Imperial

TECHNICAL REPORT

NUMBER

205-1-78-G

TITLE

COMPATIBILITY OF RES X with NUTEC #11S SURFACER

FOR

Comanche Peak Steam Electric Station

CUSTOMER

TEXAS UTILITIES

Submitted by: Gerald E. Arnold

Approved:

Date: January 26, 1978

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SUMMARY - Extensive testing was conducted to determine if Imperial's NUTEC #11S surfacer is compatible with Burke's RES X concrete curing compound. Based on results of Elcometer adhesion and Design Basis Accident testing, it was concluded that the RES X is a dissipating membrane only if exposed to the ultraviolet rays of sunlight or to heat. Without these agents, the RES X remains on the conrete indefinitely. On porous wall surfaces the RES X penetrates easily leaving no appreciable surface film to interfere with the chemical adhesion of the NUTEC #11S to the concrete. The floors, especially steel trowelled finishes, however, pose a problem because of the lack of porosity and the build up of a RES X film on the surface. This film is incompatible with the NUTEC #11S and must be removed by physical means, specifically a high pressure water blast, sand blasting, or a combination of the two methods.

INTRODUCTION - Testing of Burke's RES X was performed at the request of Brown & Root in connection with the Texas Utilities' Comanche Peak Nuclear Power Plant. RES X is a dissipating concrete curing membrane consisting of a solution of resinous solids and petroleum solvents. The RES X film, according to literature, disintegrates by oxidation. Heat and ultraviolet rays are necessary for this reaction to occur. Recommended spread rates are 200ft.^{2}/gallon for rough surfaces and 200 - 300 ft.^{2}/gallon for smooth and steel trowel finishes. The purpose of this test was to determine if NUTEC #11S is compatible with RES X.

METHOD -

a) Elcometer adhesion (cinder blocks)

RES X was applied to two 3½" x 7" x 2" high density cinder blocks at a spread rate of 200 ft.^{2}/gallon. The RES X was cured in the laboratory at 70 - 80°F. and 45-65% R.H. NUTEC #11S was applied to one block after 24 hours and to the second block after 30 days. No surface preparation was performed between coats. Both specimens were topcoated with REACTIC #1201. Three high strength aluminum dollies were applied to each specimen and removed with an Elcometer adhesion tester following sufficient cure of the coating system. Tests were conducted in accordance with Imperial Test Method 03. For comparative purposes, 2 control specimens were coated with the Imperial system only.

1. Application and Curing Data

PRODUCT	BATCH #	Date Applied	°F./% R.H.		DFT (inches)
(24 hour intercoat time - RES X/NUTEC #11S)					
RES X		10/31/77 - 1:50 p.m.	84	70	200 ft.^{2}/gal.
NUTEC #11S	LB150/2671/ LB148	11/1/77 - 1:00 p.m.	80	75	.020 - .025
NUTEC #11	LB150/2671/ LB149	11/4/77 - 8:00 a.m.	70	72	.005 - .007
REACTIC #1201	3070/2568	11/7/77 - 9:30 a.m.	71	69	.006 - .009
Dollies applied 11/9/77 Dollies removed 11/14/77					
(32 day intercoat time - RES X/NUTEC #11S)					
RES X		10/31/77 - 1:50 p.m.	84	70	200 ft.^{2}/gal.
NUTEC #11S	5386/3388/ LB148	12/2/77 - 9:00 a.m.	70	64	.020 - .25
REACTIC #1201	3070/2568	12/8/77 - 5:00 p.m.	67	71	.003 - .005
Dollies applied 12/13/77 Dollies removed 12/16/77					

2. Panel designation

Panel #	System	RES X/NUTEC #11S intercoat time
3448	11S/11/1201	24 hours
3464	RES X/11S/11/1201	24 hours
3449	11S/1201	32 days
3465	RES X/11S/1201	32 days

b). Elcometer adhesion (concrete coupons)

