

**AN 18 YEAR PERFORMANCE STUDY OF THE
STAYFLEX™ CORROSION CONTROL
AND THERMAL INSULATION SYSTEM
MANUFACTURED BY
PREFERRED SOLUTIONS, INC.
CLEVELAND, OHIO**

**PERFORMANCE SURVEY PERFORMED BY
WORLD INTERNATIONAL TESTING, INC.
STEUBENVILLE, OHIO**

***SURVEY DATE:
FEBRUARY 27, 2002***

PSI
PREFERRED SOLUTIONS, INC.

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DIVISION I: PURPOSE AND SUMMARY

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GOALS OF THE INVESTIGATION

Our objectives were to obtain data and gain knowledge of the following:

1. Verify the hydrochloric, sulfuric and nitric acid environmental conditions of the atmosphere to which the Stayflex™ System has been exposed.
2. Determine the ability of the System to maintain its integrity and remain in place for long-periods, and assess product performance characteristics which include:
 - A. Delamination
 - B. Cracking
 - C. Chemical attack
 - D. Impact resistance
 - E. Expansion and contraction
3. Determine the ability of the System to provide thermal insulation and long-term performance.
4. Evaluate through visual inspection and ultrasonic testing, the ability of the System to eliminate or retard corrosion of steel substrates.
5. Verify the speed and simplicity of installation, in regard to PSI's claims that no surface preparation is required even with difficult substrates such as corroding steel and surfaces painted with lead base paints.
6. Compare the data collected during the ten-year study to the data collected at the eighteen-year study to make realistic life expectancy projections.

SELECTION OF TEST FACILITY

In 1994, we reviewed some of the more chemically strong environments in which the System has been installed over a long-term period. We selected a manufacturing facility in the Providence, Rhode Island area, as being representative of one of the most demanding applications for the System, since it was purported to have following characteristics:

1. The plant environment contains hydrochloric, sulfuric and nitric acids to refine precious metals including gold, silver, and platinum.
2. The plant has a relatively low, 14-foot high roof deck, promoting a confined and an aggressive environment for chemical exposure to the acids and acid vapors.
3. The Stayflex™ System was installed in 1984, and thus had over a 10-year exposure history. It now has an 18-year performance record and valuable data can now be compared.

DIVISION II: TEST RESULTS

FINDINGS

Our investigation resulted in the following findings:

1. The plant facility is still creating strong chemical environments, consisting of hydrochloric, sulfuric and nitric acid vapors. Illustrations 1, 2 and 3 verify the location of the Stayflex™ System applied to the underneath side of the metal roof deck. The System consists of a nominal 1 7/8" – 2 3/8" thickness of Staycell™ 245-2.0 Spray Polyurethane Foam Insulation, covered with a nominal 1/16" Stayflex™ 2505 Thermal Barrier Coating, covered with a .005 inch Staycoat™ 200 Topcoat. The plant engineer confirmed during the 1994 survey that the System was installed in 1984. It has eliminated condensation on the metal roof deck, provides significant energy savings enabling the system to pay for itself, and has performed in a superb manner in all respects. No deviation from these facts has been noted for the 2002 survey.
2. After 18 years performance, the System is intact with no evidence of any delamination or detrimental effects from normal expansion and contraction of the building substrate. The system has been resistant to impact due to its hard coat finish.
3. Illustrations 2-16 show specific test locations, along with extraction activity. As you can see in Illustration 6, 10 and 12, the core sample conditions were favorable. Over the eighteen-year service life, virtually no degradation of the rigid polyurethane foam insulation was detected. Cross-section views of the hard shell, vinyl-ester polymer fire-resistant coating indicated a positive integrity, with no indication of composite system degradation or delamination. The topcoat did experience discoloration and slight contaminant permeation. However, this should be considered minor in relationship to the prolonged aggressive exposure over an eighteen-year period.
4. The results of the steel condition survey were also favorable. No measurable loss of section was indicated at any of the test points. The steel deck thicknesses were consistent with the maximum deviation being .005". The manufacturer's primer coating on the steel was still functioning on the majority of the surfaces of the 1 1/2" diameter test areas. There are numerous pinpoint corrosion cells throughout the steel substrates. The corrosion cells were also noted during the 1994 survey. The depth of the corrosion cells has remained constant, with no measurable loss of section. What has increased is the total number of cells per test location. The increase in cells is directly related to the original manufacturer's primer coating deteriorating after 18 years. As mentioned, there is no measurable increase in steel section loss. Therefore, evidence supports the conclusion that the attacking acid ions have been able to permeate the coating but appear to be weakened or diluted during passage thru the Staycell™ polyurethane foam towards the substrate (see Illustrations 7, 8, 13 and 14). These coating deficiencies should also be viewed as minor over an eighteen-year period in demanding environments.
5. It would appear that the Stayflex™ System is impeding moisture permeation and is preventing condensation aggression.

