Heat Treat Chambers

Proper Protocols for Use.

Heat chambers can be a great way to add value to your wood packaging material, but proper procedures need to be followed to meet the requirements by the American Lumber Standard Committee (**ALSC**) and Document 15 of the International Standards of Phytosanitary Measures (**ISPM 15**).

First Considerations

When adding a heat chamber to your facility's operation that utilizes probes to measure core temperatures, a verification study may be required.

A verification study is when the agency brings a multi-thermocouple (usually 9-12) testing device on site to determine the coldest areas of the heat chamber and to check the chamber's thermocouples for accuracy. A map is then created to show the coldest areas in the chamber which is where the facility will need to place the heat chamber thermocouples going forward.

A verification study is required for any heat chamber that operate where core temperatures measure between 133°F and 139°F.

Verification studies are performed at an additional cost to the facility.

Does your chamber need a verification study?

Heat chambers manufactured and assembled by an approved original equipment manufacturer (OEM) typically do not require a verification study by an agency when they operate at minimum core temperatures of 140°F.

Does your chamber need a verification study?

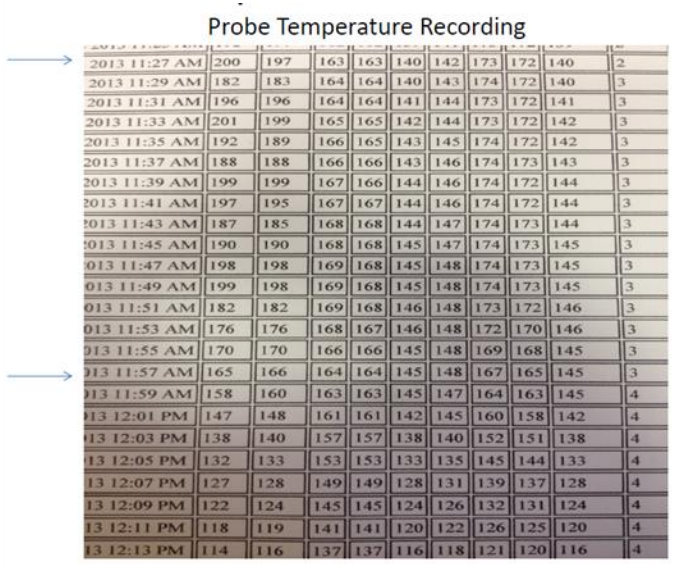
Heat chambers created from insulated trailers or other structures that are customized with equipment to provide heat and record core temperatures, require a verification study. This study verifies the customized chamber meets ISPM 15 requirements along with determining thermocouple location, and ensuring all equipment is properly operating.

2 Ways to Heat Treat Wood Packaging

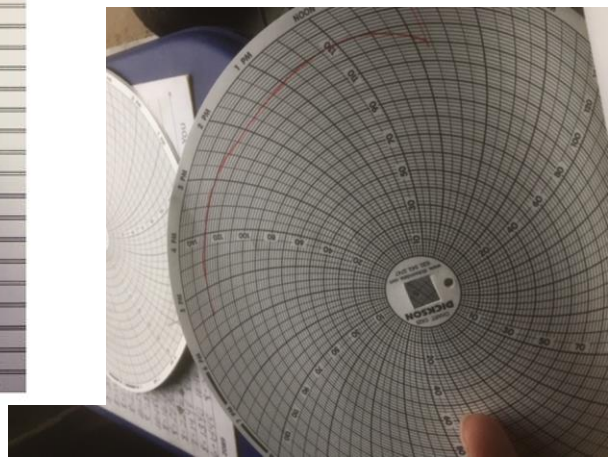
Thermocouples (a.k.a. Probes) – Thermocouples inserted into the center of thickest pieces of wood in the heat chamber to measure the core temperature.

Heat Charts – Charts developed to use with a chamber that does not have thermocouples for measuring the wood cores. Temperature and time requirements inside the chamber are based on the outside temperature when loading the chamber.

