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Report on Exterior Building Envelope
And
HVAC Conditions

Detroit Metropolitan Wayne County Airport
Airport Traffic Control Tower

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DETROIT METROPOLITAN WAYNE COUNTY AIRPORT
AIRPORT TRAFFIC CONTROL TOWER
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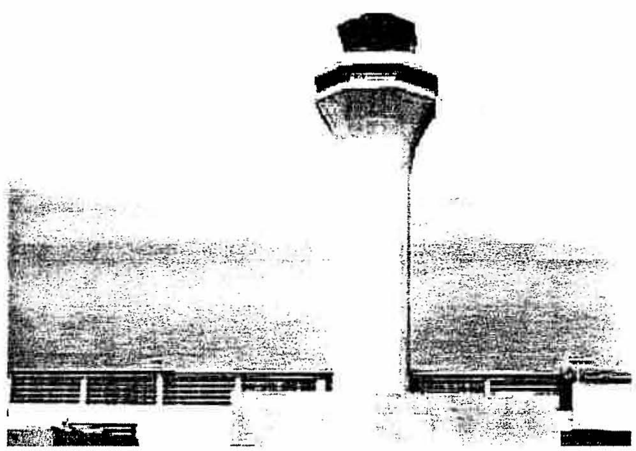
1.0 PURPOSE

The Airport Traffic Control Tower at the Detroit Metropolitan Airport has been experiencing significant water infiltration problems as well as interior moisture issues that have led to mold growth in and around the elevator shaft. The subject of mold and its associated environmental concerns has been addressed in other recent reports and is not the subject of this study. DMJMH+N visited the facility on February 27 & 28, 2006 to prepare a study that would assist the Federal Aviation Administration in determining potential causes for water infiltration and high interior humidity. It must be pointed out and noted that it was not raining at the time of the survey and DMJMH+N observed no actual water infiltration or condensation on the interior of the control tower. This study and report focuses on observed conditions, discussions with local FAA staff and makes professional architectural and engineering judgments based on our observations. The TRACON Base Building and Link are excluded from the scope of this study; however, some findings and observation notes from these areas have been included in the various sections of this report.



2.0 BACKGROUND

The DTW-ATCT was been constructed in 1990, per the FAA's new standard design for a 300-foot Major Activity Level Airport Traffic Control Tower by Leo A. Daily of Omaha, NE. This tower at Detroit is 12 stories with an overall height of 230'-6" to the top of the ASDE Penthouse. The Cab of the control tower is a 850 sq ft, 8-sided, major activity level Cab. The Tower shaft below the Cab is unoccupied, with the exception of an office at the Second Floor, mechanical equipment on the Sub-Junction level, and offices with Breakroom at the Junction Level. The tower shaft is served by a 2,500 lbs geared traction elevator and a single, pressurized exit stairway.

The ATCT is connected to the Base Building via 2 story Link structure.

3.0 GENERALCONSTRUCTION

3.1 Architectural - Construction And Exterior Envelope

The tower shaft up to the Ninth Floor, at elevation 147'-0" above the Ground Floor, is constructed of a combination of load bearing pre-cast concrete panels and cast-in-place modules with interlocking structural reinforcing steel. Cast-in-place modules are faced with thin shell architectural pre-cast concrete panels with exterior finish to match adjacent structural panels. The basic shape of the structural shaft is 34' square with narrow slanted corners. The structural system above Ninth Floor transitions into steel frame construction that is clad on the exterior with architectural pre-cast concrete panels of concave shape flaring outwards, with the largest floor area at the Junction Level, 187'-0" above the ground floor. The Junction Level is an 8-sided shape derived from a 58' x 58' square with four 15'-6" deep 'shaved off' corners. There are four microwave antenna balconies at this floor. Access to these balconies is through a door in the Office and another door in the Men's Restroom. There are also four exterior walkways connecting the microwave balconies via hinged metal louvers. As constructed, the walkways and microwave balconies share the same 4-inch thick concrete floor slab covered with some form of liquid applied waterproof coating. The two south facing microwave balcony floor slabs have large triangular openings with steel grating. These grated openings are areaways for outside air for the HVAC equipment at Sub-junction Level directly below. All structural floor slabs with the exception of solid cast concrete at the Ninth Floor, are constructed of concrete topping over metal deck supported by steel beams. All structural steel framing and underside of metal decks are fireproofed with spray-on fibrous light-density fireproofing material.

The architectural pre-cast concrete panel cladding above Junction Level reverses its direction inward toward the Cab Walkway which has a top of concrete elevation of 207'-0". These panels are wedge shaped to form the Cab Walkway enclosure that is 3 feet wide and parallel to the Cab exterior walls.

The Cab is faced with insulated metal panels of embossed finish, secured to the structural steel framing. The cab glazing and exterior fascia panels above windows are sloped 15-degrees outward from the vertical plane. The glazing system is made up of 1.5" thick clear insulating glass units in an aluminum framing system attached to and supported by the 4.5" by 8" (approximate) built-up steel Cab columns.

The ASDE Penthouse is also clad with matching insulated metal panels over steel framing and sub-girts. The penthouse roof is constructed of 1/4" thick steel plate and 17" high steel collar around circular opening for ASDE equipment and rotating dome. The penthouse roof is insulated with approx. 3-inch thick exposed cellular foam insulation.

Access to the ASDE Penthouse is through the Cab ceiling by pull down folding ladder and fixed steel ladder above. From the Penthouse there is an access door to the Cab roof which is surrounded by a 42" high parapet wall and steel tube raceway at elevation 225'-0". The steel raceway is for communication wiring and supports antenna mounts, obstruction lights and lightning protection air terminals.

3.2 Architectural - Exterior Finishes and Materials

All exterior facing concrete has an integral colored with a medium exposed aggregate finish. All joints between the structural pre-cast panels and the cast-in-place concrete are solid grouted up to the level of the Ninth Floor. All joints between architectural pre-cast panels that are above the Ninth Floor Level are double sealed with urethane based sealant over foam tube backer rods on the exterior and caulked on the interior.

Exterior floor slabs and walkways at Junction Level and Cab Walkway are waterproofed with a liquid applied coating directly over the structural concrete slabs.

The microwave balconies at Junction Level are screened with large, tensioned fabrics that are UV and weather resistant designed to minimize microwave transmission loss.

Insulated metal panel cladding over the Cab and ASDE Penthouse is described in the Exterior Envelope section above.

3.3 Mechanical Systems Description

The outdoor design condition for this location is as follows:

- Summer design temperature is 87°F DB/ 72°F WB
- Winter design temperature is 5°F.

The tower is supplied with chilled water and heating hot water from the base building. The main features of the existing HVAC system are:

- The Ground Floor has an elevator machine room, which is cooled by a ceiling mounted fan-coil unit. Building chilled water is used to cool the room.
- The Second Floor is finished space used as an office. The entire office area is air-conditioned by ceiling mounted fan-coil units, using building chilled and hot water system.
- The Third Floor is unconditioned space, except for the elevator shaft which is heated by cabinet unit heater. The elevator lobby is indirectly heated by the return air from the elevator shaft. The mechanical chase is heated by the ceiling mounted hot water unit heater.
- The Fourth through Ninth Floors are similar to the Third Floor.

- The Tenth Floor is also similar to level 3, except that the room behind the elevator shaft was ventilated by an exhaust fan in the electrical chase and heated by hot water unit heater while it was used as office space. This room is no longer used as an office and is now considered an unoccupied space. The exhaust fan and unit heater have been abandoned in place and are not functional.
- The Sub-junction, Junction and Cab levels are air-conditioned spaces, except for the mechanical rooms, which are heated by unit heaters.
- The stair shaft is an unheated space. The stair vestibule and stair itself are pressurized using pressurization exhaust fans and relief dampers. This pressurization system only works in the event of a fire/smoke condition.

4.0 OBSERVATIONS AND FINDINGS

4.1 General Exterior Observations

There is prevailing deterioration of almost all of the urethane sealant between architectural pre-cast panels. Most critical are conditions of exterior sealed joints at and around of Cab Walkway all the way down to the Junction Level below. They are oversized joints between architectural pre-cast concrete panels ranging from 1.5-inch to 2.5" filled with urethane sealant that is, in numerous locations, cracked wide open (See Photos 4.1-1, 4.1-2 and 4.1-3). This allows for rain water or melting snow to enter wall cavities and get inside the building structure. Pre-cast panel interior caulking appears to be in good condition with no visible signs of excessive deterioration. This situation, however, make it's more difficult to trace water leaks, which are channeled to the inside of the structure between the two sets of seals.

During a walk around the exterior of the Ground Floor, DMJMH+N observed multiple cracks on the surface of exposed aggregate concrete panels and mismatched color finish (See Photos 4.1-4, 4.1-5 and 4.1-6).

It is apparent that many panels are subject to deterioration, most likely caused by freeze-thaw action during the winter season. There are also hairline cracks in the grouted joints between concrete panels, which may also allow moisture and wind driven rain water to seep through and into the interior of the building envelope (See Photo 4.1-5). This observation and conclusion was subsequently confirmed through the inspection of the interior face of unfinished concrete walls, where at some levels there were visible water stains and some efflorescence along the grouted joints.

The medium exposed aggregate concrete panel exterior finish is inherently susceptible to water vapor permeance if not sealed or if concrete sealer has deteriorated beyond its useful lifetime.

Another problematic area is the elastomeric seal at the expansion joint between the 2-story Link structure and ATCT shaft. As installed, the exterior seal of the vertical expansion joint runs over 2-inch deep reveals without closing them at the intersection with the Tower concrete panels. At one point the exterior seal is punctured with a metal bracket supporting a weather sensor (See Photos 4.1-7 and 4.1-8).

4.2 Tower Shaft Observations

4.2.1 Control Cab Roof and Penthouse

Following our evaluation of the Control Tower and Base Building exterior at the Ground Level, DMJMH+N moved to the Cab and ASDE Penthouse directly above Cab roof level. It was noticed that entire underside of Penthouse metal roof cover and supporting structural beams were covered with thick layer of yellow color foam insulation. Vertical walls constructed of insulated metal panels over metal stud framing, were reasonably weather-tight and had no signs of deterioration. Visual inspection of the Cab roof verified that the single-ply roofing membrane is in good working condition with minor areas of slow draining water.

4.2.2 Cab Walkway

Inspection of the Cab Walkway revealed the concrete slab surfaced with waterproof coating surrounded by low profile concrete curbs on each side, along entire perimeter of the Cab. There was standing water in several places due to uneven surface and low slope of concrete (See Photo 4.2.2-1). There were four area drains set flat with the surface of concrete walkway. There were many cracks in concrete surface with visible epoxy sealer patches (See Photo 4.2.2-2). The Cab Walkway floor appears to be constructed in accordance with design documents as a double slab with waterproofing membrane sandwiched between them and covered on the surface with a waterproof coating.

There are problems associated with this design approach, some of which are as following:

- The concrete topping over structural slab decreases height of adjacent concrete curbs which also function as a dam to prevent surface water from entering into interior spaces.
- Due to lack of vertical space, the concrete topping has a low slope over the relatively long run to area drains. This causes surface water to drain relatively slow increasing chances of ponding.

Walls on both sides of the Cab walkway are constructed of vertically interlocked insulated metal panels. These panels and associated metal sill flashing are designed to be fastened to metal angles which are anchored to the top of concrete curbs. If curbs are too low, and in this case they are from 2-inch to 4 inch high, any amount of surface water that is not drained off by the area drains may potentially overflow and seep under the flashing and in between the segmented steel angles and top of concrete curb. The same may be true when high accumulation of snow will occur and which may start to melt above the curb line (See Photo 4.2.2-3).

4.2.3 Cable Access Level

The curb conditions of the Cab Walkway, when inspected from inside of the Cable Access Level below, revealed continuous gaps between bottom of sill angles and top of the concrete curb that are ranging from 1/4-inch to about 1-inch high. These openings were large enough to allow for observation of daylight along the bottom of insulated metal panel wall from the inside of Cable Access duct space (See Photos 4.2.3-1 and 4.2.3-2). These gaps are a result of improper installation of sill angles during the original construction, which has created potential for water intrusion into the building.

It may be reasonable to infer that these conditions were left unnoticed for the past 16 years, or ever since the Tower was built. There is extensive evidence of water and moisture intrusion to the inside of the Cable Access Level interior, in the form of stains and excessive rusting along the back of the curb (See Photo 4.2.3-3).

All of this, coupled with extensive deterioration of exterior seals between architectural pre-cast panels, that are forming the roof above the outside portions of the Cable Access Level, creates a strong potential for moisture and water intrusion into the interior of the structure. Even if the outer floor slab at the Cable Access Level is compartmentalized, with separate area drains in each of the floor segments, thus, designed to handle the water which may enter the space from above, the atmospheric moisture and/or evaporating water may introduce a large amount of water vapor that will permeate through the partitions and slab into the interior spaces. Also, the partition that separates the outer slab from the interior space of Cable Access Level has been constructed improperly with exposed fiberglass insulation installed between metal studs. Without any protective covering, water and moisture can enter from the Cab Walkway above. The metal studs and tracks are covered with rust and water stains (See Photos 4.2.3-3, 4.2.3-4 and 4.2.3-5).

Some of the area drains in the outer concrete slab were plugged with debris and green matter. Deep cracks in the concrete floor slab within immediate area of drains may be due to standing water (See Photo 4.2.3-6). Compounding this condition is the constant discharge of condensation water from pipes connected to the mechanical equipment. Since the structural floor slab is only 4-inch thick including 1.5-inch thick metal deck, concrete needs to develop crack only 2.5-inch deep before water will start running into deck flutes. Once inside a flute, it could be discharged several feet away from the drain area.

There are also several metal louvers installed in oversized openings through insulated panel wall. Large unsealed gaps around louvers perimeter are also a potential source of moisture and rain water intrusion.

While inspecting the outer perimeter of Cable Access Level, DMJMHN noticed excessive corrosion of steel plates and steel tube posts supporting the top of the architectural pre-cast panels (See Photos 4.2.3-7, 4.2.3-8 and 4.2.3-9). This may call for closer examination by a qualified structural engineer.