6. One point of interest concerning the eighteen-year study is that due to collective data documented in 1994, life projections can now realistically be estimated. In addition, the test cores from 1994 were never reinstalled, allowing the steel to be unprotected from the vapors for the past eight years. As you can see in Illustrations 14, 15, 17 and 18, the steel is experiencing significant coating deterioration and section loss. This would strongly support the hostile environment at the plant, and support the effectiveness of the Stayflex™ System.
7. The Plant Engineer stated the fire protection sprinkler system and other support appurtenances throughout the ceiling experience heavy surface corrosion and are frequently replaced.
8. The Plant Engineer stated in 1994 the Stayflex™ System had been installed in the two different areas of the plant, with each area being installed over a two day weekend. No objectionable odors had been experienced in the plant during the installation.
9. The evidence of high acid vapor exposure throughout the ceiling is overwhelming. The effectiveness of the Stayflex™ System to combat the corrosion was outstanding in 1994, and is still outstanding in 2002. Other accumulated data is shown below.

DIVISION II: TEST RESULTS

TESTING DATA CHART

TEST POINT	METAL SUBSTRATE CONDITION	STAYFLEX™ SYSTEM CONDITION & INTEGRITY	GENERAL COMMENTS
1	NO SECTION LOSS INDICATED ULTRASONICALLY. DEVIATION LESS THAN .001". NUMEROUS PINPOINT CORROSION CELLS DEVELOPING.	DISCOLORATION, NO VISIBLE DETERIORATION OR DELAMINATION OF MATERIAL CAN BE DETECTED. MATERIAL THICKNESS 1 7/8".	THE PROTECTIVE SYSTEM STILL FUNCTIONING.
2	NO SECTION LOSS INDICATED ULTRASONICALLY. DEVIATION LESS THAN .001". NUMEROUS PINPOINT CORROSION CELLS DEVELOPING.	DISCOLORATION, NO VISIBLE DETERIORATION OR DELAMINATION OF MATERIAL CAN BE DETECTED. MATERIAL THICKNESS 2".	THE PROTECTIVE SYSTEM STILL FUNCTIONING.
3	NO SECTION LOSS INDICATED ULTRASONICALLY. DEVIATION LESS THAN .005". NUMEROUS PINPOINT CORROSION CELLS DEVELOPING.	DISCOLORATION, NO VISIBLE DETERIORATION OR DELAMINATION OF MATERIAL CAN BE DETECTED. MATERIAL THICKNESS 2 ¼'-3".	THE PROTECTIVE SYSTEM STILL FUNCTIONING.
4	NO SECTION LOSS INDICATED ULTRASONICALLY. DEVIATION LESS THAN .004". NUMEROUS PINPOINT CORROSION CELLS DEVELOPING.	DISCOLORATION, NO VISIBLE DETERIORATION OR DELAMINATION OF MATERIAL CAN BE DETECTED. MATERIAL THICKNESS 2 3/8".	THE PROTECTIVE SYSTEM STILL FUNCTIONING.

