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UC-1009

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STATUS REPORT

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UCAR LATEX 812
AS A ROOF COATING VEHICLE

SUMMARY Testing on several types of polymers now available to Union Carbide for the roof coating market has been completed except for certain properties of weathered film. The tests emphasized water and caustic resistance and adhesion as well as film integrity.

Four [illegible] and UCAR Latex 443, and two versions of Rhoplex from Rohm and Haas, were the reference resins. To explore the effectiveness of modifying latexes, several variations of UCAR Latex 812 were also tested. Examples of two commercial roof coatings were included as standards of performance.

UCAR Latex 812 is not an immediately viable candidate from the results of this study. Although good in adhesion, its water/caustic resistance is very sub-standard. Most other candidates were somewhat lower ranked than UCAR 812.

Since the ultimate purpose of our efforts is to achieve a technically competitive position at American Western Manufacturing, a viable candidate must meet/surpass the performance of their "Rhoplex" AC-64-based vehicle. As this goal has not been met with current products, a new polymer is needed.

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the testing list because of the known (to UCC) sensitivity of UCAR 163 to caustic conditions.

Since any useful candidate will also possess durability, the same testing was to be conducted on films subjected to accelerated exposure, as well as on films of early (48 hours) and full cure. A period of 2000 hours of constant UV exposure in a Q-UV apparatus was selected as the basis for durability testing since several contractor associations (ICBO,UFCA,etc.) propose or want to propose accelerated exposure specifications on coatings ranging from 2000 to 8000 hours.

Vehicle Selection

UCAR Latexes 153, 154, 163 in use in the roof coating field represent an extension of ten-year old mastic and sealant technology. Newer performance requirements and broader interest in water-borne alternatives are demanding a new generation of resins. One of the immediately available "new" choices for adapting to roof coatings was UCAR Latex 812, a more flexible acrylic than UCAR 163. The n-butyl acrylate portion of UCAR 812 would be expected to give better water resistance than the essentially all ethyl acrylate UCC products now in use.

163 82
? 80 EA 72
13 2Bm 19

Various modifications, suggested by previous work, were applied to the UCAR 812 base resins: wet adhesion latexes, BAKELITE Vinyl Resins, and an acid complexing material from water resistant floor polish technology, zinc ammonium carbonate. Two lab versions of a UCC-produced LC-67 (R&H) offset, were included. LC-67 is also used in roof coatings. A "standard" coating in the industry, "Diathon", made by United Paint and Coatings, Spokane, Washington provided another link to the performance of a commerical system.

Test Formulations

The "Diathon" product represented a successful approach to the requirements of the roof coating industry specifications and performance. A mid-1981 project analyzed the composition of "Diathon" and, based on an elemental identification, performance and market knowledge and educated guesswork, the formula shown in Table I was derived by AWM and UCC.

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strips per sample were averaged and reported in Table III of this report. Both volume (l x w x h) and weight changes are noted for the 2-day and final schedules. The accelerated exposure films will be tested also when 2000 hours of UV have been completed.

Four-hour Caustic Soak Test

This test was similar to the preceding test description except the medium was 5% sodium hydroxide solution (pH > 14). Because of the extreme effect, results were obtained in hours rather than days. Since alkalinity sensitivity is of most concern early in new applications, this test is not planned for the films under-going UV exposure. Table IV shows these results.

Ponding Resistance Test

The purpose of this method was to simulate standing water areas on roofs. Free films with a circular test area of about 3 square inches were bonded with a cyanoacrylate (e.g. "Super-Glue") adhesive to a plastic or metal pint container which had the bottom cut out. The angle described by the outside of the container and the film surface was sealed for good measure (e.g. 3M Weatherstrip Adhesive) against leakage around the film. Enough margin of film surface was left extending outside the container for the sealant and necessary taping. An appropriately sized filter paper (smaller than sample film but greater than test area, e.g. No. 1, 3 1/2" Whatman) was weighed (to four places) and placed on a smooth glass plate. The assembled cup/film apparatus was placed over the filter paper. The projecting sample film edges were taped to the glass to prevent fluid transport beyond the filter paper, particularly in case of saturation or rupture of film.

About 1/2 inch of water (50 ml) was then added to the cup and the cup was capped to retard evaporation. Use of larger water amounts would give greater head or column water pressures on the film, which might be appropriate once initial screening tests are completed.

At appropriate daily intervals the filter paper was removed and weighed in milligrams for water pick-up. As the weight pick-up approached 700 mg the paper became saturated. Two films per sample were averaged to obtain the results

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of this approach with a problem substrate such as urethane foam.

So test severity was increased by going to "wet" adhesion conditions. Coated foam samples were submerged in water for 24 hours previous to testing similar to ASTM D-413. Care was taken that water access to the adhesive interface was through the coating, not the foam. This was accomplished by suspending the test blocks coating-side down to a depth which did not exceed the coating protection on the side of the test blocks of foam.

The results, as displayed in Table VIII, were obtained for 180° peel strength testing on the Instron Tester. The previosly imbedded one-inch canvas strip was pulled at one-inch per minute and the data were recorded in pounds per linear inch and the type of failure (adhesive/cohesive). Only the final dry samples showed measureable adhesion. All 2-day dry samples, including the commercial systems, failed absolutely: The strips dropped off during or immediately after soaking.

