



Neoprene[®] polychloroprene

From DuPont Performance Elastomers

A Guide to Grades, Compounding and Processing of Neoprene Rubber

Inherent Properties of Neoprene

Neoprene, the world's first fully commercial synthetic elastomer, was introduced by DuPont in 1931. Since then it has established an enviable reputation for reliable service in many demanding applications. Neoprene, made from chloroprene monomers, may be a homopolymer consisting of only chloroprene units or the polymer may be polymerized to contain sulphur and/or 2,3 comonomers such as dichloro 1,3-butadiene. Neoprene is a true multipurpose elastomer thanks to its balance of inherent properties, which include:

- Outstanding physical toughness
- Wider short- and long-term operating temperature range than general-purpose hydrocarbon elastomers
- Resistance to hydrocarbon oils and heat (ASTM D2000/SAE J200 categories BC/BE)
- Resistance to ozone, sun and weather
- Better flame retardant/self-extinguishing characteristics than exclusively hydrocarbon-based elastomers

As with all elastomers, properties inherent in the base polymer can be enhanced or degraded by compounding with additional ingredients. This concise guide will assist in the development of compounds with optimum service life which will process smoothly and economically. More detailed information on the available grades of Neoprene, processing and compounding for specific end-uses and specifications is available in a wide range of literature.

Handling Precautions

DuPont Performance Elastomers is unaware of any unusual health hazards associated with any Neoprene solid polymer. Routine industrial hygiene practices are recommended during handling and processing Neoprene solid polymers to avoid conditions such as dust buildup or static charges. For detailed information, read "Guide for Safety in Handling and FDA Status of Neoprene Solid Polymers," and observe the precautions noted therein.

Review current Material Safety Data Sheet (MSDS) for polymers and ingredients prior to first use and upon revisions.

Before proceeding with any compounding work, consult and follow label directions and observe handling precautions from suppliers of all ingredients. Specify dust-free dispersions of all potentially hazardous ingredients. Ensure that local environmental and workplace handling requirements are met. Also refer to comments on specific compounding ingredients in the safe handling guide.

Selection of Neoprene Type and Grade

The various grades of Neoprene fall within three types, e.g., G, W and T. Within each type there is a series of grades that differ primarily in resistance to crystallization and Mooney viscosity. Selection of type and grade is usually based upon a combination of four factors:

Product performance

Defined by the most important physical properties for optimum service life, e.g., tear and flex resistance (belts), compression set and stress relaxation resistance (seals, bearing pads), high and low temperature resistance (CVJ boots).

Crystallization resistance

As dictated by product operating temperatures and/or processing needs.

Mooney viscosity

Suitable for the intended processing operations with the necessary form of compound.

All DuPont Performance Elastomers grades of Neoprene have a viscosity measured using the ten pass method (N200.5700) and are measured ML 1+4 at 100°C.

Building tack

Ease of lamination in processing, where necessary.

Basic characteristics of the three types are summarized in *Table 1*, with details following. Additional information may be found in individual product bulletins.

Table 1
Characteristics of Neoprene

Types	G	W	T
Raw Polymer	Limited storage stability	Excellent storage stability	Excellent storage stability
	Polymer and compounds peptizable to varying degree	Non-peptizable Need acceleration	Least nerve, non-peptizable
	Fast curing but safe processing		Best extrusion, calendering performance
	Accelerators usually not necessary		Need acceleration
	Highest tack		
Vulcanizates	Best tear strength	Best compression set resistance	Properties similar to W-types
	Best flex	Best heat aging	
	Best resilience		

Types of Neoprene

G-Types

Characteristics that differentiate G-types are derived from their manufacture by the copolymerization of chloroprene with sulphur, stabilized or modified with thiuram disulfide. Neoprene G-types have wider molecular weight distributions than W- or T-types.

As compared with Neoprene W-types, Neoprene G-types:

- Can be mechanically or chemically peptized to a lower viscosity. Therefore, G-types can provide workable, more highly loaded stocks with minimum plasticizer levels. Neoprene GW, being essentially non-peptizable, is the one notable exception.
- More tacky and less nery, with the exception of gel-containing polymers. These properties lend themselves to extrusion, frictioning, calendering and building operations, as in hose and belt manufacture, and minimize knitting and backgrinding problems in molding
- More limited raw polymer storage stability

- Fully compounded, are more susceptible to total heat history in processing and storage time (i.e., are more prone to viscosity increase and reduction of scorch time)
- Do not normally require organic accelerators.
- Have highest tear strength, especially Neoprene GRT and Neoprene GW
- Impart highest flex fatigue resistance, higher elongation and resilience and a "snappier" feel to vulcanizates

Characteristics of Individual Grades

Medium crystallization speed

Neoprene GNA M1

A moderate viscosity and crystallization resistant polymer, thiuram disulphide stabilized and containing a staining secondary amine for improved polymer stability.