4.2.4 Elevator Shaft Overhead

DMJMH+N also had the opportunity to inspect the inside of the elevator shaft overhead (See Photos 4.2.4-1, 4.2.4-2 and 4.2.4-3). Indoor air appeared to be dry and strong air movement could be felt each time elevator cab was operating. Since inspection was conducted through the two fire-rated access doors, there was noticeable strong downward draft when elevator cab moving to the lower levels, thus pulling air into the elevator shaft. There were no visible signs of deterioration of the gypsum shaftliner panels facing inside of the shaft. However, there were whitish stains on metal studs and tracks which could indicate possible water stains as a result of presence of moisture inside of the shaft. This could be caused by either condensation or a direct run of water over metal surface, under some extreme conditions. We also noticed white deposit of powdery substance (similar to efflorescence) at the top flange of elevator hoist beam where it comes in contact with metal deck flutes (See Photo 4.2.4-4). All steel framing members inside the shaft, appear to be structurally sound, however, they were left unprimed and have developed extensive rust on surface (See Photo 4.2.4-3). This again may be indicator of moisture infiltrating and/or condensing inside the top of elevator shaft. Since this shaft is located within the center of the tower and directly under the Cab, it doesn't seem to be possible that outside water would ever migrate directly to the top of the elevator shaft. Therefore, the most probable source of moisture presence at the top of elevator shaft, could be permeance from the surrounding Cable Access Level and/or back draft from the elevator relief vent which is ducted to the outside louver at Cab Walkway above.

4.2.5 Junction Level

Following inspection of the Cable Access Level, DMJMH+N moved down to the Junction Level. We accessed the Microwave balconies from both the Men's Restroom access door and the access door in the north office room. This allowed for inspection of all four microwave balconies and exterior walkways. Our inspection of these areas revealed that the concrete slabs at the exterior walkways were not constructed in accordance with the construction documents which were issued to us for review. The details on drawings indicate a 6-inch high concrete curb with double concrete slabs (similar to the Cab Walkway) at the exterior walkways and single slabs inside the microwave balconies. The design intent for the exterior walkways was to install elastomeric waterproofing membrane sandwiched between the two slabs for moisture protection. Floor slabs at the microwave balconies were supposed to be fully isolated by the curbs and screened from outside elements by large sheets of tensioned microwave fabric. Drainage for the microwave balconies was to be assured by area drains at north facing balconies and by the trench drains adjacent to steel gratings, at the south balconies. However, as constructed, rain water can flow freely between the exterior walkways and microwave balconies (See Photo 4.2.5-1). The surface of the concrete slab at the exterior walkways and the balconies was treated with some form of a waterproofing coating. Since the microwave balconies are relatively protected from the elements by the microwave fabrics; the waterproof coating in these areas appears to be in relatively good condition, with the exception of the areas directly adjacent to hinges louver doors, where there are stains on the slabs and over curbs, which indicates water intrusion into the balconies (See Photo 4.2.5-2). The surface coating over the exterior walkway slabs has deteriorated and is not performing waterproofing function as intended (See Photos 4.2.5-3 and 4.2.5-4).

There are extensive stains on the surface of the exterior walkways, which would indicate the presence of standing water over prolonged period of time (See Photo 4.2.5-5). Further, inspection of the south facing exterior walkway, located directly outside of the mechanical room, revealed a plugged area drain, extensive water stains, heavy rusting at the bottom of guardrail post and crumbling of the waterproof coating. There is also raised concrete curb right over and along outside face of architectural pre-cast concrete panels. According to details on the construction drawings there is 6-inch wide overflow scupper to drain off excess of water in case the area drain should get plugged by debris. This concept would work well if constructed as intended with the curb at the hinges louver door to the microwave balcony and the double concrete slab. If the double slab was installed, the top of concrete would be flush with invert elevation of the scupper. Without the curb and second concrete slab, water would flow under the louver door to the microwave balcony or may fill up to 4-inches high before spill over the scupper. Relatively high levels of stains indicate that the scenario described above actually occurred (See Photo 4.2.5-6). Since the present waterproofing has no real value, the standing water could easily permeate through the 4-inch thick concrete slab and drip to inside of Mechanical Room at Sub-Junction Level below.

Along the exterior walkways are glazed guardrails mounted to the 3"x3" sq. steel posts which are spaced at 48-inch on center. At the bottom of these posts, just above the concrete slab, there are holes approximately 5/8" in diameter on opposite sides of each post. Some of these holes were sealed, however, most of them not. These posts are welded directly to the top flange of the I-beam below, which is supporting edge of walkway slab. The wind driven rain, ponding water, and/or snow built up can cause water leak to inside of structure below (See Photos 4.2.5-7 and 4.2.5-8). It is not clear of what was the purpose for having these holes. In any case, if secondary slab was installed, these holes would be buried in the concrete surface and not exposed to outside.

Directly outside of glass railing and all along the raised concrete curb, there is sheet metal flashing installed into continuous reglet. The top of the groove caused by the reglet is supposed to be sealed to prevent water intrusions. Presently almost all sealant is gone, and the reglet collects water that eventually is channeled off to the scupper. The reglet profile is flat, deep and narrow, thus collecting water, which subjected to the freeze and thaw action during cold season. This causes expansions and contractions along the edge of concrete groove, systematically destroying it (See Photo 4.2.5-9).

DMJMH+N further inspected the large aluminum louver along the south wall of the Mechanical Room (See Photos 4.2.5-10 and 4.2.5-11). This louver is largely unused by the HVAC system, with the exception of its south-east portion. The remaining area of the louver is blanked-off with insulated galvanized sheet metal panels. Installed louver does not appear to be a storm-proof type and evidently wind driven rain water penetrates between horizontal louver blades, to inside where is supposed to be stopped, as a last resort, by the blank-off panels. Blank-off panels were not designed, nor installed to provide waterproofing, and water that gets through the louver blades is trapped between the louver frame and the blank-off panel facing, then drips down onto floor inside. This is another area of concern with regard to water intrusion into the Tower structure. Inspection of the louver sill from the inside of Mechanical Room revealed extensive water stains and dampness along junction of floor slab and concrete curb supporting louver above. There also must have been extensive air leakage along the bottom of the blank-off panel, since there is large amount of foam insulation injected into the bottom of blank-off panels (See Photos 4.2.5.12 and 4.2.5-13).

At the east facing walkway, just outside of restrooms and the stairway walls, there is a large louver mounted at the soffit above. Southern portion of this louver is utilized as a stair pressurization relief vent. The remaining portion is not blanked off and allows transfer of unwanted outside air into the building. This may occur not only through the closure wall just above the soffit louver, but also at the junction of Cable Access Level outer edge of slab and slanted architectural pre-cast panels. There is a sizable gap between these elements, which according to details on construction drawings, were supposed to be covered with a weather tight closure constructed of plywood and metal flashing with sealant. In reality, there was some sort of bituminous membrane poorly installed by nailing it to the pre-cast panels (See Photos 4.2.5-14 and 4.2.5-15), this may be another potential source of moisture intrusion.

4.2.6 Sub-Junction Level

The Mechanical Room at the Sub-Junction Level is located directly below the Junction Level South Walkway and Mechanical Room. Inspection of the bottom of structural slab from interior of the Sub-Junction Level Mechanical Room has revealed large and multiple water stains and moisture caused discoloration of the spray-on fireproofing over the structural beams and bracing, as well as on the slanted plywood wall covering gap between exterior pre-cast panels and the edge of slab of Sub-Junction Level (See Photo 4.2.6-1). There is a double wall interior (stud) and exterior (concrete), due to the concave shaped architectural pre-cast panels. Photos clearly indicate rusted area drain receiver from Junction Level above and water stains on the fireproofed beams (See Photo 4.2.6-2). This drain has been plugged, as previously described in the Junction Level section of this report. Since not all stains were localized within the proximity of the drain receiver, it could be reasonable to infer that there were also water leaks coming from the Junction Level Walkway or Mechanical Room above.

From the Sub-Junction Mechanical Room DMJMH+N accessed the East Air-Shaft which is triangular in shape with sheet metal lined walls and open to the grating at Microwave Balcony above. Due to lack of light, photographs did not capture existing conditions. Visual inspection of the metal lined walls did reveal multiple water stains coming from the grating area above. Also there was visible dampness over fireproofed beam supporting Microwave Balcony slab. It also appeared that the mentioned beam is indirectly exposed to exterior elements. Therefore, the type of interior fireproofing applied over the beam, is not appropriate for this application.

Further inspection of the remaining areas of the Sub-Junction Level did not revealed any damage on the walls which may be attributed to the water or other moisture related problems. There is an access floor system installed within the Electronic Equipment Room and the closet. The interior of these rooms appeared to be in good condition and dry, however, it must be noted that there is an inaccessible space between the exterior architectural pre-cast panels and the interior shaft wall enclosure. This air gap around the entire perimeter of the Sub-Junction Level may act as a moisture barrier, but at the same time may mask possible infiltration of water or moisture coming from exterior.

It is also worth noting that the south facing stair wall is directly adjacent to Mechanical Room and the Air-Shaft. This may be significant information in conjunction with presence of multiple water stains along the same wall at levels below.

4.2.7 Tenth Floor

DMJMH+N accessed this level thru the stairway coming from Sub-Junction Level above. Stairwell walls appeared to be in good conditions, no staining was observed at or above of the floor landing. The entire stairwell is enclosed with 2-hr fire rated walls and designed to be pressurized. Access to stair landings is through the 4-feet wide pressurized vestibules that are typical at all levels.

At this level all interior spaces are surrounded by the double walls similar to the Sub-Junction Level above.

Room #1028 had been converted into an office space, however, at the time of our visit the office had been abandoned and this room was now an unoccupied space. Partitions separating this room from the elevator vestibule are designated to be 1-hour fire rated; however, the required door closer has been removed, thus compromising integrity of the wall rating.

There was a suspended 2x4 acoustical ceiling at approximately 9-feet above floor, with light fixtures, overhead unit heater and a ventilation system. There was also some built in wood shelving along the diagonal gypsum board furred bracing, at the north wall. Overall the walls surrounding this room were dry and in good condition. There were no visible repairs to the drywall.

At the north wall there was a plywood cover over an opening approximately 24" x 30" cut in the gypsum shaftwall. This wall is designated per construction documents to be a 2-hour fire rated wall. Therefore, the painted plywood access cover compromises the integrity of wall rating (See Photo 4.2.7-1)

After removal of plywood access cover two of the team members accessed the narrow space between exterior and interior walls. There was construction debris on the floor slab, and improperly installed fire safing insulation along the outer edge of the concrete floor slab. Due to a very narrow space and structural bracing at each end of the wall it was impossible to inspect entire perimeter of the Tower shaft. However, visual inspecting using flashlights did not reveal any noticeable staining that could be attributed to moisture permeating from the outside of structure. Due to very confined conditions no photographs were taken.

The Mechanical and Electrical rooms at the east side east of the elevator hoist way were inspected and both rooms were dry and warm inside. The partition between these two rooms is supposed to be a 2-hour rated wall according to the construction drawings; however, the door latchset has been removed with exposed opening thru the door. There also number of unsealed pipe through wall penetrations. All of this has compromised integrity of the wall rating (See Photos 4.2.7-2 and 4.2.7-3). All cable trays and conduits penetrating concrete slab in the Electrical room were properly fire proofed.

There was a ventilation duct penetrating fire rated wall between Electrical Room and Room #1028. Apparently the duct was exhausting air from the office room through the Sub-Junction Level and Microwave Balcony at Junction level above (See Photos 4.2.7-4 and 4.2.7-5). The duct did not appear to have built-in fire damper at penetration through fire rated wall to the office room.

4.2.8 Ninth Floor

While walking down the stair from the 10th Floor to the 9th Floor, there were numerous water stains on the north wall, over stair stringers and landings, going down to level below. Interview with Mr. Randy Grant of the FAA DTW, indicated that there are water leaks which appear to be coming down from the floors above, during heavy rainfalls.

The Ninth Floor interior wall configuration is almost identical to the Tenth Floor above, with the exception of the much narrower and thus totally inaccessible perimeter air space.

The top of the floor slab at this level also signifies the top of the straight and vertical tower shaft below. At this level the transition is made to the concave shaped architectural pre-cast panel exterior enclosure. Therefore, a conclusion can be drawn that the there is a first horizontal joint with sealant and caulking along bottom of these panels. Since interior walls are completely closed, DMJMH+N could not make visual observation of these joints; however, there were several water stains on top of concrete slab in the proximity of the perimeter walls. This is not a conclusive statement that water may be leaking from the bottom of exterior pre-cast panels, just a possibility, as water and moisture could also permeate down from the levels above.

Following inspection of the stairway at this floor, DMJMH+N entered Room #928 which is an unoccupied space in the northwest portion of the Tower shaft. There was a noticeable difference in the air temperature between this room and the Elevator Vestibule. Unoccupied Room #928 was cool, since it is not conditioned, while the adjacent elevator vestibule was warm. Room #928 has full height interior walls covered with unfinished gypsum wallboard and exposed structural framing with metal deck above covered with sprayed-on fireproofing (See Photos 4.2.8-1).

Immediately upon entering the Room #928, DMJMH+N noticed that approximately 36-inches of the bottom of the original gypsum wall board has been replaced with the new gypsum wallboard along the entire perimeter of the room (See Photos 4.2.8-2 and 4.2.8-3).

Next, team has entered Mechanical Room #927 and Electrical Room #927A. In both of these rooms, as with Room #928, the bottom 30-36" of gypsum wallboard has been replaced along entire inside perimeter of the rooms (See Photos 4.2.8-4 and 4.2.8-5).

There were numerous water and/or other liquid matter leaks from piping, valves and other mechanical equipment in the Room #927. Air was stuffy, warm and had a musty smell. Some of the most evident damage caused by the leaking equipment and piping is documented by photographs 4.2.8-6 and 4.2.8-7.

In Room #927A there were water stains on a concrete slab along the bottom of the gypsum wallboard in the proximity of the column enclosure and visible rust on the diagonal bracings coming from under the sprayed-on fireproofing (See Photo 4.2.8-5).

Along the west wall there are five metallic conduits penetrating the floor slab. The section of gypsum wall board has been cut out to allow for conduits installation. This in turn has compromised integrity of the fire rated wall between Room #928 and #927A (See Photo 4.2.8-8)

4.2.9 Eighth Floor

There were visible water stains on the south wall of stairway and stair metal stringers and treads. Since the stairway was constructed with the open risers; water could leak in any direction. It should be noted that under most present Building Codes, open risers are not permitted in the exit stairway.

The Eighth Floor is the first Tower shaft floor (counting from the top down) that has uninsulated and unfinished exterior concrete walls. This is a double height floor with the intermediate beams at elevation approx.10 feet above floor and steel grating in the upper portion of the Electrical Chase.