DIVISION III: PROJECT PHOTOGRAPHS



ILLUSTRATION 1: GENERAL VIEW OF TEST SITE SELECTED FOR EVALUATION OF STAYFLEX™ SYSTEM AFTER 18 YEARS OF SERVICE.



ILLUSTRATION 2: GENERAL VIEW OF STAYFLEX™ SYSTEM IN SERVICE IN A HIGH ACID VAPOR ENVIRONMENT AFTER 18 YEARS. NO EVIDENCE OF DELAMINATION OR SAGGING DISCOVERED.



ILLUSTRATION 3: VIEW OF TEST REGION SELECTED, LOCATED IN PROXIMITY TO HYDROCHLORIC ACID PROCESS.



ILLUSTRATION 4: VIEW OF CORE SAMPLING EXTRACTION FOR SUBSURFACE EVALUATION.



ILLUSTRATION 5: VIEW OF SUBSURFACE SUBSTRATE CONDITION SURVEY.



ILLUSTRATION 6: CROSS SECTION VIEW OF TEST CORE SAMPLE 1.
THERE WAS NO VISIBLE MATERIAL DEGRADATION NOTED.

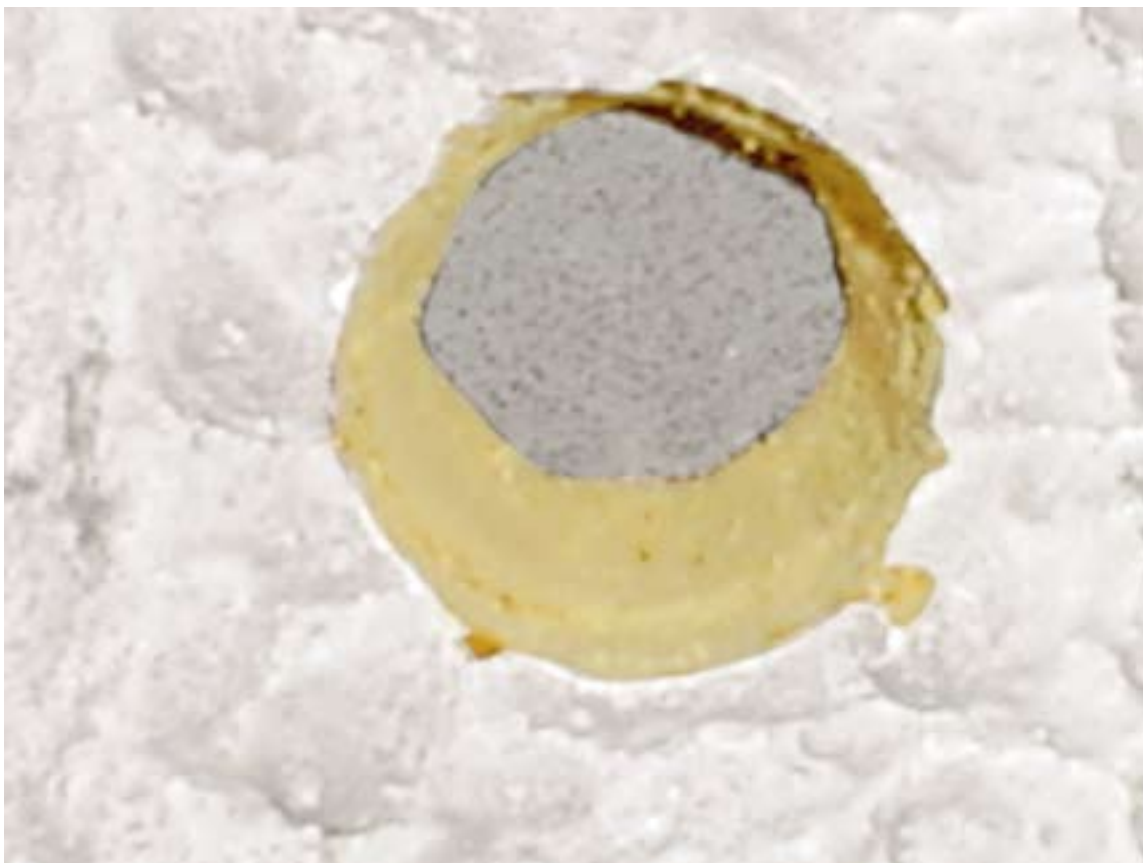


ILLUSTRATION 7: VIEW OF TEST REGION 1 , STEEL DECKING SUBSTRATE CONDITIONS. THE PINPOINT CORROSION CELLS THAT WERE OBSERVED DURING THE 1994 EVALUATION HAVE INCREASED SLIGHTLY. THIS WOULD INDICATE THAT THE STAYFLEX™ SYSTEM IS PROVIDING EXCELLENT PROTECTION FOR THE STEEL IN A HIGHLY ACIDIC ENVIRONMENT.

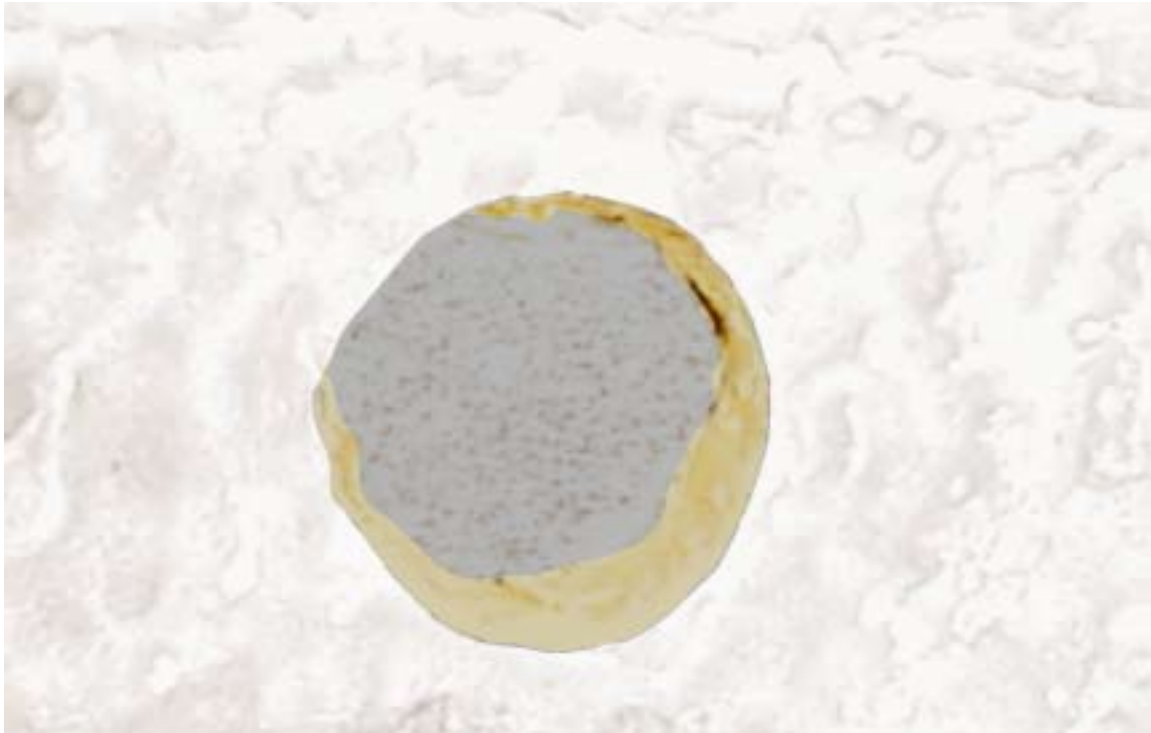


ILLUSTRATION 8: VIEW OF CORE SAMPLE 2 COATING AND SUBSTRATE CONDITIONS. AS IN SAMPLE 1, PINPOINT CORROSION WAS OBSERVED. IN COMPARISON TO THE UNPROTECTED ROOF DECKING SEEN IN ILLUSTRATION 15, THE LIFE EXPECTANCY PROJECTIONS FOR THE ROOF CAN BE ESTIMATED IN EXCESS OF AN ADDITIONAL 25 YEARS.



