12 February 2015

Mr. Charles Aspinwall
Town Administrator
Town of Millis
900 Main Street
Millis, MA 02054

Project 150119 – Leakage Pre-Investigation at the Department of the Works Building, 7 Water Street, Millis, MA

Dear Mr. Aspinwall:

At your request, we visited the Department of Works (DPW) building at 7 Water Street in Millis, Massachusetts, to review reports of water leakage. This letter report summarizes our observations, provides discussion on likely causes of the water leakage, and makes recommendations for an investigation to confirm the causes and develop remedial repairs.

1. BACKGROUND

You informed us that the Department of the Works (DPW) building at 7 Water Street in Millis, Massachusetts, has leakage issues after large snow events in the past 3 yrs. Prior investigation and repair attempts made in 2012 to correct this leakage were unsuccessful. The roof is currently leaking and causing damage to the interior office spaces from the recent major snow event on 27 January 2015.

The DPW building is a prefabricated metal building with a 4 ft high exposed concrete foundation wall (Photo 1). Original construction date and documents were not available to us.

1.1 Information from Others

We received the following information during our site visit from both Jim McKay, the Assistant Director of the DPW, and workers at the facility:

- The building was constructed during the 1970s.
- The finished office space has been repaired multiple times (2009, 2012, and 2013) because of leakage.
- A large amount of water came through the HVAC duct and the smoke detector hole in the ceiling of the office on 27 January 2015 (Photos 2 – 4).
- The building leaks mainly during large snow events but only during some wind-blown rain events.
- Leakage came out from an HVAC duct and behind the furred out column cover at the column in the machine room on 27 January 2015 (Photo 5).

- A section of vinyl-faced roof insulation detached above the mechanics cage at the northwest corner of the building and dispersed a large amount of water on 27 January 2015 (Photo 6).

1.2 Drawing Review

You provided us with drawings dated 27 March 2002 by KBA Architects. The drawings show the following scope of work to the roofing and wall system:

- Removal and replacement of the exterior metal panels with new metal panels and continuous insulation on walls and roof.
- Lapped corrugated metal roof and wall panels, face fastened, with continuous beads of sealant in the lapping metal panel ribs.
- Foam channel ends at terminations of the metal roof and wall panels.
- 2 in. rigid insulation on the interior face of the roof and wall panels.
- Continuous metal liner panel on the interior face of the insulation, with an alternate to delete the continuous metal liner and install vinyl-lined insulation.

2. OBSERVATIONS

When we arrived on site, it was snowing outside with an ambient temperature of 34°. The Town of Millis provided a boom truck for our investigation. We were unable to access the metal roof directly because of snow cover and lack of safe access and safety tie-offs.

2.1 Interior Observations

- The electricity to the office space has been shut off because of leakage into the finished walls and ceiling.
- Damp areas at the floor in the office and the mechanics office where leakage was reported from above (Photo 2).
- Water stains at HVAC duct where leakage was reported (Photo 3).
- Water stains at the smoke detector where leakage was reported (Photo 4).
- Damp insulation and water-stained ceiling tiles in the mechanics office (Photo 5).
- Detached insulation above the mechanics equipment storage area (Photo 6).
- The loft storage area above the finished spaces has water stains and damp plywood located above the leakage reported below (Photos 7 and 8).
- The exposed vinyl-faced fiberglass insulation is damaged and has open seams in multiple locations (Photo 9).

- The metal panels and insulation above and behind the damaged or open seam areas of insulation is wet and frozen (Photo 10).

- Daylight is visible at the roof-to-wall intersection in multiple areas (Photo 11).

- Equipment and tools leaning on the wall insulation causing damage to the vinyl insulation liner.

2.2 Exterior Observations

- The roof is face-fastened overlapping corrugated metal sheets with a transverse joint at the roof slope midpoint. The eave channels are closed with foam insulation (Photos 12 – 14).

- The visible fasteners are coated with sealant (Photo 15).

- The existing building fastener spacing does not reflect the spacing shown in the drawings.

- The snow on the roof is approximately 6 in. deep.

- The metal roof is visible at melted areas above and adjacent to damaged insulation and open laps in the insulation directly below (Photo 16).

- Ice dams are approximately 2 in. thick and extend 2 ft or more from the roof eave toward the roof ridge (Photo 17).

- The internal purlins transmit heat through the roof, and their locations are visible from melted areas of snow (Photo 18).

- After removing icicles at the end of a few corrugated ribs, water began flowing off the eave from below the ice dams (Photo 19).

3. DISCUSSION

The 2002 construction documents provided to us do not have specific information regarding the installed metal roofing system. We determined that the type of metal roofing system called for in the drawings appears to be installed on the building. Face-fastened lapped corrugated metal panel roofing is a difficult system to maintain watertight. The system depends on seals at all fastener penetrations and lap seams. In addition, fastening patterns are not uniform as they are dependent on the panel shape so unsealed fasteners may exist if they are located in nontypical locations. Snow buildup can cause the laps in the metal panels to flex and open under the increased surface load, stressing seals at lap seams and providing a direct path for water infiltration.