Partitions between the elevator vestibule and Room #828 and Room #827 Mechanical have been built only up to the bottom of intermediated structural beams. Since these walls were designated on the construction documents to be 1-hour and 2-hour fire rated respectively, they were not built as intended and therefore have no value from fire rating or life safety standpoint See Photo 4.2.9-1).

In Room #828 the team has observed exposed concrete walls, floor and ceiling slab above. There were fireproofed intermediate beams with bottom at about 10' above finish floor. Gypsum wallboard enclosure around elevator shaft and partition between electrical chase appeared to be original construction and undamaged.

There was some indication of dampness on the concrete walls and especially at the grouted joints at about 12 inches above finish floor (See Photo 4.2.9-2)

Overall Room #828 was very cold, especially when compared to the temperature in the adjacent elevator vestibule.

We noticed discoloration at the wall corner right above the floor slab between elevator door and the door to Mechanical Room #827 (See Photo 4.2.9-3). This is usually consistent with the water stains; however, it was not possible to trace the source of this condition.

Inside Room #827 we noted some discoloration on fireproofing at overhead beams, as well as, evidence of condensation on the bottom of Unit Heater and uninsulated portion of hot and cold water pipes (See Photo 4.2.9-4).

Electrical Chase, Room #827A was generally cold but dry. There was some evidence of concrete spalding and deposit of efflorescence along the grouted joint of diagonal concrete beam at Ninth Floor above and at the top of "C" shaped pre-cast corner panel (See Photo 4.2.9-5).

4.2.10 Seventh Floor

This level has been constructed almost identical to Eight Shaft Level above, with fireproofing applied to its underside (see photo No.).

The interior air was cold, and there were stains on fireproofed beams and floor deck above, possibly caused by moisture coming from above (See Photo 4.2.10-1). We did notice the same incorrect construction of fire rated walls and untouched original gypsum wallboard enclosing elevator shaft and both Mechanical and Electrical chases.

In Room #728 there were what appeared to be TV antennas mounted in the ceiling area.

4.2.11 Sixth Floor

Floor layout and wall construction the same as the Seventh Floor. This floor was very cold and no noticeable moisture related problems.

4.2.12 Fifth Floor

The Fifth Floor layout and wall construction is the same as the Sixth Floor and was very cold. There were several areas on this level pointing to occurrence of water on the walls or moisture related to condensation.

In Room #528, there are visible water stains at the bottom of the gypsum wallboard partition between this room and the Electrical Chase, also in the same area there is a yellowish floor discoloration at the intersection of floor slab and vertical concrete wall. This may indicate possible water intrusions through the either vertical or horizontal grouted joints between precast and cast-in-place concrete walls, then down the wall toward gypsum wallboard enclosure (See Photo 4.2.12-1).

In the Elevator Vestibule we noted some discoloration at the wall corner, right above the floor slab between elevator door and the door to the Mechanical Chase similar to the condition noted on the Eighth Floor. This is usually consistent with the water stains; however, it was not possible to trace the source of this condition.

As on the floors above, the 2-hour fire rated wall between the Elevator vestibule and the mechanical Chase incorrectly terminates at the bottom of intermediate beam instead of extending full height to the floor slab above as required by the Code (See Photo 4.2.12-2).

Inside the Electrical Chase, Room #527A, there was a large concrete wall area with numerous water stains and discoloration, likely caused by construction formwork and patching so this condition was not considered due to water infiltration.

There were also water stains at the bottom of gypsum board partition dividing Electrical and Mechanical Chases, right between door frame and cable trays (See Photo 4.2.12-3). Examination of this wall corner revealed water stains coming from the floor above.

DMJMH+N also noticed that there may be an oversized unprotected opening for the return air duct from the elevator shaft. While there is a fire damper installed in the duct at penetration, we will recommend that this opening be inspected to insure that the fire damper is installed correctly and covers the entire opening.

4.2.13 Fourth Floor

This floor is dedicated to the stair pressurization fan, outside air intake louver and related ductwork. There is a 2-hour fire rated shaftwall soffit, along the entire length of elevator vestibule, at approx.7'-4" above the floor level. The soffit serves as a plenum for transfer of outside air, from louver located on the west wall, to the Fan Room #427 on east side of the Tower shaft.

In the elevator vestibule, the entire bottom 24-inches of gypsum wall board has been replaced. At the west end of the elevator vestibule there is 2-hour fire rated wall enclosing the air shaft with rated access panel at the bottom of wall. Inspection of the interior of the air shaft indicated that there was substantial air leakage from the unused and "un-ducted" portion of the exterior louver. The air in the shaft space was very cold. The rated access panel when closed did not allow for excessive passage of cold air into the adjacent elevator vestibule, however, the hinged metal access panel appeared to be un-insulated (See Photo 4.2.13-1). This may cause possible moisture condensation on the face of the panel under the extreme cold weather conditions when it is closed and facing warm air from the elevator vestibule. At the time of the inspection all areas of elevator vestibule appeared to be warm and dry.

In Room #428 the west and north exterior walls were un-insulated concrete. The underside of the exposed slab of floor above was, like all other typical levels, covered with sprayed-on fireproofing over metal deck and beams.

At the south-west corner of the room the ductwork and louver for the stairway pressurization system were exposed to Room #428. Since this air plenum transfers the supply air to the Fan Room via the soffit enclosure above the elevator vestibule, there should be a full height fire rated enclosure separating this duct work from the Unoccupied Room #428. This exposure of the duct to Room #428 is the primary reason that this room was very cold, since the metal ductwork has direct exposure to the outside air (See Photo 4.2.13-2).

The bottom 24"-30" of gypsum board wall enclosing elevator hoistway, and the partition wall between this room (#428) and the Electrical Chase has been replaced (See Photo 4.2.13-3). We also noticed large cracks in the concrete floor slab. One significant crack was running from the joint between pre-cast panel and cast-in-place concrete at the north wall toward the north-west corner of the elevator hoistway enclosure. There was an efflorescence deposit and whitish stain of substantial area, which would indicate water and moisture intrusion from the exterior thru the grouted joints in concrete panels (See Photo 4.2.13-4). This crack in the concrete floor slab is potentially very significant, and may be the source of moisture channeled directly into the elevator shaft, where it would meet the warm air within the shaft and condense.

There were also several other floor slab cracks running diagonally from north wall to the west wall joint between pre-cast concrete and cast-in-place portion of exterior wall. Along the west wall joint there were noticeable water stains and scale deposits on concrete surface, indicating once again that exterior water entered through the grouted joints (See Photo 4.2.13-5) There also appeared to be leakage from the floor above, as there was a water stain and efflorescence like deposit over the fireproofed beam and ledger angle at floor deck above (See Photo 4.2.13-6).

After inspecting Room #428 DMJMH+N moved to examine the Fan Room #427 and adjacent Electrical Chase Room # 427A.

The east wall of the Fan Room directly behind the fan unit, was insulated with black rigid insulated panels directly applied over the exterior concrete wall. Room air was warm and uncirculated. The bottom 24"-30" bottom portion of the gypsum wallboard at the south wall, directly adjacent to stairway, has been replaced with a new gypsum wallboard.

We noted that there was a gypsum wallboard over metal stud enclosure for the cable tray that was constructed as a non-rated furring wall. When the same condition was inspected from the adjacent electrical chase, it become apparent that the 2-hour fire rated wall that is supposed to separate stair pressurization fan room from the rest of the structure, did not continue across the room to terminate against elevator shaft wall. The fire rated wall has been stopped at about 18-inches from the elevator shaft and built-out with a non-rated furring wall into the Fan Room. There was also a non-rated metal access panel installed into the furring at about 42-inches above the floor (See Photo 4.2.13-7). This condition does not meet Code requirements for the Stair Pressurization Room enclosure.

Inspection of the air plenum above rated soffit over the elevator vestibule showed large amount of construction debris left on top of the shaftwall soffit. There was public address speaker dome installed through the soffit, which it didn't appear to be installed in accordance with the fire rating requirements (See Photo 4.2.13-8). Also there were fire sprinkler pipes and risers which had rusting parts and appeared to be "sweating".

4.2.14 Third Floor

This floor is very similar in function and layout to the Fourth Floor above. There is a 2-hour fire rated soffit along the entire length of the elevator vestibule, between Mechanical Chase Room #327 and exterior wall facing west.

In unoccupied Room #328 the bottom 24"-30" portion of the elevator hoistway gypsum wallboard has been replaced with a new gypsum wallboard. Also there was a diagonal crack in the concrete floor slab, running across the room from the north exterior wall toward the corner of elevator hoistway enclosure. This appeared to be almost exact repetition of the situation described on the Fourth Floor above.

This room had no insulation over the exterior concrete walls and the air in the room was cold.

There were also two un-insulated ducts in the south-west corner of Room #328 running the full height of the room, from the 4^{th} Floor above to the 2^{nd} Floor below. These ducts provide outside air to the Second Floor and Ground Floor below. Since there are no fire dampers at floor penetrations these ducts did not meet Code requirements (See Photo 4.2.14-1).

In the Mechanical Room, #327, we noticed a similar installation of non-rated enclosure of the cable tray as had been found on the Fourth Floor above. The east wall of the mechanical room was insulated with the black rigid insulation panels installed around a large louver. The metal louver at its upper half was connected to the air plenum box thru the damper, and remaining portion was blanked-off with an insulated metal closure. There were visible water stains on the surface of the blank-off panel, with the source along the bottom of damper box (See Photo 4.2.14-2).

The exterior walls of the adjacent electrical Chase Room, #327A, were un-insulated exposed concrete. There was no visible water damage and the interior of the room was cool, but dry.

4.2.15 Second Floor

The Second Floor of the ATCT is connected to the Base Building Second Floor thru the Link structure at its east facing wall. This level had a functioning office space in Room #228. The same space is typically unoccupied at upper floors. There were no moisture related problems on this level that were reported to DMJMH+N team, therefore it was not inspected in detail.

4.2.16 Ground Level

At this level there is an elevator lobby directly accessible from the Ground Floor level of the Link. The tower stairway provides direct discharge to the outside and is not accessible from the elevator lobby.

We accessed the Ground Floor Electrical Room, #127, from the elevator lobby. The north and east walls of this room were uninsulated with exposed concrete and the room was unpainted with a bare concrete floor. In the south-east corner of the room, right by the door to the elevator lobby, there were 2-1" diameter copper pipes discharging into a floor drain. The two pipes are condensate drains from mechanical equipment above. The bottom of one of the pipes had a significant amount of oxidation on it, the adjacent gypsum wallboard partition had stains from moisture, and there was a small amount of dampness on the floor slab next to the floor sink (See Photo 4.2.16-1). There was also a water stain on the gypsum wallboard next to the copper pipe penetrating this wall See Photo 4.2.16-2).

In the Machine Room, the entire surface of the north and east walls of this room were insulated with black rigid insulation panels, directly applied over the exterior concrete walls (See Photo 4.2.16-3). There was a small amount of dampness and moisture related discoloration and stains at the junction of wall insulation and concrete floor slab along exterior walls facing east and at north-east corner. It appeared that there is some moisture intrusion through the exterior walls. Because surfaces of the exterior concrete walls were entirely covered with rigid insulation, they could not be examined for source and location of water infiltration.

There were also visible dry water stains on the epoxy coated floor slab, which could be traced back to the exterior walls and coming toward the elevator shaft enclosure (See Photo 4.2.16-3). The access door to the elevator hoistway was closed; therefore DMJMH+N did not inspect its interior. Inspection of the inside of the elevator hoistway was not a part of the scope for this report. However, DMJMH+N has noted multiple, unsealed penetration of the elevator hoistway enclosure between hoistway shaftwall enclosure and adjacent Mechanical and Electrical rooms. As it was mentioned in related paragraphs above, typical problems were occurring mostly at the Tower shaft levels 5 thru 9. At all of these levels there were oversized openings for air exhaust from the elevator shaft into the adjacent mechanical rooms. Fire dampers installed into these openings were usually smaller than the openings, thus allowing air movement between these two areas.

4.3 General Mechanical Observations

4.3.1 Base Building Mechanical Room

The natural gas fired heating hot water boilers are located in a common room with other mechanical equipment. The code would mandate that the boiler room be separated from the other mechanical equipment with minimum 1-hour rated wall. Additionally, ASHRAE 15 prohibits refrigerant equipment and open flame equipment, such as boilers, from being in the same room. However, since the room is large, the existing condition may be acceptable under a code exception. In any case, the boilers are located very close to refrigerant evaporator and any refrigerant leak will develop toxic gas when in contact with the boiler flame. DMJMH+N recommends that the FAA plan for replacement of the existing split system chillers with packaged outdoor chillers. This will eliminate any chance of the toxic gas as well as current problems of evaporator fouling. The typical service life for these types of air-cooled chillers is 20 years and the existing chillers are approaching the end of their service life. Environmentally friendly non-CFC or non-HCFC Freon can also be considered when replacing the chillers with new packaged chillers.

4.3.2 HVAC Controls System

The building currently has Barber Colman Direct Digital Control system, Network Model 8000. This system is outdated and replacement parts are no longer available. Any damaged electronics cards may be repaired, with 3 to 4 week lead time without any guarantee. We suggest that FAA consider replacing the existing building automation system with a new "Invensys" building automation system. The existing wiring can be reused; however, some of the actuators may need to be replaced. This newer Barber Colman DDC system is internet accessible and has open protocol, which could be accessed remotely from other FAA facilities.

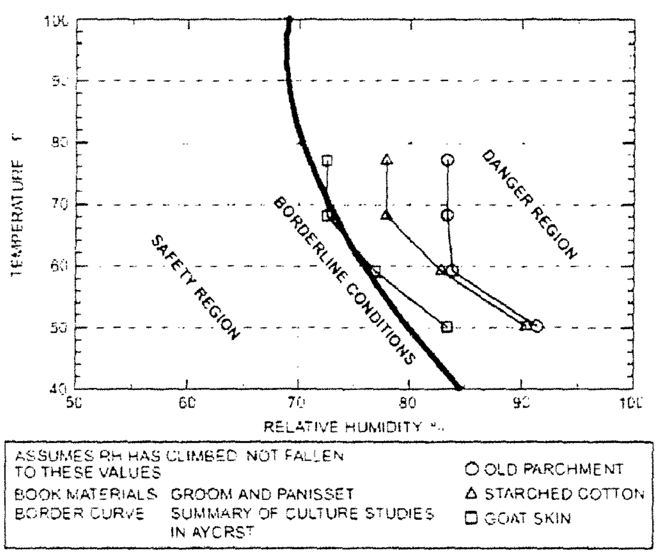
4.3.3 Back-up HVAC System for ASDE Equipment

The electronics equipment is installed in the ASDE equipment room on top of the cab. We believe these are critical equipment for the proper operation of the ASDE and the ATCT operations. This room has only one split HVAC system, and no back-up system. FAA should consider adding redundant a/c unit as a back-up.

