— BACK TO THE FUTURE: —

ROOF DECKS QUICKLY CORRODED BY INSULATION

By Chuck Marvin, RRC, and Bruce Byrne

The roof industry potentially has another "phenolic foam" situation on its hands. Unlike the phenolic challenge from the 1980s and 1990s, today's damage involves a different insulation corroding metal decks within a few years of original construction. For the corrosion to occur, leaks do not need to be present. The dynamics have been known for over 13 years in non-roof-related industries. Through the process of managing a client's assets in Southeast Florida, we found ourselves researching and uncovering a potentially devastating condition.

Bruce Byrne, senior roof consultant for Roof Solutions Incorporated (RSI), was performing routine inspections last year on a group of buildings ranging in age from six to eight years old. The metal decking on one building in the portfolio was severely corroded. A similar building in the same area had been inspected for a New York client in 2007 during a due diligence survey prior to procurement. This building required a roof replacement due to the deck's deteriorated condition. A third building has since been identified with the same construction and deck condition.

We now have experience with three buildings—all well under ten years of age—with severely corroded metal decks. Portions of these decks were completely rusted through. These three buildings were constructed within a couple of years of one another using the same construction materials: a mechanically attached TPO single ply directly over 1 inch of wood fiber insulation. In warm states such as Florida, Texas, and California, this inexpensive construction is used in large warehouses not equipped with air conditioning.

It is our opinion that this information needs to be released industrywide. We have

Photo 1 — Typical activities at a wood fiber manufacturing plant.

SEVERELY AFFECTED AREAS

Photo 2 — Note the burned-looking insulation at this severely deteriorated location. This was common on all significantly compromised deck areas, including those replaced to address fall-through potential. This is typical of what was sent in originally for testing and showed lower levels of chlorine on all components.

Photo 3 — The severely compromised locations are small but numerous and randomly dispersed. The roof area encompassed between 5% to no more than 10% of the deck area. The two buildings addressed were only six and eight years old. The deterioration is stunning and created a very real safety issue. We suspect deck failure will accelerate exponentially.

Photo 4 — The fasteners and plates were severely attacked.

heard one industry associate note this condition, but no connection was made. We hope this information helps others in assisting clients. At this time, we are releasing selected portions of the report generated from our research and findings. The manufacturer's name is omitted due to the warranty and legal status. The following is otherwise directly from our report:

FINDINGS IN SUMMARY

The corrosion of the metal decking has been found to be associated with the leaching of the element *chlorine* from [manufacturer withheld] wood fiber insulation that was originally installed in the roof system when these buildings were erected.

SUPPORTING RESEARCH AND FINDINGS

RSI used a recognized metallurgical testing laboratory to analyze the TPO membrane, insulation, and metal deck. The laboratory originally theorized that the chlorine was introduced into the roof assembly by an outside source. Possible contamination was originally suspected to have occurred during the cleaning of the top surface of the roof

MODERATELY AFFECTED AREAS

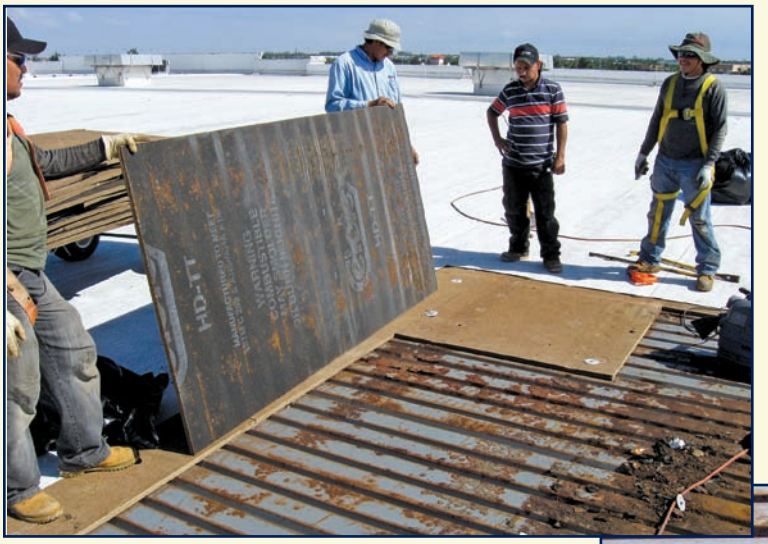

Photo 5 — This is a typical location where the insulation board is not visually deteriorated, other than minor discoloration. Rust streaks are observed on the insulation. This insulation is typical of what was sent in for a second round of testing, revealing a high level of chlorine concentrated in the insulation.