Elongation/Tensile Test

Results of this ASTM D-2370 based test are reported in Table IX. This standard film integrity test allowed relative comparisons among the samples for free-films of both the early and full cure versions. The Instron Tester was set at 0.2 inches per minute crosshead speed. Samples were dumbbell cut specimens with 0.25 x 0.025 inch test sections. Data were obtained at room temperature and are the result of an average of three determinations per sample.

Water Vapor Porosity Test

Another standard test was the water vapor transmission measurement by ASTM E96, Procedure A. Using Gardner permeability cups containing a drier, a free film is sealed over the cup and placed in a 50% relative humidity environment. The accumulation of vapor through the film was determined by weight. The equilibrium rate was calculated after 4 to 7 days as both metric permeability and English permeance. While English perms are a common reference, metric permeability is technically preferred because of the convenience of the units and the additional consideraton of

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sitive materials. Lower solids were necessary to accomodate wet adhesion additives.

The level of modification of UCAR 163 by TPX-6277 directly improved the viscosity response, a situation also experienced at American Western but not fully resolved in their production. The normally undesirable high thickener demand of AC-64 was a handy feature in high solids roof coatings, as seen here. Alsip's LC-67 offset (AX-9110) also offered an improvement over UCAR 153 and 163 in this property.

However, the most important comparisions were the performance of UCAR 812 versus the AC-64 system. It was through these test results that the viability of UCAR 812 as a roof coating resin candidate became questioned. In five of the eight tests, AC-64 was a clear choice over UCAR 812. These tests emphasized the better water and caustic resistance of AC-64. On the plus side, UCAR 812 showed a substantial advantage in foam wet adhesion. But all versions tested had better adhesion than AC-64, and field experience contradicts that conclusion. A test by test discussion follows.

Water Swell

Interestingly, the early cure versions outperformed the more completely dried samples overall. This suggests that the early cure systems had not lost enough inter-or intra-particle water to accomodate the same degree of swelling as the final dry systems. Likewise, it follows there was a significant degree of void-forming shrinkage occurring, which provided the space for water accumulation as drying progressed. The early cure commercial versions resisted volume swell better that the UCC systems even though weight increases may have been equivalent.

"Diathon" provided the lowest swell by a clear margin, according to Table III. This sample of "Diathon" was obtained at a time when it was thought to be based on a high percentage styrene-containing polymer (from Specialty Polymers). The composition of "Diathon" is now indicated to be acrylic from Rhom and Haas. Testing has not been done on the most recent version.

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of these samples could occur because the testing was only four hours duration. The very low swelling of the best samples may have been more significant with a longer test time compared with those which were already approaching 50%.

Ponding

As a class of polymer types, UCAR 812 had the worst ponding resistance compared with the TPX-6277/UCAR 163 blends, the AX-9110 types and the AC-64 coatings. The UCAR 812 allowed saturation sooner from faster absorption than the others up to the one week ponding time. Among the UCAR 812 modifications, the BAKELITE VROH resin version was substantially better than the other variants, though not as good as the non-UCAR 812 types.

As would be expected, the final dry was dramatically better than the 2-day group. Whether or not the one week testing time is sufficient is open to question. With all the existing flat roofs, the insurance of a two to four (or more) week performance might eventually be demanded by nervous end-users of water-borne coatings.

Contrary to indications of the water swell testing, the best ponding resistance came from the Torrance version of LC-47 (AX-9110). The AC-64 and the 4:1 TPX-6277/UCAR 163 formulations were very acceptable seconds. Another surprising result from Tables Va and Vb was the comparatively poor showing for "Diathon".

Since increasing the amount of TPX-6277 in the UCAR 163 blends improved ponding, and both were similar to the AC-64/WP-1 system, this testing does not predict that our previous 7:1 blend at AWM would be any more sensitive to water ponding than their system under early-or full-cure conditions. The ability to retain adhesion to the foam in spite of water penetration may be a factor.

Efflorescence

Blister and efflorescence ("wicking") resistance were generally good for all types and cures of this formulation. An edge could be given to the Alsip AX-9110 and "Diathon" in the early-cure but the differences are small and may not be repeatable. The blistering on the AC-64 and the high pH UCAR 812 did consistently appear early (hours) in the

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three-week test according to Table VI. There was no wide-scale adhesion loss on any of the test blocks in this procedure, which produces noticeable failures within hours or days on ordinary coatings. An effort to aid the adhesion/blister resistance of UCAR 812 by applying over an especially "sticky" primer proved to be unproductive or unnecessary.

Wet "Hot" Adhesion

The rigorous action of caustic under hydrostatic pressure effectively separated the "doers" from the "watchers" in this test. All versions of UCAR 812 succumbed, although the BAKELITE VROH version performed valiantly enough to rate a fair second place to the virtually unaffected AC-64/WP-1 and Torrance AX-9110 (LC-67). The ZAC-modified UCAR 812 failed so badly so early that hydroxide salts emerged through the relatively thick coating in substantial amounts. Some initial resistance to failure was offered by wet adhesion and vinyl modifications of UCAR 812.

The TPX-6277/UCAR 163 blends began failing early and were among the worst performers. Essentially the same effects were demonstrated with "Diathon". In this second caustic exposure type test, the Torrance AX-9110 showed the same unusual performance not anticipated from its low water resistance exhibited elsewhere.

Foam Wet Adhesion

The biggest surprise of this project was the almost non-existent showing by AC-64 in this difficult substrate test. Even our poorest was a wide margin better. This result parallels earlier lab testing of our products against this system and so should "red flag" any superior performance conclusions, since AWM doesn't experience the comparison that way.