4.3.4 Excessive Interior Humidity

The control tower is basically an un-occupied shaft and per FAA Order 6480.7c, cooling is not recommended for most of the areas. However, in a humid climate the moisture leakage into the building through uninsulated walls, cracks or leaky plumbing may result in excessive interior humidity.

Moisture related problems typically result when the space is humid (greater than 70% relative humidity) and hot. The graph below, which has been taken from the ASHRAE Applications Handbook, illustrates this condition.



To avoid this condition, DMJMH+N recommends that specific and positive measures be taken to reduce the humidity within the ATCT shaft. Two possible options to reduce humidity are the installation of dehumidifiers or the installation of fan coil units. These options will be discussed in detail in Section 6.

5.0 CONCLUSIONS

The existing conditions of the exterior building envelope provide many potential paths for water and moisture intrusion into the interior of the tower shaft. This is occurring either, through the failed sealed joints between architectural pre-cast panels, and to a lesser degree through the grouted joints between pre-cast and cast-in-place concrete walls below the Ninth Floor.

We also noticed that many valves in the piping systems were leaking to some degree. The most dramatic example of the impact of this is a rusting door closer on the door to the Electrical Chase, #827A on the Eight Floor. Leaking fluid from the faulty valves above the door has almost completely destroyed closer arm.

In addition to maintenance related items, there are also problems related directly to the design on which the construction of this tower was based.

- The configuration of architectural pre-cast panels at the top of the tower makes it difficult to identify failed joints and then to repair any failed sealant at joints.
- Raised concrete curbs along walkways are of profile that is too low to stop rainfall water from overflow and finding its way to the interior of structure.
- There are many exterior concrete walkways and microwave balconies which constitute a roof over interior spaces, therefore, potential for leakage to interior is greatly enhanced.
- The choice of medium exposed aggregate finish on the exterior surface of concrete may not be appropriate for the weather conditions in Detroit area. If there was a concrete sealer specified and applied, it is ineffective after of so many years in service. This type of finish inherently produces uncounted amounts of so called "bug holes" on the surface, thus providing additional opportunity for water to enter the surface skin and be subjected to the destructive freeze and thaw cycle during cold season.

There are also numerous instances of improper installation of materials and deviations from the design documents that occurred during the construction of this tower. All of these, which have been documented earlier in this report, are creating potential for water and moisture intrusion into the interior of the structure, and are detrimental and contributing factors to the steady deterioration of interior finishes and equipment.

The design of the tower shaft was based on the assumption that most of the floors will be unoccupied; therefore exterior walls at levels up to the Ninth Floor were specified as uninsulated and not provided with mechanical conditioning or ventilation. This approach, while reducing the initial construction cost, did not consider the long term impact of these decisions.

6.0 RECOMMENDATIONS

6.1 Exterior Envelope

6.1.1 General

It will be very difficult and in many places nearly impossible to waterproof and/or weather seal the existing tower shaft from the interior due to the fact that many places are simply not accessible, short of tearing down interior walls and finishes. If continuity of weather barrier cannot be achieved from the interior of the structure, corrective work must start on the exterior, which is the best location because you will preventing water from entering the building in the first place.

Therefore, the emphasis of our initial recommendations will be on methods, materials and applications designed to improve performance of the exterior envelope that consists mainly of pre-cast and cast-in-place concrete

6.1.2 Repair Joints Between Pre-Cast Concrete Panels

Remove all existing exterior sealant and backer rods from joints between pre-cast panels and clean up all joints per new sealant manufacturer recommendations.

Install new silicone sealant suitable for wide joints, such as Dow Corning 790 Silicone Building Sealant with 20 year material warranty.

Sealant shall be installed over closed or open cell foam backing rods (as recommended by sealant manufacturer for this application). Backing rods shall be continuous and installed into joints with minimum of 25% compression and installed in such a manner that will allow for exterior face of sealant to be in concave configuration with a minimum sealant thickness of 3/8-inch. Scope of this work should include Tower Shaft, Base Building and Link as all of these structures display the same degree of exterior sealant degradation.

6.1.3 Waterproof Exterior Concrete

Apply waterproofing coating over entire exterior surface of pre-cast panels and cast-in-place concrete to seal the porous surface, hairline cracks in the grouted joints and "bug holes" on the surface of exposed aggregate concrete finish. The coating shall provide a surface impervious to water but shall also have the ability to "breathe" allowing water vapor to escape from inside the substrate. Coating shall be colored and of matte finish to minimize surface and application imperfections.

There are several products available to suit the application, however, primary recommendation would be to use a silicone based coating for compatibility with the new silicone sealant. The use of compatible materials would provide for easier coating installation, as it could be applied directly over sealant without need for special protective measures.

The recommended product is the Dow Corning® AllGuard Silicone Elastomeric Coating which is a one-part, 100% water-based silicone applied over a compatible primer. Typical application would be by the use of spray equipment; however, this material can be applied by roller and brush. This coating is available in many standard colors or can be custom colored to match existing tower color scheme and provide uniformity to sometimes mismatched existing panels. The manufacturer offers projects specific 10-year limited product warranty.

An alternate comparable product is GE SEC2400 Silicone Elastomeric Coating.

A product that has been previously used on a similar tower is Canyon Tone Stain by United Coatings. This is a water-based acrylic penetrating pigmented sealer with 10-year manufacturer warranty. The use of this acrylic sealer would have to be coordinated with the use of the silicone based sealant. It would likely be best to seal the concrete with the acrylic sealer, then install the silicone joint sealant.

6.1.4 Waterproof Cab Walkway

This will include installation of a new waterproofing system over a properly prepared concrete surface. Method of preparation shall be per the waterproofing manufacturer's recommendations. Most manufacturers would likely require abrasive grinding. It should be noted that remedial work may have to include reconfiguring low profile existing curbs to satisfy the minimum requirements of the products and manufacturers listed below.

There are several waterproofing products available that are suitable for this application:

- Liquid applied polyurethane based multilayered pedestrian deck coating system, Peda-Gard by Neogard, a Division of Jones-Blair. This product carries a manufacturers standard 5-year warranty.
- Another suitable product for promenade and roof deck covering systems is a Weather wear by Dex-O-Tex, a Division of Crossfield. This is a multilayered; trowel applied waterproofing and wearing surface system which consist of a proprietary combination of polymeric liquid rubber-latex and vulcanizers with pre-engineered aggregates. The total thickness of the material varies from 3/16-inch to 1/4-inch. Although this product has a proven record of performance,

the manufacturer provides a limited one-year, material only replacement warranty.

6.1.5 Insulate Underside of Cab Walkway

Provide thermal insulation at underside of Cab walkway per construction drawings.

6.1.6 Curb at Cab Walkway

Examine from the inside of Cable Access space the bottom of insulated metal panels at wall on outside of Cab walkway. Identify and remove existing steel angle sections that are installed with overlap over other adjacent sill angles, thus causing separation from the top of walkway concrete curb, cut them to fit flush with other adjacent angles and fasten to top of concrete curb. Apply continuous bead of silicone sealant all around insulated metal panel perimeter.

6.1.7 Louvers at Cab Walkway

Close oversized openings between louver framing and insulated metal panels with sheet metal flashing installed over continuous bead of silicone sealant and fastened to adjacent panel facings with stainless steel fasteners and neoprene washers. Finish metal flashing to match existing adjacent metal panels. From inside the Cable Access space install fiberglass insulation all around the perimeter of the louvers.

6.1.8 Cable Access Perimeter Area

Clean up and check for proper drainage all area drains around outer perimeter concrete slabs.

Dry and clean concrete slab using method recommended by the manufacturer of the floor paint product specified in the paragraph below. Fill cracks with epoxy concrete filler prior to painting.

Apply a coat of concrete floor paint that is moisture, weather and pedestrian traffic resistant such as DRYLOK® Latex Concrete Floor Paint by United Gilsonite Laboratories.

Inspect the entire length of short wall directly below C12 metal channel supporting Cab walkway slab and curb. Replace worn out or old batt insulation that shows discoloration and signs of exposure to water with the new insulation as specified in the Interior Section below, then completely seal with fire retardant vapor barrier, also specified in the Interior Section below.

Vapor barrier should be installed to prevent infiltration of moisture from around outside perimeter of floor slab at junction with slanted pre-cast concrete panels, then to inside of structure below. The vapor barrier shall be as specified in the Interior Section below. Install approx. 30" high strip of continuous vapor barrier adhesively attached with double faced sealant tape to the slanted pre-cast concrete panels at the top and to edge of concrete slab below. Afterwards, permanently secure the vapor barrier with 16 gage furring strips and shot pins.

6.1.9 Waterproof Junction Level Walkways

This will include installation of a new waterproofing over a properly prepared concrete surface. Method of preparation shall be per the waterproofing manufacturer's recommendations. It is recommended that if a thermoplastic roofing membrane is selected as a waterproofing material, raised curbs will be erected between walkways and the microwave balconies to configuration as specified in the original design. This would allow for installation of additional tapered rigid polyisocyanurate insulation, which would improve thermal performance of the building envelope. This would also allow for replacement of rusted roof drains and utilization of existing overflow scuppers in architectural pre-cast concrete panels. Another benefit of this approach would be a separation of walkways from the microwave balconies to prevent rainwater from the walkway flowing into the microwave balconies.

- The primary recommended product is a fully adhered PVC Thermoplastic roofing membrane G410, minimum 60 mil thick, with sand coated walkways adhesively applied to the membrane for pedestrian traffic wearing surface. Availability and length of warranty for this application would have to be verified by the manufacturer's representative due to the unusual configuration of existing substrate. On a more traditional roofing application this system may obtain a 20-year manufacturer's warranty.
- We do not recommend using the liquid applied products as specified for the Cab Walkway. We believe that a solution resembling the original design intent is the best solution for the Junction Level exterior walkways.

6.1.10 Louver at Junction Level Walkways

The existing louver is not a storm proof type louver and allows for a large volume of wind driven water thru the blades. Despite the use of blank-off panels on the inside of Mechanical Room, there is evidence of water spills on the curb wall and the floor slab. Consideration should be given to upgrade this louver to be more water resistant but which would allow the same volume of outside air coming in. Additional water deflecting baffles or screens could be engineered for outside installation directly over existing louver vertical mullions.

6.1.11 Waterproof Microwave Balconies

At present there are indications that microwave antennas are not used any more due to changes in technology. It would be worth consideration to remove antennas and supporting pipes, post and bracing and clean-up debris from the balconies. Then, install insulation and thermoplastic roofing membrane over triangular shaped north-west and north-east balconies, to improve thermal protection over spaces at Sub-Junction Level below. This approach would allow for positive elimination of any water intrusions thru the north facing balconies. The same cannot be repeated at south balconies, due to open gratings to airshafts at sub-Junction below. However, as it was mentioned in sections above, there is evidence of water spills thru the gratings onto fireproofed structural beams below. Recommended remedy would be to install between 12-16 inches high baffles over the slab, which should run parallel to tensioned microwave fabrics to deflect wind driven rainwater coming from under the fabric's bottom bar. There should be build-in thru wall scuppers for controlled channeling of water to the existing trench drains.

6.1.12 Tower Shaft at Link and Base Building

It is recommended that the punctured Elastomeric seal be repaired or replaced in its entirety. Since there were reports of water leaks to inside of Link structure from the roof above, entire roof area should be examined with most careful attention to the roof expansion joint. The Base Building and Link structure were not a part of DMJMHN survey; therefore we did not enter the Link and Base Building roof for inspection.

There is an unusually wide sealed joint between pre-cast concrete panels at Link and the Base Building that has deteriorated and is punctured in several areas. Sealant joints are typically not designed for such a wide openings, therefore it is our recommendation to remove the sealant from these joints at each side of the Link, and replace them with either elastomeric expansion joint covers or with custom formed sheet metal covers with fiberglass insulation friction fit between pre-cast panels (See Photo 6.1.12-1).

Clean off dirt and debris from entire bottom perimeter of the Tower shaft, Link and Base Building.

6.2 Interior Recommendations

6.2.1 Insulate Exterior Walls

Install thermal insulation at all exposed concrete walls below Ninth Shaft Level. Insulation should be installed over the full height of the wall, from top of floor slab to underside of beam or ledger angle supporting the metal deck above. Insulation should be friction fit between 6" metal studs at 16" O/C. There should be an air gap of 1" between face of metal studs and face of concrete walls to avoid transfer of cold to inside of room. Due to limitation of existing conveying system studs may be segmented in lengths that will allow vertical delivery through the elevator or through the stairway. Metal stud support system shall be engineered to allow for stud splicing to full wall height and braced back to the existing concrete walls. Cover studs and insulation with fire retardant vapor barrier.

Thermal insulation should be unfaced fiberglass batts complying with ASTM C665, Type I and ASTM E 136. Available product is Thermal Batt Insulation by Owens Corning.

Install high strength, scrim reinforced, puncture resistant and fire retardant vapor barrier which shall be rated as Class I and Class A flame spread rating per UBC-42 and ASTM E-84. Available product is TX-1200®FR by Griffolyn Div. of Reef Industries. Vapor barrier shall be securely attached to metal studs with all joints taped in accordance with manufacturer recommendations.

6.2.2 Improve Air Circulation

To improve air circulation and to provide more uniform temperatures between heated and unheated areas of the tower shaft, it is recommended to either remove the door between the elevator vestibule and the unoccupied room or completely remove the partition wall between elevator vestibules and unoccupied room where feasible. This recommendation is based on the condition that the Code would require the unoccupied space to always remain unoccupied. There shall be no permanent use of nor storage allowed in these areas.

A larger opening will allow for increased air circulation. Removing the door only would be the minimum recommendation, however, if budgets allow, the entire partition wall should be removed at Floors 5 thru 10. At Floors 3 and 4, where there is a rated gypsum wallboard soffits separating elevator vestibule from air shaft above the partition wall is supporting this rated soffit. At these 2 locations we recommend removing the hollow metal doors and frames, applying a double layer of 5/8" Type "X" around the entire perimeter of the opening, matching the thickness of existing wall, then taping the joints with approved fire rated joint compound.