<u>Electronically recorded documentation of treatment times and temperatures is required regardless of the process used.</u>


Probe Temperature Recording

2013 11:27 AM	200	197	163	163	140	142	173	172	140	2
2013 11:29 AM	182	183	164	164	140	143	174	172	140	3
2013 11:31 AM	196	196	164	164	141	144	173	172	141	3
2013 11:33 AM	201	199	165	165	142	144	173	172	142	3
2013 11:35 AM	192	189	166	165	143	145	174	172	142	3
2013 11:37 AM	188	188	166	166	143	146	174	173	143	3
2013 11:39 AM	199	199	167	166	144	146	174	172	144	3
2013 11:41 AM	197	195	167	167	144	146	174	172	144	3
2013 11:43 AM	187	185	168	168	144	147	174	173	144	3
2013 11:45 AM	190	190	168	168	145	147	174	173	145	3
2013 11:47 AM	198	198	169	168	145	148	174	173	145	3
2013 11:49 AM	199	198	169	168	145	148	174	173	145	3
2013 11:51 AM	182	182	169	168	146	148	173	172	146	3
2013 11:53 AM	176	176	168	167	146	148	172	170	146	3
2013 11:55 AM	170	170	166	166	145	148	169	168	145	3
2013 11:57 AM	165	166	164	164	145	148	167	165	145	3
2013 11:59 AM	158	160	163	163	145	147	164	163	145	4
2013 12:01 PM	147	148	161	161	142	145	160	158	142	4
2013 12:03 PM	138	140	157	157	138	140	152	151	138	4
2013 12:05 PM	132	133	153	153	133	135	145	144	133	4
2013 12:07 PM	127	128	149	149	128	131	139	137	128	4
2013 12:09 PM	122	124	145	145	124	126	132	131	124	4
2013 12:11 PM	118	119	141	141	120	122	126	125	120	4
2013 12:13 PM	114	116	137	137	116	118	121	120	116	4



Thermocouple Requirements for Conformance

<u>Thermocouples should be located in the coldest areas of the chamber and sealed into center of the thickest wood being treated.</u> This is to verify that all wood will reach the required temperature **<u>in its core</u>** for the required time.

The required core temperature and time for chambers using thermocouples is a minimum of 140°F for a minimum of 30 consecutive minutes.

Heat chambers having a verification study completed on them can operate with core temperatures between 133°F and 139°F for a minimum of 30 consecutive minutes.

<u>Anything less than this is non-conforming.</u>

Thermocouple Requirements Cont'd.

<u>Thermocouple holes must be sealed at the opening to prevent the conduction of heat to the probe that measures the temperature in the core.</u> Several types of conforming seals include:

- **Rubber stoppers**
- **Plumber's putty**
- **Foam ear plugs**
- **Rubber "O" rings**

There are other options, but it is important that no heat is allowed to conduct from the opening to the heat measuring device of the thermocouple.

Thermocouple Requirements (Cont'd)

The pallets in these pictures have a stringer that is thinner than the combined thicknesses of the adjoining deck boards. **Because of this, a surrogate block should be employed for the thermocouple placement that is as thick or thicker than the combined thickness of the two deck boards.**

Sandwiching a thermocouple between two boards is non-conforming.

Thermocouple Requirements (Cont'd)

When employing a **"surrogate block"** for thermocouple placement, it is important to use it properly. A surrogate block is an individual piece of solid wood that is as thick or thicker than the thickest wood in the chamber. Scenarios where surrogate blocks are recommended are:

