Pinholes & Holidays Technical Bulletin

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PINHOLES – Everything You Need to Know AND How to Avoid Them…

*While these suggestions will aid in the reduction of holidays there is no 100% effective method. To maximize effectiveness, utilize as many of the listed procedures in combination. Skipping one step can negate the advantage gained by other efforts. Always perform detailed inspection of all coated surfaces both visually and using holiday detection equipment. There is no substitute for thorough inspection and proper repairs to defects. Please also refer to the Holiday Testing Technical Bulletin.

A holiday in a coating or lining is a defect in the coating film which exposes the coated substrate to the atmosphere or the contained material. Holidays can be large, small and even microscopic. Holidays are created in two ways:

- **Failure to effectively cover the substrate with the coating**
- **Movement of water, water vapor or air from within the substrate through the uncured coating, resulting in a void or "holiday." These are commonly referred to as a "pinhole" in the coating film.**

Holidays are especially detrimental to a coating and the substrate in highly corrosive environments, causing the substrate to corrode and undercut the coating. Failure can occur as quickly as a matter of days or weeks in severe cases. The most common form of a holiday is caused by failure to uniformly apply the coating over all surfaces. Typically, these types of holidays are found along edges, in corners, around protrusions, indentions and in areas difficult to spray or otherwise apply the coating.

On steel surfaces this type of holiday can be prevented by:

- Grinding and smoothing rough edges, corners and pitting caused by corrosion
- Design or reconfiguration of structural members to allow better access
- Application of stripe coating on all problem areas prior to spray application
- Application of total dry film thickness (DFT) in multiple coats
- Use of alternative application methods such as troweling, back rolling, brushing, etc.

On concrete and masonry substrates this type of holiday can be prevented by:

- Thorough preparation with a high/ultra-high pressure water cleaning or abrasive blast to open up bug holes and honeycombs
- Grinding edges, corners, form lines, joints and other rough areas
- Filling and smoothing of bug holes, honeycombs and other rough areas using a high early strength or polymer modified cement compatible with the epoxy topcoat
- Application of highly penetrating primers such as Raven 155, 171, 171FS, or 175
- Application of total DFT in multiple coats
- Use of alternative application methods such as troweling, back rolling, brushing, etc.

A less common, but more troublesome defect is a holiday that is caused by water vapor transmission or expanding air from within a porous substrate such as concrete. These "pinholes" are typically small in size and may appear simply as a hole, volcano looking bubble, or even a bump with a small hole through the coating. These "outgassing" pinholes can be especially difficult to get rid of once they have occurred.

The outgassing effect is explained as follows: concrete releases air and water vapor that expands when temperatures rise or humidity changes, and conversely, the concrete absorbs air and water vapor that constricts when temperatures drop or humidity rises. This is because air and water vapor, like all elements in nature, seek thermal equilibrium with their surroundings.

By its nature, concrete is inherently porous, usually 2-7%. The air voids in concrete are a direct result of concrete placement, mixing water content, surface conditions, admixture use and finishing method. There is a positive side to entraining air in areas

where freeze/thaw resistance is needed as higher air content avoids damaging concrete and actually increases its durability, however, this can also lead to outgassing problems when coatings are applied. Air entry in concrete, while enhancing durability, adds to outgassing. The more air enters, the higher the chance of outgassing. Inspection of the surface of concrete is a good indicator of the likelihood of outgassing. If many honeycombs and bug holes are visible it is likely that aggressive efforts will be required to combat outgassing and reduce pinholes that may occur. Very dense concrete has less air entry and therefore is less likely to promote outgassing. For green concrete, the addition of excessive mix water also compounds the effects of outgassing as the unused water during hydration moves from the concrete to the atmosphere.

Thus, the key causes of outgassing "pinholes" in concrete coatings are:

- Rising substrate temperatures resulting in expanding air and water vapor transmission
- Significant difference in substrate and atmospheric relative humidity
- Subsurface voids in concrete that hold air and water vapor

Pinholes in Raven 405 due to off gassing on a concrete tank. Substrate temperature had increased only 3 degrees due to intermittent sun exposure. Adjacent wall was coated without pinholes the previous day, there was no sun exposure that day. This wall was resprayed at night after temp fell 5 degrees and did not pinhole.