This was the one test in which UCAR 812 exhibited outstanding results. Although the hard wet adhesion UCAR 812 was the best, modification of UCAR 812 did not, in general, improve on the original. The UCAR 174 primer and zinc ammonium carbonate versions, shown in Table VIII, severely decreased adhesion.

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Alsip's LC-67 offset (AX-9110) performed on a par with the UCAR 812 and somewhat better than the TPX-6277/UCAR 163 blends. Higher levels of UCAR 163 seemed to offer better wet foam adhesion. Recalling that some of the problems leading to "Diathon's" recent formulation change were connected with poor foam adhesion, the AX-9110 Torrance level of adhesion would be considered marginal at best.

The "essence" of the real AC-64 adhesion advantage seems to be elusive in our laboratory testing so far. This wet version may have been as overly severe as the first dry version was not, as might be surmised from the across-the-board failures of the 2-day dry samples.

Film Integrity

Most of the AWM formulation versions were equal to or better than a "guideline" minimum elongation of 300%. As shown in Table IX, Torrance AX-9110 (LC-67 type) was far short. "Diathon" was close, even though their literature specifies 400%. UCAR 812 had the most flexible and best strength combination.

All coatings except "Diathon", AC-64/WP-1 and 1:1 TPX-6277/UCAR 163 improved in flexibility as cure time increased. However, it may be that film strength is more important than flexibility when the coatings are relatively new (2-day dry), so that rain, flowing water, and other abrasive influences may be resisted. The 4:1 TPX-6277/UCAR 163, "Diathon", BAKELITE VMCA/UCAR 812, hard wet adhesion UCAR 812 and Alsip AX-9110 (LC-67 type) were all notable for strengfth at early cure. The AC-64/WP-1 was as weak as the poor Torrance AX-9110 at this incomplete dry stage. The AC-64/WP-1 system did cure to a surprisingly flexible and strong film.

Modification of UCAR 812 did not improve film flexibility, but all versions were certainly well into the acceptable range if such changes were to offer benefits in other properties. The hard wet adhesion and BAKELITE VMCH/UCAR 812 variants depressed elongation the most.

The TPX-6277/163 systems were about equal to the lowest UCAR 812 versions. As expected, flexibility decreased and tensile increased with the TPX-6277 level. Somewhat puzzling was the observation that the AX-9110 types were rela-

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tively low in elongation considering the supposedly lower glass transition of this polymer type than all the others.

Of great interest will be the UV-exposed film data, particularly with the plasticized AC-64 coating. The UCAR 812 systems would be expected to retain the most flexibility in weathered films.

Water Vapor Porosity

There were no poor results among the candidates in this test. All coatings tested in the low end of the range expected for latex coatings (3 to 30 x 10^{-2} metric perm-cm or about .1-10 perms). This was probably due in large part to the relatively thick films used for these roof coats, as well as good formulation practice and reasonable PVC level. Early cure permeability tended to be higher than the complete cure versions, though not always.

The lowest porosities at both cure conditions were from AC-64/WP-1, Alsip's AX-9110 (LC-67 type) and the TPX-6277/UCAR 163 blends. Modification of UCAR 812 usually raised the porosity, with the BAKELITE VROH version pushing it the farthest. Previous testing of "Diathon" placed it above the levels in this project but still in the lower third of the usual latex range.

Rating the Vehicles

Obtaining a relative positioning for comparing the merits of competing systems can be challenging when there is no clear-cut best choice across the board. The AC-64/WP-1 vehicle might be a top-rated system because of its prominence in the majority of tests. However, wet adhesion was a bad test for this one. Since some of the tests may be considered more important than the others and thus deserving higher influence in a rating, a weighted ranking seemed appropriate.

The protocol for such a ranking was to establish 1) groups of tests by their importance and 2) groups of similar performance for the samples in each test. The two main categories were the cure times. The following test grouping was proposed:

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Priority	Tests	Multiply relative rank value by
1	Ponding Foam Wet Adhesion Wet, "Hot", Adhesion	3
2	Water Swell Caustic Swell Elongation/Tensile	2
3	Tombstone Porosity	1

For each test in each cure condition, the coatings were simply ranked in relative groups of approximately equivalent performance. Ranking scale was 4 (best) to 0 (worst) by the arbitrary division of excellent = 4, good = 3, fair = 2, poor = 1 and dismal = 0. For tests in which all performance was adequate (e.g. Tombstone, Porosity), an "all OK" rating worth 3 was used. For each vehicle, the relative ranks, multiplied by the test priority values, were accumulated to generate an overall score for that vehicle in each cure category. The sample score was then divided by the number of tests in which it was run to yield a normalized ranking. See the Appendix for details of the ranking procedure.

Figure 1 shows the ranking for the UCAR 812 variations tested at a 2-day cure time. The "control" AC-64/WP-1 was also included on the bar chart for comparative purposes. With early cure, the hard wet adhesion and BAKELITE VMCH versions of UCAR 812 were equal "seconds" to AC-64/WP-1. The others were close behind.

A similar ranking for the remaining resin types of the 2-day cure revealed generally higher performance than the UCAR 812 types. "Diathon" ranked highest of all. The TPX-6277/UCAR 163 4:1 and Alsip's AX-9110 (LC-67 type) were the others which ranked above AC-64/WP-1. Figure 2 displays this data.

