

Monsanto

FROM (NAME & LOCATION)

A. W. M. Coaker - St. Louis Organic Research

DATE March 26, 1970

SUBJECT MARCH 19, 1970 VISIT TO BELL LABS

REFERENCE

TO :

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R. E. Lamkin Los Angeles
J. J. McNamara Everett
C. Cook Everett
R. N. Brell Wilmington
E. C. McCabe Wilmington
J. R. Beightol New York
E. H. Fording New York
K. A. Wells KWELL
Cumming Paton CPATO
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Present for Bell Labs: Jack DeCoste - Senior Formulation Chemist
Marty Wright - Formulation Chemist

Present for Monsanto: Jim Beightol
Bill Coaker

Note: Bell Lab's data should not be discussed with Western Electric without first clearing with Jim Beightol or Ed Fording.

Objectives

1. Clarify definitions of some terms used by Bell/W.E.
2. Review use pattern of selected W.E. compounds.
3. Define some of Bell/W.E.'s priorities so that Monsanto can do supportive work leading to increased business.
4. Confirm favorable status of XWC-214 for type 450 use.
5. Discuss testing procedure used for ASTM D-746 brittleness temperature.

Summary

1. Use of the terms station wire, line cord, switchboard wire, terminating cable and bridle wire was discussed (see details). Jack said that line wire refers to power cable used for high voltage transmission and is not a Bell/W.E. term.

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2. Compounds discussed included types 101, 104, 410 (discontinued and replaced by 412), 450, 531, 644, 650, 710, 720, and 730. There is an opportunity for non-copper-staining versions of Santicizers 412 and 429 in W.E. type 412 compound.
3. DeCoste's current top priority job is revamping the line cord construction. It is now type 101 primary insulation under type 450 jacket. W.E.'s design engineers have asked for a 28% minimum oxygen index and would like to use the same formulation for primary and jacket. Tentatively, Jack is recommending one-third each of chlorinated paraffin, phosphate ester and phthalate ester as the plasticizer system (see Details). TCP, Santicizer 140 and S-148 are being tested.
4. In terms of W.E.'s flexural modulus specifications, our XWC-214 plasticizer at 66 phr was slightly too stiff both at room temperature and at -20° C., but it was better than the control on lard oil extraction. Therefore, a slight increase in level, or a slight change in composition could make it totally satisfactory.
5. Marty Wright said he is very severe in rating failures on D-746 specimens. He bends specimens at least 90° after impact and calls them failures if any noticeable cracks show. He normally runs D-746 as a (go/no go) test at a specification temperature using the 2/10 maximum failures criterion, rather than usually trying to establish the correct T_b by ASTM plotting and estimating procedures.

Details

Due to a long session with Columbia Cable earlier, we arrived too late for a full treatment of our desired agenda in office hours. Jack DeCoste accepted my invitation to dinner, so we were able to cover most of the subjects, but were not able to get specific details on specifications for which Jack would have had to consult his files.

Due to time limitations, we discussed Item 4 first, so that Marty and Jack could consult their lab records. By copy of this report I am asking Jim Beightol to get us the BTL, Inc./ WECO, Inc. specifications on Type 412 Insulation.

Objective 1 - Definitions and Discussion of Each:

- Station wire is used to wire homes and office buildings for telephones. It is the fairly small, $\sim 1/8$ " diameter construction in which normally PE primary insulation is used with a PVC type 730 jacket. Type 730 is plasticized with DOP and uses Arcowax 1115 (replacement for Aristowax 165) to reduce surface friction and ease the pulling of station wire through holes and conduits.
- Line cord is used to connect telephones to junction boxes. It is PVC type 101 primary insulation with PVC type 450 jacket. This is Jack's #1 priority flame retardance project. W.E. has asked Bell Labs for a formulation with 28% oxygen index or higher, which uses no antimony oxide or very little and which is suitable for use as primary insulation as well as for jacketing in this use. The formulation must essentially match the benchmark, 45 phr DOP, in overall properties, including low temperature performance, lacquer marring, softening of paints, tear and abrasion resistance, aging behavior and volatility, odor, copper corrosion, etc.

In this application as part of the plasticizer system Jack and Marty are testing TCP, Santicizer 140 and Santicizer 148. Jack said that Santicizer 148 has been found deficient in its ability to raise the oxygen index, but he will continue testing to see whether its contribution to low temperature properties justifies its use in spite of questionable lacquer mar (still under test) and relatively poor oxygen index contribution compared to TCP and S-140.

Formulations being tested for the new line cord primary insulation and jacket are based on one-third each of chlorinated paraffin phosphate ester and phthalate ester. Various examples of each have been plugged in.

- Switchboard wire exists in many different styles, types and sizes which we did not review thoroughly. Jack said there are several different degrees of flame retardance needed depending on the design of switchboards and exchanges. Type 531 PVC jacket is used in some switchboard wire, and exchange cable sometimes uses type 104 primary insulation with flame-proofed cellulose acetate jacket.