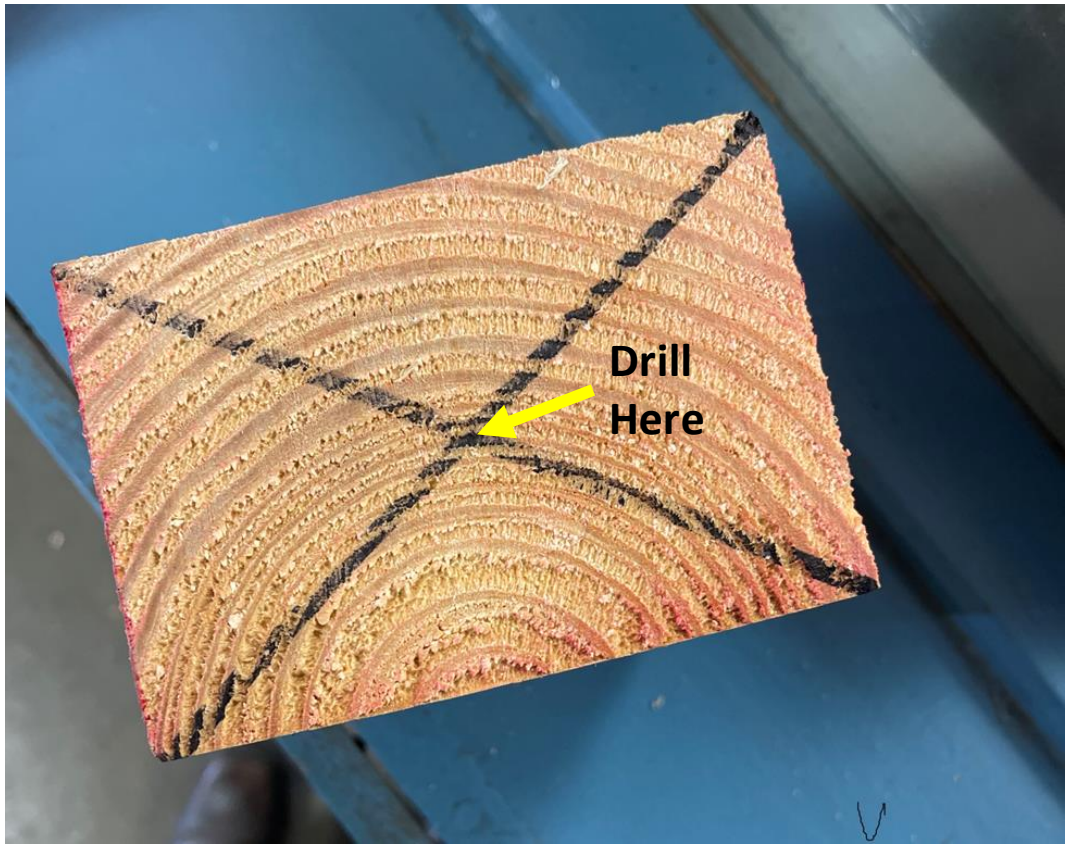
- Where the combined thickness of two adjoining pieces of wood exceeds the thickest individual solid piece in the chamber. An example of this is a recycled pallet with companion stringers. In this situation, a thermocouple cannot be placed in an individual stringer nor sandwiched between the original and companion stringer because they are not a solid piece of wood.

- Where the thickest wood in the chamber cannot be reached with a thermocouple.

Thermocouple Requirements (Cont'd)

Properly seating probes in surrogate blocks is very important for conformance to be met. Probes should be seated in the center of the block and the best way to determine this is to draw two straight lines from opposite corners, and where these lines meet is considered the center of the block. Determine what half the distance is of the thinnest part of the block and that is the minimum depth drilled into the wood for the thermocouples. Make certain the length of the block is long enough for that same distance to be maintained on the back side from where it was drilled. The hole must also be deep enough to hold the probe in place (usually a 2" to 3" minimum).

Example: For a 4" thick x 6" wide x 6" long surrogate block, 4" is the thinnest part of the block so the minimum depth of the hole for the sensors in the probe is 2" (center of block). The minimum length of the block should be at least 6" so it can maintain its position in the pallets. A little longer would be safer.



Thermocouple Requirements (Cont'd)

Surrogate blocks also require routine examination to ensure they are not damaged from continued use. **Blocks that are cracked or damaged should be replaced with new blocks**

Surrogate blocks should be allowed to cool down before reusing. If charges are run back-to-back using surrogate blocks, a facility should maintain several sets so that blocks from the previous charge are not used with the following charge. These blocks would not have had an opportunity to cool down from the first charge and will give a higher reading than the actual core temperatures of the WPM currently being treated. **If "hot" blocks are used in a new charge, it is a non-conformance.**

Heat Charts

Kiln Time Table

2"x4"	Outside Temp at Start of Kiln Charge			
Kiln Temp (°F)	30°F	50°F	70°F	90°F
	Heat Treatment Time (Minutes)			
160	262	246	226	197
170	238	222	201	177
180	222	205	185	165
190	205	193	177	157
200	197	181	165	149
210	185	173	161	141

Heat charts were developed for kilns or chambers not having thermocouples to place into wood. The chart above is an example of what is used based on the thickest wood in the chamber. Once this size is identified, the temperature and time needed to treat the material is determined from the outside temperature at the start of the charge. **The lowest temperature allowed is 160°F and the hotter the temperature the shorter the time required in the chamber. The chamber must meet the prescribed "Kiln Temp" temperature for the "Heat Treatment Time" required to start.**

Heat Treating Lumber

When heat treating lumber there should be gaps between the lumber layers to allow for airflow so that the heated air can properly treat each piece.