Slow crystallizing

Neoprene GW

An optimized sulphur-modified polychloroprene with improved storage and mill breakdown resistance similar to W-types but without the need for organic accelerators. Tear strength, resilience and flex crack resistance are similar to those of G-types. Heat resistance approaches thiourea cured W-grades. Compression set resistance lies between that of traditional G and W variants.

Neoprene GRT

A sulphur copolymer with good crystallization resistance. Has the best green tack of any Neoprene and is used extensively for frictioning, or where good building tack is required.

W-Types

As compared with Neoprene G-types, W-grades:

- More stable in the raw state
- Mix faster but cannot be mechanically or chemically peptized
- Require organic accelerators. By selection of type and level, they offer greater latitude in processing safety and cure rate
- Less prone to mill sticking and collapse on extrusion
- Offer superior vulcanizate heat and compression set resistance
- Accept higher levels of filler for a given level of compression set or tensile strength, hence can yield more economical compounds
- Yield non-staining, non-tarnishing vulcanizates
- Show improved color stability

Characteristics of Individual Grades

Fast crystallizing

Neoprene W

A stabilized, rapid crystallizing chloroprene polymer with good raw stability. Accelerated with ethylene thiourea (ETU), provides excellent heat and compression set resistance.

Neoprene WM 1

Lower viscosity Neoprene W for improved processing in highly loaded compounds and lower processing temperatures.

Neoprene WHV

High viscosity Neoprene W for low cost, highly extended compounds or to raise the viscosity and green strength of lightly loaded or highly plasticized compounds.

Neoprene WHV 100

Slightly lower viscosity than WHV.

Medium crystallization speed

Neoprene WB

Polychloroprene containing a high proportion of gel for exceptionally smooth processing and very low nerve. Used in blends, typically in amounts up to 25%, Neoprene WB produces high quality calendered sheet and smooth, collapse-resistant extrusions with low die swell.

Vulcanizates based upon Neoprene WB resemble those of other W-types in heat, ozone, oil and compression set resistance but exhibit lower tensile and tear strengths and flex crack/cut growth resistance when used with preferred W-type cure systems.

Very slow crystallizing

Neoprene WRT

A copolymer offering maximum crystallization resistance. Up to 50% more accelerator may be required to achieve the cure rate equivalent to that of Neoprene W. Vulcanizates have somewhat lower tensile and tear strengths compared to those of Neoprene W.

Neoprene WD

A high viscosity, crystallization resistant analogue of WRT useful in situations where high levels of plasticizer would cause excessively soft Neoprene WRT compounds.

T-Types

Neoprene T-types effectively combine the smooth processing of Neoprene WB with the tensile properties of Neoprene W. The three grades are:

Fast crystallizing

Neoprene TW

Generally exhibits properties analogous to those of Neoprene W but permits faster mixing, smoother extrusion and calendering with slightly better crystallization resistance.

Neoprene TW 100

Higher viscosity grade of Neoprene TW useful where greater extension without loss of processing advantages is needed.

Very slow crystallizing

Neoprene WB blend with Neoprene WRT

Blending Neoprene WB with Neoprene WRT provides a composition having improved processing and crystallization resistance.

At a Glance Polymer Selection Guide

Tables 2, 3, 4 and 5 summarize basic details of the Neoprene types and grades. As previously indicated, a wide range of bulletins and data sheets are available that describe the products in compounding, processing and end-use performance. These should always be consulted prior to commencing work with Neoprene.

Basic Principles

Balanced compounds based upon Neoprene G-, W-, or T-types will normally contain most of the classes of ingredients indicated in Table 5.

Acid Acceptors

High-Activity Magnesium Oxide (Magnesia)

The primary function of metal oxide in Neoprene compounds is to neutralize trace hydrogen chloride that may be liberated by the polymer during processing, vulcanization heat aging or service. By removing the hydrogen chloride, magnesium oxide prevents auto catalytic decomposition resulting in greater stability. Magnesium oxide also takes part in the vulcanization (crosslinking) process. Use of 4 parts magnesium oxide and 5 parts zinc oxide generally results in a good balance of processing safety and cure rate and is typically used. Higher levels of magnesia may be desirable for high temperature molding, especially injection molding. Lower levels of magnesia (2 pphr) may be used in some continuous vulcanization cure systems. Suitable grades of magnesium oxide are fine particle precipitated calcined types with a high surface activities measured by iodine number preferably above 130.

