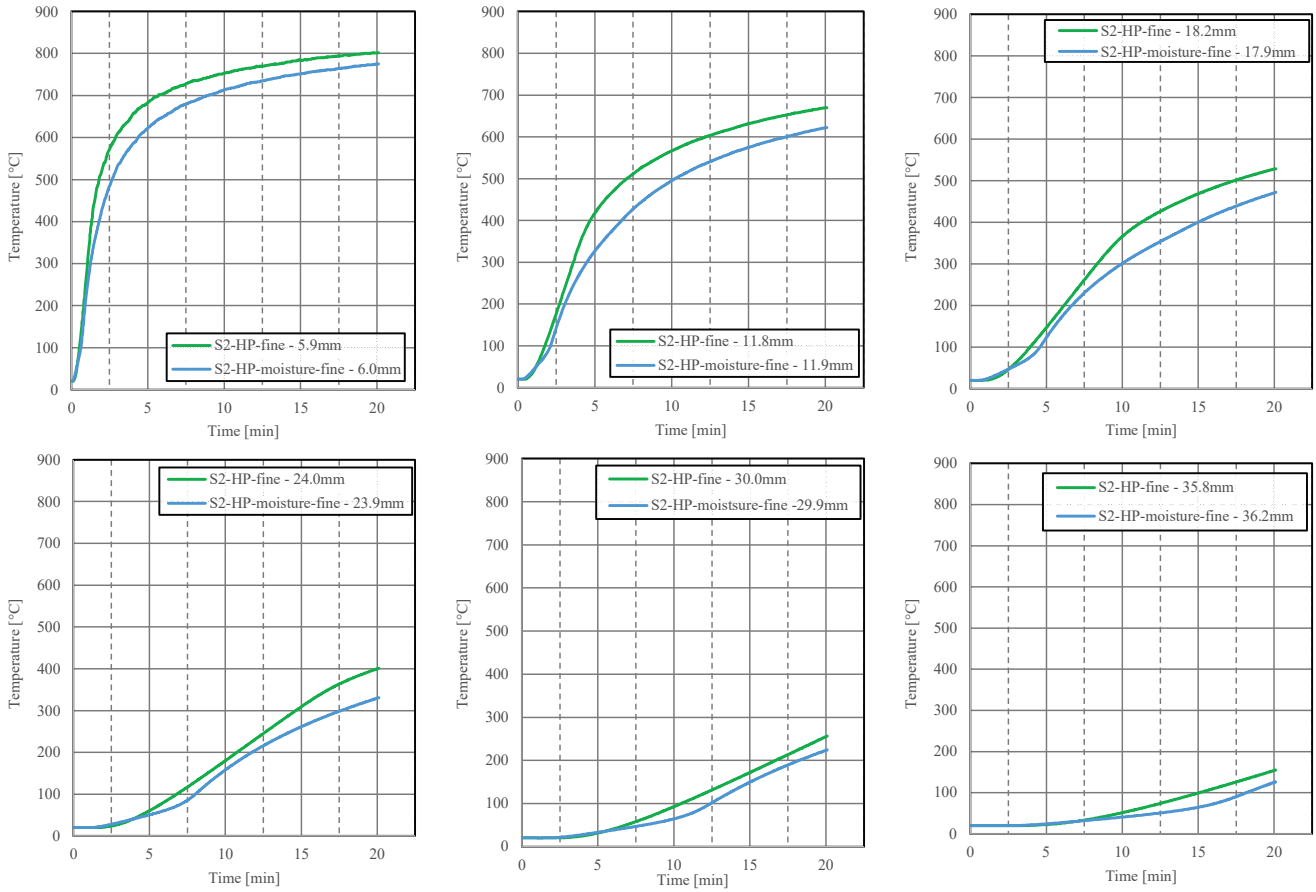


Graph 68: Gas temperature measurements at the start (left), at the end (middle) and behind the fire chamber (left) for the simulation with ignition by a heat panel and moisture and the experiment

Appendix H – Influence of moisture content on simulation results – Further comparisons

H.1 Simulations “S2-HF-fine” & “S2-HF-moisture-fine”

This shows the comparison between the simulation with dry timber and timber with a moisture content for the simulation situation with ignition by a heat panel.