Subsequently the key means of reducing outgassing pinholes in concrete coatings are:

- Avoid coating application and cure during rising changes in substrate temperature
- Avoid the introduction of water to concrete
- Allow for equalization of the relative humidity of the concrete to the surrounding atmosphere
- Open up subsurface voids using abrasive blasting or aggressive water cleaning (min. 5000 psi)
- Densify the substrate surface

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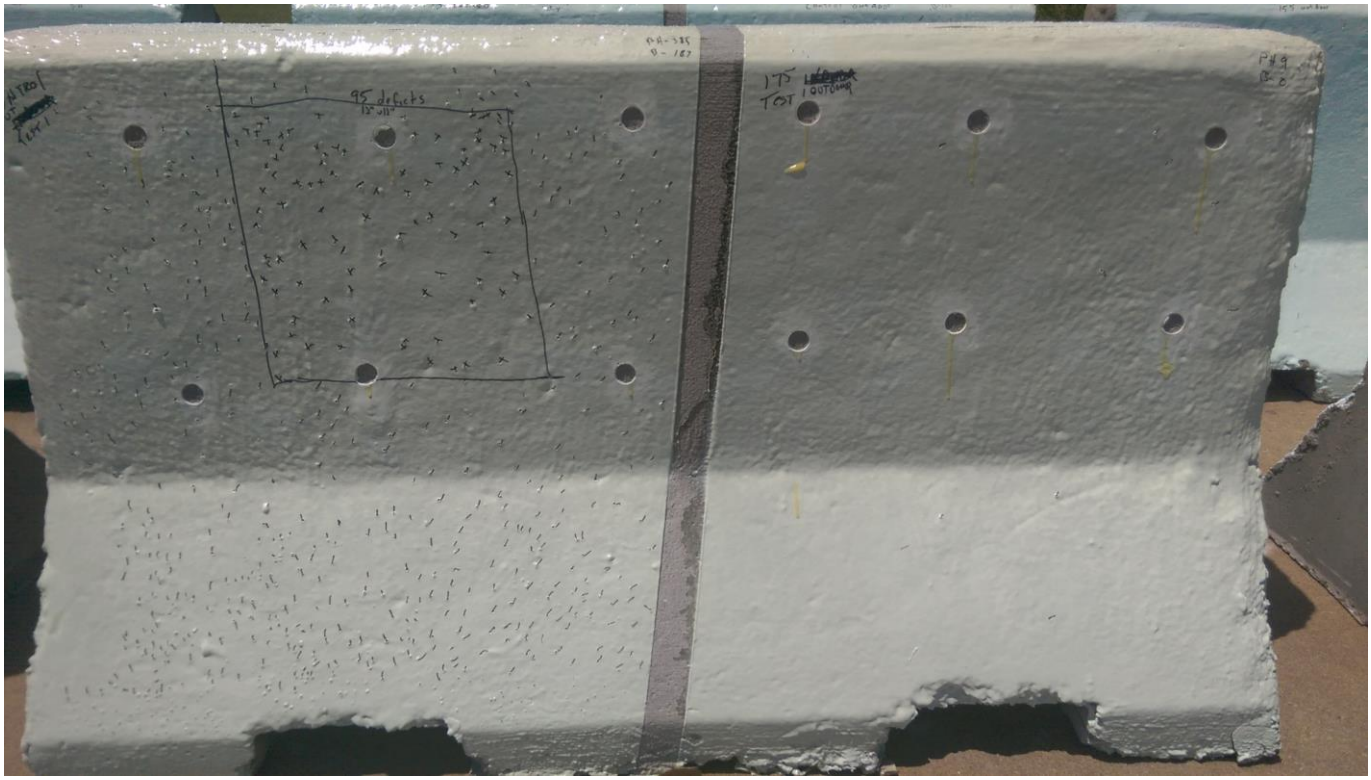
Pinholes and Holidays



Both sides were coated at the same time. No primer was used on the left block of the concrete before coating, resulting in numerous pinholes. The right side of the block was primed with Raven 175 before being top coated. As result, pinholes were drastically reduced if appearing at all.

Pinholes can be reduced significantly by adhering to the following:

- Aggressively profile the substrate and fill all surface defects as previously stated
- Allow the substrate to dry after water cleaning so that moisture content in the substrate will have a chance to equalizer with the surrounding atmosphere
- Observe substrate temperature throughout the day/night and select an application time when the surface temperature of the substrate is declining (allow for a minimum of 3-5 degree drop if possible)
- Shade, cover or otherwise protect the substrate from sunlight to minimize the resulting rise in substrate temperature
- Apply a penetrating primer such as Raven 155, 171, 171FS, and 175 to seal the surface.
- Utilize multiple applications of primers to ensure saturation of the substrate.
- Raven 155 is highly effective on dry and green concrete.
- Raven 171, 171FS, and 175 should be used on moisture filled substrates in 100% RH situations.
- Raven 155 can be used with 171, 171FS, and 175 in extreme moisture vapor transmission cases
- Allow primers to cure to at least a tack free state before additional applications
- Initially apply a light application of the coating of less than 15 mils and allow it to become tacky prior to additional applications
- Trowel or squeegee the first and/or second applications to fill voids and displace air in the surface of the substrate
- Repair existing holidays prior to the final application of coating to provide a uniform topcoat without defects