Air Flow

Air flow moves in the path of least resistance so it should be restricted through baffles or the staggering of WPM or lumber stacks to force the heated air through the WPM or lumber which improves the efficiency and consistency in heating the wood to its core.

ALSC Conformance Issues

Non-conformances occur when ALSC requirements are not met. Many of these issues result from:

- **Time and temperature requirements not being met.**
- **No record of time and temperature readings.**
- **Thermocouples not being placed in the thickest pieces of wood.**
- **Improper seating and/or sealing of thermocouples.**
- **Thermocouples not placed in the coldest areas of the chamber.**
- **Wood packaging not properly oriented in the chamber.**

Any of these non-conformances will require process correction and retreatment of the wood packaging that was in the chamber when the problem occurred.

Examples of Non-Conforming Issues

In this situation, the two deck boards should be measured to make sure the combined thicknesses are not thicker than the stinger. In addition, this probe is not properly sealed at the opening.

The thermocouple should be sealed using plumbers putty, O-rings, ear plugs, etc. so heat does not conduct into the opening.

This is a non-conformance.

Examples of Non-Conforming Issues

In this situation a seal was used but not properly seated to prevent the conduction of heat into the opening.

The hole drilled should have been made a little larger at the opening to allow a proper seating of the rubber stopper, so the opening is correctly sealed.

This is a non-conformance.

Examples of Non-Conforming Issues

The surrogate block shown is not in the coldest area of the heat chamber. The metal it sits on could also heat the block faster than the associated WPM in the chamber.

The surrogate block should be set into the pallets, so its heating matches the WPM it is supposed to represent.

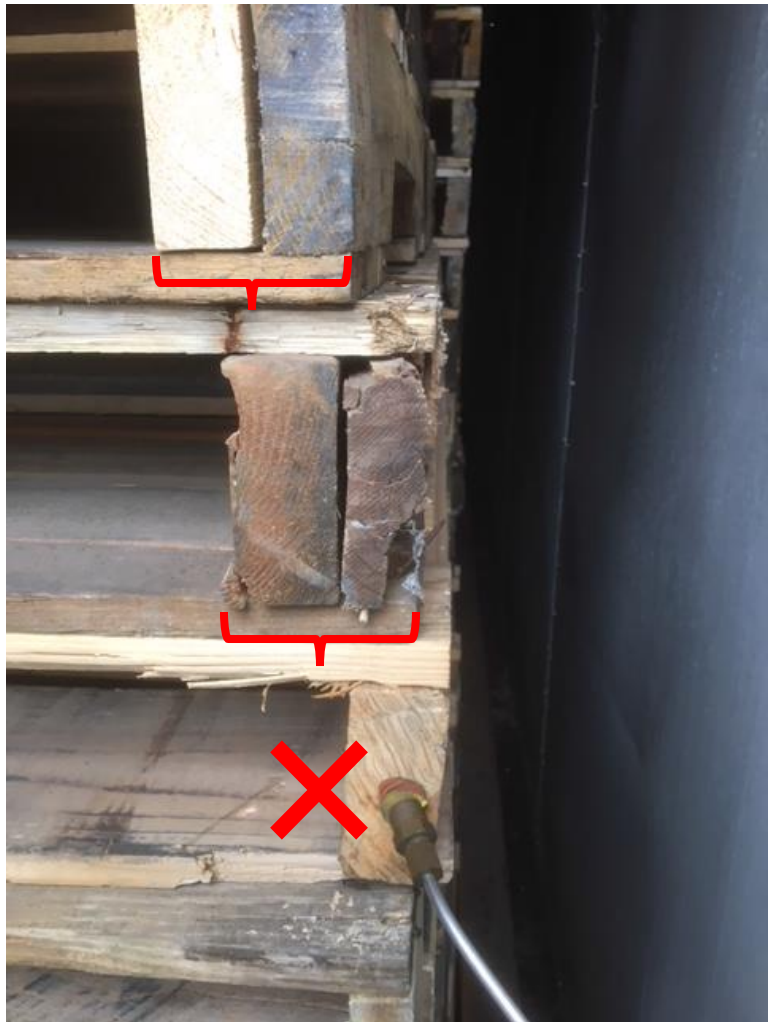
This is a non-conformance.