- Terminating cable is usually type 644 PVC jacket over PE primary insulation. The large diameter overhead exchange cable usually has the primary insulation changed from PE to PVC near an exchange to get the maximum of flame retardance near the exchange. Flammability of PE has been blamed for the loss of a couple of large exchanges which have been destroyed by fire.
- Drop wire comes into a building from outside.
- Bridle wire is another W.E. definition. It is usually single strand rubber-insulated wire with a neoprene jacket.

Objective 2 - Use Pattern of Selected W.E. Compounds

- Type 101 has been used as primary insulation for line cord. It will probably be replaced with a more flame retardant formula, as discussed above.
- Type 104 is plasticized with 60 phr of TCP and is used as primary insulation where the highest degree of flame retardance is wanted, at or near an exchange. Jack said that when a wire bundle of several hundred small, insulated wires using type 104 is set afire with a gas flame and the flame removed, it goes out more rapidly than a bundle insulated with a formula plasticized with DOP and adjusted to the same oxygen index with antimony oxide. For this reason type 104 is specified by W.E. for critical areas.

W. E. regarded flammability, brittleness temperature and electrical properties as the key factors in selecting type 104 originally and in acceptance testing on individual lots. Use of TXP instead of TCP in this compound, according to Jack, causes a loss of about 5° C. in T_b . Use of electrical grade clay in the formula in place of OMYA BSH is not inherently objectionable to Jack. He said that B. F. Goodrich recently had two carloads of type 104 returned for failing to meet the T_b specification. On further checking, W.E. found Goodrich had used TXP without authorization.

If we want to improve the VR of our type 104 compound, Jack gave us the all-clear to use clay provided we don't then proceed to fail the low temperature test, or slip in TXP or S-140 sub rosa.

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On negotiating a modus operandi with W.E., Jack felt that our producing location (Springfield) should negotiate with W.E.'s receiving location (Buffalo, and others as they get involved) regarding the strict interpretation of VR specifications, etc. Jack authorizes use of clay instead of OMYA-BSH provided the compound still meets all performance specifications stated by W.E.

- Type 410 was plasticized with 57 phr of Paraplex G-30 and 10 phr of DOP. It has been superseded by type 412 in which 15 phr of the G-30 is replaced by Plastolein 9765. The prime requisite for the polymeric plasticizers is total absence of copper corrosion. Jack said that corrosion of copper conductors causes severe background noise and cannot be tolerated for this or for esthetic reasons. If Monsanto has a recommendation for type 412 backed by some data, it should be submitted much in the fashion that the handset cord (type 450) candidates have been. Bell Labs would then test our candidate(s) in due course. We could submit a total system or a Paraplex G-30 type or a Plastolein 9765/Admex 761-type plasticizer having no copper-staining propensity.

Certain switchboard cords have a woven Nylon outer jacket. Type 412 PVC is used directly under the woven Nylon and is also used in applications requiring a clear jacket. The flammability status on this compound has not changed, but non-flammability may be required in the future. Crucial properties at present are copper corrosion, insulating properties and resistance to lard oil and Bayol 35 extractions. The market for type 412, according to Jack, is stable and is growing.

- Type 450 is the telephone handset cord jacket with which we are familiar through preparing to submit our candidates XWC-214 and XWC-215.
- Type 644 is semi-rigid PVC for 60° C. service. It is plasticized with 35 phr of DOP and is running well as primary insulation in switchboard and central office wire. Its flammability is satisfactory as is.
- Type 650 is semi-rigid PVC for 85° C. service. It is plasticized with 12/13/5 of 810 phthalate/DTDP/DPP. It is used where hardness is desirable together with a low dielectric constant. W.E., Buffalo, is evaluating DIDP for cost-saving reasons. I advised Jack that he could make the compound

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harder without sacrificing low temperature properties if he replaced the 13 phr of DTDP with a suitably lower amount (e.g. 9 or 10 phr) of DUP. Jack indicated little likelihood of his doing any work on this before W.E., Buffalo, completes their testing on DIDP. I also pointed out that the reduction in plasticizer level possible with DUP helps flammability.

- Type 531 is another application with which we are familiar, since Santicizer 711 was submitted, but did not succeed in replacing Elastex 81 P. This formulation originally was based on Hercoflex 600 and later was changed to 81 P. Antimony oxide originally was put in simultaneously to achieve flame retardance, opacity and light stability. Recently, the oxygen index tentative specification on type 531 was set at 25% minimum, which is easy to achieve with quite a low antimony oxide level. Further work on the flammability of this compound depends on whether W.E. approves the 25% minimum oxygen index level, and if not, the priority of improvement.
- Types 710 (DNODP, weather-resistant plastic), 720 (DOP-plasticized jacket) and 730 (DOP-plasticized, Aristowax 165/Arcowax 1115-modified, low surface friction jacket) were touched on but not discussed in detail. It got too late to continue before we had discussed types 750 and 752 at all.

