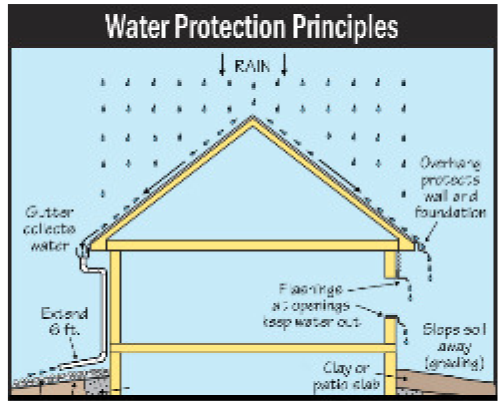
August 12, 2021

Diagnostic Inspection
Clarinda Correctional Facility
2000 N 16th Street, Clarinda, Iowa 51632

Background:
The Clarinda Correctional Facility located in Clarinda, Iowa has a reported history of elevated moisture related conditions, including bulk water intrusion that results in water draining from ceiling mounted light fixtures located in the cells at the exterior wall assembly. Moisture intrusion events are reported to occur throughout the year and are mostly (but not solely) associated with rain. Various moisture intrusion issues have been reported since the facility was constructed around 1994. Suboptimal grading and drainage observed around and below the building's exterior contribute to the moisture intrusion. The current mechanical system is exhausting more air from the Pods than it is supplying resulting in significant negative pressure which brings unconditioned outside air into the occupied spaces. It is reported that there are several cells which are unable to be occupied due to the excessive moisture intrusion issues.

The facility was constructed around 1994 with slab on grade floors, insulated concrete wall panels and a standing seam metal roof. The provided plans detail a concrete roof deck with rigid insulation and membrane flashing under the 1.5/12 pitch standing metal seam roof. Several sections of the standing metal seam roof were replaced in 2017, in an attempt to resolve the moisture intrusion issues that have plagued the facility since it was constructed.

Water Management:



A building's performance may be fundamentally judged by its ability to manage water and its removal by natural and mechanical means. The basis of water management is rooted in exterior grading and drainage designed to accommodate typical rainfall at that location. Furthermore, the consistent maintenance of grading and drainage reduces the risk of moisture intrusion and damage. An umbrella represents the ideal function in terms of consistent coverage and drainage towards the outer edge. Considering that water from rainfall is typically the greatest source of moisture to be managed by a building, deficiencies in design and/or maintenance will contribute significantly to moisture issues including condensation and mold.

Air Leakage and Condensation Management:
Reducing air leakage in buildings is another aspect of managing moisture in buildings. Outside air leaking into a building often carries a significant amount of moisture. In summer months the added moisture raises the indoor humidity resulting in comfort complaints and also makes the cooling system work harder and cost more to operate. Air leakage from outside may also result in condensation. Colder surfaces and higher relative humidity air always increase the risk of condensation. In typical summertime conditions, as air leaking in from outside is cooled within the air-conditioned facility, water vapor in the air will change state from a vapor to a liquid. In winter conditions, cold air leaking in from outside can result in low surface temperatures which can condense water from the inside air. Liquid water droplets (condensate) may accumulate; often forming larger drops that run down walls causing puddles or are droplets may be absorbed into porous building materials, including ceiling and wall coverings that create favorable conditions for biological growth. Under some circumstances the condensation results in rust occurring on metal surfaces such as supply grilles and structural components.

Pressure Balance Management:
Dormitory HVAC systems are typically balanced or slightly positive in pressure due to the prescribed introduction of fresh air ventilation. Unbalanced pressure from HVAC equipment is caused when the HVAC supplies and return airflows are not balanced. This will contribute to water intrusion. For example, Pod-C was significantly negatively pressurized. Hot outside air was observed rushing in through cracks in the outside wall. Negative pressure can also suck in water drops through a leaky wall penetration which, without negative pressure sucking it in, would otherwise drain down the outside surface.