Likewise, the complete cure (final dry) testing was separated into UCAR 812 and "Others" groups and the ranking shown in Figures 3 and 4 respectively. BAKELITE VROH was the clear top performer in the UCAR 812 modifications, although most others ranked fairly high. As in the early

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cure category, the other terms ranked somewhat higher than the average UCAR 812 types, with AC-64/WP-1 edging out UCAR 812/VROH for best rank. "Diathon" was much lower ranked in the final dry versus the top ranking at 2-days dry.

By combining the two cure category rankings, a single composite rank for each formula version was obtained. Figure 5 demonstrates this comparison. That ranking demonstrated the following order of performance (or, perhaps, desirability):

Order	AWM Formulation Variant
1	AC-64/WP-1 vehicle.
2	Alsip's AX-9110 (LC-67) vehicle
3	UCAR 812/BAKELITE VROH vehicle
4	UCAR 812 vehicle
5	TPX-6277/UCAR 163 4:1 vehicle
6	TPX-6277/UCAR 163 1:1 vehicle
7	"Diathon" (not AWM)
8	Torrance's AX-9110 (LC-67) vehicle
9	UCAR 812/Hard Wet Adhesion vehicle
10	UCAR 812/BAKELITE VMCH vehicle
11	High pH UCAR 812 vehicle
11	UCAR 812/Soft Wet Adhesion vehicle
12	UCAR 812/Zinc Ammonium Carbonate vehicle
13	UCAR 812 vehicle with UCAR 174-based primer

While the top ranked systems may not be superior in all tests, they ranked high enough consistently in the individual tests to come out ahead of those characterized by wide variation from test to test. This is particularly true for the first four or five in the preceding list. Note that in spite of the poor foam wet adhesion of AC-64/WP-1, it still came out on top from its excellent performance in a majority of the tests.

CONCLUSIONS

Union Carbide does not have an "off-the-shelf" alternative that would be advantageous to submit to American Western Manufacturing now. Some resin types have shown promise and could be developed further. The results seem to indicate polymer composition should be moving in the direction of higher acrylates, i.e. away from ethyl acrylate. UCAR Latex 812 certainly has some attractive properties of film

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flexibility/strength and adhesion. But it falls short of practical water/caustic resistance for a generic roof coating resin.

Although LC-67 (Rohm and Haas) is an old technology, its composition does have merit as seen in the Alsip version of this polymer, which ranked well in all the tests. Its shortcoming could be adhesion under wet, caustic conditions but the Torrance version was outstanding in this respect. Combining the best results of each would have produced a coating easily competitive with the AC-64 system. The key to obtaining these complimentary features is, no doubt, to be found in how the two nearly equivalent latexes were put together.

While the TPX-6277/UCAR Latex 163 blends are in many ways admirable performers, they always seemed to fall just enough behind the AC-64 coating as to eliminate this family as a viable approach for our next assault on AWM, at least not without some extensive redesign.

The BAKELITE VROH modification of UCAR 812 came out fairly strong in the ranking, in which most variations handicapped the UCAR 812 polymer. This vinyl/latex combination showed best in ponding and both adhesion tests, the three top rated requirements. Only its [illegible] were [illegible] ances help the ranking down. In a production-scale operation, handling the [illegible] emulsion/solution problems presented by this approach might be formidable.

The upcoming weathered film testing will be interesting for its "scientific" value, since exposures are rarely carried to these extremes on candidate systems. But, they will probably not alter the ranking of these resins significantly, given the immediate problem areas shown by this current testing phase.

The most important improvements to strive for in the next generation of roof coating polymers remains greatly augmented water/caustic resistance with inherent (rather than additive) adhesion performance over difficult surfaces such as "hot" masonry and slick polyurethane foam insulation.

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BUSINESS CONFIDENTIAL

TABLE I

American Western Manufacturing

Test Formula

100 Gallons

		Pounds
Latex (@ 54.0% N.V.)		662
"Gafac" BH-650	Pre-Mix*	6
"Antara" LM-400		6
Ethylene Glycol		15
Aqueous Ammonia 28°		10
KTPP	Pre-Mix	0.75
"Tamol" 850		9
"Triton" X-100		4
"Nalco" 2303		5
"Ti-Pure" R-900 TiO_2		48
Aluminum Trihydrate		212
"Vicron" 25-11 $CaCO_2$		141
"Mistron" C-500 Talc		82
		1201

Properties	
Total Solids, % by weight	72
Total Solids, % by volume	62
PVC,%	38
Viscosity, KU	95-105
pH	8-9.5

* Caution: Active exotherm on neutralization with NH_4OH

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TABLE III

Two-Week Water Soak[1)]

Volume/Weight Swell[2)]

% Increase (Decrease)[3)]

Resin in AWM Formulation	2-Day Dry	Final Dry[4)]	I. D. #
UCAR Latex 812 as is	-	W 102/74*	29-32-A
UCAR Latex 812 @ 8.5 pH	W (7)/14*	W 84/66*	29-32-B
ZAC mod. UCAR Latex 812[5)]	L (30)/8*	W 75/61*	29-32-D
WAGS mod. UCAR Latex 812[6)]	L (24)/22	W 38/30*	29-32-E
WAGH mod. UCAR Latex 812[7)]	T 60/9	T 46/38*	29-32-F
VROH mod. UCAR Latex 812[8)]	T 135/51*	W 99/78*	29-32-G
VMCH mod. UCAR Latex 812[9)]	T 62/13	T 72/60	29-32-H
TPX-6277/ UCAR Latex 163 4:1 dry	T 57/11	T 72/61	29-32-I
TPX-6277/UCAR Latex 163 1:1 dry	T 58/11	T 61/51	29-32-J
AX-9110 (Alsip)[10)]	T 62/7	T 58/44	29-32-K
AX-9110 (Torrance)[11)]	T 178/222*	W 241/186	29-32-L
AC-64/WP-1[12)]	T 4/5	T 55/43	29-32-M
"Diathon"[13)]	T 5/10*	T 20/20*	29-32-N