Examples of Non-Conforming Issues

When companion stringers are used in the repair of WPM, the combined thickness of the two pieces must be used to determine the thickest wood in the chamber. This thermocouple was placed in a single stringer which would not be considered the thickest piece of wood.

You cannot sandwich the thermocouple in-between the two pieces either as heat can conduct to it. In this situation, a surrogate block should have been used that is equal to the thickest combined pieces in the chamber. If the doubled 2x4's are the thickest pieces in the chamber a solid 4x4 surrogate block should have been employed to properly measure wood core temperature.

This is a non-conformance.



Examples of Non-Conforming Issues

The surrogate block used for the thermocouple is not the largest piece of wood in the chamber.

This is a non-conformance.

Examples of Non-Conforming Issues

The surrogate block used for the thermocouple is not properly drilled in the center of the block. Offset holes in surrogate blocks are not allowed.

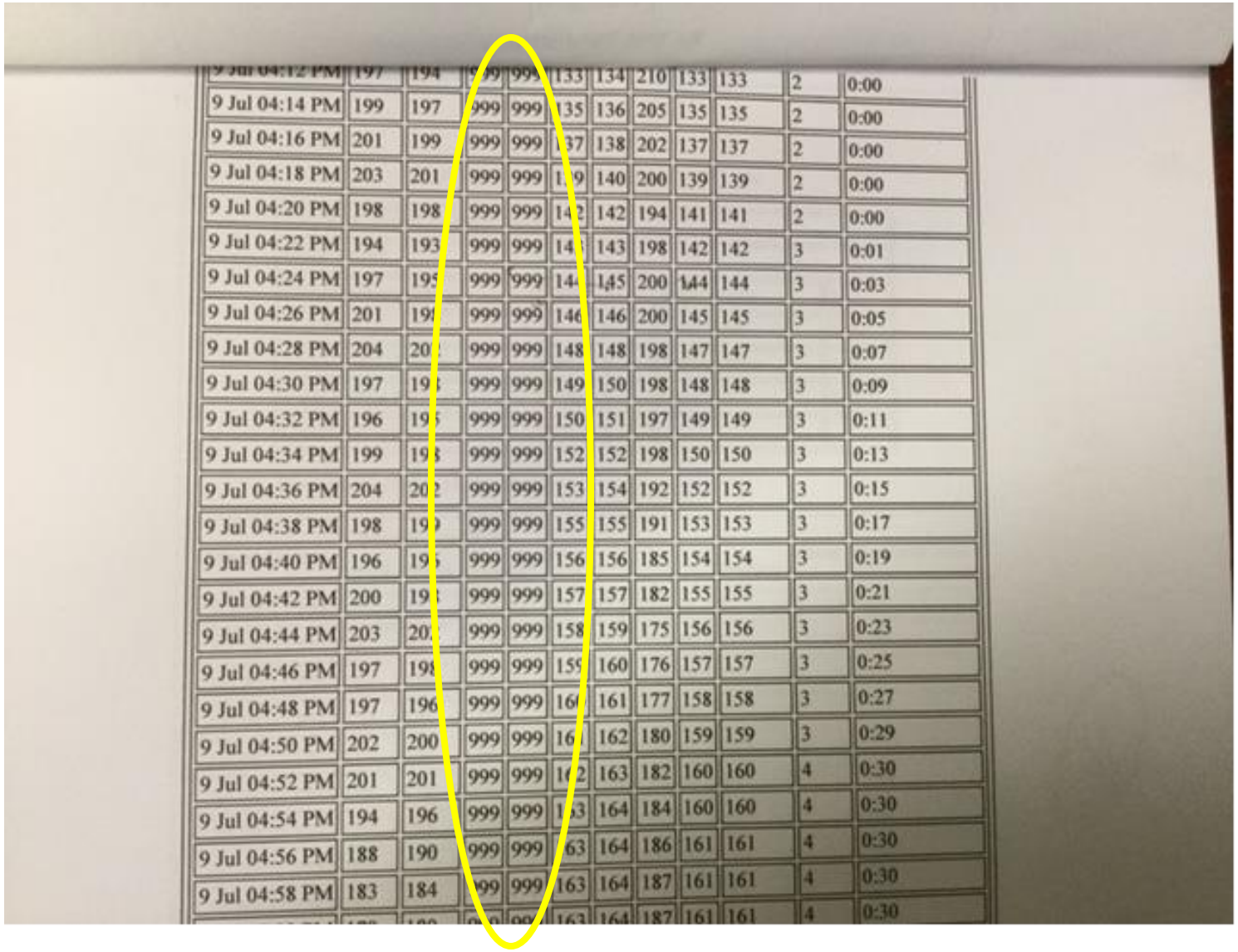
This is a non-conformance.

