M F M A
Maple Flooring Manufacturers Association, Inc.

April 29, 2019

Libby Simmons
Dover School District
23 Alumni Drive
Dover, NH 60181

Ms. Simmons,

Enclosed is the MFMA Flooring Inspection Report on the maple athletic floor system at the Dover High School in Dover, New Hampshire.

As you will see, we have made every effort to address each concern raised regarding the floor. This report has only been sent to you. Further distribution of our findings is strictly up to you.

Should you have any questions or comments on the report, please do not hesitate to contact me at 888-480-9138. Thanks again for your patience.

Respectfully,

Daniel F. Heney
Executive Director

Enclosure

cc: MFMA Technical Advisory Committee

MAPLE FLOORING MANUFACTURERS ASSOCIATION
DOVER HIGH SCHOOL
DOVER, NEW HAMPSHIRE
INSPECTOR: DANIEL F. HENEY
DATE OF INSPECTION: APRIL 4, 2019

Introduction:

Maple flooring systems are evaluated in terms of structural integrity, playability, and aesthetics. The MFMA Inspection Service includes preparatory time before the inspection, interviews with involved parties, the actual on-site inspection and follow-up. The on-site inspection covers grade, millage and specie, condition of the maple flooring, condition of the subfloor and concrete slab (if viewing is requested and if possible), examination of general site conditions, and a review of the floor sanding, sealing, and finishing.

System:

Flooring system history that was available was forwarded to the MFMA for review. In this report, MFMA will address all relevant issues expressed before the inspection and concerns raised while our inspector was on-site.

The maple athletic floor system installed by New England Sports Floors at Dover High School is a "Alliance" sport floor system manufactured by Connor Sports. This system consists of MFMA 25/32" x 2 ¼" random length strip northern hard maple flooring factory assembled subfloor panels with 3/4" x 4" x 8' UL plywood nailers set at Alliance I spacing with 3/4" Rezill pads attached. Sleeper anchorage struts shall be nominal 1/2" x 4" UL grade plywood with pre-drilled anchor pockets. The subfloor is anchored to the concrete slab with collared steel drive pins. The entire system rests over a 6 mil polyethylene vapor retarder.

Concerns/Recommendations:

MFMA's conclusions and recommendations are indicated in **bold** for the maple athletic floor systems at Dover High School in Dover, New Hampshire.

Officials are primarily concerned with if the floor meets ball rebound figures for DIN 18032, Part 2, cupping of flooring strips, loose boards, shrinkage separations, straightness of the volleyball inserts, rattling of volleyball sleeve covers, the existence of a low spot in the floor and the remaining life of the floor if it is sanded.

1. Our inspector began by testing the maple athletic floor system for potential ball rebound based on concerns over dead spots. In layman's terms, "dead spots" are locations in a maple athletic floor system where ball rebound is markedly less than on the majority of the rest of the surface.

   MFMA was asked to test the floor to ensure it complies with DIN 18032, Part 2 for ball rebound. In most simple terms, the DIN 18032, Part 2 ball bounce standard uses a concrete floor as a base measurement for rebound performance, and compare rebound on all maple surfaces as a percentage relative to results on concrete. Specialized equipment and software is used to time impact intervals of a ball dropped at multiple locations across an athletic surface, and calculations based on these impact figures result in a composite score for the floor.

   Connor Sport's "Alliance" anchored resilient athletic wood floor system was installed at Dover High School claims to meet or exceed the standards for DIN 18032, Part 2. The ball rebound requirement for DIN 18032, Part 2 is 90%

   MFMA ball rebound test uses a consistent testing procedure throughout the entire test. Individuals standing on the floor while performing the test will not have any impact when testing ball rebound on a gymnasium floor.

   The average ball bounce on the floor was 98.48%. Below is a chart with the ball rebound percentages for each location.

Dover High School			
Dead Spot Testing			
Test Date: April 4, 2019			
Point	Ball Rebound (%)	Point	EN/ASTM Rebound (%)
1	96	21	99
2	98	22	98
3	99	23	97
4	99	24	98
5	100	25	99
6	99	26	101
7	99	27	96
8	98	28	98
9	98	29	98
10	100	30	99
11	100	31	98
12	100	32	97
13	100	33	99
14	92	34	97
15	96	35	100
16	100	36	99
17	97	37	99
18	98	38	98
19	100	39	100
20	100	40	100
		Average	98.48%
		Maximum	101%
		Minimum	92%

The DIN 18032, Part 2 standard requires that the ball rebound level meet or exceed 90% of the rebound height of concrete and requires that all points be within +/-3% from the average value.