1) Strips ≈4 x 1/2 x .025 inches, submerged in tap water at room temp.
2) Letter indicates which dimension swelled most: L=length, W=width, T=thickness.
3) * means greatest swell occurred at one week then no change or decreased.
4) Final dry is two weeks air dry and one week 120°F. dry.
5) Zinc ammonium carbonate @ 1.5% wet.
6) Wet adhesion soft (TPX-6324A) @ 15% dry.
7) Wet adhesion hard (TPX-6352) @ 15% dry.
8) VROH/plasticizer (1:1) @ 8% dry.
9) VMCH/plasticizer (1:1) @ 8% dry.
10) 1-RES-133, L-67 match.
11) 18-1-2-18, L-67 match.
12) 7% dry WP-1 plasticizer.
13) "Blue Dot", United Paint and Coatings, Spokane, WA. This formulation has since changed.

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TABLE Va

Ponding Evaluation[1)]

2-Day Dry

Resin in AWM Formulation	Thickness, mils	mg of Water Transferred at Hours[2)]				
		24	48	96	120	169
UCAR Latex 812 @ 8.5 pH	27	409	-	Sat'd		
ZAC mod. UL 812[3)]	33	374	-	Sat'd		
WAGS mod. UL 812[4)]	26	215	-	Sat'd		
WAGH mod. UL 812[5)]	18	300	476	-	Sat'd	
VROH mod. UL 812[6)]	23	122	296	-	Sat'd	
VMCH mod. UL 812[7)]	27	333	544	-	Sat'd	
TPX-6277/UL 163 4:1 dry	24	314	463	-	649	
TPX-6277/UL 163 1:1 dry	25	377	617			
AX-9110 (Alsip)[8)]	18	315	435	-	646	
AX-9110 (Torrance)[9)]	31	113	-	201	200	207
AC-64/WP-1[10)]	34	380	-	592	631	

1) Free film of ~3 in^2 glued to open bottom cup; 1/2 in. water in cup; weight increase of filter paper under film measures water transfer through film.

2) Average of two samples; >700 mg ≈ saturated filter paper.

3) Zinc ammonium carbonate @ 1.5% wet.

4) Wet adhesion soft (TPX-6324A) @ 15% dry.

5) Wet adhesion hard (TPX-6352) @ 15% dry.

6) VROH/plasticizer (1:1) @ 8% dry.

7) VMCH/plasticizer (1:1) @ 8% dry.

8) 1-RES-133, L-67 match.

9) 18-1-2-18, L-67 match.

10) 7% dry WP-1 plasticizer.

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TABLE VI

Three-Week Tombstone Test[1)]

Blistering/Efflorescence[2)]

Number, Size/Amount[3)]

Resin in AWM Formulation	2-Day Dry	Final Dry[4)]	I. D. #
UCAR Latex 812 as is	2M*/Small	None/Small	29-32-A
UCAR Latex 812 @ 8.5 pH	3M*/None	1M*/Trace	29-32-B
29-39-A over 174-based primer[5)]	3S/Small	None/Small	29-32-C
ZAC mod. UCAR Latex 812[6)]	2M*/None	1S/Small	29-32-D
WAGS mod. UCAR Latex 812[7)]	2L*/None	None/Small	29-32-E
WAGH mod. UCAR Latex 812[8)]	1S/None	1M/Trace	29-32-F
VROH mod. UCAR Latex 812[9)]	2L*/Small	None/Small	29-32-G
VMCH mod. UCAR Latex 812[10)]	1M*/None	None/Small	29-32-H
TPX-6277/UL 163 4:1 dry	1S/Trace	1S/Small	29-32-I
TPX-6277/UL 163 1:1 dry	1S/None	None/Small	29-32-J
AX-9110 (Alsip)[11)]	None	None/Small	29-32-K
AX-9110 (Torrance)[12)]	3L*/Small	1S/Small	29-32-L
AC-64/WP-1[13)]	2L*/Small	1M*/Small	29-32-M
"Diathon"[14)]	None	1S/Small	29-32-N

1) Coated brick placques with bottom 1/4 (uncoated) immersed in 1% Na_2SO_4 solution.
2) * means blistering appeared within two hours.
3) S=small, M=medium, L=large.
4) Final dry is two weeks air dry and one week 120°F. dry.
5) Primer-based on UL 174 @ 20% N.V., containing 23.5 phr of solvent (1:2:1 CELLOSOLVE Acetate, Methyl Ethyl Ketone, Butyl CARBITOL).
6) Zinc ammonium carbonate @ 1.5% wet.
7) Wet adhesion soft (TPX-6324A) @ 15% dry.
8) Wet adhesion hard (TPX-6352) @ 15% dry.
9) VROH/plasticizer (1:1) @ 8% dry.
10) VMCH/plasticizer (1:1) @ 8% dry.
11) 1-RES-133, L-67 match.
12) 18-1-2-18, L-67 match.
13) 7% dry WP-1 plasticizer.
14) "Blue Dot", United Paint and Coatings, Spokane, WA This formulation has since changed.