Summary:
To resolve moisture issues in a building, one must first identify the sources of moisture that contribute to adverse conditions and then identify the pathways that moisture followed to gain entry into the building. With the acknowledgement that buildings are complex systems of interdependent components, diagnosing and resolving issues can be varied and layered.

A visual and invasive inspection of the building was conducted along with several diagnostic tests to assess the root cause(s) of the moisture problems. Given the time constraint, the inspection was largely confined to Pod-C. The general findings and recommendations are based on the assumption that other Pods will have similar conditions. The following tasks were completed as part of the diagnostic inspection:

1. Several of the cells located in Pod-C, which was reported to be the Pod with the most issues, were visually inspected to document water staining patterns and the extent of the moisture intrusion issues impacting the occupants. Synthetic smoke was used as a visual aid to document the direction of air movement and particularly to identify leakage of outside air.
2. An infrared camera was used to scan for outdoor air leakage (the outside temperature was 83°F at noon).
3. The roof assembly was surveyed, and an invasive inspection was completed to document the as-built construction of the roof assembly, as the plans were altered from the original design.
4. Diagnostic testing conducted included water permeance of cementitious surfaces using a Rilem Tube system and water penetration testing using a calibrated AAMA 501 Nozzle. Rilem tube testing was conducted on the CMU block and two different textures of panelized wall to determine if the wall assembly is absorbing moisture and then potentially releasing it into the conditioned/occupied space.
5. The building exterior at Pod-C was visually surveyed, and photo documented.

The detailed observations in attached annotated photos that follow highlight these observations and demonstrate that:

- Deficiencies in the standing metal seam roof installation exist, allowing bulk water to enter the roof assembly and then enter conditioned/occupied space.
- There are multiple unsealed penetrations through the concrete fractured fin wall panel allowing for bulk water to enter the conditioned/occupied space.
- The sealant joints in the concrete wall panel have deteriorated which can allow for uncontrolled air leakage and water intrusion.
- The exterior concrete wall panel transition to the concrete roof deck is unsealed behind the light fixtures in the Cells resulting in both air leakage and bulk water intrusion at this location.
- The CMU block wall sections of the facility are untreated allowing for the water permeable block to absorb moisture and for the moisture to enter the facility.
- The mechanical system is unbalanced resulting in the system exhausting more air than it is supplying, thus introducing a negative pressure in the Pod which contributes to moisture problems.
- The design and maintenance of the property's drainage and exterior grading accounts for some of the moisture intrusion occurring at the exterior wall assembly on the first floor.

Recommendations:

Based on the observed deficiencies the following repairs are recommended:

- Entire roof replacement down to the concrete roof deck. The new roof should include adding a self-adhering vapor barrier on the concrete roof deck. Install an appropriate drip edge on the standing metal seam roof to keep water from rolling back under the metal roof. Install the lightning protection system with clamps or other fashion that will not penetrate or damage the roof.

- All light fixtures in the Cells located on the exterior wall assembly should be removed and the exterior wall to concrete roof deck transition should be cleaned/prepared and caulked continuously from the interior prior to installing a new light fixture.
- Re-caulk all exterior sealant joints in the concrete wall panel system, including the panel to window joints; be sure these caulk lines extend all of the way to the top to make a continuous barrier to water entry.
- Continuously air seal with appropriate sealant all penetrations through the exterior wall panel.
- Replace all caulk joints at the exterior wall panel to the adjacent concrete sidewalks.
- Install a fluid-applied water-proofing material on all exposed to rain CMU block wall areas and smooth precast panel walls.
- Repair or replace gutters to prevent open seams from draining water down the surface of the building exterior walls.
- Conduct retro-commissioning on the HVAC system including a test and balance to resolve the negative pressure issues.

If there are any questions, please feel free to contact me at or Jack Cox at any time.