Objective 3 - Priorities and

Objective 4 - XWC-214 Status

- Bell Labs' and our work on type 450 jacket should have top priority, because this is at a stage where it could lead to additional business for Monsanto and a cost/savings for Western Electric in the very near future.

XWC-214 and XWC-215 were submitted by Paul Graham and have gone through the complete gamut of tests. They both failed on room temperature flexural modulus by ASTM D-747, but not badly, and on modulus of rigidity at -20° C. by ASTM D-1043. On lard oil extraction, both our candidates had a margin of safety compared to the control, but they had no leeway on brittleness temperature or torsional resilience.

The crucial numbers were as follows:

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<u>Plasticizer</u>	<u>Modulus after Lard Oil Imm'n</u>	<u>Rigidity Modulus at -20° C., p.s.i.</u>	<u>Room Temp. Modulus in Flexure, p.s.i.</u>
Control	140%	8.5×10^3	907
XWC-214	120%	10.4×10^3	940
XWC-215	110%	12.1×10^3	958
Specification	200% max.	9.95×10^3 max.	930 max. 570 min.

Jack and Marty know that XWC-214 is Santicizer 429/S-711 40/60 and that XWC-215 is Santicizer 429/S-711/DUP 45/35/20. Looking over all the data, including prices which were given to them by Paul Graham earlier as guides, they prefer XWC-214 and suggest that it could be readily adjusted either by a small increase in level from the recommended 66 phr or by a small change in polymeric/monomeric ratio to increase the proportion of S-711. We plan to try both these approaches and to communicate results promptly to Paul Graham for follow-up with Bell Labs and W.E.

Jack mentioned also that W.E. has done some independent work on the candidates that he and Marty Wright have been studying for type 450 PVC and that W.E. is more lenient in their judgements. In other words, Monsanto's XWC-214, of all candidates, by Bell Labs' testing came closest to passing all tests. By W.E.'s testing, several candidates passed all tests. Jack said he plans to have a detailed review with W.E. in the near future to try to resolve discrepancies.

Regarding flame-retarding of type 450, Jack said that the hydrated alumina in the formula helps, but the oxygen index specification has not yet been finalized by the applications engineers. He expects to be able to meet whatever oxygen index specification they set, without major reformulation of the plasticizer system.

- The system Jack and Marty are most actively working on now is the replacement for the type 101/type 450 combination in line cord. When Jim Beightol called in to the New York office just before entering Bell Labs an embargo was placed on detailed discussion of Chuck Bias' flammability data with Jack DeCoste. I obeyed this, but found that Jack is aware of the perspective on Santicizer 148 from his own testing. In other words, S-148 has

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better low temperature properties and poorer oxygen index than S-140 or TCP, and Jack DeCoste and Marty Wright know these facts quantitatively.

- Solving the VR/low temperature problem on type 104 PVC has high priority with Bell Labs/W.E. Jack asked us to generate data (or get Springfield to do it) showing that replacement of the OMYA BSH in type 104 by electrical grade clay and using TCP rather than TXP will give both acceptable brittleness temperature and electrical properties. Otherwise the problem might have to be solved by revising the specifications, but W.E. is reluctant to give on either property, and might look for other bidders who think they can meet all specifications as now written, if Monsanto and BFG cannot meet shipment dates with in-spec. material.

Objective 5 - ASTM D-746 Procedure:

Jack said that years ago the interpretation of a break in the D-746 procedure was that the specimen must shatter, break in two or almost break into two pieces with just a weak hinge holding the parts together.

In the current tentative method which was adopted in 1964 and must be confirmed or revised in April 1970, it says, ". . . Failure is defined as . . . any crack in the specimen which is visible to the unaided eye. . . . it should be bent to an angle of 90 degrees . . . then be examined for cracks at the bend".

On most plasticized PVC formulas there is several degrees difference between the 50% failure temperature judged by shattering or by micro-cracks.

Also, there can be a several degree difference if the test is run to the 2/10 maximum allowable failures point judged in one case by shattering and in the other by occurrence of micro-cracks.

In summary, Jack and Marty agree with the observation I have made that technique of judging failure is important in setting an absolute temperature level for T_b of any composition, but is relatively unimportant in ranking compositions provided the ranker uses a consistent criterion of failure for all the compositions he is ranking.

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Jack said that occasionally he may use the formula or the graphical method in ASTM D-746 for arriving at an estimate of T_b . Far more often, however, he runs it simply as a go/no go test at a definite temperature and judges by the criterion, 2/10 maximum allowable failures, defining a failure as a micro-crack or larger crack discernible after bending the specimen through 90 degrees.

Bill Coaker

A. W. M. Coaker

jp

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