Examples of Non-Conforming Issues

Pallets should be arranged so that stringers are aligned with or parallel to the air flow. Pallets should not be placed in the heat chamber where they greatly restrict airflow.

This is a non-conformance.

Examples of Non-Conforming Issues



9 Jul 04:12 PM	197	194	999	999	133	134	210	133	133	2	0:00
9 Jul 04:14 PM	199	197	999	999	135	136	205	135	135	2	0:00
9 Jul 04:16 PM	201	199	999	999	137	138	202	137	137	2	0:00
9 Jul 04:18 PM	203	201	999	999	139	140	200	139	139	2	0:00
9 Jul 04:20 PM	198	198	999	999	142	142	194	141	141	2	0:00
9 Jul 04:22 PM	194	193	999	999	145	143	198	142	142	3	0:01
9 Jul 04:24 PM	197	195	999	999	144	145	200	144	144	3	0:03
9 Jul 04:26 PM	201	199	999	999	146	146	200	145	145	3	0:05
9 Jul 04:28 PM	204	202	999	999	148	148	198	147	147	3	0:07
9 Jul 04:30 PM	197	195	999	999	149	150	198	148	148	3	0:09
9 Jul 04:32 PM	196	195	999	999	150	151	197	149	149	3	0:11
9 Jul 04:34 PM	199	198	999	999	152	152	198	150	150	3	0:13
9 Jul 04:36 PM	204	202	999	999	153	154	192	152	152	3	0:15
9 Jul 04:38 PM	198	199	999	999	155	155	191	153	153	3	0:17
9 Jul 04:40 PM	196	195	999	999	156	156	185	154	154	3	0:19
9 Jul 04:42 PM	200	198	999	999	157	157	182	155	155	3	0:21
9 Jul 04:44 PM	203	202	999	999	158	159	175	156	156	3	0:23
9 Jul 04:46 PM	197	198	999	999	159	160	176	157	157	3	0:25
9 Jul 04:48 PM	197	196	999	999	160	161	177	158	158	3	0:27
9 Jul 04:50 PM	202	200	999	999	161	162	180	159	159	3	0:29
9 Jul 04:52 PM	201	201	999	999	162	163	182	160	160	4	0:30
9 Jul 04:54 PM	194	196	999	999	163	164	184	160	160	4	0:30
9 Jul 04:56 PM	188	190	999	999	163	164	186	161	161	4	0:30
9 Jul 04:58 PM	183	184	999	999	163	164	187	161	161	4	0:30
					163	164	187	161	161	4	0:30

The report shown has an error code showing on both sensors of the first thermocouple and as a result is not providing any temperature information.

This is a non-conformance.

The thermocouple with error codes should be replaced and the WPM retreated where all thermocouples show conforming time and temperature requirements.

At least one sensor must be working on each probe to measure conformance.

Examples of Non-Conforming Issues

The start temperatures on these thermocouples are to hot for just starting the chamber. This indicates the probability of surrogate blocks that were reused from the previous charge and not given time to cool down.

This would be a non-conformance.

Surrogate block temperatures should be the same temperature as the WPM or lumber being loaded into the chamber to be treated.

