

Rain Penetration Functional Test

Instructions: For each system included on the checklist, verify the items indicated using **Yes** for acceptable, **No** for unacceptable, or **NA** for Not Applicable. For unacceptable items, identify what is required to correct the problem in the comments area provided. Use numbers to refer to comments. Identify the responsible contractor, if know, for any items requiring further action.

Equipment Required: Shortridge Air Flow Measuring Computer with Velgrid probe, rotating vane anemometer, or equivalent device to verify louver face velocity and wind velocity; Rain gauge and stop watch (optional) for documenting rainfall rate during the test; Compass (optional) for estimating the wind direction. Camera (optional) for documenting water penetration on louver blades and general conditions at the time of test.

Acceptance Criteria: Louver applied at or below its rated point of beginning water penetration; Intake compartment remains dry during a heavy rain; Water penetration that does occur during a driving rain is contained and drained from the system with out adversely affecting the system or surrounding building; Equipment and components located in the intake compartment have been selected and installed in a manner that will allow them to tolerate minor moisture penetrations that can occur during a driving rain or during heavy fog.

Date(s) of Test: _____

Time(s) of Test: _____

Test Technician _____

Item Number	Requirement	System Identifier
	All applicable prestart and start-up verification checks from the equipment manufacturer have been completed.	
	Louver installation and flashing is complete	
	Building envelope construction above and immediately adjacent to the louver location is complete.	
	Heavy rainfall is anticipated or occurring.	
	Air handling system is arranged to operate at the design flow rate and capable of operation in that mode. Applicable additional verification checks from the preceding list should be inserted here.	
	Obtain and document the following information.	
	Air handling system design flow rate _____ cfm	
	Louver design face velocity _____ fp	
	Louver point of beginning water penetration _____ fpm	
	Louver free area or free area ratio _____ sq.ft. or %	
	Louver make _____	
	Louver model _____	
	Louver blade profile (sketch example) _____	

Documenting information such as the blade profile will allow you to assess if the louver that is installed is in fact what was submitted on. Make and model information may not be apparent in the field installation, but the blade profile will provide a good clue as to whether or not the installed louver is what should be there.

Set up the rain gauge at a representative location to document the rainfall rate. Temporarily cover the gauge so that it doesn't begin to accumulate rain until the time of testing.

Verify that the installed louver matches what was specified and submitted on using nameplates, blade profile comparison, or other techniques. Note basis used for making this determination.

Verify that the system can be operated on 100% outdoor air with out compromising the area served under the current outdoor environmental conditions.

Index the system to 100% outdoor air.

Verify that the system can be operated at design flow with out compromising the area served under the current load conditions.

Index the system to 100% flow.

Determine and document the average louver face velocity by traversing the filter bank and using the following calculation steps. Note instrumentation used for the measurements.

Louver height	_____	inches
Louver width	_____	inches
Louver area in square feet ((height x width)/144)	_____	sq/ft.
Filter bank height	_____	inches
Filter bank width	_____	inches
Filter bank area in square feet ((height x width)/144)	_____	sq/ft.
Average filter face velocity from traverse	_____	fpm
Calculated flow rate (filter velocity x filter area)	_____	cfm
Calculated louver face velocity (Flow rate/Louver area)	_____	fpm
Instrument used to measure face velocity	_____	

Verify that the actual face velocity is at or below 110% of the design face velocity.

Verify that the actual face velocity is below the louver point of beginning water penetration.

If there currently is not a heavy rainstorm, return the system to normal operation and complete the remaining steps of the procedure when a heavy rain occurs. Make provisions so the system can be quickly returned to 100% outdoor air/100% flow at that time.

All of these steps can be completed with out the heavy rainfall occurring. Since this test is dependent on a heavy rainfall, it may be the most efficient to perform them ahead of time and then simply document performance under heavy rain conditions when the event occurs.

During a heavy rainstorm, return the system to 100% outdoor air/100% flow operation.

Remove the cover from the rain gauge and start the stopwatch to time the accumulation of rain during the test.

Document the wind speed and direction.

Wind speed	_____	mph
Wind direction	_____	

The following is an example of a completed checklist that was custom tailored to a 100% outdoor air system serving a clean room using the preceding template as a starting point.

Rain Penetration Functional Test - Edited and Completed Example

Instructions: For each system included on the checklist, verify the items indicated using **Yes** for acceptable, **No** for unacceptable, or **NA** for Not Applicable. For unacceptable items, identify what is required to correct the problem in the comments area provided. Use numbers to refer to comments. Identify the responsible contractor, if know, for any items requiring further action.

Acceptance Criteria: Louver applied at or below its rated point of beginning water penetration; Intake compartment remains dry during a heavy rain; Water penetration that does occur during a driving rain is contained and drained from the system with out adversely affecting the system or surrounding building; Equipment and components located in the intake compartment have been selected and installed in a manner that will allow them to tolerate minor moisture penetrations that can occur during a driving rain or during heavy fog.