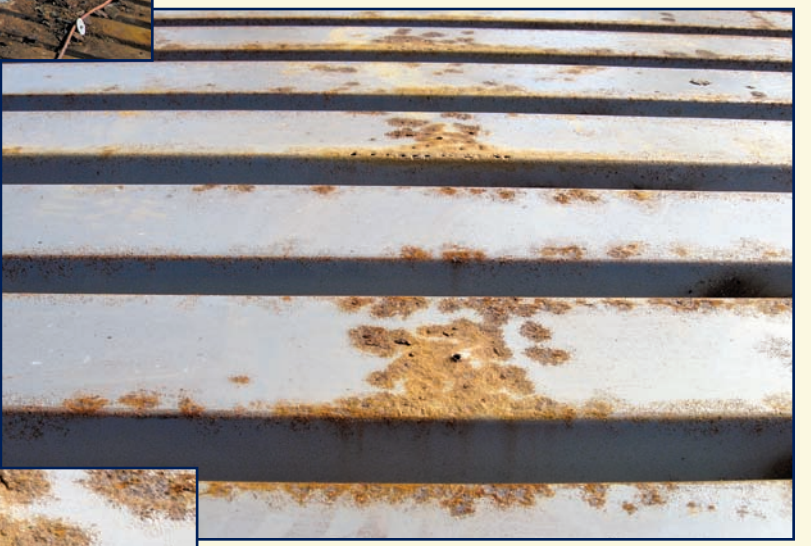

Photo 6 — Perhaps 60% to 70% of the deck area under the roof exposed by a full tear-off was found to be in this condition and treated with a rust inhibitor.

Photo 7 — A close-up of Photo 6 shows pitting and scale are developing. This was a former plate-and-screw location; the condition appears to accelerate at these locations.

membrane, perhaps using a chlorine-based product. RSI researched this theory but could find no evidence that any such cleaning process was ever conducted by owners, tenants, the original builder, or the roofing contractors (either the original installer or maintenance contractor).

Environmental and manufacturing sources of chlorine within the building and in the surrounding geographical areas were scrutinized by RSI. Our research team could find no manufacturing sources within the building, nor could we find any in the geographical area that could have contributed to these levels of chlorine being found. No other environmental sources that might have contributed to chlorine levels were discovered.

As a result, additional roof samples were sent in for further testing. These samples were not as deteriorated as the original samples.

- The energy-dispersive spectroscopy (EDS) tests found chlorine contamination in the new samples. Instead of the chlorine's being found on every component tested, it was pri-

marily concentrated within the wood fiber insulation. The lab also found levels of phosphorus inside the wood fiber insulation.

- This discovery of the element phosphorus struck a nerve with the RSI research team. Phosphorus fertilizer is used in the production of sugarcane in Southern Florida. The discovery of the phosphorus within this product indicated that they are sugarcane (otherwise known as bagasse [pronounced ba-gæs]) wood fiber boards.
- This finding led RSI to conduct exhaustive research on the product. It was discovered that the leaching of chlorine from this particular wood fiber product has been known to corrode beryllium and stainless steel metals that are used in the aerospace and Department of Energy (nuclear) industries. This information has been documented for at least the past 13 years.
- Unfortunately, this disturbing knowledge appears to have been restricted to the aerospace and Department of Energy industries where the product has been used as a thermal insulator, in storage containment, and as an impact-absorbent material. In the body of its report, RSI has included studies, tests, and documents from renowned laboratories such as the Los Alamos National Laboratory, NM; the Amarillo National Resource Center for Plutonium, University of Texas; and the Nuclear Engineering Teaching Lab. These documents date from 1997 through to 2001. A contact with the National Aeronautics and Space Administration (NASA) indicated that there have been a number of studies conducted since 2001, but the distribution of thes results appears to be restricted by the Department of Homeland Security.

