



January 17, 1951

MEMORANDUM TO: R. E. WING ✓

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File (2)

SUBJECT: Engineering Project 507 - Final Report

REF: Memo same subject dated November 28, 1950

The purpose of the final phase of this project was to check the suitability of the cable binder constructions for MSCA and S, T, D and FSGA sizes 3 through 9, type cables suggested in the November 28, 1950 memo.

Conclusions:

1. As reported in the November 28, 1950 memo, the low insulation resistance found on MSCA type cables is caused by the attack of hydrochloric acid liberated in small quantities from the vinyl asbestos tapes previously used as a cable binder. It was further found that the PVC sheath liberates enough HCl to seriously lower the insulation resistance of these cables, even in the absence of heating, except during the extrusion operation.
2. That silicone asbestos tapes suggested in the above reference memo as a cable binder do not provide protection for the singles and should not be used alone.
3. It is therefore suggested that one Rockbestos Spec. B tape, applied 1/2 to 2/3 lap, be used directly over the cabled conductors under a single silicone asbestos tape applied 1/4 lap. This construction gives good protection to the singles from the attack of HCl, it was found to be sufficiently watertight, and no difficulties were encountered from tape rupture in the tubing operation.
4. The Production Department found that it was possible to apply a synthetic sheath over a single silicone asbestos tape construction without rupturing the tape on an MSCA-7 type cable. Previous experience has shown that this is not possible for larger size cables, and the single tape construction should not be specified.
5. The additional curing procedure recommended in the November 28th memo for silicone rubber singles must be used. The Research Department found that it was not possible to up-grade the IR of completed cables without removing the sheath and both cable tapes and then curing the cable at 300°F. for at least four hours. It has been necessary to subject some of our silicone rubber insulated

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cables now in production to an additional cure of four hours at 300°F. or eight hours at 250°F. after the cable tape operation because of low IR. This treatment should be avoided where possible because the additional heating will lower the percent elongation to break of the singles which is now barely above the temporary minimum of 60% allowable on most cables. If the additional cure is made because of low IR, the cable must be respooled twice and tipped with the die called for on the cable wrap operation in order to check for swell of the Scotch tape used in patching broken cable tapes. This should be done to prevent jamming and resultant breaks during the tubing operation.

6. It was suggested by the Dow Corning representative that the DC-181 would not be subject to the attack of HCl were it completely cured. A 50-foot sample of MSCA-7 was made with singles having been cured at 480°F. for 24 hours, a single silicone asbestos tape applied 1/4 lap over the cabled conductors, and a regular Navy sheath applied overall. Two 25-foot samples were made from the above; the as made IR of each was measured, and the control sample was cured in a circulating air oven for 24 hours at 250°F. Following this treatment, the IR test results showed that the oven-aged sample had been attacked to the extent that its IR was approximately 3% of the as made value. It was found that the high temperature cure made the rubber stiff and it adhered to the conductor so firmly that it could not be removed for tensile and elongation tests.

Procedure:

Two 125-foot samples of MSCA-7 were made in accordance with W. W. Gaylord's memo of November 28, 1950. The following tests were run with the results shown:

1. Water Leakage Test - Standard water leakage tests were run on each of the above samples as outlined in Navy Spec. 1501.

<u>Spec. & Construction</u>	<u>Water Leakage Cu. Inches</u>
A. MSCA-7 - 1 Silicone asbestos tape 1/4 lap	3.78 Col 4, 10% reduction
B. MSCA-7 - 1 Silicone asbestos tape 1/4 lap over 1 - B tape 1/2 to 2/3 lap	1.46 Col 3, 5% reduction

All leakage on both samples was through the strand caused by inadequate plugging. Three singles in sample B were found without any sealing compound in the strand. Inspection tests made on DSGA-4 cables showed no leakage for three samples tested. A physical examination following the water leakage tests revealed the following: water followed the shingle in the silicone asbestos tape for the entire length of one sample, 2/3 of another sample and the first 2 inches from gland end of the third sample, the leakage path evidently being along the overlapped portions of

the silicone asbestos tapes. In only one sample was there any evidence of water having worked under the B tape, and this for only 2 inches from the gland end of the cable. There was no evidence of water in any other components of the cable. These results are surprising because the cable was subjected to an additional cure of four hours at 300°F. after the cable tape operation and it was expected that B tape shrinkage and Duxseal expansion would cause separation of the tapes and resultant high water leakage.