Best Regards,

Jeremy Yoder
Tremco Sales Representative
jyoder@tremcoinc.com
515-208-4241

Annotated Photographs

	Photo 1: Ducted supply grilles in the cells have rusted, likely the result of condensation occurring on the cold surface.
	Photo 2: Metal toilet and sink combination in each cell has an opening into the plumbing chase that serves as the return plenum. Excess return airflow creates a significant negative pressure in the Pods.
	Photo 3: Synthetic smoke demonstrates that the opening in the toilet and sink combination serves as the return air termination for the mechanical system. The return air flows through the plumbing chase which also functions as plenum return which travels up the chase and opens into the Pod common area.

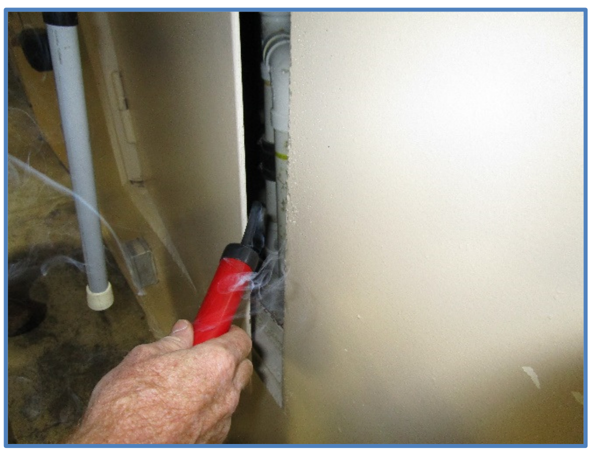
	Photo 4: Inside view of the plumbing chase that is used as part of the return air plenum. The plenum is also connected to floors below through the plumbing chase. It is reported that several of the chases have standing water in the bottom of them, presumably from ground water seeping into the building.
	Photo 5: Synthetic smoke illustrates the plumbing chase at the access doors is under negative pressure. This type of un-ducted return air system is notorious for unintentional transport of air into the return stream from remote areas that could be laden with moisture or contaminants.
	Photo 6: Cobwebs at the exterior wall to roof transition on the 2nd Floor demonstrates air leakage at this location. Synthetic smoke and infrared imaging confirm the story told by the spiders. The exterior wall to roof deck transition is unsealed in multiple areas; synthetic smoke clearly illustrates these areas as air leakage sites. Depending on the temperature difference between indoors and outdoors, airflow direction (and other factors) infrared imaging will not always show air leakage.

	Photo 7: Synthetic smoke illustrating air leakage at the exterior wall to metal roof deck transitions where the spray fire retardant is not continuous.
	Photo 8: The metal structural angles to hold the concrete deck to the precast concrete panel located throughout the building are rusting; likely due to the bulk water entering from the roof assembly. Tape (Red Arrow) has been installed in an apparent attempt to prevent bulk water intrusion. Signs of bulk water intrusion were observed throughout Pod-C.
	Photo 9: At the bottom of the wall on the second-floor the interior finishes have deteriorated exposing the metal structural angle supporting the concrete slab floor. Rust on the structural angle is a sign of long-term exposure to bulk water or high humidity levels.

	Photo 10: Tape (Red Arrow) has been installed in an attempt to prevent bulk water intrusion. Signs of bulk water intrusion were observed throughout Pod-C. Viewed from the exterior of the building, caulk joints between the concrete wall panel and the window assemblies were observed to be deteriorating which can contribute to bulk water intrusion. Negative pressure observed in the Pods can actually suck this water into the building.
	Photo 11: Rust on the structural angle supporting the concrete roof deck is observed throughout Pod-C. This is likely from prolonged bulk water intrusion from the concrete wall panel and concrete roof deck. A structural engineer should evaluate the deterioration of the structural components to determine if additional repairs are required.
	Photo 12: On the first floor the access panel for the plumbing/mechanical chase is located in a shower stall. Having an access panel located in a shower stall promotes the moisture pathway into the chase. If possible do not use the shower with the access panel located in the shower stall.