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TABLE VIII

Urethane Foam Wet Adhesion[1]

after 24-hour Water Soak[2]

Maximum, Average pli/type Failure[3]

Resin in AWM Formulation	Final Dry[4]	I. D. #
UCAR Latex 812 as is	5.2, 2.9/A	29-32-A
UCAR Latex 812 @ 8.5 pH	4.4, 2.1/A	29-32-B
29-39-A over 174 based primer[5]	1.2, 0.6/A	29-32-C
ZAC mod. UCAR Latex 812[6]	2.2, 1.4/A	29-32-D
WAGS mod. UCAR Latex 812[7]	4.6, 3.5/A-C	29-32-E
WAGH mod. UCAR Latex 812[8]	5.4, 3.3/C	29-32-F
VROH mod. UCAR Latex 812[9]	3.9, 2.8/A	29-32-G
VMCH mod. UCAR Latex 812[10]	4.2, 2.6/A-C	29-32-H
TPX-6277/UL 163 4:1 dry	4.4, 1.6/A	29-32-I
TPX-6277/UL 163 1:1 dry	4.1, 2.5/C	29-32-J
AX-9110 (Alsip)[11]	4.6, 3.0/C	29-32-K
AX-9110 (Torrance)[12]	2.1, 1.4/C	29-32-L
AC-64/WP-1[13]	0.3, 0.1/A	29-32-M
"Diathon"[14]	2.2, 1.4/C	29-32-N

1) ASTM D-413 type test (180° peel on imbedded 1" canvas strip) on urethane foam test blocks.
2) Room temperature.
3) Pounds per linear inch; A=adhesive, C=cohesive.
4) Final dry is two weeks air dry and one week 120°F. dry; 48-hour dry all failed.
5) Primer-based on UL 174 @ 20% N.V.; containing 23.5 phr of solvent (1:2:1 CELLOSOLVE Acetate, Methyl Ethyl Ketone, Butyl CARBITOL).
6) Zinc Ammonium carbonate @ 1.5% wet.
7) Wet adhesion soft (TPX-6324A) @ 15% dry.
8) Wet adhesion hard (TPX-6352) @ 15% dry.
9) VROH/plasticizer (1:1) @ 8% dry.
10) VMCH/plasticizer (1:1) @ 8% dry.
11) 1-RES-133, L-67 match.
12) 18-1-2-18, L-67 match.
13) 7% dry WP-1 plasticizer.
14) "Blue Dot", United Paint and Coatings, Spokane, WA. This formulation has since changed.

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TABLE X

Water Vapor Transmission[1)]

10^{-2} Metric perm-cm/English perms[2)]

Resin in AWM Formulation	2-Day Dry	Final Dry[3)]	I. D. #
UCAR Latex 812 as is	-	7.7/1.8	29-32-A
UCAR Latex 812 @ 8.5 pH	8.6/1.8	8.6/1.9	29-32-B
ZAC mod. UCAR Latex 812[4)]	10.3/2.0	8.9/1.9	29-32-D
WAGS mod. UCAR Latex 812[5)]	11.2/2.6	6.8/1.8	29-32-E
WAGH mod. UCAR Latex 812[6)]	10.1/1.9	8.7/2.0	29-32-F
VROH mod. UCAR Latex 812[7)]	14.5/2.4	9.0/1.7	29-32-G
VMCH mod. UCAR Latex 812[8)]	8.3/1.4	8.7/1.6	29-32-H
TPX-6277/UL 163 4:1 dry	8.0/1.9	4.5/0.8	29-32-I
TPX-6277/UL 163 1:1 dry	3.8/1.0	5.1/0.9	29-32-J
AX-9110 (Alsip)[9)]	3.6/1.0	5.2/1.0	29-32-K
AX-9110 (Torrance)[10)]	11.1/1.9	8.2/1.6	29-32-L
AC-64/WP-1[11)]	3.8/0.7	4.8/1.0	29-32-M