Table 2
Neoprene G-Types

	Raw polymer	Peptizable (except GW)	
	Compounds	Best tack Fast curing without accelerators Limited storage stability	
	Vulcanizates	High tear strength Best flex crack/cut growth resistance Moderate heat resistance Moderate set resistance	
Grades	ML 1 + 4 at 100°C	Features	
GNA M1	42–54	Better raw polymer stability	(M)
GNA M2	47–59		
GW	37–49	Balanced blend of G & W properties, non-peptizable	(S)
GRT M1	34–46	High crystallization resistance/tack	(S)
GRT M2	40–52		

(M) = Medium crystallization speed (S) = Slow crystallization

Table 3
Neoprene W-Types

	Raw polymer	Non-Peptizable	
	Compounds	Excellent storage stability Need accelerators	
	Vulcanizates	Excellent heat resistance Best compression set resistance Lower modulus	
Grades	ML4 — 100°C	Features	
W	40–49	General purpose	(F)
WM 1	34–41	Low viscosity W	(F)
WHV	106–125	Highest viscosity W	(F)
WHV 100	90–110	Lower viscosity WHV	(F)
WB	43–52	Gel-containing, smooth processing	(M)
WRT	41–51	Maximum crystallization resistance	(VS)
WD	100–120	High viscosity WRT	(VS)

(F) = Fast crystallizing (M) = Medium crystallization speed (S) = Slow crystallizing (VS) = Very slow crystallizing

Table 4
Neoprene T-Types

	Polymer, Compounds and Vulcanizates	Basic properties of W-Types with the smooth processing Least nerve Non-peptizable	
Grades	ML4 — 100°C	Features	
TW	42–52	Smoother processing than W	(F)
TW 100	82–99	Higher viscosity TW	(F)

(F) = Fast crystallizing (VS) = Very slow crystallizing

Table 5
Compounding Ingredients for Neoprene

Class	Typical
Acid Acceptor	Metal oxides (1) High-activity magnesium oxide, MgO (2) Red lead, Pb ₃ O ₄
Vulcanizing Agent	Zinc oxide
Vulcanization Accelerator	(1) Thioureas for W and T-types, sometimes G (2) Sulphur-based for W-types
Vulcanization Retarder	MBTS in G-Types, CBS, TMTD or MBTS in W-types
Antioxidant	Octylated diphenylamine
Antiozonant	Mixed diaryl-p-phenylene diamines with selected waxes, to 3 phr
Fillers	Carbon black; precipitated silica; calcium silicate; hydrated alumina; china clay
Plasticizers	Aromatic or naphthenic process oils; mono esters; polyester; chlorinated waxes
Processing Aids	Stearic acid; waxes; low molecular weight polyethylene; high-cis polybutadiene; special factices

Surface activity indicates the ability of the oxide to absorb or react with hydrogen chloride. Therefore, the higher the value, the greater the processing safety and vulcanizate properties, especially with G-types. Neoprene G-type Mooney Scorch times ranging from 54 to 16 min for 10 pt rise at 121°C have been recorded. Scorch times are directly related to the activity of the magnesium oxide incorporated.

To prevent loss of surface activity in storage due to pick up of atmospheric moisture or carbon dioxide, purchase in hermetically sealed sachets is recommended, as offered by most suppliers of high activity rubber grade of magnesium oxide (Mooney scorch time at 121°C has been halved by exposure of magnesia to 50% relative humidity for 24 hr).

Alternatively, there are a number of commercial dispersions, typically 75% active powder, that exhibit good storage stability. However, these may contain magnesia with a lower surface activity, hence care should be taken in demanding conditions. Some dispersions may also contain surfactants that can impair water resistance.

Red Lead

For improved water resistance, a lead oxide, usually 20 parts of red lead Pb₃O₄, may replace the magnesia/zinc oxide combination. For health reasons, red lead should always be added as a dispersion, 90% in EPDM. Owing to more limited reactivity with hydrogen chloride, stabilization is less efficient. Therefore, its use is confined to Neoprene W- or T-types with safe curing systems.