2. Insulation Resistance Tests: Two 25-foot samples were cut from the 125-foot length of MSCA-7 made with 1-Silicone asbestos Tape over the cabled conductors. The IR of each conductor to all other conductors and armor was measured with the following results:

<u>Sample</u>	<u>Insulation Resistance in Megohms/M' at 15.5°C</u>		
	<u>Min.</u>	<u>Max.</u>	<u>Av. 7/C</u>
Control	400	675	526
Test	416	693	553

The test sample was then placed in a circulating air oven for 24 hours at 200°F., removed and allowed to cool to room temperature and the IR of both samples was checked again.

<u>Sample</u>	<u>Insulation Resistance in Megohms/M' at 15.5°C</u>			<u>% of As Made Value</u>
	<u>Min.</u>	<u>Max.</u>	<u>Av. 7/C</u>	
Control	480	764	604	115
Test	20.4	99.7	37.7	6.82

It was felt that the reduction in IR found on the test sample was caused by the attack of HCl liberated by the vinyl sheath. To show this, it was decided to cut the control sample in half, remove the sheath and armor from one length, and then cure both samples in the oven at 200°F for 24 hour periods, reading the IR after each heating cycle.

<u>Heating Time</u>	<u>Insulation Resistance in Megohms/M' at 15.5°F.</u>							
	<u>With Sheath and Armor Intact</u>				<u>With Sheath and Armor Removed</u>			
	<u>Min.</u>	<u>Max.</u>	<u>Av. 7/C</u>	<u>% as Made</u>	<u>Min.</u>	<u>Max.</u>	<u>Av. 7/C</u>	<u>% as Made</u>
As Made	526	903	688		510	878	668	
24 hrs.	16.5	80.3	30.4	4.41	438	591	507	75.9
48 hrs.	9.50	18.8	14.0	2.04	739	923	788	118
78 hrs.	.641	1.05	.900	.131	768	1100	910	136

This test conclusively showed that the sheath was liberating sufficient quantities of HCl to degrade the IR. It further shows that the silicone asbestos tape is not an adequate barrier alone to prevent the attack.

The effectiveness of the B tape silicone asbestos tape construction was checked as follows: two 25-foot samples were cut from the 125-foot cable RP507E (as designated in W. W. Gaylord's memo dated November 28, 1950) as made by the Production Department. The IR each conductor to all others and armor was checked for both samples. One length, the test sample, was then subjected to cycles of heating at 200°F. for 24 hours and cooling to room temperature after which the IR of both samples was measured again. This procedure was repeated for a total of four cycles, at which time the test sample had been cured for 89 hours at 200°F. The curing temperature was then raised to 250°F. and the test sample was subjected to an additional 24 hours of heating at this temperature. The IR of both samples was checked again. The other 25-foot length, the control sample, was aged at room temperature for the total test period. Summary of test results is shown below:

Insulation Resistance in Megohms/M' at 15.5°C

Heating Time	Test Sample				Control Sample			
	Min.	Max.	Av. 7/C	% as Made	Min.	Max.	Av. 7/C	% as Made
As made	477	853	671		494	697	550	
After 24 hrs at 200°F.	649	974	795	118	637	1160	935	166
After 48 hrs at 200°F.	405	646	516	76.9	575	1130	836	152
After 72 hrs at 200°F.	314	539	424	63.2	657	1390	974	177
After 89 hrs at 200°F.	379	609	501	74.7	-	-	-	-
After 89 hrs at 200°F. and 24 hrs at 250°F.	263	414	328	48.9	646	1170	943	171

It is evident that some attack occurred during the curing. However, as the test sample final value is well above the Navy minimum of 100 Megohms/M', it is felt that the B tape silicone asbestos tape construction provides adequate protection for the silicone rubber.

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