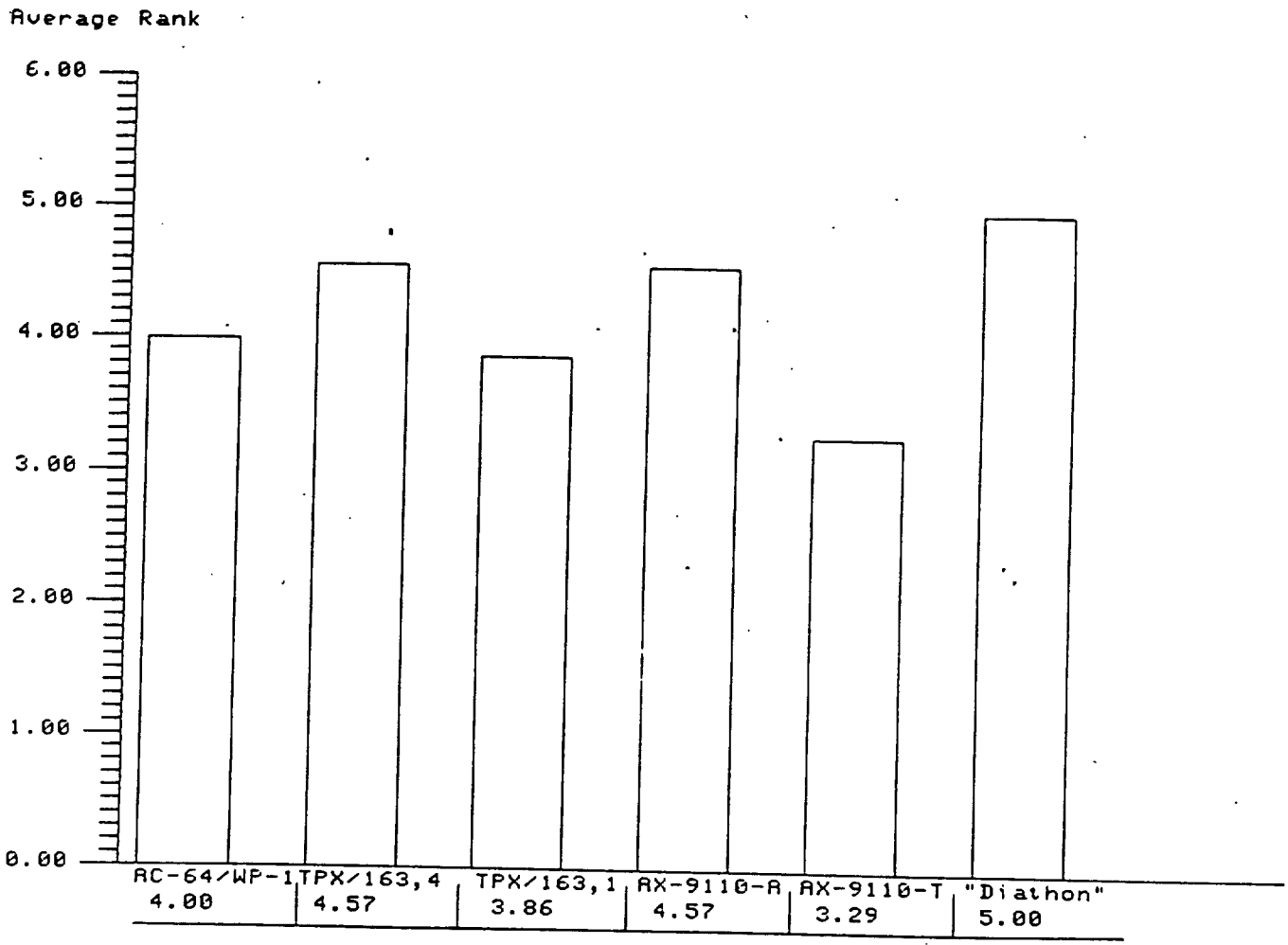
1) ASTM E96-Procedure A; Previous tests on "Diathon" (29-32-N) gave 10.0/3.0 in above units.
2) Metric term is preferred to common "perms" because sample area and thickness is accounted for.
3) Final dry is two weeks air dry and one week 120°F. dry.
4) Zinc ammonium carbonate @ 1.5% wet.
5) Wet adhesion soft (TPX-6324A) @ 15% dry.
6) Wet adhesion hard (TPX-6352) @ 15% dry.
7) VROH/plasticizer (1:1) @ 8% dry.
8) VMCH/plasticizer (1:1) @ 8% dry.
9) 1-RES-133, L-67 match.
10) 18-1-2-18, L-67 match.
11) 7% dry WP-1 plasticizer