Calcium Stearate

This substance has limited use as an acid acceptor. Replacement of 4 parts magnesium oxide by an equimolar quantity (5.4 parts) of calcium stearate can retard hardening on heat aging and may be useful where specifications call for hardness increase of 5 pt or less after 7 days at 100°C.

Vulcanizing Agent

A good rubber grade of zinc oxide should be specified to minimize differences in curing activity.

Vulcanization Accelerators

As previously indicated, Neoprene G-types do not normally require an organic accelerator to develop a good state of cure at acceptable rates. For faster cure, 0.5 parts active ethylene thiourea (ETU) added as a dispersion is suggested. Predictably, increased rate and state of cure, and reduced scorch resistance, are proportional to the amount added.

All Neoprene W- and T-types require an organic accelerator.

Table 6 lists the common systems in order of increasing cure rate and decreasing processing safety.

The best balance of vulcanizate modulus, resilience, compression set and heat aging is normally provided by use of ETU. Processing safety can be improved by adding CBS or TMTD in carbon black stocks, or MBTS with mineral fillers such as china clay.

Table 6
Acceleration Systems for Neoprene W- and T-Types

Ingredients	Parts/100 Neoprene	Primary use
A. Stocks containing 4 parts MgO, 5 parts ZnO		
TMTM	0.5–1.0	
DOTG	0.5–1.0	Maximum processing safety
Sulphur	1.0–1.5	
ETU*	0.55–0.75	Mineral filler loading
MBTS	0.5–1.0	
ETU*	0.4–0.75	Carbon black loading
TMTD or CBS	0.5–1.0	
TMTM	0.5	
DOTG	0.5	Medium to fast cure with moderate processing safety
Sulphur	1.0	
ETU*	0.2–0.4	
ETU*	0.4–0.75	Maximum economy Optimum heat/compression set resistance
Methylthiazolidinthion (CRV or MTT)	0.4–1.5	Substitute for ETU Sometimes inconsistent cure, use higher level for high carbon black loading.
Tributyl thiourea*	3.0	Excellent set and ozone resistance, non-stain
Trimethyl thiourea*	0.75–1.5	Excellent compression set resistance
Epoxy resin	1.0–2.0	
Salicylic acid	1.0–2.0	High elongation/tear strength Low discoloration under lead
Diethylthiourea* (DETU)	1.0–2.0	Fast high temperature cures (LCM) Practical cures at lower temperatures
DPTU* (Thiocarbanilide)	1.0–2.0	As DETU
Dicumyl peroxide (40%)* N,N'-m-phenylenedimaleimide	1.5–2.0 1.5	Excellent set resistance and processing safety (Poor heat aging with 4.0 magnesium oxide and 5 pphr zinc oxide)
B. Stocks containing 20 parts red lead, Pb3O4*, no MgO or ZnO		
TMTM	0.5–1.0	Best water resistance
Sulphur	0.5–1.0	Bin storage stability with alkaline fillers

*Active ingredient level. To be used as a dispersion.

Where presence of ETU is unacceptable even in dispersed form, use of Neoprene GW without accelerator may be considered where ultimate compression set resistance is not required. At 170–180°C cure is usually sufficiently fast even for injection molding. Alternative proprietary accelerators include dimethyl ammonium hydrogen isophthalate, Vanax® CPA. This may require higher amounts for equivalent cure rate. Information on ETU-free alternatives are available on request.

Other possibilities include the TMTM, DPG or DOTG/sulphur systems where maximum resistance to heat or compression set above 70°C is not required.

The best property balance is obtained using sulphur at a level of 0.5–0.75 parts with accelerator levels at 0.75–1.0 parts each. Scorch resistance and bin storage stability are good. Addition of 0.3–0.5 parts ETU results in a fast cure rate with processing safety.

For continuous vulcanization up to 200°C or acceptable cure cycles at below-normal temperatures, up to 2 parts DETU or DPTU may be specified. Such stocks are impractically scorchy for normal processing. Heat history must be kept to a minimum and refrigerated storage is advised.

Water resistant Neoprene compounds containing red lead normally employ 0.5–1.0 part each of TMTM and sulphur as cure system. Acidic fillers promote poor scorch and bin storage stability. Preferred ingredients are furnace blacks or non-acidic clays.

Although they provide very low compression set and good processing safety, peroxide cures promote poor heat aging in Neoprene, even when high levels of efficient antioxidants are incorporated. They are rarely used.