RES X was applied to four 2" x 4" x 2" concrete coupons prepared in accordance with Bechtel CP954, at a spread rate of 100 ft.^{2}/gallon. The RES X coated coupons were cured in the laboratory at 70 - 80°F. and 45-65% R.H. Two coupons were coated with NUTEC #11S after 48 hours. The remaining specimens were surfaced after 50 days, following a 3000 psi water blast which was achieved using a Graco Bulldog (30:1) and a .043" tip. All concrete blocks were topcoated with REACTIC #1201. One high strength aluminum dolly was applied to each specimen by means of an epoxy resin-type adhesive and removed with an Elcometer adhesion tester following sufficient cure of the coating system and adhesive. Tests were performed as directed by Imperial Test Method 03. Control specimens were also coated with the Imperial system only. The concrete substrates were allowed to stand for 48 hours and 50 days as were the RES X coated specimens.

1. Application and Curing Data

PRODUCT	BATCH #	Date Applied	°F./%R.H.		DFT (inches)
(48 hour intercoat time - RES X/NUTEC #11S					
RES X		11/17/77 - 1:00 p.m.	78	65	100ft.^{2}/gal.
NUTEC #11S	LB150/2671/ LB148	11.19.77 - 11:00 a.m.	72	70	.018 - .024
REACTIC #1201	2467/2491	11/26/77 - 10:00 a.m.	74	58	.005 - .007
Dollies applied 12/1/77 Dollies removed 12/3/77					
(50 day intercoat time - RES X/NUTEC #11S)					
RES X		11/17/77 1:00 p.m.	78	65	100ft.^{2}/gal.
NUTEC #11S	3227/3228/ 3229	1/9/78 11:00 a.m.	78	67	.018 - .022
REACTIC #1201	2467/2568	1/12/78 10:00 a.m.	58	66	.004 - .006
Dollies applied 1/13/78 Dollies removed 1/16/78					

2. Panel designation

Lab. Panel #	Concrete #	RES X/#11S intercoat time	Surface Prep.
3493	632 (11S/1201)	48 hours	None
3494	667 (11S/1201)	48 hours	None
3495	801 (11S/1201)	50 days	3000 psi water
3496	861 (11S/1201	50 days	3000 psi water
3525	602 (RES X/11S/1201)	48 hours	None
3526	680 (RES X/11S/1201)	48 hours	None
3527	793 (RES X/11S/1201)	50 days	3000 psi water
3528	803 (RES X/11S/1201)	50 days	3000 psi water

c) Elcometer adhesion (concrete coupons)

Four 2" x 4" x 2" concrete coupons were coated with RES X at spread rate of 250ft.^{2}/gallon. The specimens were stored in darkness at 70-80°F. and 45-65% R.H. for 120 days prior to the application of the next coat. NUTEC #11S was applied to each coupon following a 100 psi compressed air blast. One high strength aluminum dolly was applied to each specimen directly to the #11S surfacer by means of an epoxy resin-type adhesive. The adhesive was allowed to cure for 72 hours. The dollies were removed with an Elcometer adhesion tester and the force required to remove the dollies and the mode of failure were recorded. The Elcometer adhesion testing was performed on the smooth surface of the concrete coupons.

1. Application and Curing Data

PRODUCT	BATCH #	Date Applied	°F./% R.H.		DFT (inches)
RES X		8/8/77 8:00 a.m.	81	87	250ft.^{2}/gal.
NUTEC #11S	3386/3388/ LB149	12/10/77 9:00 a.m.	58	38	.020 - .025

2. Panel Designation

Lab. Panel #	Concrete #	RES X/#11S Intercoat time
3283	163	120 days
3284	171	120 days
3285	172	120 days
3286	188	120 days

d) Design Basis Accident

Concrete coupons previously used in adhesion tests (see b) 2.) were submitted to Coastal Science Associates for an autoclave screen test designed to simulate Loss of Coolant Accident temparature and pressure conditions. The maximum temperature and pressure obtained was 307°F. and 57 psig respectively. All specimens were inspected within one hour of their removal from the autoclave for signs of visual damage and then "sounded" by tapping with a solid instrument to determine if any disbonding had occurred at the substrate.

1. Application and Curing Data

See b) 1.