This means that all standards with a uniformity requirement have established a 6% window of acceptable performance in the lab. It is MFMA's position that field testing cannot be held to a tighter standard than laboratory conditions. When MFMA conducts field tests with the intention of identifying dead spots, we create a 6% window from the highest and lowest rebound levels to establish the areas or points that meet the standard.

The reason MFMA doesn't use the average is that we do not feel that we can accurately determine the 'true average' of a sport surface in the field. This is due to the inability to accurately locate critical structural locations in a system after it has been installed. Also, without extensive mapping it is impossible to determine what percentage of a floor responds the same as individual points tested.

While all locations tested exceeded 90% ball rebound, it is MFMA's opinion that in one test location (Test Location #14) the ball rebound did not meet DIN 18032, Part 2 for ball rebound within the maple athletic floor system at Dover High School because the ball rebound in this location was outside the 6% window for uniformity. Test location #14 was 3 percentage points outside the 6% window (101%-95%) for uniformity. Test Location 14 is located along the south side of the playing court just west of the half court line.

MFMA will provide the typical repair procedure for this dead spot but other recommendations in the report may affect the need for such a repair given its location.

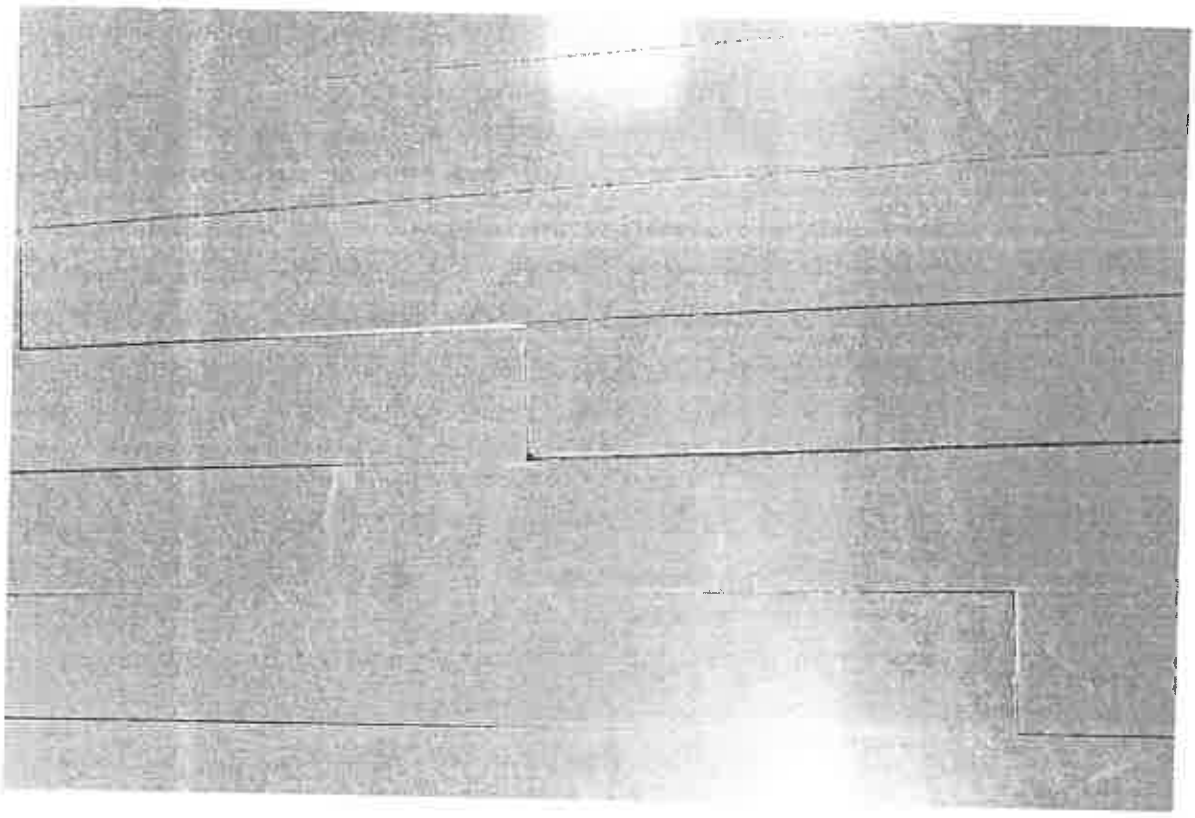
The one location identified by MFMA with reduced ball rebound should be repaired to provide the school with a consistent playing surface. Given the anchored nature of the system, pinning the floor in this location would appear to be the optimal repair situation. MFMA recommends drilling and pinning the floor system to the concrete slab. This procedure will ensure subfloor components contact with concrete slab which should eliminate the "dead spots". Pin holes should be plugged and lightly sanded once the pins are in place. There is another repair procedure that school officials indicated has already been done to the floor system at Dover High School which involves the use of expanding foam. This is typically done by removing a single flooring strip from the affected area or drill a 1/2" hole through the maple flooring in the area where the reduced ball rebound has been identified. Using the expanding foam (Great Stuff) insert the material to the subfloor. Once this material hardens the dead spot should be no longer present. Insert a wood dowel into the hole to provide an aesthetically pleasing repair or replace the single flooring strip.