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Figure 2

Overall Cure Category Ranking

2-Day Dry Other Resin Types



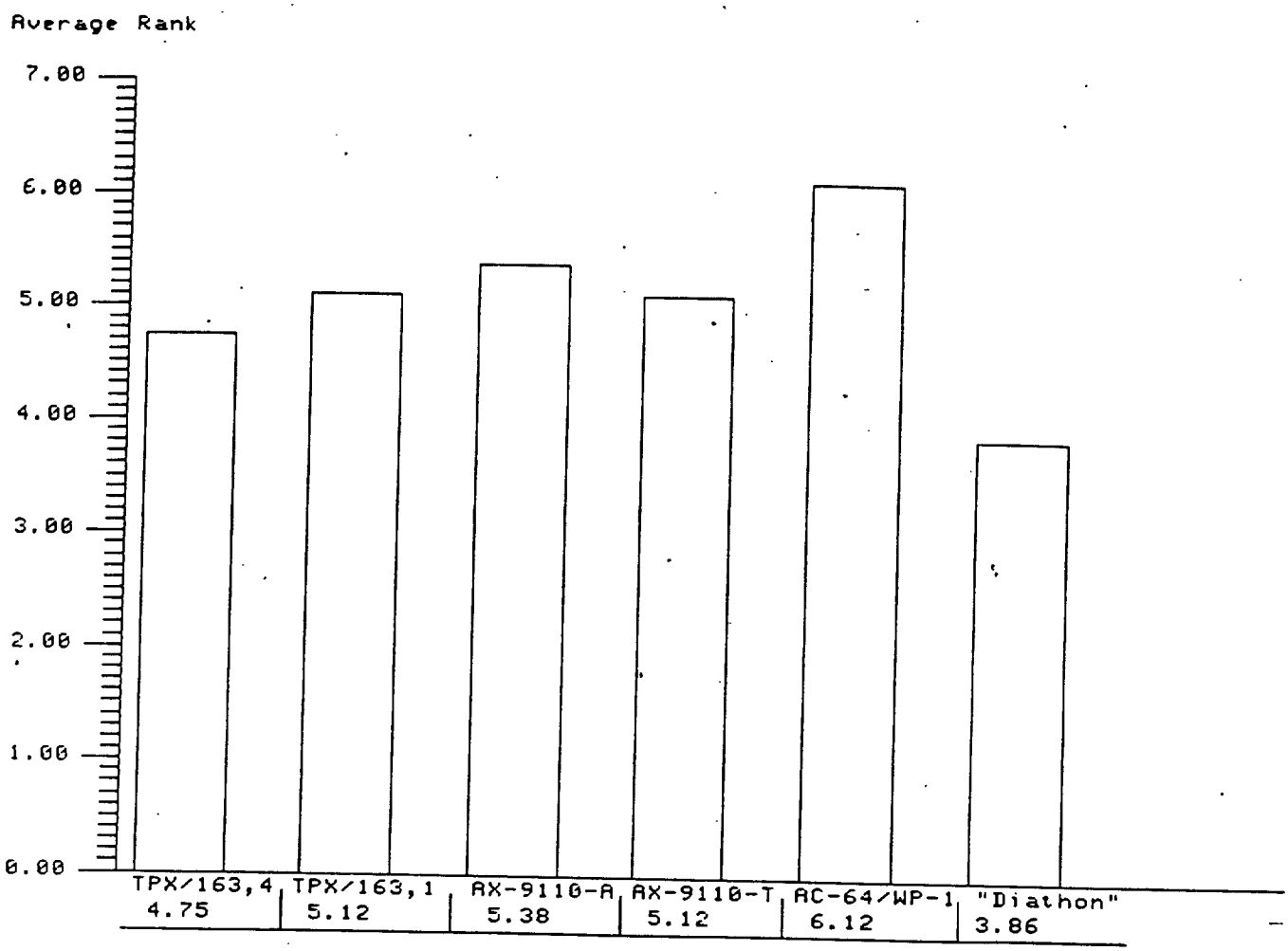
AC-64/WP-1
TPX/163,4
TPX/163,1
AX-9110-A
AX-9110-T
"Diathon"

7% dry plasticizer
TPX-6277/UCAR 163 4:1 dry
TPX-6277/UCAR 163 1:1 dry
1-RES-133, Alsip LC-67 match
18-1-2-18, Torrance LC-67 match
United Paint and Coatings, Spokane, WA

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Figure 4

Overall Cure Category Ranking



TPX/163,4	TPX-6277/UCAR 163 4:1 dry
TPX/163,1	TPX-6277/UCAR 163 1:1 dry
AX-9110-A	1-RES-133, Alsip LC-67 match
AX-9110-T	18-1-2-18, Torrance LC-67 match
AC-64/WP-1	7% dry plasticizer
"Diathon"	United Paint and Coatings, Spokane, WA

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APPENDIX

UCAR LATEX 812 ROOF COATING STUDY
DETAILS OF RANKING SYSTEM

Forced Rankings Summary By Test

Relative Performance of Vehicles in
AWM Formulation 29-32-

2-Day Dirt

L > | M=K=I>G > | E=F=H>B=D=J
3 | 2 | 1

All failed = 0

Not run

K>N > | D>F=E> | E>G > | L
4 | 3 | 2 | 0

M=N=L>K=I>J > | H=G>F=E>D=B
3 | 1

I > H>=F>=N>K>= | J=G>=B=E=D>= | M=L
4 | 3 | 1
By Tensile

K=N>F=J=I>H>D>B>E>A=C>G=M>L
OK = 3

K=J=M>I=H=B>F=D>L=E>G
OK = 3

Final Dirt

PONDING (3)
L>M > | I>J>K>G > | H>E>B>N>A>F > | D
4 | 3 | 2 | 1

FOAM WET ADHESION (3)
F=E>A=K>J=H=G>B > | I > | D=N=L>C>M
3 | 2 | 1

CAUSTIC BLOCK ADHESION (3)
L=M>G > | E>B>K>I>F>N>J>H>D
4 | 1

WATER [illegible] (3)
N>E>[illegible]K > | J>H=I>D>[illegible] | L
2 | 1 | 0

CAUSTIC SWELL (2)
M>L=N>I=K>J > | H=G>F=E=D>B=A
3 | 2

ELONGATION/TENSILE (2)
B>=E>=D>=G>=A>=M>F>=I>=H>=K>=J > | N>=L
3 | 1
By Elongation

TOMBSTONE (1)
A=C=E=G=H=J=K>D=I=L=N>B=F=M
OK = 3

POROSITY (1)
I=M>J=K>E=A>L>B=H=F=D=G
OK = 3

Rating Scale:

Excellent	4
Good (OK)	3
Fair	2
Poor	1
Dismal	0

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Distribution:

D. R. Bassett - 720-130

G. W. Buttrick - Tucker

W. D. Claus - Bound Brook

F. P. Del Guidice - 720-133

R. D. James - Torrance

A. L. Mantz - Somerset

A. S. Manzella - Somerset

W. D. Massey - Garland

H. Mayfield - 720-121

A. A. Mees - L-3497

W. P. Miller - 720-123

G. V. Olhoft - Alsip

H. Ortiz - Puerto Rico

E. L. Peterson - L-3499

R. C. Pierrehumbert - Garland

M. J. Pollack - 720-128

G. W. Sanders - Torrance

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