Date and time	Chamber conditions									Phase	Heat treat time
	DryB	WetB	Internal						Primary		
24 May 01:51 PM	130	130	127	127	126	128	127	126	126	2	0:00
24 May 01:53 PM	139	137	132	132	130	132	130	129	129	2	0:00
24 May 01:55 PM	173	169	165	165	158	160	156	155	155	2	0:00
24 May 01:57 PM	191	187	187	187	182	184	178	178	178	3	0:01
24 May 01:59 PM	201	197	201	201	200	202	198	197	197	3	0:03
24 May 02:01 PM	196	192	195	195	194	197	194	193	193	3	0:05
24 May 02:03 PM	196	194	201	200	201	203	201	200	200	3	0:07
24 May 02:05 PM	203	199	200	200	200	202	200	199	199	3	0:09
24 May 02:07 PM	190	188	193	193	194	196	195	195	193	3	0:11
24 May 02:09 PM	197	195	199	199	200	202	200	199	199	3	0:13
24 May 02:11 PM	202	198	199	199	198	200	198	198	198	3	0:15

Examples of Non-Conforming Issues

In this example, the thermocouple is in a companion stringer on the pallet. There are three issues here:

1. This wood where the thermocouple is placed is not a solid piece of wood but one of two adjoining pieces of wood.
2. The thermocouple is offset from the center. Even if it was a solid piece of wood, the thermocouple must be centered in the wood so an accurate core temperature can be measured.
3. The probe has not been properly sealed at the wood opening.

This is a non-conformance.

Examples of Non-Conforming Issues

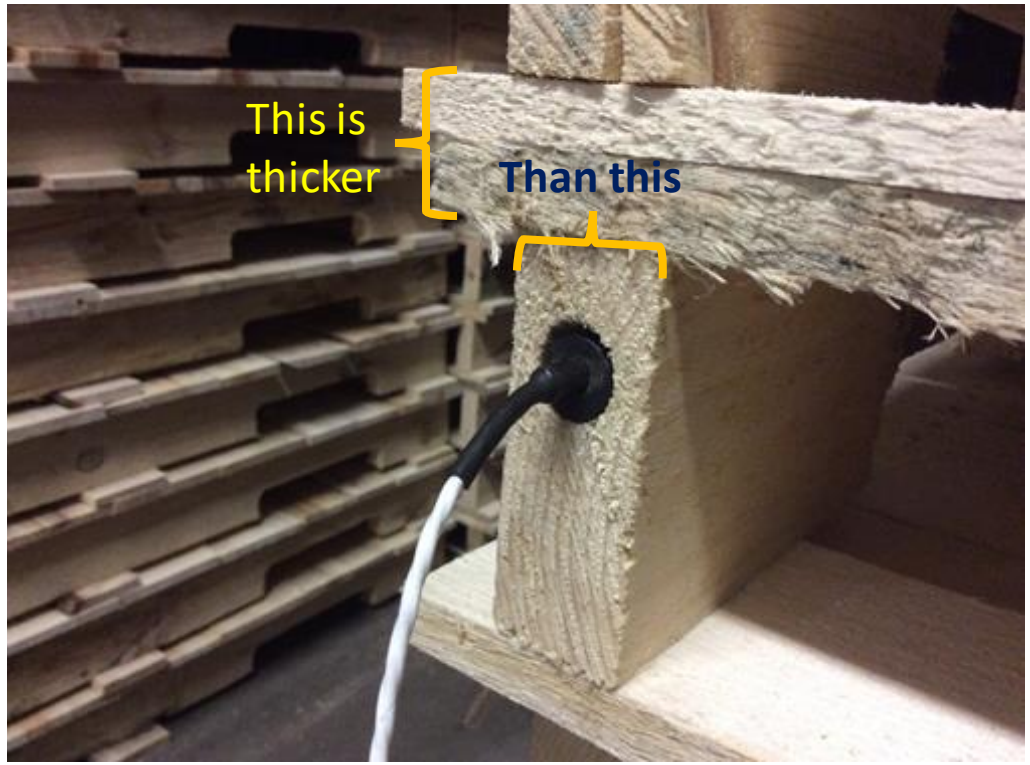
The thermocouple in this example is sandwiched between two adjoining pieces of wood. This is non-conforming no matter how tight the joint is. A surrogate block should have been used for the proper placement of the thermocouple.