2. Panel designation

Lab. Panel #	System	RES X/11S Intercoat time	Date submitted for testing
3493	#11S/1201	48 hours	12/12/77
3525	RES X/11S/1201	48 hours	12/12/77
3495	#11S/1201	50 days	1/16/78
3527	RES X/11S/1201	50 days	1/16/78

RESULTS -

a) Elcometer adhesion (cinder blocks)

Panel #	System	Intercoat time	Force Required to remove dolly	Failure mode
3448	11S/11/1201 (Control)	24 hrs	a) 250 psi b) 200 psi c) 300 psi	100% concrete 100% concrete 100% concrete
3464	RES X/11S/ 11/1201	24 hrs	a) 50 psi b) 100 psi c) 250 psi	95% 11S/concrete. 5% concrete 90% 11S/concrete. 10% concrete 100% concrete
3449	11S/1201 (Control)	32 days	a) 450 psi b) 600 psi c) 200 psi	100% concrete 100% concrete 100% concrete
3465	11S/1201	32 days	a) 50 psi b) 100 psi c) 100 psi	90% 11S/concrete. 10% concrete 90% 11S/concrete. 10% concrete 90% 11S/concrete. 10% concrete

DISCUSSION - Cinder blocks used were of high density concrete. Although the surface is rough, the porosity is low and the RES X accumulates on the surface as a film. This adhesion test demonstrates that RES X cured under laboratory conditions without heat or ultraviolet rays has deteriorated very little, if any, thus resulting in poor adhesion of the NUTEC #11S to the substrate. Excellent adhesion was obtained with the control specimens.

b) Elcometer Adhesion (concrete coupons)

Panel #	System	Intercoat time	Surface Preparation	Force required to Remove dolly	Failure Mode
3493	11S/1201	48 hrs	None	450 psi*	100% concrete
3494	11S/1201	48 hrs	None	800 psi*	100% concrete
3525	RES X/11S/ 1201	48 hrs	None	500 psi*	50% concrete 50% 11S/concrete
3526	RES X/11S/ 1201	48 hrs	None	500 psi*	90% concrete 10% 11S/concrete
3495	11S/1201	50 days	3000 psi water	450 psi**	100% concrete
3496	11S/1201	50 days	3000 psi water	300 psi**	100% concrete
3527	RES X/11S/ 1201	50 days	3000 psi water	700 psi**	100% concrete
3528	RES X/11S/ 1201	50 days	3000 psi water	450 psi**	80% concrete 20% 11S/concrete

* Adhesion tests performed on simulated wall surface.
** Adhesion tests performed on simulated floor surface.

DISCUSSION - Specimens 3493, 3494, 3525, and 3526 represent adhesion tests on simulated wall surfaces. Even though the RES X had cured only 48 hours penetration into the porous concrete was sufficient to allow the NUTEC 11S to bond to the substrate. The values obtained (500 psi for both specimens) indicates good adhesion of the 11S to the concrete, however, the mode of failure (some disbonding between the 11S and the concrete) reveals a decrease in the bonding that is not normally observed with the NUTEC 11S surfacer. Note that in all control specimens failure occurred 100% in the concrete.

Specimens 3495, 3496, 3527, and 3528 represent adhesion tests on simulated floor surfaces. The surface tested is smooth and porosity is low. The RES X was allowed to stand for 50 days prior to the application of the NUTEC 11S. Because the test coupons were stored in the laboratory under controlled conditions, any appreciable dissipation of the RES X film was unlikely. The improvement in adhesion is due to the 3000 psi water blast used to remove the RES X film. Both RES X specimens exhibited good adhesion values with the majority of the failure in the concrete. Coupon #3528 demonstrated approximately 20% adhesion loss between the 11S and the RES X sealed concrete, indicating the water blast did not remove all of the residue on the surface.

c) Elcometer adhesion (concrete coupons)

Panel #	System	Intercoat Time	Force required to remove dolly	Failure Mode
3283	RES X/11S	120 days	700 psi	100% concrete
3284	RES X/11S	120 days	350 psi	100% concrete
3285	RES X/11S	120 days	200 psi	100% 11S/ concrete
3286	RES X/11S	120 days	400 psi	100% 11S/ concrete

DISCUSSION - The results here are inconsistent, two specimens exhibiting excellent adhesion and the remaining two demonstrating poor bonding between the NUTEC 11S and the RES X sealed concrete. Specimens 3283 and 3284 were originally designated for other testing. The concrete coupons had previously (18 months) been treated with a 1% Silane solution which may have promoted adhesion.