2. Our inspector observed the reported cupping is scattered location in the floor. Our inspector noted that the edges of flooring strips in scattered locations were raised but the floor in these areas also had shrinkage separations.

MFMA suspects that the floor in these areas suffer from compression set. Compression set describes the condition where the extreme edges of the flooring appear bulged upwardly above the balance of the board face, giving rise to a "Ripple-Like" surface appearance.

Compression Ridging is typically due to a substantial increase in wood moisture giving rise to over-expansion within a wood floor, e.g., a condition wherein expansion of wood exceeds the free space available between flooring boards. It is generally associated with prolonged extreme moisture conditions via high relative humidity, migrating moisture, or inundation. This condition typically affects portions of or the entire floor depending upon the situation. Compression ridging does not go away on its own and requires a sanding to remove the ridges.

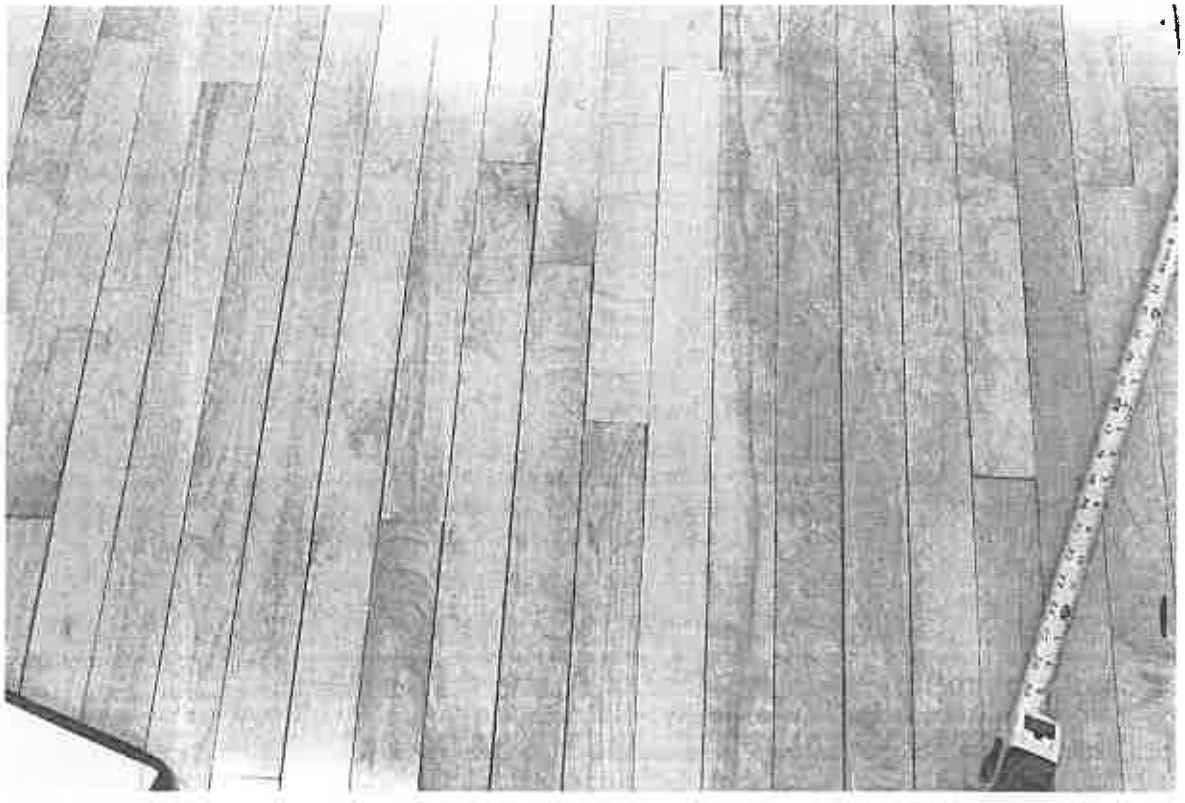
3. Facility officials indicated that they were concerned about loose flooring strips in the floor system. Officials reported loose flooring strips along the ends of the floor system and loose flooring strip within the interior portion of the floor system. Our inspector was unable to find any loose flooring strips at the perimeter but did locate several boards within the interior of the floor system where one end of a flooring strip could be kicked into the shrinkage gaps.