Date(s) of Test: Prep work - July 12, 1998

Time(s) of Test: Prep work - 7:30 am

Test Technician Joe Kazam, Sarah Presiski

Item Number	Requirement	03-MAU01-01-01
1	All applicable prestart and start-up verification checks from the equipment manufacturer have been completed.	Yes
2	Building envelope construction above and immediately adjacent to the louver location is complete.	Yes
3	Heavy rainfall is anticipated or occurring.	Yes
4	Air handling system is arranged to operate at the design flow rate and capable of operation in that mode.	Note 1
5	Sealing, flashing, thermal expansion gaps and bracing provided per the manufacturers installation recommendations	Note 2
6	Intake screen provided with a grid large enough to prevent nuisance clogging	Yes
7	Intake screen arranged and accessible for cleaning	Yes
8	Intake arranged to minimize water damage	Yes
9	Intake compartment arranged to accommodate water entry and pitched to drain	Note 3
10	Intake compartment constructed of moisture tolerant materials	Note 4
11	Filters located so as to be affected by moisture penetration during a driving rain or fog conditions are moisture tolerant and selected to minimize the impact of frozen moisture on system performance.	Note 4
12	Obtain and document the following information. Air handling system design flow rate <u>45,000</u> cfm Louver design face velocity <u>469</u> fpm Louver point of beginning water penetration <u>804(free area)</u> fpm Louver free area or free area ratio <u>55%</u> sq.ft. or % Louver make <u>Ruskin</u> Louver model <u>ELF375X</u> Louver blade profile (sketch example) _____	

13	Set up the rain gauge at a representative location to document the rainfall rate. Temporarily cover the gauge so that it doesn't begin to accumulate rain until the time of testing.	Done
14	Verify that the installed louver matches what was specified and submitted on using nameplates, blade profile comparison, or other techniques. Note basis used for making this determination.	O.K., Blade profile basis
15	Note the current number of fans running and their speed based on the variable speed drive display. 03-SF01-01-01 Status <u>On</u> Speed <u>52.1</u> hz. 03-SF01-01-02 Status <u>On</u> Speed <u>52.1</u> hz.	
16	Determine and document the average louver face velocity by traversing the filter bank and using the following calculation steps. Note instrumentation used for the measurements. Louver height <u>96</u> inches Louver width <u>144</u> inches Louver area in square feet ((height x width)/144) <u>96</u> sq/ft. Filter bank height <u>120</u> inches Filter bank width <u>144</u> inches Filter bank area in square feet ((height x width)/144) <u>120</u> sq/ft. Average filter face velocity from traverse <u>319</u> fpm Calculated flow rate (filter velocity x filter area) <u>38,280</u> cfm Calculated louver face velocity (Flow rate/Louver area) <u>399</u> fpm Instrument used to measure face velocity <u>Shortridge</u>	
17	Verify that the actual face velocity is at or below 110% of the design face velocity.	Yes
18	Verify that the measured face velocity is below the louver point of beginning water penetration.	Yes
19	If there currently is not a heavy rainstorm, return the system to normal operation and complete the remaining steps of the procedure when a heavy rain occurs.	Delayed, see below
20	During a heavy rainstorm, re-verify the fan operating status and speeds. Note time and date if different from when the preceding steps were performed. Time <u>3:15 pm</u> Date <u>July 14, 1998</u> 03-SF01-01-01 Status _____ Speed _____ hz. 03-SF01-01-02 Status _____ Speed _____ hz.	Fan status same as before
21	Remove the cover from the rain gauge and start the stopwatch to time the accumulation of rain during the test.	Done
22	Document the wind speed with the rotating vane anemometer and estimate direction. Wind speed <u>8, gust 17</u> mph Wind direction (estimate) <u>SSW</u>	Done
23	Observe the louver blades and the intake compartment to determine if water is being carried through the louver blades and into the intake compartment. Note observations below. <u>Under steady rain with no gusts, the last 1/2 inch of blade never</u>	O.K. See comments and photo

really got wet.

24	Continue to monitor and observe the louver performance for 15 minutes. Note any additional observations below. <u>Gusts caused some carry-over, but actual raindrops never reached the louver. Any water that did penetrate, tended to run towards the drain, but it wasn't much water.</u>	O.K.
25	Document test conditions with photographs of the louver blades and intake compartment.	Done
26	Return the system to normal operation.	Done
27	Cover the rain gauge and turn off the stopwatch. Document the accumulated rainfall over the duration of the test and calculate the rainfall rate. Accumulated rainwater <u>3/8</u> inches Duration of test <u>20</u> minutes Duration of test in hours (divide minutes by 60) <u>.33</u> hours Rainfall rate during the test <u>1.14</u> in./hr.	

Comments:

1. Current flow settings at 85% of design based on clean room qualification requirements. Unlikely to change unless process changes. Increasing flow beyond current settings significantly upsets process and is unacceptable to Owner. Therefore, we tested at the current settings. It may be desirable to repeat this test if/when the system is reconfigured in the future for different tools if the flow rates increase since our observation was that we were close to seeing some water penetration through the louver under our test conditions.
2. There is no reinforcement between the louver sections. The last time I looked at a large multi-section louver like this one, the manufacturer required 1/4" steel plate between sections or braces to the corners in an application like this. The MC should confirm that is not required for this louver by checking the manufacturer's installation instructions.
3. The compartment has a drain, but it is capped. We didn't have a pipe wrench to remove the cap, so that needs to be taken care of. A trip is probably not necessary since this is the first compartment and ahead of the filters.
4. Standard cardboard framed type prefilters are installed. The specs call for filters with moisture resistant "beverage board" frames. Could be important here since filters are within 4 feet of the intake louver and will probably filter out moisture from heavy fog. Deeper pleats may also be a good idea to prevent excessive pressure drop when this moisture freezes in the winter.