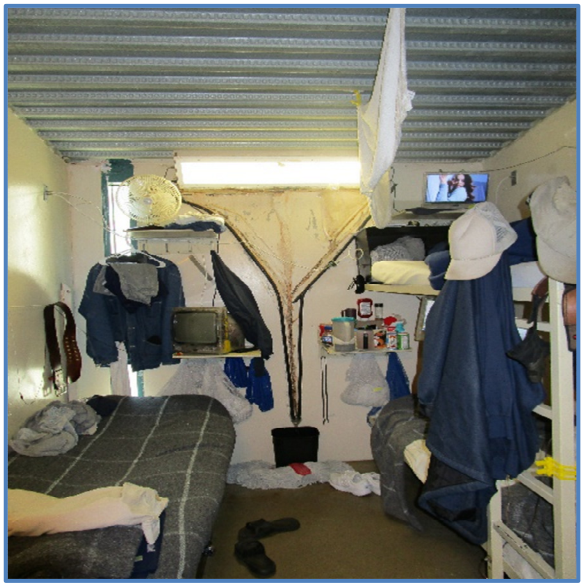


Photo 13: In Pod-C-Unit 1, Cell 16 an example of the occupants attempting to manage the bulk water intrusion occurring behind the light fixture. Gasket material was used to direct water into a trash can that reportedly must be emptied every 30 minutes during rain events. Dry mop heads are placed on the floor around the trashcan to absorb additional bulk water.

An invasive inspection of the light fixture occurred in this same cell to inspect the pathway of the bulk water intrusion issue.

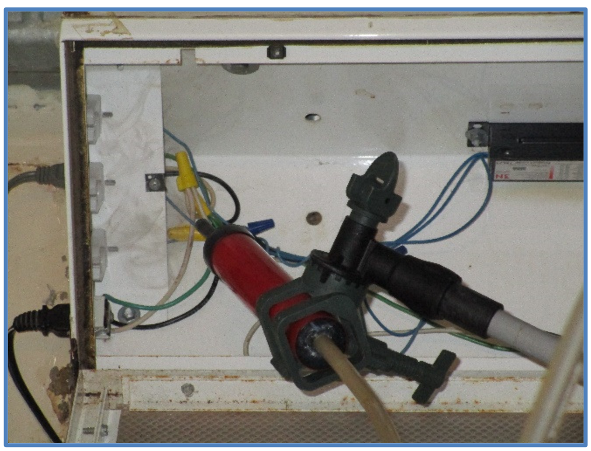


Photo 14: Synthetic smoke is blowing inwards illustrating the negative pressure induced air leakage occurring through the light fixture.

Photo 15: Removing the light fixture revealed that the metal deck is completely unsealed at the top of the concrete wall panel transition to the wall. Rust is occurring on the light fixture and on the structural metal angle.

	Photo 16: Synthetic smoke demonstrates inward air leakage occurring at the transition between the top of the concrete wall panel and the underside of the roof deck. Air leakage will add to the moisture load on the mechanical system and can cause condensation inside the light fixture. The exterior wall to roof deck transition should be continuously sealed around the entire perimeter of the Pods by removing all light fixtures.
	Photo 17: Rust occurring on the light fixture removed from Pod-C cell 16 as the result of air leakage and bulk water intrusion.
	Photo 18: Exterior wall to roof deck transition has been repaired with caulking but the sealant is not continuous and will continue to fail until the bulk water intrusion from the roof is repaired.

<u>Photo 19:</u> Synthetic smoke demonstrates the negative pressure between the Unit 1 of Pod-C. Standing in the hall area outside Unit 1, smoke directed at the Pod-C Unit 1 door is rushing back towards the hall.

<u>Photo 20:</u> A digital manometer measured the negative pressure between Unit 1 of Pod-C and the common hall area to be -12.9 Pascals. This is a significant negative pressure resulting from an unbalanced HVAC system. This will cause outside air and moisture to be sucked into the occupied conditioned space.

<u>Photo 21:</u> The temperature and relative humidity were periodically measured throughout the inspection.