This is a non-conformance.

Examples of Non-Conforming Issues

In this example, the adjoining deck boards are thicker than the stringer the thermocouple is placed in. A surrogate block that is as thick or thicker than the combined thickness of the adjoining deck boards should be employed to position the thermocouple.

This is a non-conformance.



Examples of Non-Conforming Issues

The thickest set of boards without spacing should be used to determine the size of surrogate block needed for this charge. It is obvious that the 2x4 being used is too small to represent the thickest piece of wood in the heat chamber. This is non-conforming.

Examples of Non-Conforming Issues

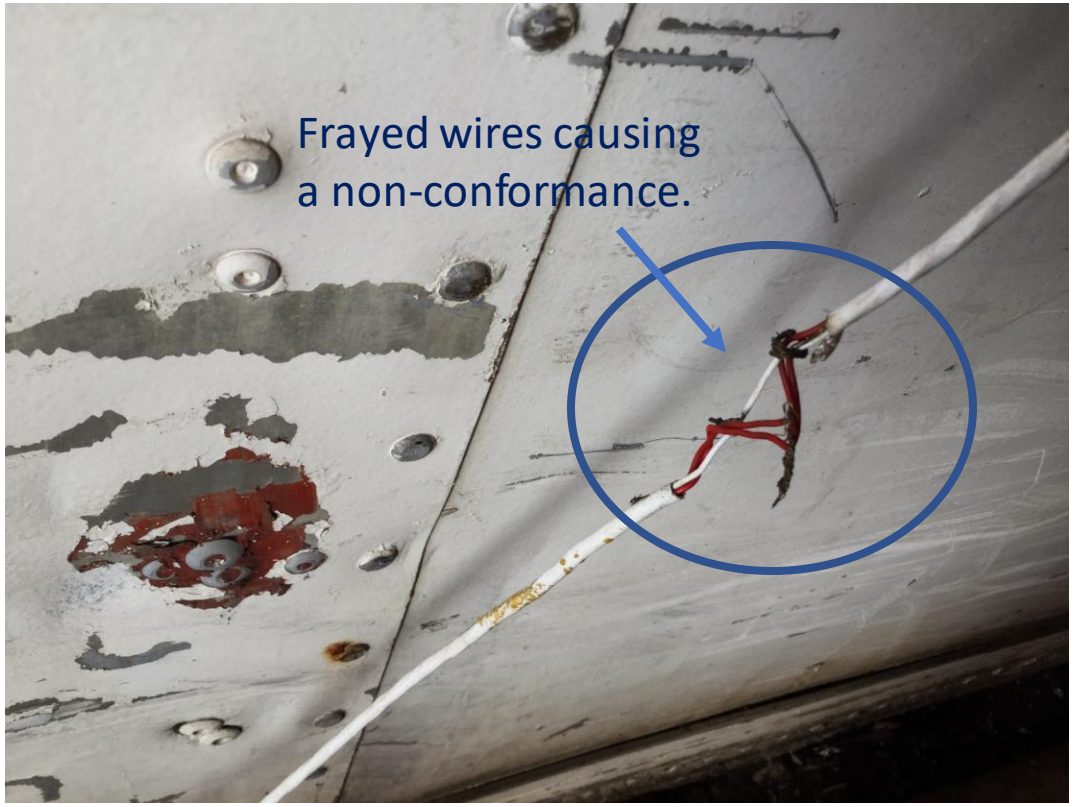
The holes in these surrogate blocks were drilled so big the thinner walls would not accurately verify the proper heat treating of the thickest solid piece of WPM.

This is a non-conformance.

Examples of Non-Conforming Issues

All equipment in the heat chamber must be in good working order. Frayed thermocouple wires, major leaks in the chamber, and other equipment not in good working order can cause a non-conformance.

This is a non-conformance.



Summary

In summary, the areas that are important to monitor for heat chamber conformance are:

- Arrangement of the wood packaging being treated.
- Thermocouple Placement and sealing.
- Equipment condition.
- Time and temperature reports.

Making certain your heat chamber meets the program requirements in these areas will help ensure conformance at each inspection.