The floor system installed at Dover High School is a Connor Sports "Alliance" floor system which has a subfloor that provides nailing sleepers. Per Connor's installation specification the flooring should be nailed at each intersection with the subfloor nailers. The subfloor nailers are spaced 11" o.c. and the width of the plywood nailers is 4" which leaves a space between plywood nailers of 7". Therefore, end joints in flooring strips could fall between subfloor nailers resulting in one end of the flooring strip being unable to be anchored to the subfloor, especially with shorter flooring strips. In a floor suffering from extreme shrinkage like the floor at Dover High School those end joints are susceptible to side-to-side movement. Under normal condition the tightness of the floor system and the tongue and groove of the flooring strip are sufficient to hold that flooring strip in place. MFMA does not consider this condition a design defect or an installation error. This is a result of the extremely dry conditions in the gymnasium.

4. Facility officials indicated that shrinkage separation in the floor was a concern. Our inspector checked the floor for shrinkage separations and noted that they were present throughout the floor system.

Our inspector checked the moisture content levels in the maple flooring and recorded the environmental conditions in the gymnasium. Our inspector recorded moisture contents readings from four locations throughout the floor system. Our inspector found no measurable amount of moisture in the floor. The Delmhorst moisture meter used by our inspector cannot read moisture contents below 6%. Our inspector also recorded the environmental conditions within the gymnasium on the day of the inspection. The average temperature was 70.5 degrees Fahrenheit with a relative humidity level of 15.5%. According to the USDA, based on the temperature and relative humidity levels recorded on the day of our inspection the maple flooring at Dover High School should have a moisture content of 3.5%. That means the maple floor system at Dover High School may have been exposed to extremely dry indoor relative humidity conditions if conditions like those observed on the day of our inspection are representative of typical environmental conditions in the space. The unmeasurable low moisture content conditions of the maple flooring at Dover High School seems to indicate that the floor has been exposed to extremely dry conditions. According to the USDA, maple flooring in New Hampshire should have a moisture content range of 6%-12%. The low end of that range can be expected in the winter months and the high end of that range in the summer months.



Our inspector was provided environmental data from a HOBO reader installed in the gymnasium to record environmental conditions in the space. The data covers a time period between September 18, 2018 thru October 15, 2018. According to that data the average temperature was 67.38 degrees Fahrenheit with a relative humidity level of 53.95%. According to the USDA, based on the average temperature and average relative humidity levels from the data provided the maple flooring at Dover High School would have a moisture content of 10.1% during this time period.

When you compare the environmental conditions from the day of our inspection and the average environmental conditions from the HOBO reader it shows that the temperature has risen slightly while the relative humidity levels in the gym have dropped almost 40 percentage points. The would result in a maple flooring moisture content loss of 6.5% which will result in 3/64" contraction per flooring strip.

It is MFMA's opinion that there is reason to believe that humidity levels differences have been in excess of 15% which has resulted in significant shrinkage. Wood is a hygroscopic material. When exposed to varying temperatures and humidities, it will release or absorb moisture until it is at equilibrium with the surrounding atmosphere.