	Photo 22: On the interior side of the smooth precast concrete wall panels connecting the Pods to the main area of the facility the structural connections and rigid insulation is visible where the roof deck ties into the building. Rust indicates that this is a moisture pathway.
	Photo 23: Synthetic smoke illustrates an air leakage pathway under the standing metal seam roof where the concrete roof deck ties into the smooth precast wall panel.
	Photo 24: Deterioration is occurring at the metal structural plate holding up the concrete roof deck and concrete wall panel indicating prolonged exposure to bulk water infiltration.

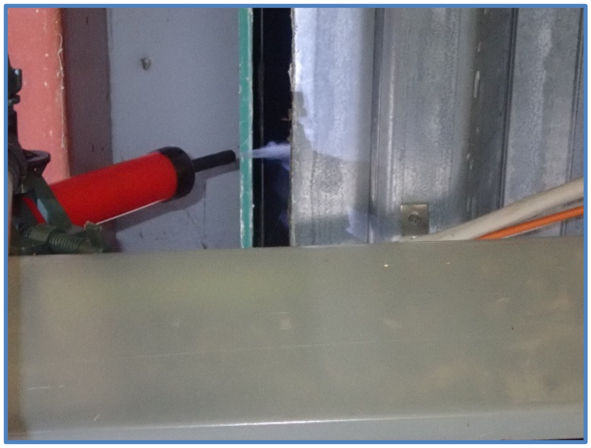
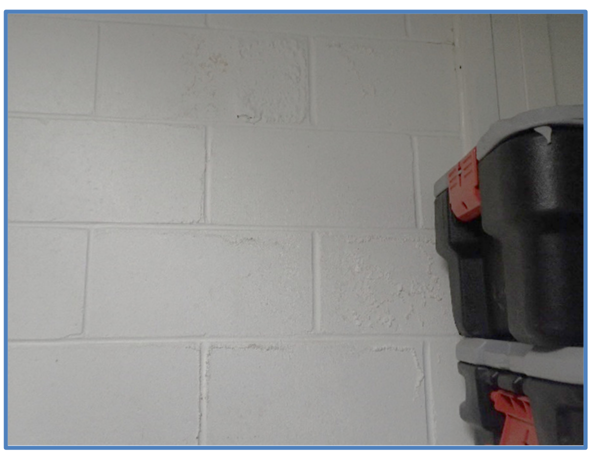
	Photo 25: Where the Pod transitions to the main building there is an expansion joint; synthetic smoke rushing inwards demonstrates this area to be an air leakage site.
	Photo 26: The roof over the main building is a different assembly than is observed over Pod-C. This roof assembly is a vinyl liner system over fiberglass insulation typically found in a pre-engineered metal building. With this roof assembly the vinyl liner is the air barrier – the air barrier is damaged in multiple locations allowing for uncontrolled infiltration. It is unclear how (or if) this air barrier transitions to the Pods air barriers. Non-continuous roof air barriers also cause air infiltration due to warm air rising and escaping out of the roof (stack effect).
	Photo 27: Areas of the painted CMU block wall, located on the second-floor of the main building used as a storage area and maintenance shop. The paint is peeling off the block wall, likely due to the CMU block wall absorbing water.

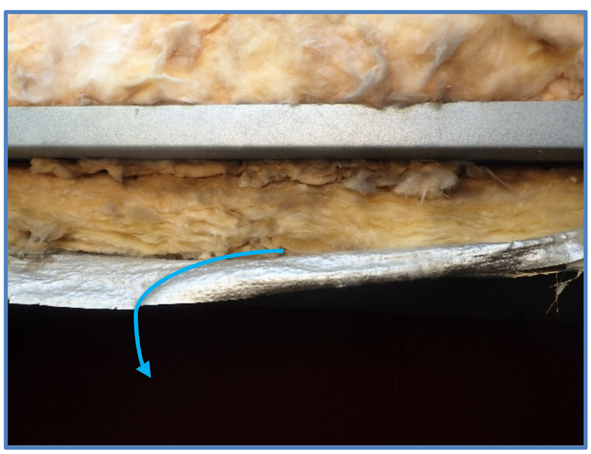
	Photo 28: Areas of the painted CMU block wall, located on the second-floor of the main building which is a storage area and maintenance shop. The paint is peeling off the block wall, likely due to the CMU block wall absorbing water.
	Photo 29: Cricket installed adjacent to the roof hatch appears to be too small and does not properly direct water away from the opening.
	Photo 30: Water was observed dripping off the vinyl liner of the roof assembly in the main building. The source of the water could not be determined.