The insulation facer is intended to work as a vapor barrier. Damage to the insulation facer and gaps in the insulation allow warm moist air to reach the face of the metal wall and roof panels, where it can condense. As a result, condensation may exacerbate the water leakage problems.

Insufficient insulation and insulation gaps cause snow to melt on the roof, creating liquid water to form ice dams. Ice dams form when melting snow (warmed from the building interior) refreezes at the edge of a roof damming water drainage off the roof. The water collects and freezes, increasing the ice dam and the reservoir of water on the roof. Ice dams can allow water to build up and completely submerge the metal ribs and face fasteners, putting added pressure on fastener and lap seam seals.

4. FURTHER INVESTIGATION

In order to fully determine the causes of water leakage, we recommend a further in-depth investigation utilizing the following methods:

- Water testing the roof above leakage areas using spray rack and flooding joints in the roofing
- Removal of insulation on the interior to view the underside of the roof and wall panels
- Removal of roof panels to verify the roofing construction including verification of sealant joints

We recommend performing the investigation when the roof is safely accessible and temperatures allow for water testing (35° and rising). We also recommend performing the investigation when removal of roofing panels will not adversely affect the use of the building.

At the conclusion of our investigation, we will provide you with repair options to address the water leakage. These may range from the most economical and least durable (adding sealant) to the most invasive and most durable (replace the roofing). We will discuss the costs of each in relation to the expected service life of the repairs to allow you to make an informed decision about which to implement.

We would be glad to provide you with a proposal to perform the investigation and provide a report with repair recommendations. We will require contractor assistance for access and making openings during the investigation.

Thank you for the opportunity to continue to be of service to the Town of Millis. We look forward to assisting you on the next phase of this project.

Sincerely yours,

Peter M. Babaian
Associate Principal

Edward S. Farrington
Staff III – Building Technology

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Photo 1

7 Water Street.

Photo 2

Office leakage area.

Photo 3

HVAC vent where leakage came through.

Photo 4

Smoke detector where leakage came through.

Photo 5

Mechanics area leakage at HVAC duct.

Photo 6

Detached insulation above mechanics tool storage area.

Photo 7

Loft area above mechanics work area.

Photo 8

Wet loft area floor above office area.

Photo 9

Open insulation at leak area above mechanics room.

Photo 10

Wet metal panel and insulation.

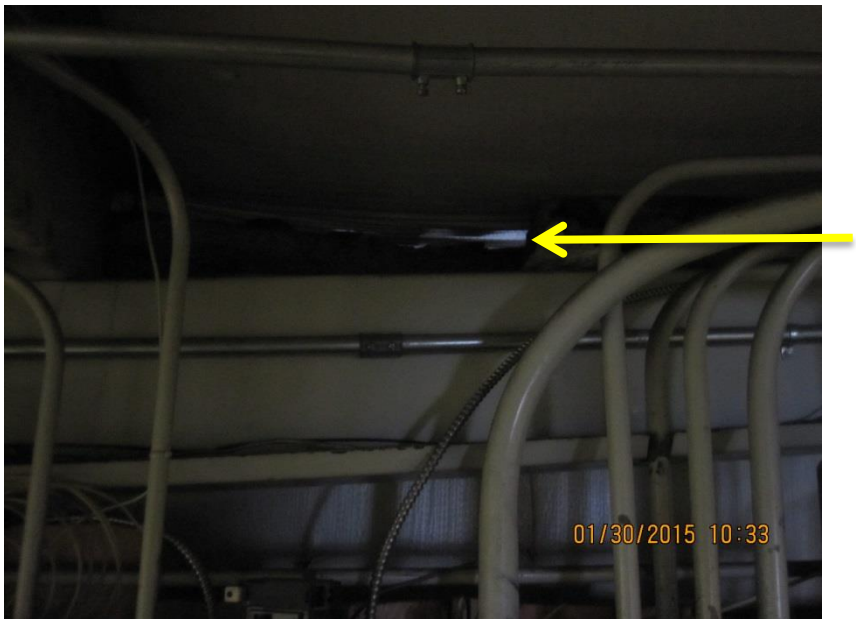

Photo 11

Daylight visible at wall-to-roof transition.

Photo 12

Transverse lap in corrugated metal roofing.

Photo 13

Corrugated metal roofing lap.

Photo 14

Insulation end cap at channel.

Photo 15

Face fasteners at corrugated metal roofing. Insulation below is open.

Photo 16
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Melted snow above insulation gap.

Photo 17

Ice dam at eave edge.

Photo 18

Perlin spacing transmitting through snow.

Photo 19

Water draining from ice dam.