6.2.3 Third Floor Duct Isolation

At the Third Floor install a 2-hour fire rated shaft wall chase to enclose existing metal ducts in the southwest corner of the unoccupied Room #328. Shaft wall enclosure shall comply with pertinent UL Design Number. The shaft wall enclosure shall extend full height of the room.

Additionally, install fusible link fire dampers at the Third and Fourth Floors on both of the 8"x8" ducts.

6.2.4 Enclosure for Stairway Pressurization Fan Ductwork

In Room #428, construct 2-hour fire rated and insulated wall enclosure around the exposed ductwork and connection to the louver for the stairway pressurization system. The new wall(s) should extend into Room #428 sufficiently to allow the installation of a door for access into this area. Lighting and new switch will have to be provided in this new room.

6.2.5 22"x12" Grilles in Elevator Shaft Wall

Typical at all levels (5 through 9) where elevator shaft wall is facing the Mechanical Chase; inspect the grille and fire damper for proper operation and verify that there are no openings when damper is fully closed. If the fire damper does not close the entire opening, close remaining opening tight to not allow the passage of smoke, with fire rated gypsum board and fire safing insulation.

Since the elevator shaft is essentially open to mechanical/plumbing chase, we suggest that the mechanical chase be examined regularly for any pipe leaks. Any leaks shall be repaired as soon as possible. Additionally, the elevator pit should be examined regularly and checked for any standing water.

6.2.6 Elevator Relief Damper

The elevator relief damper at the top of the shaft shall be checked for leaks and confirm that the damper blades are insulated. All ducts extending from the shaft to louver shall also be insulated to eliminate heat loss from the building.

6.2.7 Wall Between Mechanical and Electrical Chases

With the exception of the Third and Fourth Floors, remove door and partitions (where practical) between Mechanical and Electrical Chases for improved air circulation and temperature equalization between these rooms.

6.2.8 Upgrade Fire Rating of Cable Tray Enclosure

At the Third and Fourth Floors, provide fire resistant construction of existing cable tray enclosure protruding into the Mechanical Chase by replacing non-rated access door with a 1½-hour fire rated access door and by adding an additional layer of 5/8" type "X" gypsum wallboard over the existing, secured to metal studs with sheet metal screws (SMS).

6.2.9 Rated Floor Penetrations

In all Mechanical and Electrical Chases identify all unsealed pipe, conduit and cable tray penetrations thru floor and install 2-hour fire rated fire stopping in accordance with appropriate UL Design requirements.

6.2.10 Extend Height of Rated Walls

Extend 2-hour fire rated partitions between elevator vestibule and Mechanical Chases to full height up to the underside of floor deck above. This requirement applies to wall construction at Floors 5 through 8. All ductwork penetrating these partitions must have fire dampers installed.

6.2.11 Modify Repaired Walls

Based on DMJMHN field observation of installed repairs of damaged original gypsum wallboard; we believe that all joints should be staggered and properly taped with fire rated joint compound. The bottom of the new gypsum wallboard panels should be maintained at about 1/4-inch above concrete floor slab and sealed with continuous bead of fire rated sealant.

6.2.12 Positive Pressure System for Cab

Install a new static pressure sensor in the cab and tie it to the building Direct Digital Control system to modulate the return and outdoor air dampers to keep the cab under positive pressure at all times. This should eliminate any outdoor air leakage into the cab.

6.2.13 Air Balancing

An AABC Certified air balancing company shall provide a thorough air balance in the cab and occupied areas of the Junction and Sub-junction floors.

6.2.14 Dehumidifiers

Install packaged dehumidifiers on Floors 3 through 10 to dry out the air. The humidifiers should be furnished with condensate pumps to pump the moisture to the nearest drain. Please see the attached dehumidifier catalog cut. For the elevator shaft, the dehumidifier can be installed at the elevator overhead on the Cable access Level or at the Ground Floor with ductwork.

As an alternate approach to the dehumidifiers, six row chilled water fan coil units can be installed to reduce the humidity in the unoccupied areas of each floor. This option is only valid if the existing chiller is replaced and the new chiller is sized to accommodate the additional heat load. Reference Section 4.3.1.

Recommendations in paragraphs 6.2.3, 6.2.4, 6.2.6, 6.2.7 and 6.2.8 deal with Code compliance issues. These recommendations describe corrective actions that are required to achieve proper fire safety but they are also perquisites to all of the other Interior recommendations.

7.0 FUTURE PROTOTYPE DESIGN RECOMMENDATIONS

In the development of a prototype control tower, it is difficult to develop a single design the effectively works in all geographic and climactic Regions of the FAA. Seismic, wind, temperature and humidity are but a few of the variables that designers will encounter during the development of a new control tower. In addition, the variation in requirements and priorities between the FAA Regions introduces additional variable. The purpose of this write-up is not to address the task of developing a new prototype control tower, but merely point out, based on past and current experience, a few design aspects that should be considered in the development of a new standard ATCT.

7.1 Exterior Envelope

Concrete, as the exterior material of an ATCT, provides a durable and reliable exterior surface. Cast-in-Place or pre-cast concrete have been successfully use in the past. It must be understood, however, that concrete, being a porous material, requires proper sealing and caulking of joints both at the time of construction and at proper maintenance intervals. We feel that the following areas of the exterior envelop of airport traffic control towers should be given serious consideration

7.1.1 Minimize the Number of Joints

Precast concrete requires caulking of joints between sections of precast. Minimize or eliminate the precast concrete. When using precast concrete, make sections as large as possible to cut down on the number of joints. Use cast-in-place concrete to reduce joints.

7.1.2 Precast Elements as a Roof

Avoid using precast elements as a roof or sloping surface. The degradation of joints and waterproofing sealant make this scenario susceptible to water infiltration.

7.1.3 Silicone Sealants

Specify only the highest grade of silicone sealants.

7.1.4 Exterior Walkways

Minimize the number of exterior walkways. Avoid the use of exposed (coated) concrete for exterior walkways. Use only insulation and single-ply membrane roofing.

7.1.5 Increase Drainage Slopes

Provide a minimum of 3/8" per foot for roofs and walkways.

7.1.6 Exterior Insulation

Design for insulation on the outside of the structure for roof areas versus on the interior of the structure.

7.1.7 Storm Proof Louvers

Specify storm resistant louvers having Wind Driven Rain Performance effectiveness rating of not less than 0.99 and bearing an AMCA Certified Rating Seal. Avoid oversized and unducted louvers.

7.1.8 Curbs

All curbs should be a minimum of 8" above the exterior finished surface.

7.1.9 ASDE-3 Penthouse

Recognizing that this design may be replaced by the ADSE-X, a similar design in the future should eliminate the exposed steel structure.

7.2 Interior Areas

The following conditions should be considered for the design of interior spaces within an airport traffic control tower:

- Insulate all exterior walls
- Provide properly designed vapor barrier
- Consider the use of spray applied foam thermal insulation covered with a spray on cementitious barrier.
- Avoid large unoccupied and unconditioned spaces.
- Avoid small concealed/confined spaces.
- Provide air movement in vertical shafts.
- Consider the use of cast-in-place concrete or CMU walls for the elevator shaft, mechanical/electrical chases and the stairway enclosure.

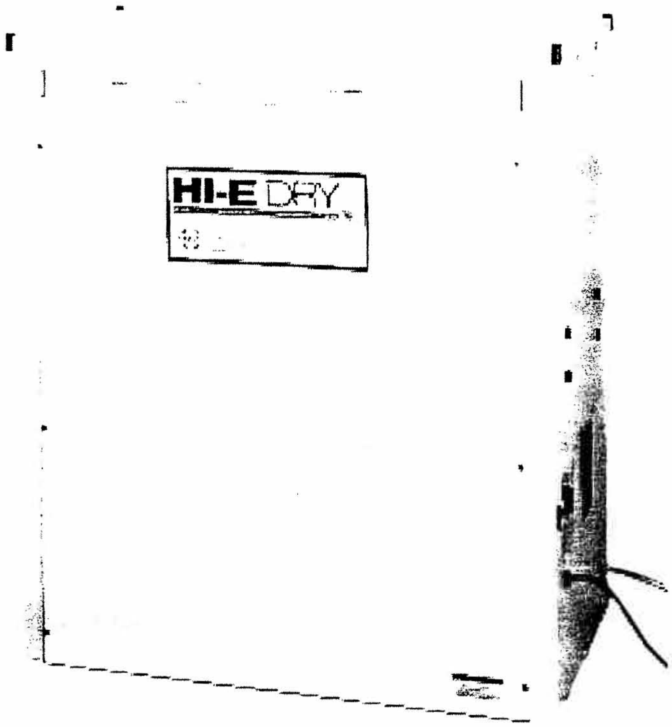
- When applicable, use certified mold-mildew resistant gypsum board for walls.
- Heat all shafts and chases.
- Insure temperature moderation between adjacent spaces.
- In humid areas, or as deemed necessary, consider the initial installation of dehumidifiers or deep cooling coils in elevator shaft and mechanical chases to provide positive measures to reduce humidity.
- Avoid the use of basements. When necessary specify the highest grade/quality of waterproofing system available.

APPENDIX A

DEHUMIDIFIER CATALOG CUT

HI-E DRY

THE HIGH-EFFICIENCY



Therma-Stor Products
a division of DEC International, Inc.

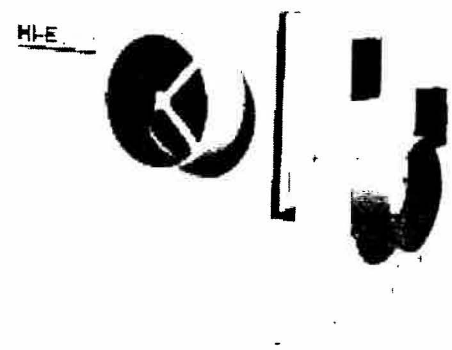
P.O. Box 8050, Madison, WI 53708
1-800-533-7533
Phone 608-222-5301   Fax 608-222-1447

HI-E DRY

Therma-Stor Products developed the first HI-E DRY dehumidifier in the late 1980s. Utilizing the patented *Revaporator* process, this unit removed more than twice the amount of water per kilowatt hour of electricity than any other refrigerant dehumidifier.

HI-E DRY dehumidifiers are designed and built with emphasis on efficiency and durability. Today's HI-E Dry dehumidifiers remove up to seven pints of water per kilowatt hour, while the industry average remains at only two to three pints.

The high-efficiency design of HI-E DRY dehumidifiers offer more than just dramatically reduced utility costs. The larger water removal capacity from a smaller, more efficient refrigeration system eliminates the need for 220 volt circuits in many applications. The smaller refrigeration system allows HI-E DRY dehumidifiers to cost less than other commercial dehumidifiers of equal capacity.



Original HI-E DRY I.C.U. dehumidifier with patented "revaporator" technology.

APPLICATIONS

HI-E DRY dehumidifiers control damaging moisture and humidity in a wide range of applications. Designed to operate in a variety of conditions, HI-E DRY dehumidifiers will reduce the relative humidity of inlet air with a dewpoint above 35° F. The ability to function effectively in lower temperatures is built into every HI-E DRY dehumidifier. Under all conditions, the lower operating cost, lower unit cost, and availability of high capacity "plug-in" installation on most models, make HI-E DRY dehumidifiers the right solution to most humidity problems.


HI-E Dry 200 in water treatment facility

HEALTH & FITNESS
Indoor Pools
Whirlpools and Spas
Therapy Rooms
Locker Rooms
Health Clubs
Skating Rinks
Hospitals
Allergy Control
Gymnasiums

UTILITIES
Water Treatment Plants
Pumping Stations
Power Plants
Sanitation Plants
Well Houses
Switching Stations
Telecommunications Centers

ARCHIVES
Museums
Libraries
Art Galleries
Records Storage
Film & Tape Storage

FOOD & DRUG
Cheese Factories
Bakeries
Pharmaceutical Labs
Food Drying
Canning Plants
Resturants and Bars
Supermarkets
Meat Packaging

MANUFACTURING
Tool and Die Shops
Paper & Pulp Production
Powder Blending
Packaging Areas
Plastic Molding & Processing

COMPUTER & ELECTRONICS
Clean Rooms
Electronics Assembly
Computer Rooms

GRAPHICS
Printing
Photo Labs
Pre-Press Areas
Silk Screening

Therma-Stor Products
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HI-E DRY

THE HIGH EFFICIENCY

HI-E DRY MODEL 195

SPECIFICATION

1-1 High efficiency dehumidifier that utilizes refrigeration to cool the incoming air stream below its dewpoint as it passes through the dehumidification (evaporator) coil. This cooling results in the removal of moisture (latent heat) and reduction in temperature (sensible heat). The cooled and dried air is used to pre-cool the incoming air stream resulting in up to a 200 percent increase in overal efficiency. After the pre-cooling stage the processed air is reheated by passing through the condenser coil. The latent heat removed by the evaporator coil is returned to the air stream at this stage as sensible heat, resulting in an overall temperature increase from the incoming air.

1-2 The unit is controlled by a dehumidistat with settings from 20 to 80 percent relative humidity and a positive "on" and "off" setting.

1-3 The unit contains a blower switch that permits continuous blower operation independent of dehumidification.

1-4 The unit is portable and provided with four casters.

1-5 The unit contains an internal condensate pump capable of lifting condensate 12 feet, and 20 feet of condensate hose.

1-6 The wiring of the unit is through a factory installed six foot power cord; 115 volt with ground.

1-7 Capacities and Performance

Blower	540 CFM
Kilowatts (80° 60%)	1.25
Supply Voltage	115-1-60
Running Amps	12.0 (Std.)

**Specifications subject to change without notice.*

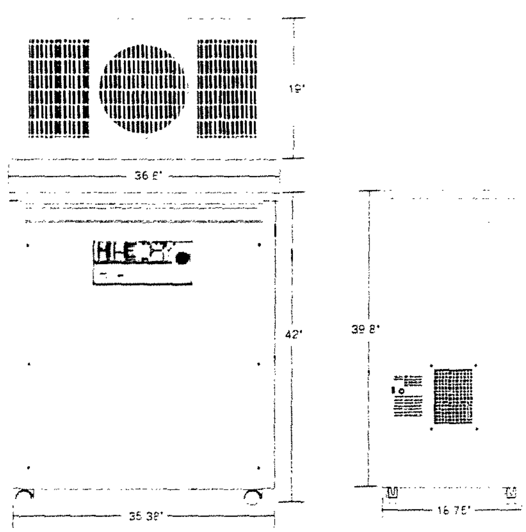
Minimum Performance at Set Conditions

Intake Air	**70° 60%**	**80° 60%**
Water removal (per day)	143 LBS	190 LBS
Pints/KWH	5.0	5.9

1-8 The HI-E DRY Model 100 is only manufactured by Therma-Stor Products, div. of DEC International, Inc. Madison, Wisconsin.