	Photo 31: Along the area that was re-roofed in 2017 synthetic smoke demonstrated that outdoor air leakage into the building was occurring at this location.
	Photo 32: The CMU block wall located at the fire wall separating the Pod from the main building where 1 of 3 RILEM Tube tests were conducted. RILEM tubes are filled with water and situated to drain though the masonry; water levels in the tubes are checked every 5 minutes over a 20-minute period. An acceptable performance is achieved if the level of water drops no more than 20% of the original height during the 20-minute test period.
	Photo 33: For the evaluation of CMU blocks, the original water level was 2.5ml and the final level after 20-minutes should lose no more than 0.5ml. The tube located on the CMU block wall, the tube completely emptied into the CMU in less than one minute, indicating the block is quite porous and absorbs water during rain events. Based on the RILEM tube testing all CMU block should be coated with a fluid-applied waterproofing product.

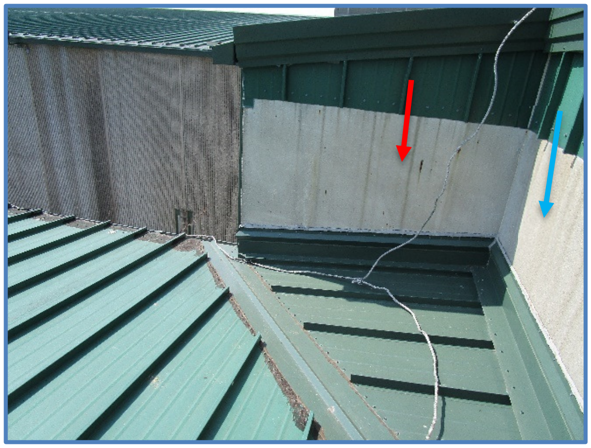
	<u>Photo 34:</u> RILEM tube test location #2 (Red Arrow) was located on the smooth precast wall panel. RILEM tube test location #3 (Blue Arrow) was located on the rougher precast wall panel.
	<u>Photo 35:</u> RILEM tube testing location #2 with the water filled tube adhere to the wall. The water emptied into the material at the 15-minute mark, indicating the wall is somewhat porous and absorbs some water during rain events.
	<u>Photo 35:</u> RILEM tube testing location #3 with the water filled tube adhere to the wall. The water did not drop below 20% of the initial water level during the test, indicating the rougher precast wall absorbs minimal water during rain events.

	Photo 36: North corner of Pod-C, Unit 2, where the invasive inspection of the roof assembly was conducted to determine the actual construction of the roof assembly.
	Photo 37: The standing metal seam roof panels are not continuously sealed to the metal drip edge. Some locations are missing screws. These defects will allow water to roll under the standing seam roof; wind driven rain will enter the assembly in even greater amounts.
	Photo 38: Lifting up the ridge cap revealed fiberglass batt stuffed in the ridge cap over rigid insulation board. No ice and water shield or vapor barrier was observed, as currently recommended. The rigid insulation was placed directly on top of the concrete roof deck; the seams in the rigid insulation were not taped. To minimize moisture intrusion an ice and water shield is normally installed over the rigid insulation.