Coupons 3285 and 3286 may better represent the potential problems on steel trowelled floors. The adhesion tests were performed on the smooth surface of each coupon. The smoothness of the concrete is a result of the method in which the coupons are prepared. In this case, the surface tested was very smooth and glossy thus simulating a steel trowelled finish. The RES X was cured for 120 days in the laboratory at 70-80° F. and 45-65% relative humidity, with no exposure to sunlight (ultraviolet rays). Prior to the application of NUTEC 11S only a 100 psi compressed air blast was used to remove any dust or other contaminants which may have accumulated over the four month period. The Elcometer testing indicates very poor adhesion of the 11S to the RES X sealed concrete. Therefore, it can be concluded that the RES X film will not disintegrate without heat or ultraviolet light.

d) Design Basis Accident

Panel #	System	Intercoat Time	Results
3493	11S/1201	48 hours	No defects
3525	RES X/11S/1201	48 hours*	Two ¼" diameter areas of delamination - coating intact.
3495	11S/1201	50 days	No defects
3527	RES X/11S/1201	50 days	No defects.

* The tested coating system was intact and no defects were visually discovered. However, upon "sounding" the specimen two areas of apparent delamination or disbonding were noted. This finding was confirmed by removing the coating in the questionable areas with a sharp instrument to determine the degree of disbonding.

DISCUSSION - This test demonstrates that if proper surface preparation procedures are used to remove the RES X, the adhesion of the NUTEC 11S surfacer to the concrete is assured.

More importantly, specimen 3525 indicates that if the RES X film does not dissipate with time or is not removed by some physical means, an adhesion problem is inevitable.

CONCLUSIONS - Burke's RES X is a dissipating concrete curing membrane consisting of a solution of resinous (hydrocarbons) solids and petroleum solvents. As an intact film the RES X is a poor base for subsequent coatings. This fact is substantiated by the results of this testing and is readily admitted to by the RES X manufacturer.

The dissipation rate of the RES X curing membrane depends upon oxidation resulting from heat and ultraviolet rays. The length of time which the RES X is exposed is irrelevant; the accumulative and quantitative amount of sunlight and heat is important. Without exposure to the ultraviolet rays of sunlight or heat, the RES X remains on the concrete as a surface film and can only be removed by physical means.

The major concern, therefore, is how effective the surface preparation is in removing any remaining surface film. Whether or not a 7 day, 30 day, or 120 day dissipation period is allowed, is unimportant. Based on laboratory tests, high pressure water (3000 psi) is sufficient to remove the RES X and providing anadequate base for adhesion of the NUTEC 11S surfacer. The only time limitation that should be imposed is the 28 day cure period established by ACI 301.

The main factor controlling build up of a surface film is the porosity of the concrete. Throughout the adhesion and DBA testing, simulated wall surfaces coated with RES X posed no compatibility problems because of the degree of porosity. The RES X penetrates well into formed wall surfaces, leaving no surface film to interfere with the adhesion of the NUTEC 11S surfacer. Despite this finding, high pressure water is recommended as a safeguard. The simulated floor surfaces, especially very smooth surfaces with very little porosity, pose a definite problem. Because of the low porosity, penetration is impeded and a surface film is effected. Without the natural breakdown of the film or proper physical preparation (e.g. waterblasting, sandblasting) to remove the film, poor adhesion of subsequent coating will occur.