ILLUSTRATION 9: ULTRASONIC TESTING OF THE STEEL VERIFIED THAT NO MEASURABLE SECTION LOSS HAS OCCURRED.



ILLUSTRATION 10: CROSS SECTION VIEW OF TEST CORE SAMPLE 2.
THERE IS NO VISIBLE MATERIAL DEGRADATION NOTED.



ILLUSTRATION 11: VIEW OF SECOND TEST SITE SELECTED FOR
EVALUATION OF STAYFLEX™ SYSTEM AFTER 18 YEARS OF SERVICE.



ILLUSTRATION 12: CROSS SECTION VIEW OF TEST CORE SAMPLE 3.
THERE IS NO VISIBLE MATERIAL DEGRADATION NOTED.

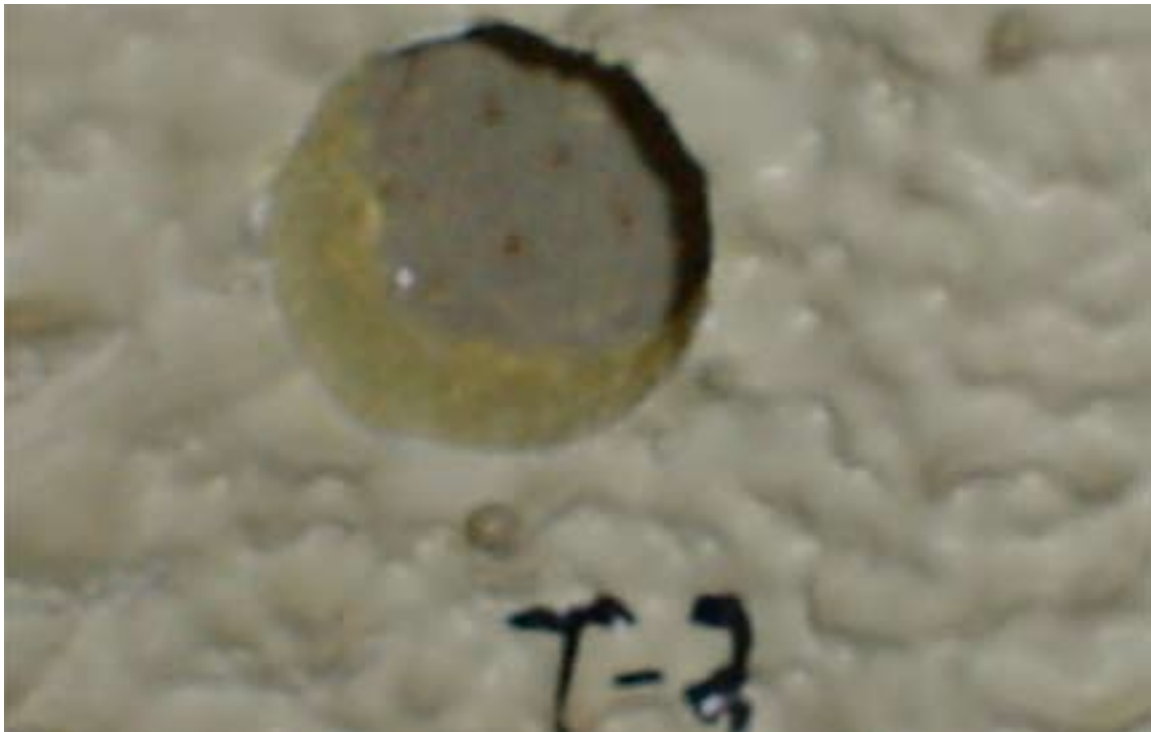


ILLUSTRATION 13: VIEW OF COATING AND STEEL CONDITIONS, TEST AREA 3.
NO MEASURABLE SECTION LOSS NOTED, VERIFIED ULTRASONICALLY.