	Photo 39: Removing the first section of standing seam roof panel illustrated sealant on the metal drip edge that was replaced after the original install. However, there was no hemmed edge on the panels to prevent water from rolling back over the top of the metal drip edge.
	Photo 40: Removing the metal drip edge exposed the wood blocking that exhibits water stains and other signs of moisture intrusion. At the time of this inspection the wood blocking was not wet.
	Photo 41: A section of the rigid insulation board was removed to allow for inspection of the concrete deck. There was no fully adhered vapor barrier installed underneath the rigid insulation board, as is common practice with concrete roof decks. The rusted metal structural angle (Red Arrow) is also visible from the Cells below.

	Photo 42: Close up view of the metal structural angle holding the concrete roof deck in place. A small crack is observed between the metal and concrete (Red Circle).
	Photo 43: The lightening protection has been installed through the joint in the concrete fractured fin exterior wall panel.
	Photo 44: A closer inspection of the sealant joint in the concrete wall panel system revealed that the seam is open behind the wood blocking. This opening in the sealant joint allows bulk water to enter the concrete wall panel and enter the conditioned space. All wood blocking should be removed from the roof and face of the concrete panels to allow for the joint in the concrete wall panels to be continuously sealed.

	Photo 45: Removal of the metal drip edge revealed there are two separate sections of metal drip edge installed over a small section of membrane flashing. This does not match the detail from the construction drawings provided.
	Photo 46: The metal drip edge for the roof assembly was sealed to the precast wall panel from underneath – it is reported that the metal drip edge was replaced after the original construction. A piece of metal drip edge appears to have been installed at a window head. No invasive inspection was conducted above the window assembly to document the construction in this area. The sealant around the perimeter of the metal is not continuous.
	Photo 47: The caulk joint around the window assembly has deteriorated resulting in damage to the metal window frame and the glazing.

	Photo 48: CMU block infill below the window assembly has been damaged. Rust is observed on the window frame.
	Photo 49: Multiple penetrations through the precast wall panel are unsealed. This added penetration appears to have cracked the face of the panels. Deterioration of the wall panel joint is visible throughout the exterior wall assembly. Water can run in through this penetration or be sucked in due to the negative pressure on the other side of the wall.
	Photo 50: Multiple penetrations through the precast wall panel are unsealed. Water can run in through this penetration or be sucked in due to the negative pressure on the other side of the wall.

	Photo 51: Multiple penetrations through the precast wall panel are unsealed. Water can run in through this penetration or be sucked in due to the negative pressure on the other side of the wall.
	Photo 52: The caulk joints have deteriorated at the seams in the concrete wall panels as well as the joint between the wall and the sidewalk. These deteriorated joints allow for water intrusion.
	Photo 53: The metal roof panels do not extend over the metal drip edge allowing for water to roll back under the roof panels.

Photo 54: Staining on the concrete wall panel correlate to seams in the gutter system. Gutters are only located around portions of the Pods, not the entire perimeter as recommended for moisture management.

Photo 55: The gutter system has failed and does not properly manage the water from the roof. Seams in the gutter system that leak result in staining on the concrete wall panel and puddling on the sidewalk below.