Based on the results of the RES X testing program and discussions with Mr. Al Brownlee with Conspec Marketing and Manufacturing Company, the following recommendations are made. RES X should be applied to concrete surfaces in accordance with the manufacturer's recommendations. Care should be taken to avoid an unnecessary build up of RES X on the concrete, especially floor surfaces. The concrete shall be allowed to cure a minimum of 28 days as directed by ACI 301. Prior to application of Imperial's coatings, 4000 psi water blasting, 2500 psi water blasting with sand injection, or sand sweeping shall be used to remove any remaining RES X. Adequate surface preparation shall be made by visually inspecting the concrete surface for "water beads". Beading of the water indicates the presence of the RES X and additional surface preparation will be required until this beading is eliminated.

REFERENCES - LAB. Notebook 56, p.p. 1-17
LAB. Notebook 33, p. 147

COASTAL SCIENCE ASSOCIATES, INC.
6900 CANAL BLVD.
NEW ORLEANS, LOUISIANNA 70124
TEL. 504-283-7251

SUBJECT: DESIGN BASIS ACCIDENT COATINGS TEST REPORT.

DATE: 12/19/77

DBA TEST CONDITIONS: HOUSTON LIGHT AND POWER, SHORT TO 48 HRS.

SAMPLE NUMBER: 3493 SAMPLE TYPE: CONCRETE COUPON

SAMPLE #	DESCRIPTION
3493	SIDE ONE: NO DEFECTS
	SIDE TWO: NO DEFECTS
	SIDE THREE: NO DEFECTS
	SIDE FOUR: NO DEFECTS

REPORT WRITTEN FOR: SOUTHERN IMPERIAL

REPORT # 057121977

APPROVED BY Charles A Trimpe

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TEL. 504-283-7251

SUBJECT: DESIGN BASIS ACCIDENT COATINGS TEST REPORT.

DATE: 12/15/77

DBA TEST CONDITIONS: HOUSTON LIGHT AND POWER, SHORTENED TO 48 HRS.

SAMPLE NUMBER: 3525 SAMPLE TYPE: CONCRETE COUPON

SAMPLE #	DESCRIPTION
3525	SIDE ONE: DELAMINATION, UPPER LEFT CORNER
	SIDE TWO: NO VISIBLE DEFECTS, NO DELAMINATION
	SIDE THREE: NO VISIBLE DEFECTS, NO DELAMINATION
	SIDE FOUR: NO VISIBLE DEFECTS, NO DELAMINATION

REPORT WRITTEN FOR: SOUTHERN IMPERIAL

REPORT # 056121577

APPROVED BY: Richard A. Fragala

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SUBJECT: DESIGN BASIS ACCIDENT COATINGS TEST REPORT.

DATE: 1/18/78

DBA TEST CONDITIONS: HOUSTON LIGHT AND POWER, 24 HR. SCREEN TEST

HIGHEST TEMPERATURE (DEG. F) REACHED DURING RUN 307

SAMPLE NUMBER: 3527 SAMPLE TYPE: CONCRETE COUPON

SAMPLE #	DESCRIPTION
3527	SIDE 1: NO DEFECTS
	SIDE 2: NO DEFECTS
	SIDE 3: NO DEFECTS
	SIDE 4: NO DEFECTS

REPORT WRITTEN FOR: SOUTHERN IMPERIAL COATINGS

REPORT # 059011778

APPROVED BY... Harold A. Brungard...

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SUBJECT: DESIGN BASIS ACCIDENT COATINGS TEST REPORT.

