CAUSE AND EFFECT:
A CASE STUDY ON BUILDING OCCUPANCY USE CHANGE

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Before making changes in a building's occupancy use, the building owner must understand what impact the change will have on the building's roof system and structural elements. Without a clear understanding, occupancy change can adversely affect roof system performance and the building's structural elements.

Recently a food manufacturing facility reported water leakage within a conditioned warehouse space used to store food product after initial processing and prior to final processing. Assuming they had a roof leak, the building owner contacted their roof repair contractor for assistance. The contractor visited the site, walked the area of reported leakage, installed a few small patches to the roof membrane, and invoiced the building owner for repairs. However, water leakage soon returned, and the leak repair process was repeated. Frustrated and aggravated, the building owner contacted Benchmark for assistance.

The building's roofing system was installed in 1999, using an in-seam, mechanically fastened PVC single-ply roof membrane. Below the membrane, a polyethylene film vapor retarder, was loose laid over the insulation substrate. The insulation substrate consisted of two layers of 2" polyisocyanurate, with the top layer mechanically fastened through the bottom layer of insulation to the painted steel deck. The roof system provided an approximate thermal resistance value of R=22.8, consistent with code requirements at the time of installation for a typical conditioned space. We found that the polyethylene film vapor retarder was not sealed at roof perimeters or roof penetrations and based on the extent of deck corrosion, it must have been poorly sealed at side and end laps.

Due to facility operational changes, the building owner installed three large HVAC units on the roof and new interior ductwork within the previous five years. These recently added HVAC units now condition/cool the interior space to a temperature range of 45° F to 55° F. This lowered the interior temperature approximately 10° F to 20° F from the original design. The change cooled the processed food more rapidly, allowing for expedited processing and increased production.

During our site visit we observed the following conditions:

- Interior ductwork was not insulated at the time of installation.
- Water condensation was visible on the exterior ductwork surfaces.
- Active water drippage was evident from the interior deck surface and roof joists.
- Rust corrosion/perforation of the deck was evident at various locations on the bottom surface of the deck.

Suspecting a possible condensation issue, dewpoint and temperature gradient calculations were performed. The calculations revealed that water vapor condensation was occurring at the steel deck. During summer conditions, water vapor from hot, humid outside air was condensing on the top surface of the deck. During winter conditions, water vapor from warm, moist interior air was condensing on the bottom surface of the deck. Based on the calculations, condensation was possible in certain summertime circumstances prior to the change in interior conditioning but was occurring both during the summer and with reverse drive in the winter after the change to the interior.

While the need for a vapor retarder was recognized in the existing roof assembly, improper installation (lack of proper seals at lap seams, roof perimeters, and penetrations) rendered the vapor retarder ineffective. When new HVAC units were installed, the occupancy of the building space changed, thus necessitating the need for a vapor retarder on the bottom side of the roof assembly.

Unfortunately, the only method available to resolve condensation issues was to remove and replace the existing roofing system. The new roof system design included installation of a thermal barrier to serve as the substrate for the bottom side vapor retarder membrane. New insulation of sufficient thermal resistance (R-value) was adhered over the vapor retarder to ensure the dew point temperature occurred within the insulation layers. Finally, the new roof membrane was adhered to the insulation substrate. The membrane was carefully selected and specified to also serve as the top side vapor retarder membrane.

During the new roof design, allowances for steel deck replacement and steel deck restoration (prime painting) were incorporated to address visually identified areas of steel deck rust perforation and the anticipated top side surface rusting of the steel deck. Our project documents did not include interior ductwork insulation. The building owner assumed responsibility for the HVAC ductwork insulation.

During the roof replacement project, we found the quantity of top side steel deck surface rusting was significantly greater than the allowance included in the project documents. If these condensation issues had not been remedied and roof replacement delayed, the change in building occupancy would have resulted in significant additional expense to replace the steel deck. This case study clearly shows that even seemingly minor modifications to the interior use and occupancy can have substantial impacts on the functional service life of the roof and building structural elements.