GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RESEARCH DESIGNS AND STANDARDS ORGANISATION

Manak Nagar, Lucknow-226011.

No.EL/3.5.24/DE1. Feb., 1981.

SPECIAL MAINTENANCE INSTRUCTIONS NO.RDSO/EL/RS/SMI/65

VARNISHES FOR REWINDING OF CLASS 'F' TRACTION ARMATURES.

1. OBJECT:

Railways are rewinding various types of Class 'F' traction motor armatures using different makes and grades of varnishes. The performance of the rewound armatures is not satisfactory and infant mortality rate of rewound armatures is high. Amongst other reasons, use of incorrect or unsuitable varnishes during various stages of rewinding can lead to premature insulation failures. This SMI has been prepared with a view to standardizing the usage of varnishes in various stages of rewinding. The recommendations in this SMI are based on a series of evaluation tests carried out in accordance with a special test programme.

2. CLASSIFICATION OF VARNISHES ACCORDING TO THEIR USAGE:

Depending upon their usage, varnishes may be classified as follows:

i) Mica Bonding Varnish: These varnishes are employed for preparing glass-mica tapes, flexible mica sheets, foliums and wrappers. The most important requirements of mica-bonding varnish are complete flexibility in 'C' stage, good adhesive strength and quick drying and curing properties.

ii) Impregnating varnishes: These varnishes are employed for ensuring good bonding between conductors of a coil side, good inter-layer adhesion of ground insulation and obtaining a mono-lithic, voidfree and compact insulation in the slot portion. The most important requirement of impregnating varnishes are as follows:

a) Excellent Bond strength.

b) Semi-Rigid cured film.

c) High solids content.

d) Thermosetting properties.

e) Suitable for moulding under heat and pressure.

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Some flexibility of cured film is essential to allow for flexing and twisting of armature coils during armature winding operations.

Semi-Rigid, Solventless resin systems are most suited for this application.

.iii) Impregnating Varnishes: These varnishes are used for dip or vacuum-pressure impregnation of armatures after rewinding . The most important requirements of impregnating varnishes are as follows:

a) Correct viscosity at room temperature.

b) Good wettability of windings and high resin retention.

c) High bond strength.

d) High solids content.

e) Semi-flexible cured film.

f) Resistance to moisture.

Varnishes with smaller baking schedules are preferred. Solventless resin systems are preferred to solvent bond varnishes in impregnation. Compatibility with other varnishes is essential.

.iv) Finishing varnishes: These varnishes are employed for providing a final coating on the surface of end windings and other insulated portions of wound armatures. The most important requirements of finishing varnishes are as follows:

a) Air drying.

b) Cold curing (Curing at room temperature).

c) High arc resistance and track resistance.

d) Impervious to moisture penetration.

e) Semi-flexible film.

Varnishes which can be applied by a spray-gun are preferred to brush application varnishes.

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3. RECOMMENDED VARNISHES.

The evaluation tests have shown that amongst the indigenously available class 'F' varnishes, which have been commonly used for such applications, no varnish meets all the requirements simultaneously. However, the best available alternatives which are compatible have been selected for adoption as an interim measure. These two alternatives are shown in Table 1:

TABLE 1 : INTERIM SCHEMES

Usage	Alt. 1	Alt. 2
a) Mica-Bonding varnish.	Elmoglass V-172/M (Dr.Beck & Co.)	Elmoglass V-172/M (Dr.Beck & Co.)
b) Laminating varnish.	Elmothorn P-50 (Dr.Beck & Co.)	VBR 99 (Hard Castle & Waud).
c) Impregnating varnish	Elmothorn P-50 (Dr.Beck & Co.)	VBR 99 (Hard Castle & Waud).
d) Finishing varnish.	Epoxy Gel Coat & Hardner HY 411 (Dr. Beck & Co.).	-

NOTE: i) These alternatives are recommendedonly as an interim measure, till the right combination of varnishes and resins is developed indigenously. Efforts are being made to speed up this development.

ii) Although each alternative is by itself a compatible system, they are not compatible amongst each other. Hence an armature rewound with Alt.1 material should not be impregnated in subsequent overhauls with Alt. 2 impregnating varnish & vice-versa.

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4. Baking Schedules:

Proper curing of varnishes at each stage is very essential to obtain their declared properties. Whereas it is the duty of the manufacturers of built-up mica products, like glass mica tapes to ensure proper solvent removal of flexible tapes, it is not for therewinding shops to ensure this correct moulding cycle is followed in manufacture of coils and prescribed baking schedule is followed for curing of impregnating varnishes after winding and dip/vacuum-pressure impregnation. It is also advantageous to cure completely the mica-tape binder in overhanges by baking the armature BEFORE impregnation also.

The curing schedules of the varnishes in Alt. 1 and Alt.2 are shown in Table 2.

Table 2. Curing Schedule (excluding heating up time)

S.No.	Type	Recommended varnish	Curing schedule	Stage	Purpose
1.	Mica-Bonding	Elnoglass V-172/M	1½ hours at 150°C.	After placement of power coils in the armature, but before impregnation.	To ensure complete curing of binder in glass-mica tape in the overhangs.
2.	Impregnating.	Elnotherm F-50	2 hours at 120°C (for solvent removal followed by 6 hours at 160°C for resin cure or 12 hours at 120°C.	For dip or vacuum impregnation in new manufacture as well as during AOH & POH, just before Permanent banding.	To cure the impregnatin resin which has penetrated in the end windings & slot crevices, thus improving the heat transfer & moisture resistance properties of the armature.
3.	Impregnating	VBR 99.	4 Hours at 150°C	-do-	-do-
4.	Finishing.	Epoxy gelcoat + Hardner EH 411	16 hours at room temp. followed by 4 hours at 80°C.	After Permanent building apply by brush.	To obtain glossy finish, with high track resistance & moisture proofing.

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NOTE:- 1) For complete curing, the armature should be maintained at the prescribed temperature for the prescribed time and, therefore, the time required to raise the temperature of the armature to its prescribed value has not been included in this table. This period can be as high as 4 to 6 hours and should be allowed over and abovethe curing time.

ii) In most baking ovens, the job temperature is lower than the thermostat setting. Correct armature temperature should be ensured by conducting trials on each oven, and for each type of armature.

iii) The temperature for solvent removal of impregnating varnishes need not be adjusted on the oven separately. It takes some time for the armature to reach the final curing temperature and solvent removal automatically occurs in this period. Hence, the oven should be set straight away for the curing temperature. Air circulation with vent pipe is essential in the oven to take away the solvents.

5. Procurement of Mica Products:

Railways should ensure that all class 'F' glass-mica tapes, flexible micanites and foliums are procured with Elmoglass V-172/M as binder until further instructions. Adequate quality control should be introduced both by tape manufacturer and the Railway workshops to ensure that properties of the mica-bonding varnish are maintained at the guaranteed level. Constant liaison with varnish manufacturer in ensuring proper quality standards of their products, is essential.

6. Agency for Implementation:

All traction motor rewinding shops on electrified Railways.

7. Distribution:

As per sheet attached.

Sd/- A.A.HATTANGADI
for Director General/Elec.