Model Dimensions

	Unit	Shipping
Width:	36.6"	39.25"
Height:	42"	48.75"
Depth:	19"	30"
Weight:	175 lb	214 lb



Therma-Stor Products

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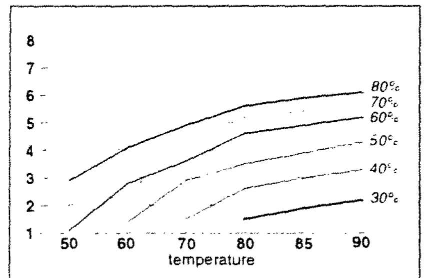
HI-EDRY

THE HIGH-EFFICIENCY D...

HI-E DRY *MODEL* 100

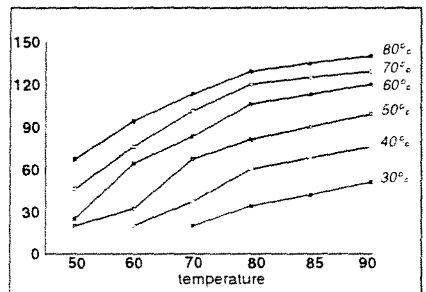
Lbs per Hour

Air temp	Relative Humidity 30	40	50	60	70	80
50				1.1	2.0	2.9
60			1.4	2.8	3.3	4.1
70		1.5	2.9	3.6	4.4	4.9
80	1.5	2.6	3.5	4.6	5.2	5.6
85	1.9	3.0	3.9	4.9	5.4	5.9
90	2.2	3.3	4.3	5.2	5.6	6.1



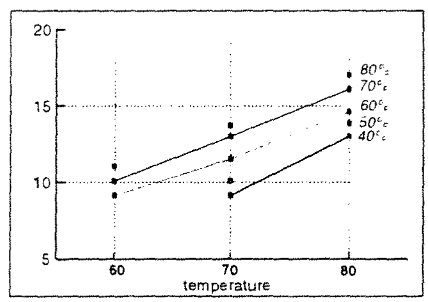
Capacity; Pints per Day

Air temp	Relative Humidity 30	40	50	60	70	80
50				25	46	67
60			32	64	76	94
70		37	67	82.9	101	113
80	34	60	81	106	120	129
85	42	68	90	113	125	135
90	51	76	99	120	129	140



KWH per Day

Air temp	Relative Humidity 40	50	60	70	80
60			0.91	10.1	11.0
70	9.1	10.1	11.5	13.0	13.7
80	13.0	13.9	14.7	16.1	17.0

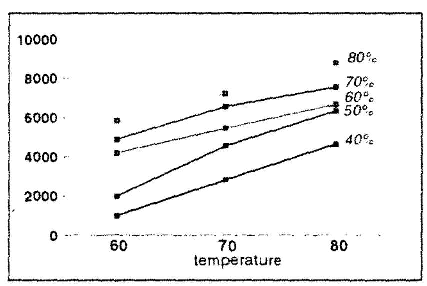


BTUs per Hour

Air temp	Relative Humidity 40	50	60	70	80
60			4200	4900	5850
70	2810	4550	5450	6550	7200
80	4650	6330	6660	7545	8800

* *Defrost conditions*

Specifications subject to change without notice



DEC INTERNATIONAL

Therma-Stor Products

a division of DEC International, Inc.

HI-E DRY

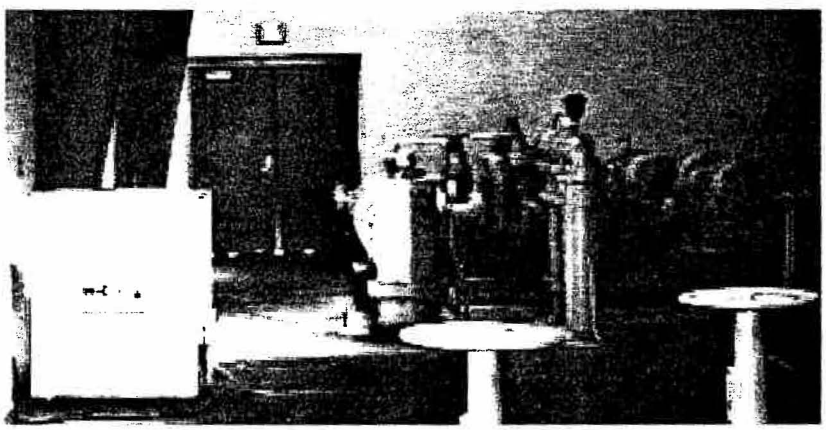
THE HIGH-EFFICIENCY DE...

HI-E DRY Three-way Savings:

1 LOW UNIT COST.
HI-E DRY dehumidifiers utilize heat transfer innovations that dramatically improve performance. This enables Therma-Stor Products to build higher capacity dehumidifiers with smaller refrigeration systems. That results in lower equipment cost.

2 LOW INSTALLATION COST.
A smaller refrigeration system requires a smaller electrical load. The HI-E DRY model 195 removes over 183 pounds of water a day (80°F 60%RH) while drawing only twelve amps of electricity. The HI-E DRY 195 plugs into a 115 volt 15 amp outlet, and provides all the humidity control necessary for a 440 square foot of pool. (82°F Air Temp., 80°F Water Temp. 60% Relative Humidity)

3 LOW OPERATING COST.
HI-E DRY dehumidifiers remove two to three times more water per kilowatt hour of electricity than conventional dehumidifiers. Annual energy savings from controlling the humidity of a 440 square foot pool would be about 15,000 KWH., or $1,200.00 at $0.08 KWH.



Therma-Stor Products is a division of DEC International based in Madison, Wisconsin. Incorporated in 1947 as Dairy Equipment Company, DEC currently contains 15 operating units located in six countries manufacturing 43 different product lines. Over 40 percent of DEC's $160 million in sales in 1998 were outside the U.S.

Therma-Stor Products was established in 1977 to apply heat transfer innovations to residential and commercial markets. Heat recovery water heating systems, ventilation systems, and dehumidifiers comprise Therma-Stor's primary products. Therma-Stor has received the Wisconsin Society of Professional Engineers Governor's New Product Award and the U.S. Department of Energy's Award for Energy Innovation. Currently DEC and Therma-Stor Products technical expertise account for several patented and patent-pending innovations.

DEC INTERNATIONAL

Therma-Stor Products
a division of DEC International, Inc.

HI-E DRY

THE HIGH-EFFICIENCY

HI-E DRY MODEL 100

SPECIFICATION

1-1 High efficiency dehumidifier that utilizes refrigeration to cool the incoming air stream below its dewpoint as it passes through the dehumidification (evaporator) coil. This cooling results in the removal of moisture (latent heat) and reduction in temperature (sensible heat). The cooled and dried air is used to pre-cool the incoming air stream resulting in up to a 200 percent increase in overal efficiency. After the pre-cooling stage the processed air is reheated by passing through the condenser coil. The latent heat removed by the evaporator coil is returned to the air stream at this stage as sensible heat, resulting in an overall temperature increase from the incoming air.

1-2 The unit is controlled by a dehumidistat with settings from 20 to 80 percent relative humidity and a positive "on" and "off" setting.

1-3 The unit contains a blower switch that permits continuous blower operation independent of dehumidification.

1-4 The unit is portable and provided with four casters.

1-5 The unit contains an internal condensate pump capable of lifting condensate 20 feet, and 20 feet of condensate hose.

1-6 The wiring of the unit is through a factory installed six foot power cord; 115 volt with ground.

1-7 Capacities and Performance

Blower	255 CFM
Kilowatts	0.61 (80° 60%)
Supply Voltage	115-1-60
Running Amps	6.8

**Specifications subject to change without notice*

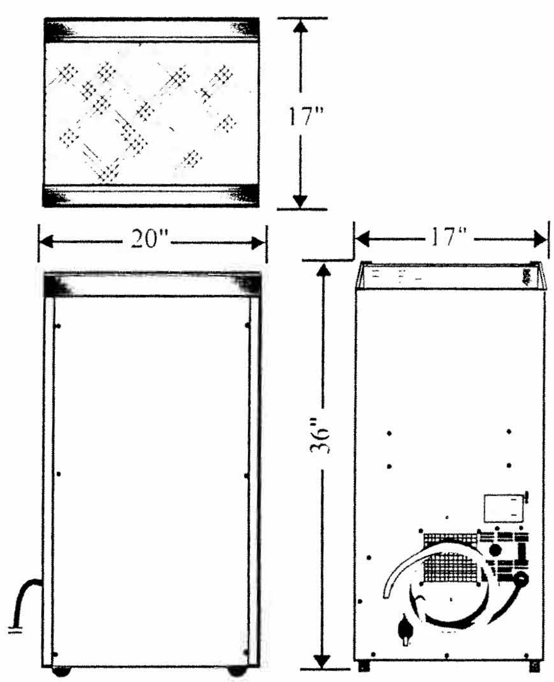
Minimum Performance at Set Conditions

Intake Air	**70° 60%**	**80° 60%**
Water removal (per day)	86 LBS	110 LBS
Pints/KWH	6.0	6.8

1-8 The HI-E DRY Model 100 is only manufactured by Therma-Stor Products, div. of DEC International, Inc. Madison, Wisconsin.

MODEL 100 DIMENSIONS

	UNIT	SHIPPING
Width	20 inches	25 inches
Height	36 inches	41 inches
Depth	17 inches	24 inches
Weight	110 Lbs.	125 Lbs.



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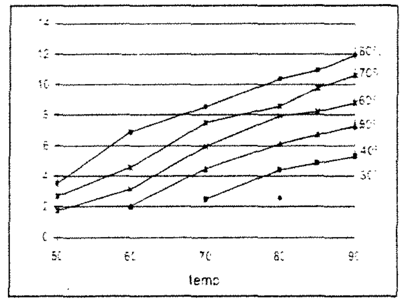
HI-E DRY

HI-E DRY MODEL 195

Lbs per Hour

Relative Humidity

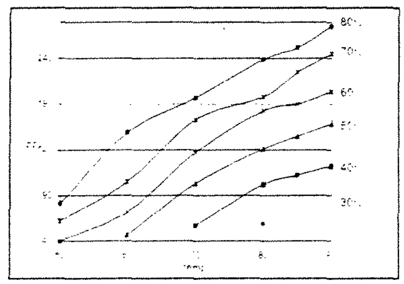
Air temp	30	40	50	60	70	80
50				1.73*	2.68*	3.51*
60			2.04*	3.12*	4.55*	6.89
70		2.47*	4.46	5.94	7.50	8.54
80	2.56	4.42	6.11	7.93	8.58	10.36
85		4.85	6.72	8.23	9.75	10.92
90		5.29	7.28	8.80	10.62	11.92



Capacity; Pints per Day

Relative Humidity

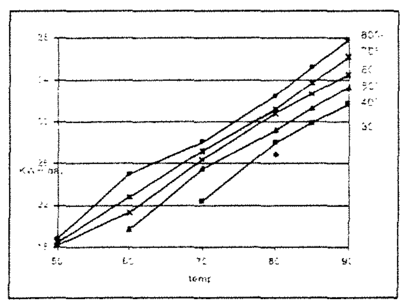
Air temp	30	40	50	60	70	80
50				40*	62*	81*
60			47*	72*	105*	159
70		57*	103	137	173	197
80	59	102	141	183	198	239
85		112	155	190	225	252
90		122	168	203	245	275



KWH per Day

Relative Humidity

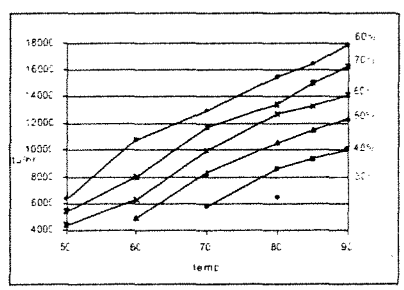
Air temp	30	40	50	60	70	80
50				18.2*	18.5*	18.8*
60			19.7*	21.3*	22.8*	25.0
70		22.4*	25.5	27.2	27.2	28.1
80	26.9	28.0	29.2	31.2	31.2	32.5
85		29.9	31.3	33.7	33.7	35.2
90		31.7	33.3	34.5	36.2	37.9



BTUs per Hour

Relative Humidity

Air temp	30	40	50	60	70	80
50				4403*	5444*	6349*
60			4934*	6296*	8007*	10771
70		5772*	8300	9971	11719	12936
80	6502	8610	10551	12684	13422	15468
85		9334	11485	13272	15003	16442
90		10044	12359	14118	16266	17869



* *Defrost conditions*

Specifications subject to change without notice

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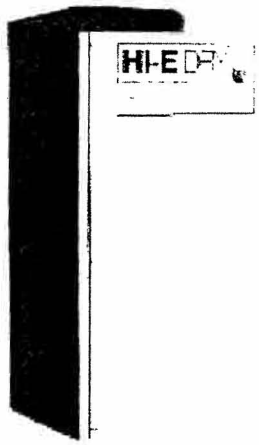
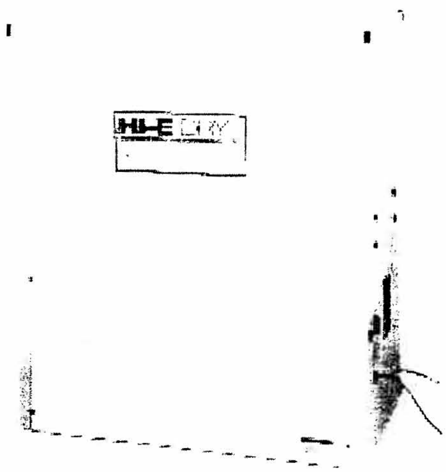
HI-E DRY

THE HIGH-EFFICIENCY





HI-E DRY Model 100

Water Removal Rates (Pints/Day)

90°F, 90%	172 pints
80°F, 80%	129 pints
80°F, 60%	106 pints
70°F, 80%	113 pints
70°F, 60%	83 pints
60°F, 80%	94 pints
60°F, 60%	64 pints
50°F, 80%	67 pints
50°F, 60%	25 pints

Specifications

Width	17 inches
Length	20 inches
Height	36 inches
Weight	110 lbs.
Power	115 VAC 7 amps
Blower	255 CFM
Capacity (24 hrs.)	106 pints (80°, 60%)
Temp. Range	33°F–110°F
Warranty	5 Year Limited

HI-E DRY Model 195

Water Removal Rates (Pints/Day)

90°F, 90%	312 pints
80°F, 80%	239pints
80°F, 60%	183 pints
70°F, 80%	197 pints
70°F, 60%	105 pints
60°F, 80%	159 pints
60°F, 60%	72 pints
50°F, 80%	81 pints
50°F, 60%	40 pints

Specifications

Width	19 inches
Length	37 inches
Height	42 inches
Weight	175 lbs.
Power	115 VAC 12 amps
Blower	540 CFM
Capacity (24 hrs.)	183 pints (80°, 60%)
Temp. Range	33°F–110°F
Warranty	5 Year Limited

All illustrations and specifications contained in this brochure are based on the latest product information available at the time of printing. Therma-Stor Products reserves the right to: (1) make changes at any time, without notice, to product designs, specifications, materials and colors, (2) introduce new products to the marketplace, and (3) discontinue products as it sees fit. If you have any questions, call 1-800-533-7533.