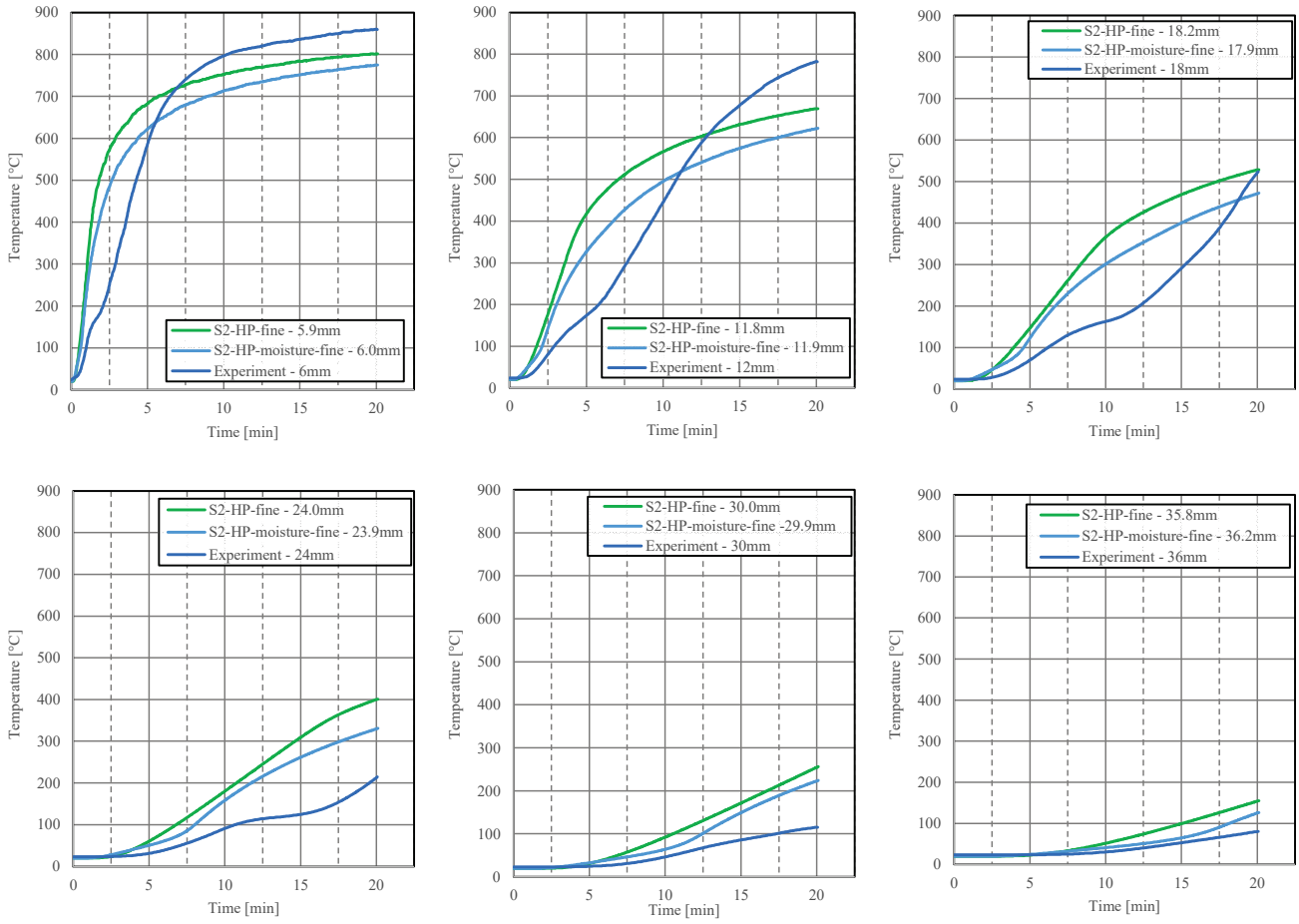


Graph 69: Temperature measurements inside the timber sample for simulations "S2-HP-fine" & "S2-HP-moisture-fine"

Appendix I – Additional comparisons with experimental data

I.1 Temperature measurements in the wood sample

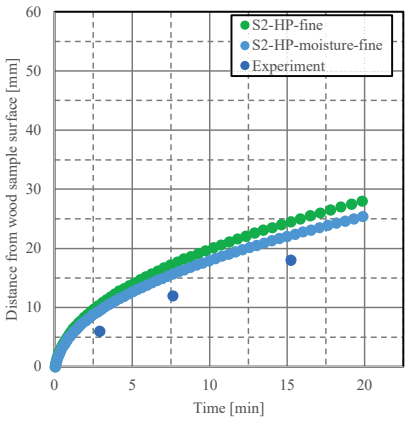
The following graphs compare the simulated temperatures inside the timber sample for the simulations with the ignition by the heat panel with the ones measured in the experiment, for depths of 6 [mm], 12 [mm], 18 [mm], 24 [mm], 30 [mm] and 36 [mm] from the timber surface.



Graph 70: Comparison of temperature measurements inside the timber sample for simulations "S2-HP-fine" & "S2-HP-moisture-fine" with the experimental data

I.2 Char properties

The following graph compares the 300°C-ISO profile from the simulations with ignition by the heat panel with the experimental data.



Graph 71: Comparison of the 300°C-ISO profile for the simulations "S2-HP-fine" & " S2-HP-moisture-fine " with the experimental data

Appendix J – Raw data of simulations, analyses and comparisons