ILLUSTRATION 14: CORE SAMPLE 4 WAS TAKEN IN PROXIMITY TO A 1994 TEST REGION FOR COMPARISON PURPOSES. A SLIGHT INCREASE IN THE NUMBER OF PINPOINT CORROSION CELLS WAS NOTED IN THE 2002 TEST LOCATION. THE EXPOSED TEST LOCATION FROM 1994 HAS DRAMATIC SECTION LOSS IN EXCESS OF 50%. THIS WOULD SUPPORT THE SUPERIOR PERFORMANCE OF THE STAYFLEX™ SYSTEM OVER THE PAST 18 YEARS.

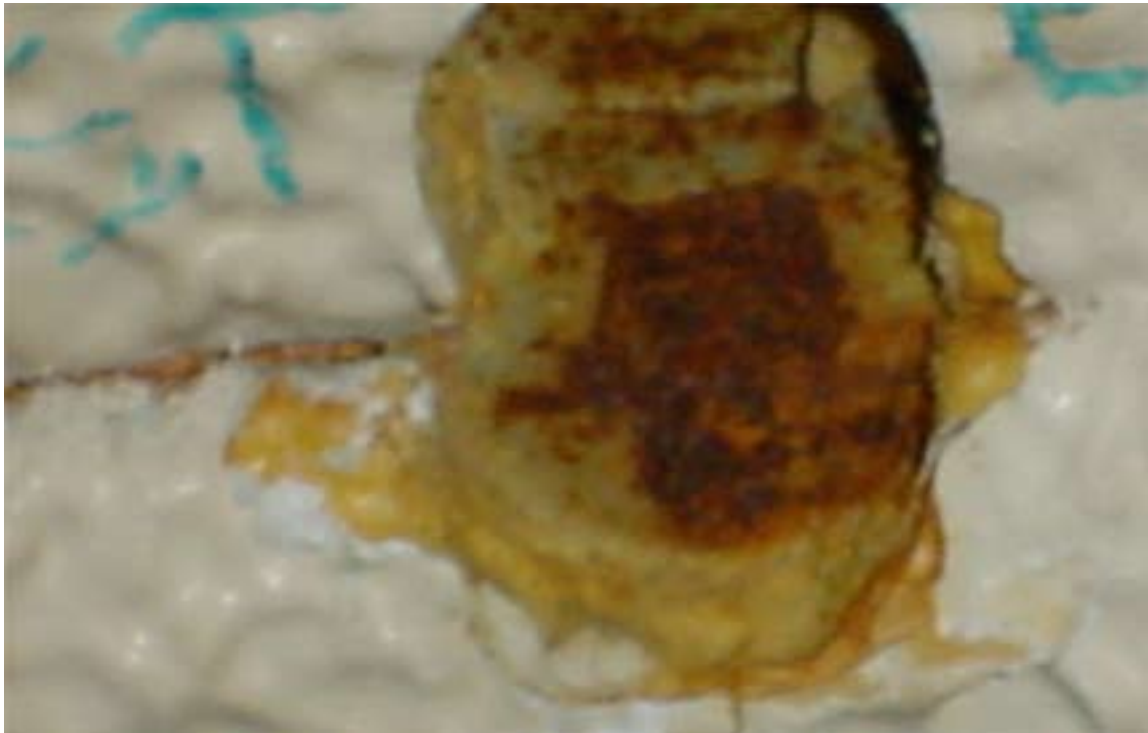


ILLUSTRATION 15: A VIEW OF TEST AREA 2, 1994. SIGNIFICANT DETERIORATION WAS DISCOVERED ON THE UNPROTECTED STEEL ROOF DECKING WHICH HAS BEEN EXPOSED SINCE 1994. THIS DISCOVERY WOULD ALSO SUPPORT THE SUPERIOR PERFORMANCE OF THE STAYFLEX™ SYSTEM IN A HIGH ACID VAPOR ENVIRONMENT.