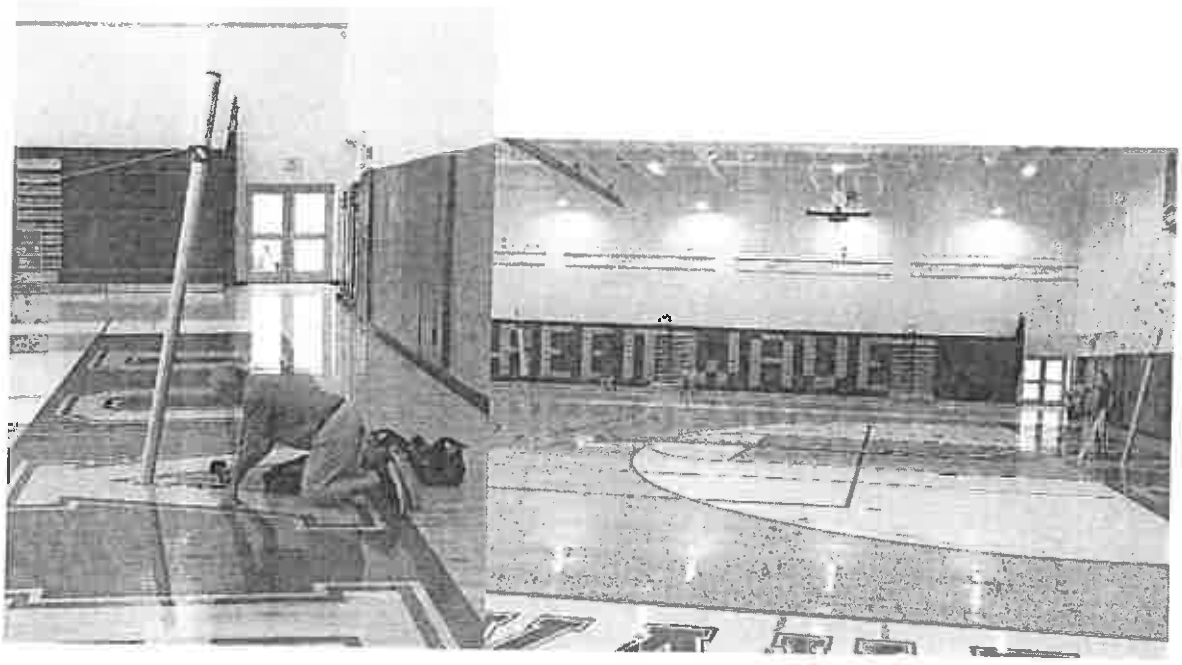
The Maple Flooring Manufacturers Association (MFMA) recommends that the facility's environment be stable when the flooring materials arrive, during installation and after installation -- air temperature between 55 and 75 degrees and indoor relative humidity between 35 and 50 percent.

After installation, maple flooring typically requires a year or two to stabilize -- through a complete cycle of seasonal changes. The floor will continue to adjust to environmental changes throughout its life span.

The appearance of shrinkage cracks during winter months is not unusual. However, the shrinkage cracks at Dover High School are not normal shrinkage and are considered extreme shrinkage. These cracks will normally close in the spring and early summer, as the floor picks up moisture from the air. We do recommend the use of humidification/dehumidification systems, if available, to maintain proper humidity levels. At 70 degrees, maple flooring exposed to relative humidity levels below 25% will not reach 6% moisture content.

MFMA strongly recommends officials contact a HVAC expert to assess the HVAC equipment to help utilize the system to provide the best possible environment for the maple athletic floor. After the HVAC equipment is evaluated and recommendations to help utilize the system to provide the best possible environment for the maple athletic floor are achieved the shrinkage separations should be minimized.

5. Our inspector was asked to comment on the volleyball sleeve installation. Our inspector was shown the pictures below of the volleyball stanchions installed in the volleyball sleeves.



The volleyball sleeves were not installed correctly. To correct this situation will involve removing sections of the floor system to provide access to the concrete slab to correct the sleeve. This will require providing adequate space for removal of the sleeves, typically involving jack hammering the concrete slab to remove the existing sleeves. Once old sleeves are removed and new sleeves installed, the subfloor system will have to be reinstalled and new maple flooring installed.