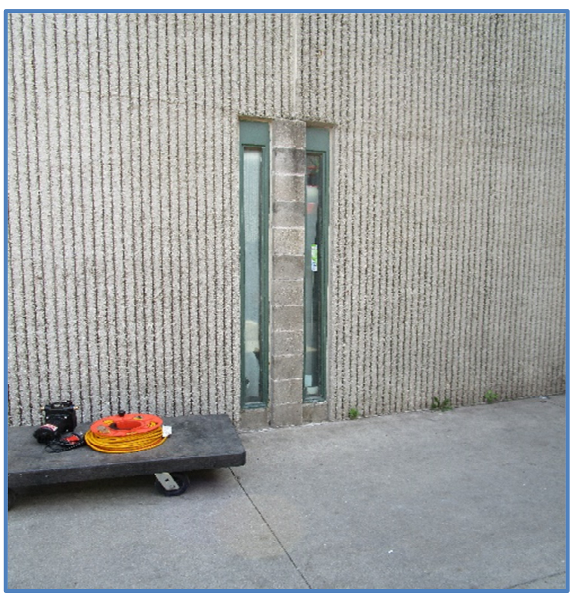
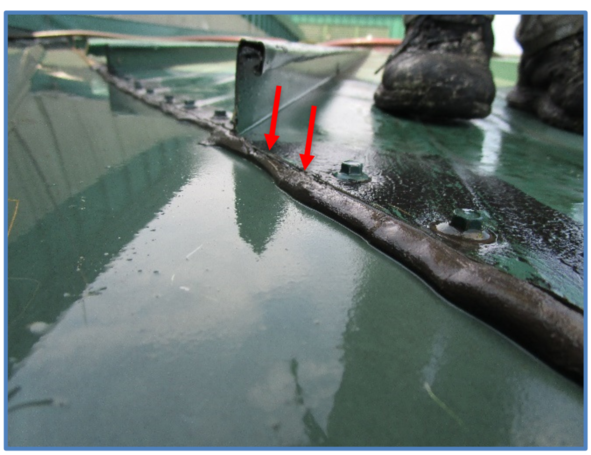


Photo 56: Around the main area of the facility CMU block is observed between the fixed windows. These blocks appear uncoated and likely allow water to penetrate as was demonstrated with the Rilem test for the CMU block at the fire walls.

	Photo 57: AAMA 501 nozzle was used to test for water penetration at the roof over Pod-C Unit 1 along the south elevation to determine the cause of the bulk water intrusion. Nozzle testing at the valley determined water entry was occurring under the panels (Red Arrow).
	Photo 58: Temporary repair was completed by Tremco while onsite to prevent further bulk water intrusion at this location.
	Photo 59: During the nozzle testing, bubbles occurred at the sealant joint between the roof panels and the valley pan (Red Arrows) indicating water is getting under the roof panels past the sealant joints.

	<u>Photo 60:</u> When nozzle testing was conducted around the valley pan, water was observed running down the inside of the precast wall panel in Pod-C-Unit 1, Cell 16.at the unsealed location behind where the light fixture had been removed.
	<u>Photo 61:</u> The trashcan filled quickly from the nozzle test around the valley pan.

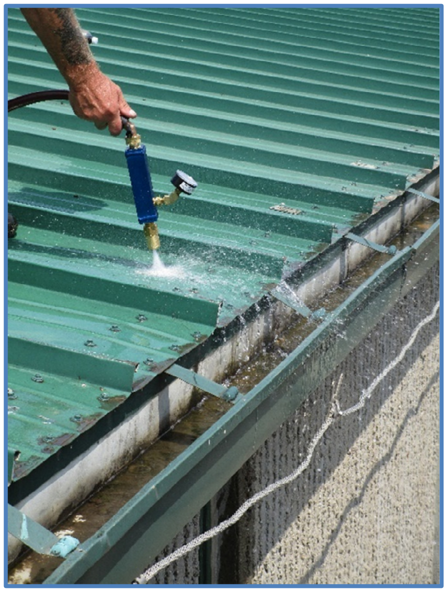
	Photo 62: Nozzle testing at a location where the lightening protection system had punctured the metal roof panel resulted in water intrusion in the adjacent cell.
	Photo 63: Hole in the metal roof panel where the lightening protection damaged the roof.
	Photo 64: Temporary repair was completed by Tremco while onsite to prevent further bulk water intrusion at this location.

	Photo 65: Water was observed running down the wall during the nozzle test at the hole from the lightening protection.
	Photo 66: Water was observed running down the wall during the nozzle test at the hole from the lightening protection.
	Photo 67: Relief dampers on the Pod HVAC System. Some HVAC System's relief dampers were open, some closed, some partially open. With similar indoor and outdoor conditions, the relief dampers should be tracking each other. This observation combined with the measured negative pressures strongly suggest the need to conduct retro-commissioning on the HVAC system including a test and balance to resolve the negative pressure issues.