Vulcanization Retarders

In Neoprene G-types, up to 1 part MBTS is an effective retarder. It may also be added to allow processing of overaged polymer. MBTS, CBS or TMTD are effective retarders in Neoprene W- and T-types. Examples are given in *Table 6*.

Antioxidants and Antiozonants

Unlike unsaturated general purpose elastomers, Neoprene has inherent resistance to attack by oxygen, ozone, heat and light. However, long term optimum service performance requires the addition of an effective antioxidant and antiozonant.

Among possible antioxidants, octylated diphenylamine, 2–4 parts, is preferred as it imparts the best heat stability, has no effect upon scorch or bin storage and is relatively nonstaining. Ketone amine and quinoline based types seriously affect scorch and bin storage and must be avoided.

Effective antiozonants tend to adversely affect processing safety and to promote staining. Among para-phenylene diamine derivatives, mixed diaryl para-phenylene diamine has only a slight effect upon scorch and bin storage and gives the best balance of long term protection, being non-extractable in water and of low volatility. However, all PPD derivatives may cause migratory and contact staining of painted surfaces. Given the limited options for effective nonstaining antiozonants, it is suggested that a DuPont Performance Elastomers technical representative be consulted if one appears to be required.

Reinforcing and Extending Fillers

Carbon Blacks

As with all elastomers, Neoprene requires the addition of appropriate reinforcing fillers to achieve the required balance of processability, hardness and tensile or tear properties. The most widely used is carbon black.

Although the most highly reinforcing blacks N110 (SAF) or N242, N220, N231, N219 (ISAF) can, under optimized mixing conditions, give the best tensile and tear strength values, dispersion difficulties in practice lead to N330 (HAF) or N326 (HAF-LS) being the finest particle carbons generally used. For most applications, N550 (FEF), N683 (APF), N660 (GPF), N772 or 774 (SRF) or N990 (MT) blacks, or blends, enable specification and service requirements to be met. N550, N683 or N660, alone or blended with N772 or N774 are preferred for extrusion or calendering stocks. Where requirements permit, economical compounds may be prepared using high loadings of N772 or N774 or N660 blacks, with significant levels of plasticizer. Alternatively, blends of N772 or N774 with mineral fillers such as china clay or whiting can be considered where compression set and physical property requirements are modest.

Mineral Fillers

The most commonly used mineral fillers in Neoprene are precipitated silica, calcium silicate, china clay and whiting. Hydrated alumina may be incorporated to raise ignition temperatures and limiting oxygen index values.

Precipitated silica, preferably with up to 3 parts triethanolamine or other dispersing aid if used at high levels, gives the highest levels of tensile strength, elongation and tear resistance. China clays may be hard or soft depending on the degree of reinforcement and loading required. Calcined clays are used for best compression set and electrical properties.

Whiting finds limited use as a cheap non-reinforcing filler but it adversely affects weather resistance. If used, a stearate coated precipitated grade is preferable. Platy talc may be incorporated for good extrusion and electrical properties.

Plasticizers

As with all elastomers, softeners, plasticizers and extenders are frequently added to Neoprene to facilitate processing, enhance specific properties or reduce cost. Levels may be from 5 to more than 50 parts. Care must be taken both in type selection and quantity to ensure that the attractive property balance inherent in Neoprene is maintained.

Highly aromatic oils are compatible with Neoprene at all levels and are relatively low in cost. They increase uncured tack at high dosage levels and can cause vulcanizates to slightly stain paint films. Naphthenic oils do not have these effects and give better long-term heat resistance but their compatibility is limited to approximately 15 parts maximum, depending upon the source.

Ester plasticizers are required to maintain and increase flexibility of Neoprene vulcanizates at temperatures to -40°C but tend to increase the crystallization rate of susceptible grades. Most commercial types such as the sebacates, adipates, phthalates, phosphates and oleates may be used depending upon the necessary balance of low temperature flexibility, volatility and cost. Di-2-ethyl-hexyl (di-octyl) sebacate (DOS) is often used for its favorable combination of these factors. Butyl oleate is effective at low temperatures but relatively volatile at 100°C . Phthalates may be an economical choice where low temperature requirements permit their use.

Polymeric plasticizers and hydrocarbon or coumarone-indene resins can retard crystallization but do not improve low temperature flexibility. Phosphates tend to be used where self-extinguishing characteristics are critical but low temperature flexibility less so.