The new maple flooring will need to be sanded down to match the profile of the existing maple. This will require the rest of the floor to be lightly sanded, sealed, painted and finished to provide a smooth uniform surface. This type of light sanding typically does not remove more than 1/64" of wear layer.

6. School officials indicated that they were concerned because the volleyball sleeve covers rattle when a basketball is bounced on the floor. Our inspector bounced a basketball while conducting the ball rebound test on the floor and the covers did rattle.

   MFMA suspects this is related to the design of the volleyball sleeve cover as it does not tightly secure the top of the sleeve while in the locked position. MFMA would recommend inserting small felt pads along the inside rim of the cover to reduce rattling or the replacement of the covers with different covers that lock securely in place.

7. Our inspector was asked to address the low spots reported in the floor system. Our inspector noted there was some visual evidence of a low spot in the floor in two locations, both located around the half court line in the main playing surface. It was reported that the low spot in the floor measured ¼". Our inspector was unable to verify the depth of the low spot during the inspection.

   No standard specification exists for levelness of a finished maple floor. The MFMA standard for flatness in a concrete slab continues to be 1/8" variance in a 10' radius.

   Several factors can contribute to varying elevations on a maple floor. Fixed flooring installations tend to transmit variances in the concrete slab to the surface over time. Floating floor systems may bridge low spots on the slab, or may amplify high spots depending on the placement of sleepers or other subfloor components. Careful slab finishing by the general contractor can mitigate surface levelness difficulties by eliminating subfloor variances prior to installation of the finished surface.

   MFMA recommends that the general contractor provide a concrete slab, troweled smooth and flat to a tolerance of 1/8" in a 10' radius for all gymnasium floors. However, once the flooring contractor starts installation of the maple floor system they are responsible for the slab's condition.

When the volleyball sleeves are corrected the area of the floor system in the low spots should be removed and the concrete slab be leveled in this area with a concrete leveling product or the reinstalled floor system should have appropriately sized wood blocks inserted between the "Rezill" pads and the Alliance subfloor to make up for the concrete deficiencies. The design of the Alliance system is ideal for this type of wood block repair. The subfloor system will have to be reinstalled and new maple flooring installed in this area.

The new maple flooring will need to be sanded down to match the profile of the existing maple. This will require the rest of the floor to be lightly sanded, sealed, painted and finished to provide a smooth uniform surface. This type of light sanding typically does not remove more than 1/64" of wear layer.

8. School officials inquired about the remaining life of the floor system after repairs are made. Since MFMA is recommending the removal of existing maple flooring and replacement with new maple flooring and a sanding of the entire floor the impact on the overall life of the floor system will be minimal.

   Unfortunately, there are additional factors that shorten the flooring life cycle; the number of available sandings of the floor depends on the people sanding the floor, a skilled sanding craftsman will remove the minimal amount of flooring surface necessary for the flooring to look rejuvenated, someone not possessing the equivalent skill and knowledge could shorten the floor systems life.

   The process can be less aggressive since there is finish layer build-up since installation. A floor that has not been sanded for an extended period of time (plus 15 years) will have more surface removed while trying to aggressively sand-thru the thick finish layers that have built-up. In the case of the floor system at Dover High School, the light sanding will just require the removal of the paint and finishing products from installation (4 coats of finishing products and a paint layer). A minimal amount of wear layer (approximately 1/64") will be moved from the existing maple flooring.

   The overall consensus, there are up to six sands available in a 25/32" thick maple floor, if the floor is sanded at reasonable frequency and is maintained and sanded by a knowledgeable skilled flooring contractor and does not suffer any environmental or abuse damage. The general average of 8 to 12 years for owners having their floors sanded results in a typical average life span in excess of 75 years. Thus, removing a 1/64" of wear layer will result is an anticipated loss of life of approximately 6 years.

9. Our inspector noted several cracked and splintered flooring strips during our inspection. Our inspector pointed these flooring strip out to school officials indicating that they are a safety hazard.