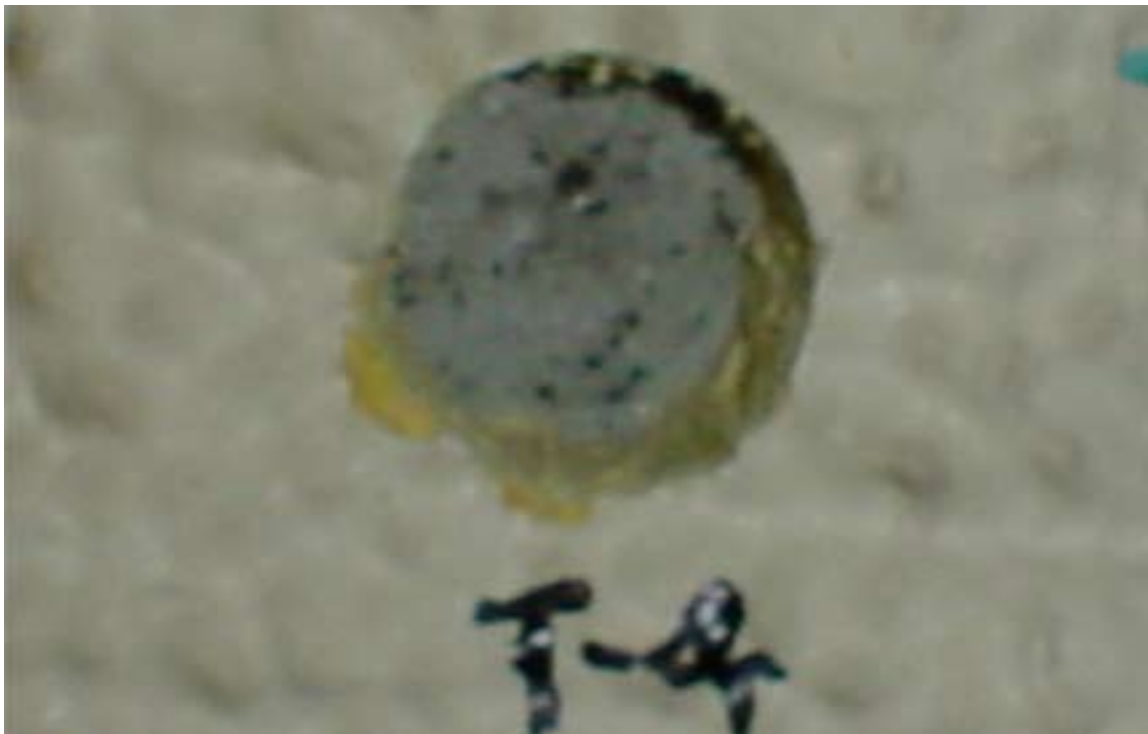


ILLUSTRATION 16: VIEW OF TEST AREA 4. ALL ADHESION CHARACTERISTICS ARE STILL FUNCTIONING. NO MEASURABLE SECTION LOSS INDICATED.



ILLUSTRATIONS 17 & 18: THE DETERIORATED CONDITIONS OF THE ROOF DECKING, EXPOSED SINCE 1994, WOULD GREATLY SUPPORT THE FINANCIAL NECESSITY OF A PRODUCT LIKE THE STAYFLEX™ SYSTEM. FROM 1981 TO 1994, NO MEASURABLE LOSS OF SECTION WAS NOTED ON THE STEEL DECKING, AND ONLY MINOR PIN-POINT CORROSION CELLS. FROM 1994 TO 2002, 100% COATING DETERIORATION HAS OCCURRED, AND SECTION LOSS UP TO 60% WAS DISCOVERED AT THE EXPOSED STEEL TEST POINTS FROM 1994. THIS WOULD SUPPORT TWO POINTS; THAT THE ACIDIC ENVIRONMENT IS EXTREMELY HOSTILE, AND THAT THE STAYFLEX™ SYSTEM IS PROVIDING EXCELLENT PROTECTION FOR THE ROOF STEEL.