A quick synopsis of the use of bagasse follows. After the stalks of the sugarcane are crushed to extract their juice (for the production of sugar products), an organic fibrous residue, bagasse, remains. Bagasse was transported (trucked) from the various sugar cane refineries to plants for production into wood fiber insulation boards. The bagasse was stockpiled unprotected in open fields near a plant, and when it was needed for production purposes, it was moved onto conveyor belts to transport the raw material into the factory for subsequent production (see *Photo 1*).

In RSI's subsequent investigation, we became aware that liquid chlorine was applied to the bagasse during its storage to kill the microbial growth resulting from the rapid development of mold in the sugarcane from high levels of sugar, water, and heat in the bagasse. The molding phenomenon in bagasse is rampant and can lead to an interstitial lung disease called bagassosis.

Cane-based fiberboard has been used extensively in various Department of Energy (DOE) packages as a thermal insulator and impact absorber. Cane-based fiberboard was manufactured in only one plant located in Louisiana. However, this fiberboard plant shut down in early 2007 due to the impact of Hurricane Katrina and other economic factors. Therefore, cane-based fiberboard is no longer available for use in the manufacture of new shipping packaging.

Current consolidation plans by the Department of Energy entail the procurement of several thousand new Model 9975 shipping packages. Therefore, an alternative to cane-based fiberboard is needed. The manufacturer in question currently produces fiberboard from other cellulosic materials, such as hardwood and softwood.

CONCLUSION AND DISCUSSION

The above extract from RSI's report addresses only one situation. We now understand the source of the corrosion. The catalyst leading to the deck corrosion was not as clear. With phenolic insulation, water was required to produce corrosion. Phenolic insulation was typically used to obtain high thermal resistance values in climate-controlled buildings. Water entering through roof leaks was required for the phenolic insulation to start corroding the decks.

In the case presented here, the deck was corroded where leaks occurred, but the catalyst could not exclusively be roof membrane leaks. The three relatively new buildings identified to date were not chronic leakers. RSI found the deteriorated deck conditions to be widespread and often located away from any roof leaks. In addition to specific assembly components, the buildings had another thing in common: they were not air-conditioned. The air was often

hot and humid. It is logical to assume convection would allow the wood fiber to be exposed to continual moisture. It is our opinion that leaks or continual exposure to high levels of humidity will provide the catalyst for corrosion.

What is not known is the effect, if any, when this wood fiber is used as a cover board even in climate-controlled buildings. Will continuously high humidity be enough to allow the chlorine to reach the deck? This wood fiber was also a popular re-cover board. We believe that roof leaks will prove to be a strong enough catalyst in future years to promote deck deterioration. This, of course, is not proven and is one reason we have chosen to release this information to RCI, Inc. Other constructions using this material need to be evaluated as the years pass and leaks develop.

RECOMMENDATION AND CAUTION

We encourage all firms to identify, where possible, the use of sugarcane-based wood fiber insulation in past designs or in the assets they manage. Although roof performance is an issue, the main emphasis here is safety. In one of our three buildings, a dozen areas required immediate replacement due to the potential for falling through the roof. One of the three buildings had its deck painted in recent years, making corrosion difficult to identify from below. We suggest RCI, Inc. consider acting as a central clearinghouse for future reporting and data accumulation.

REFERENCES

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Chuck Marvin is a Registered Roof Consultant who founded Roof Solutions Incorporated in 1994 to represent owners in an unbiased manner. From 1986 to 1990, he worked for Tremco, learning the manufacturing side of the business; and from 1990 to 1994, for Simon Roofing, learning the contracting side. Marvin's work has been published in several journals, and in 1998, he won the Horowitz Award for excellence in writing from RCI, Inc. for his contribution to *Interface*.

Bruce Byrne

Bruce Byrne has been involved in the roofing and waterproofing industry since 1978 and worked in the technical services department of several nationally known manufacturers. He has also served as an expert witness in a number of litigation cases and is an associate member of the Building Officials Association of Florida (BOAF). Bruce has a state-of-Florida certified roofing contractor's license and has worked as a senior consultant for Roof Solutions for the past decade.