For a single flooring strip replacement here are two different procedures that MFMA recommends:

1. **The replacement of the maple strip can be completed by altering a new maple strip in order to facilitate its installation. This can be accomplished by removing the bottom of the groove side of the new flooring strips to allow placement into the existing system. The old flooring strip will need to be removed without damaging any of the adjacent boards. Once the old board is removed, the replacement maple strip should be inserted, face-screwed and plugged to anchor them adequately into the subfloor.**

2. **The replacement of the maple strip can be completed with the use of a "half-replacement" surface strip. The fractured maple flooring strip will need to be routed and chiseled out to ensure a snug fit for the half replacement strip. The half replacement strip is glued to the lower half of an existing maple strip. Be sure to check the profile before adhering the replacement strip to the existing surface. Use of this technique may reduce the need for multiple areas of face nailing.**

General Recommendations

1. Indoor relative humidity and temperature levels maintained in the facility during and following the installation play a key role in flooring system expansion and/or shrinkage. Environmental conditions inside an athletic facility directly affect flooring performance. Wood is a hygroscopic material. When exposed to varying temperatures and humidity levels, maple flooring will release and absorb moisture until it is at an equilibrium point corresponding to the surrounding atmosphere (see enclosed USDA Equilibrium Moisture Content Chart.)

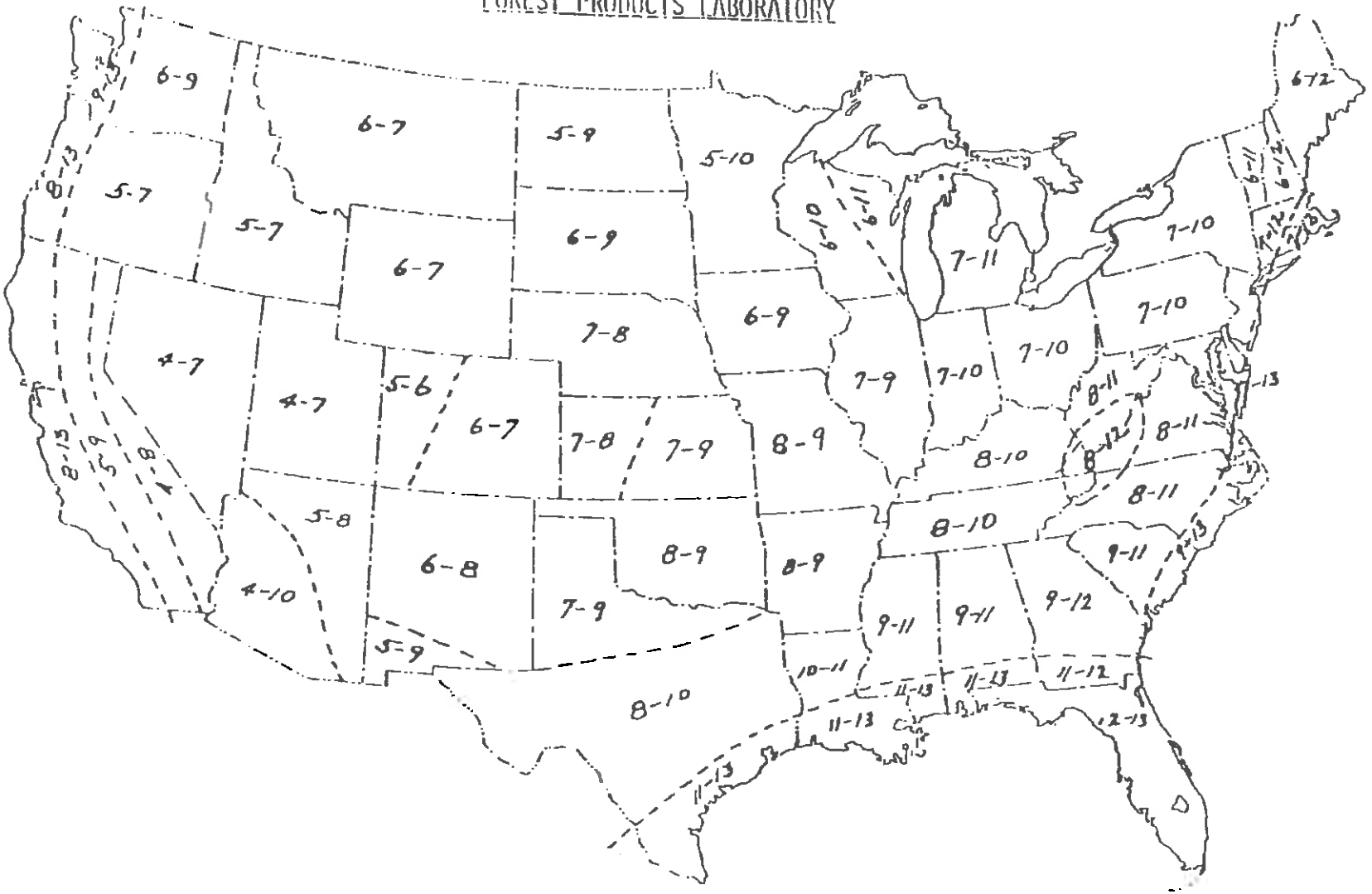
   Swelling, cupping and, in extreme cases, buckling are the result of the natural adjustment of the flooring and subfloor materials to wetter environmental conditions.