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1-800-533-7533
Phone 608-222-5301
Fax 608-222-1447

APPENDIX B

PHOTOGRAPHS

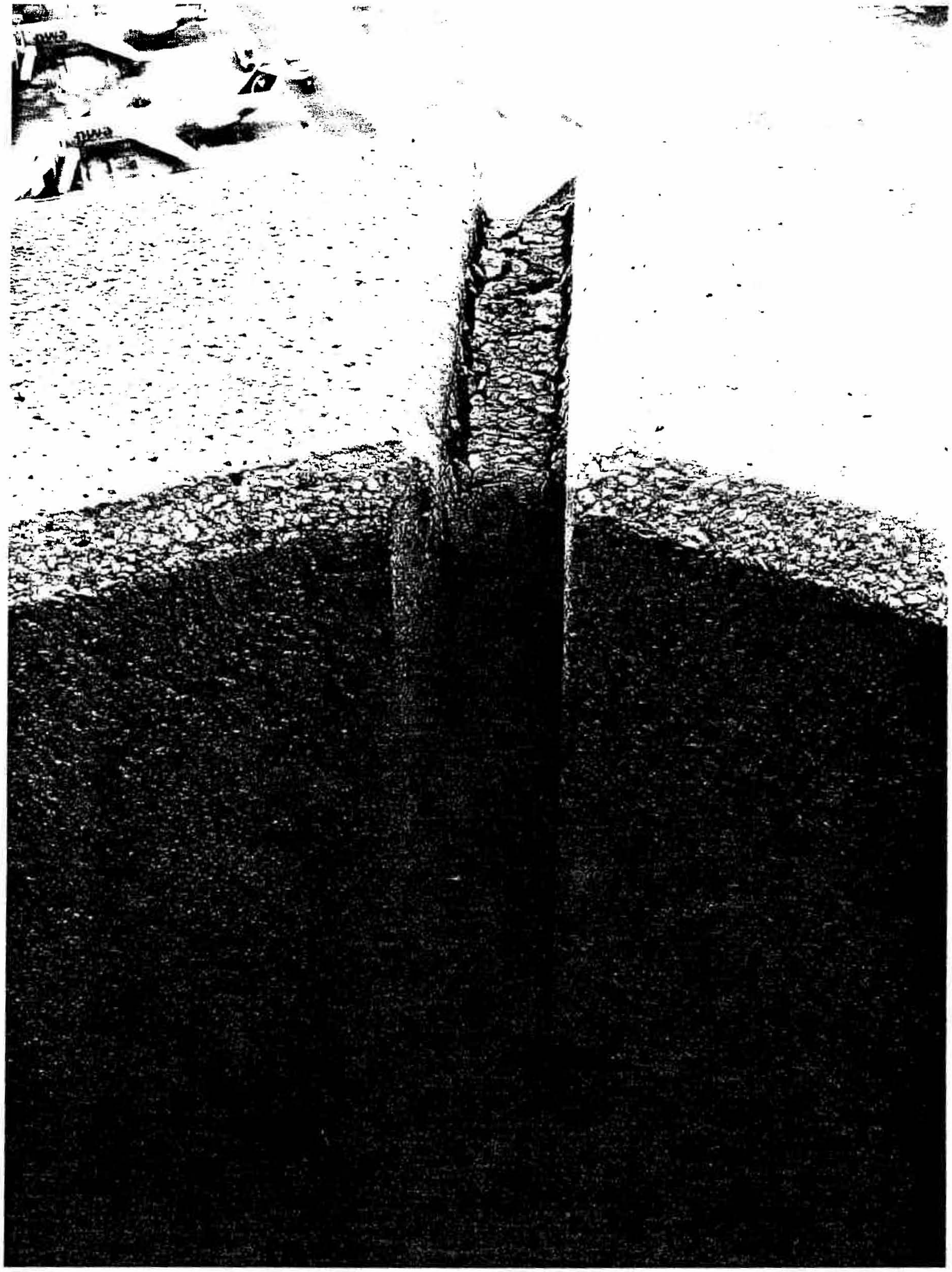

Photo 4.1-1
Precast Concrete Joint at Cab Walkway

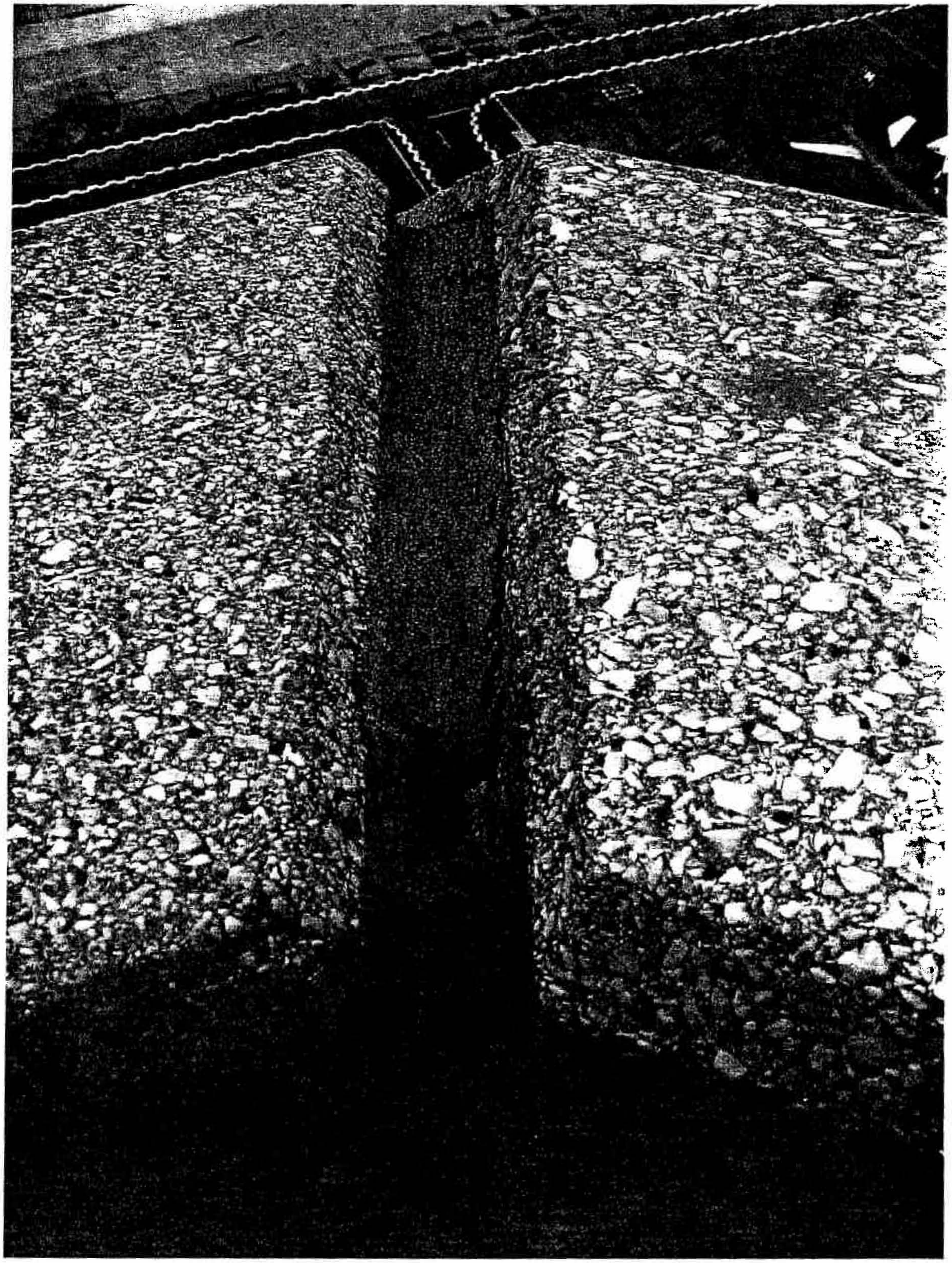

Photo 4.1-2
Precast Concrete Joint at Cab Walkway

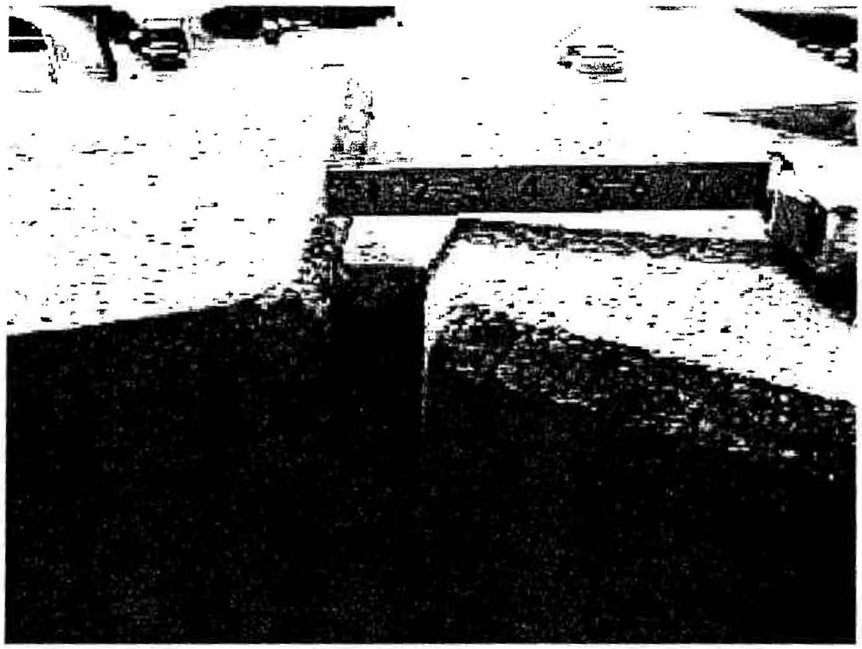

Photo 4.1-3
Precast Concrete Joint at Cab Walkway

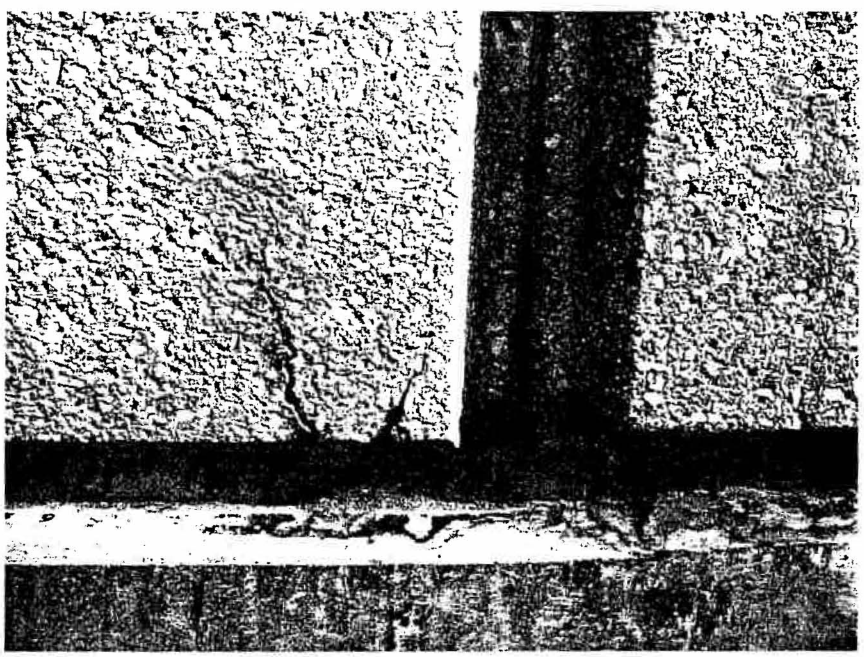

Photo 4.1-4
ATCT Ground Level

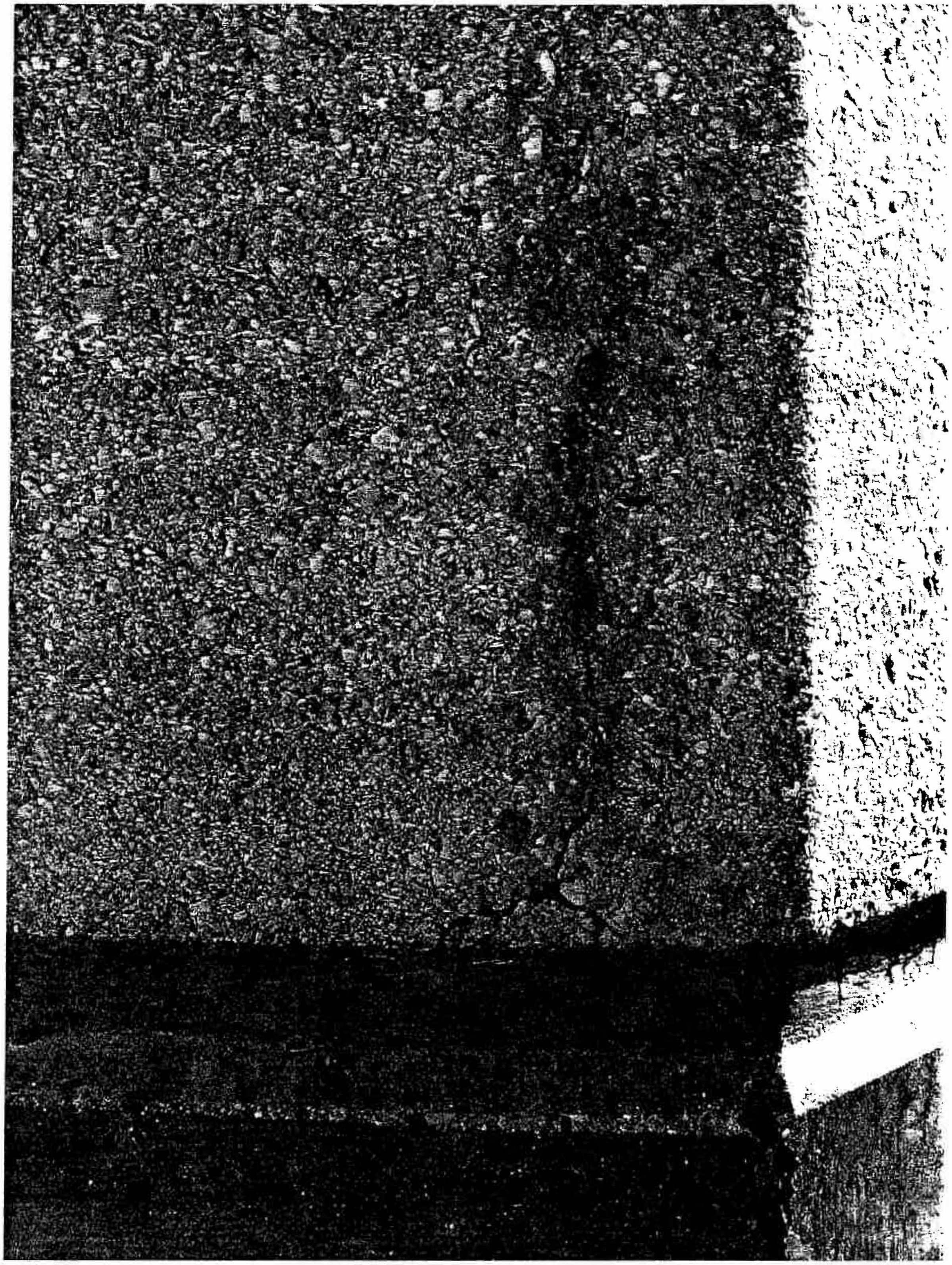