DATE: 1/18/78

DBA TEST CONDITIONS: HOUSTON LIGHT AND POWER, 24 HR. SCREEN TEST

HIGHEST TEMPERATURE (DEG. F) REACHED DURING RUN 307

SAMPLE NUMBER: 3495 SAMPLE TYPE: CONCRETE COUPON

SAMPLE #	DESCRIPTION
3495	SIDE 1: NO DEFECTS
	SIDE 2: NO DEFECTS
	SIDE 3: NO DEFECTS
	SIDE 4: NO DEFECTS

REPORT WRITTEN FOR: SOUTHERN IMPERIAL COATINGS

REPORT # 059011778

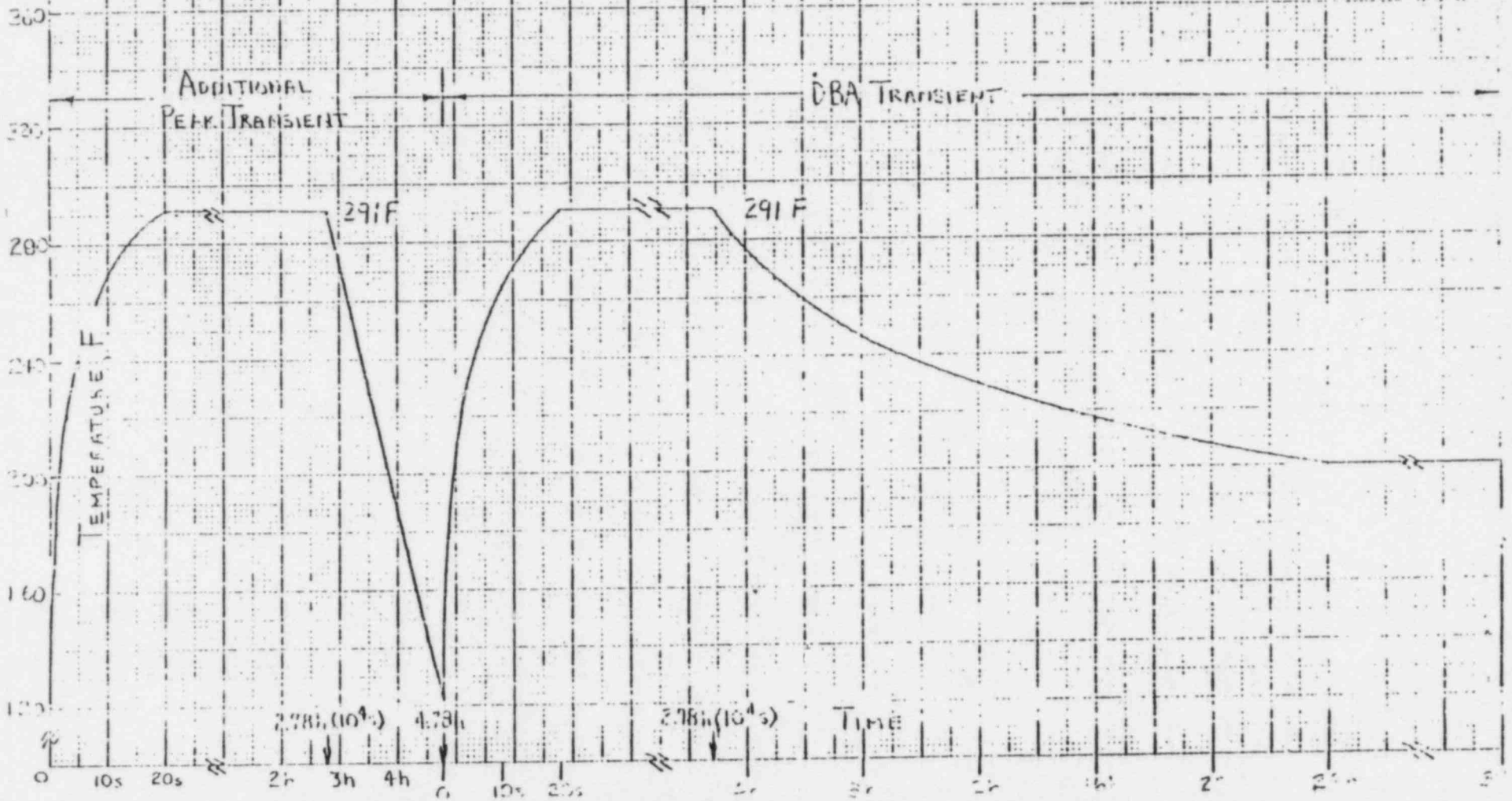
APPROVED BY.....

Houston Power & Light <South Texas>

ENVIRONMENTAL QUALIFICATION TEST PROFILE

Temperature Versus Time

REVISION 0, 10/22/75



ENVIRONMENTAL QUALIFICATION TEST PROFILE

Pressure Versus Time

REVISION 0, 10/22/75