   Shrinkage separations are the natural adjustment of the flooring materials to drier environmental conditions. In facilities without humidity controls, maple flooring typically contracts during winter months.

   Lower indoor relative humidity levels draw moisture out of the flooring, causing shrinkage. The cycle reverses in the summer months with the return of higher air temperature and humidity levels. Normal seasonal flooring moisture content variations should be expected, and they will result in some flooring system movement.

2. The maple flooring system should always be cleaned using floor-cleaning products that are compatible with the finish. Contact your finish manufacturer with any product compatibility questions. Enclosed are some brochures to help direct recommended maintenance procedures for your maple flooring system.

FROM THE
US DEPARTMENT OF AGRICULTURE
FOREST PRODUCTS LABORATORY



Variation of average moisture content. In each pair of figures, the first is average moisture content during January and the second is average moisture content during July for wood used indoors.

Maple Flooring Manufacturers Association

Relative Humidity
&
Equilibrium Moisture Content Tables

MOISTURE CONTENT OF WOOD IN EQUILIBRIUM WITH STATED DRY-BULB TEMPERATURE AND RELATIVE HUMIDITY

TEMPERATURE DRY-BULB FAHRENHEIT	RELATIVE HUMIDITY, PERCENT																			
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	98
30	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21	24.3	26.9
40	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.3	13.5	14.9	16.5	18.5	21	24.3	26.9
50	1.4	2.6	3.6	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.2	12.3	13.4	14.8	16.4	18.4	20.9	24.3	26.9
60	1.3	2.5	3.6	4.6	5.4	6.2	7	7.8	8.6	9.4	10.2	11.1	12.1	13.3	14.6	16.2	18.2	20.7	24.1	26.8
70	1.3	2.5	3.5	4.5	5.4	6.2	6.9	7.7	8.5	9.2	10.1	11	12	13.1	14.4	16	17.9	20.5	23.9	26.6
80	1.3	2.4	3.5	4.4	5.3	6.1	6.8	7.6	8.3	9.1	9.9	10.8	11.7	12.9	14.2	15.7	17.7	20.2	23.6	26.3
90	1.2	2.3	3.4	4.3	5.1	5.9	6.7	7.4	8.1	8.9	9.7	10.5	11.5	12.6	13.9	15.4	17.3	19.8	23.3	26
100	1.2	2.3	3.3	4.2	5	5.8	6.5	7.2	7.9	8.7	9.5	10.3	11.2	12.3	13.6	15.1	17	19.5	22.9	25.6

Source: United States Department of Agriculture "Wood Handbook"

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Maple Flooring Manufacturers Association
Dimension Change Chart

Based on Average Possible Change in Width
(Tangential Face) 2-1/4"

A Moisture Content Difference of	May Result in an Approximate Width Change of	
1%	1/128"	
2%	1/64"	Scant
3%	1/64"	Full
4%	1/32"	Scant
5%	1/32"	Full
6%	3/64"	Scant
7%	3/64"	Full
8%	1/16"	Scant
9%	1/16"	
10%	1/16"	Full
11%	5/64"	
12%	5/64"	Full
13%	3/32"	
14%	3/32"	Full
15%	7/64"	
16%	7/64"	Full
17%	1/8"	Scant
18%	1/8"	Full
19%	9/64"	Scant
20%	9/64"	Full
21%	5/32"	Scant
22%	5/32"	Full
23%	11/64"	Scant
24%	11/64"	Full

(The Greatest Possible Dimensional Change Occurs in the Tangential Direction)

Source: United States Department of Agriculture - Forest Products Laboratory

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