Photo 4.1-5
ATCT Ground Level

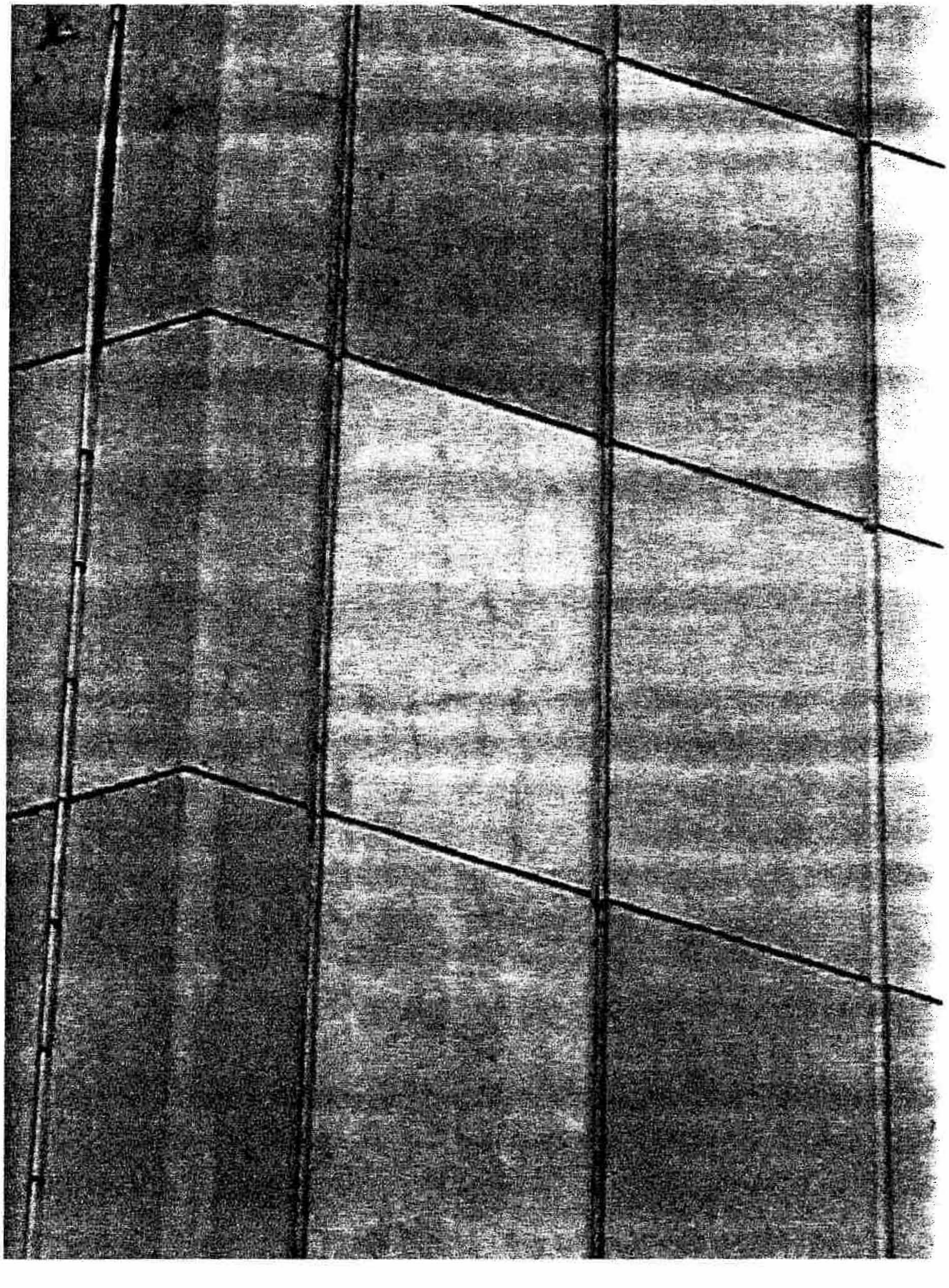

Photo 4.1-6
Cracking & Mismatch of Color in ATCT Structural Precast Panels

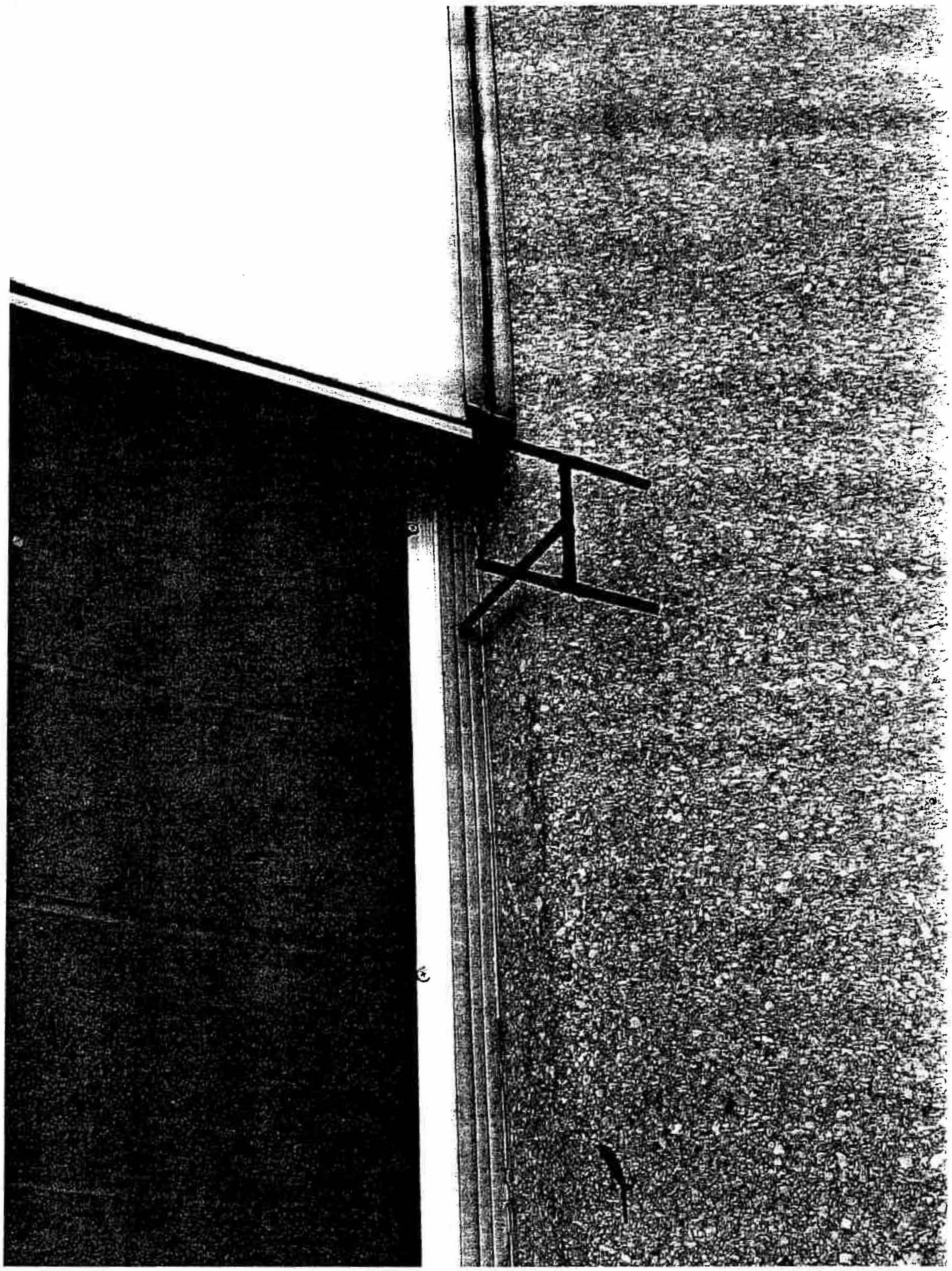

Photo 4.1-7
Penetration Through Elastomeric Seal @ Link to ATCT Shaft

Photo 4.1-8
Elastomeric Seal @ Link to ATCT Shaft

Photo 4.2.2-1
Cab Walkway

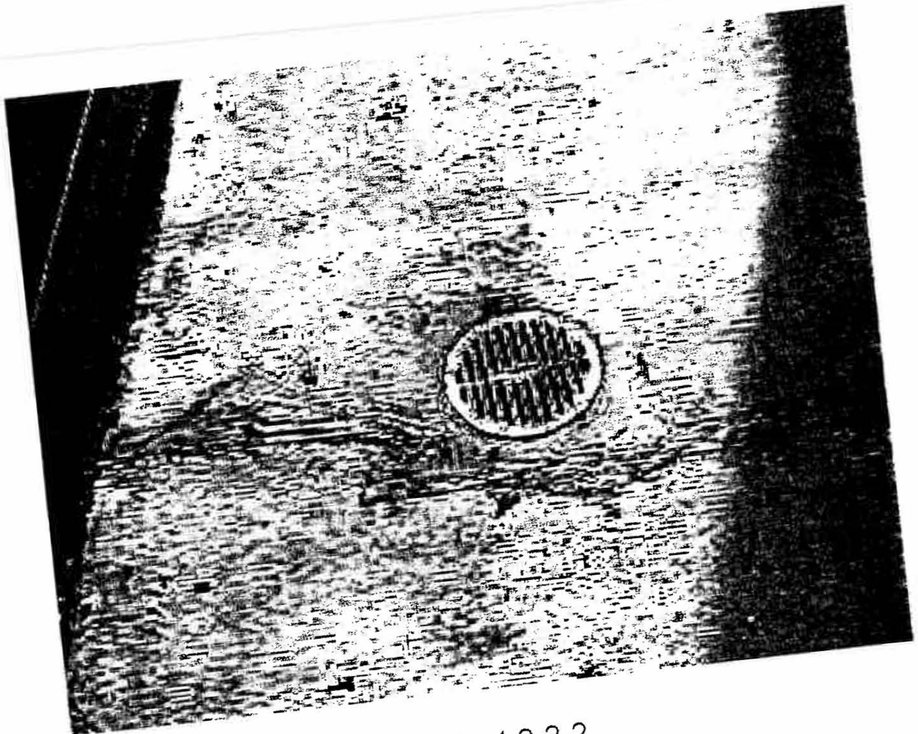

Photo 4.2.2-2
Cab Walkway

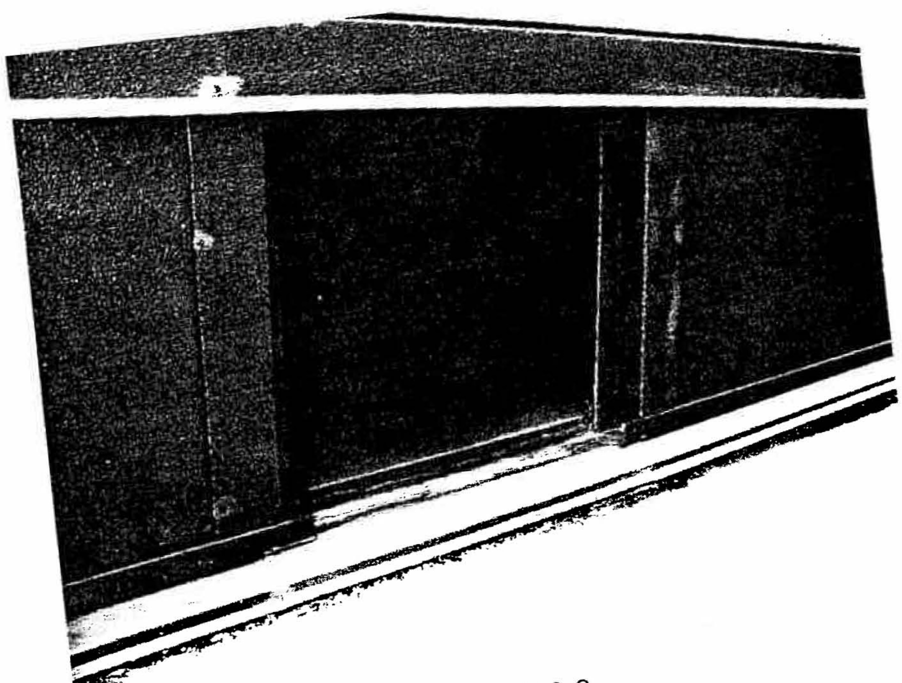

Photo 4.2.2-3
Elevator Relief Louver at Cab Walkway