Chlorinated hydrocarbons and waxes are available both in solid and liquid forms with chlorine content between 40 and 70%. Liquid forms tend to cause mold sticking. Therefore, solid grades or blends tend to be preferred. Their use is confined to Neoprene compounds with optimum ignition resistance or self-extinguishing characteristics.

Processing Aids

Special low oil swell factices may be used in Neoprene compounding, especially in low hardness compounds, for soft rollers. Such factices decrease compound nerve and may permit higher liquid plasticizer levels. Some loss of physical properties, especially compression set, is likely.

General purpose process aids include stearic acid, petrolatum (petroleum jelly), paraffin or microcrystalline waxes and low molecular weight polyethylene. Stearic acid is particularly effective in minimizing mill and calender roll sticking. To prevent significant retardation of cure rate, levels should be limited to 1 part in W-type compounds, 2 parts in G-types. Typically, 1 part petrolatum, 1-3 parts wax or up to 5 parts low molecular weight polyethylene may be incorporated. Note, however, that enhanced roll release with the latter requires temperatures above the softening point of the PE, $75-80^{\circ}\text{C}$. It is effective as an internal mold release agent, as are waxes.

High cis-1,4-polybutadiene at 3-5 parts provides maximum roll release properties in very sticky stocks. Slight activation of cure will be observed.

For ease of mixing, reduction of structure and nerve and optimum physical properties in silica loaded Neoprene compounds, 3% of the silica content of triethanolamine or calcium stearate should be included. Both should be added with a small amount of filler early in the mixing cycle. A typical application is extruded yellow mining cable.

Compounding for Specific Requirements

Abrasion Resistance

Incorporate a fine particle size carbon black such as N330 or N326, typically up to 40 parts. N326, HAF-LS, is particularly useful where abrasion resistance is required with high resistance to tear and chipping. Plasticizers should be naphthenic and kept to a minimum hence G-type polymers such as Neoprene GW are preferable.

Adhesion to Substrates

Metals

Wherever the required property balance permits, combinations of reinforcing blacks such as N330, N326 (HAF) etc. with 10 parts precipitated silica will enhance bond strength. Plasticizer levels, preferably aromatic oil or di-2-ethyl hexyl sebacate for low temperature flexibility, should be kept to a minimum. An excess of any plasticizer or process aid may impair bond strength.

All major suppliers of bonding agents offer one or two-part primer systems for bonding Neoprene to ferrous or other metals. *Table 8 (page 22)* provides a non-exhaustive list of potential metal bonding primers. The table also includes practical advice on metal bonding in production.

A molding compound for bonding should have optimum acid acceptance derived from the correct selection of magnesia, its package and storage. If service conditions involve extended high temperatures, 6 parts magnesia and 10 parts zinc oxide should be specified.

Direct bonding of nonferrous metals such as brass and zinc may be accomplished without primer using 1.5 parts sulphur. In this case, ETU and derivatives should be avoided. With these substrates, inclusion of 5 parts of a cobalt complex, Manobond® C, is useful for development of higher, more consistent bond strengths.

Textile Fibers

Adhesion of Neoprene to fibers depends upon the nature of the fiber. Fabric treatment is normally not required for cotton. A low viscosity Neoprene GRT will provide maximum penetration and wetting of a fabric or fiber.

When nylon or polyester is used a primer coat of 30% Neoprene compound solution in toluene containing 4–6% organic isocyanate is applied as a dip or spread coat. The isocyanate treated fabric must be protected from atmospheric moisture between dipping or spreading and final coating to ensure maximum bond strength.

For polyester tension members, as used in raw-edge V-belts, the cord supplier will normally pretreat with an isocyanate primer followed by a resorcinol-formaldehyde/vinyl pyridine/polychloroprene latex dip.

Blending Neoprene With Other Elastomers

Blends of Neoprene are sometimes used commercially. For example, with blends of Neoprene and natural rubber (NR) are often used to provide good hot tear strength and building tack. Blends of Neoprene and styrene butadiene rubber (SBR) are often desirable for compound cost reduction and blends with NBR exhibit enhanced oil and fuel resistance. Careful compounding is necessary to minimize modification of the overall unique blend of properties offered by Neoprene. It is important to remember that Neoprene is a relatively slow curing elastomer requiring acceleration systems which are ultra fast when used with diene elastomers. Selection of curing systems for the co-vulcanization of blends based upon Neoprene must take into account the need for adequate processing safety and storage stability of the final full compound.

For consistent properties and performance, intimate mixing of the polymers is essential.

The viscosities of both polymers of the blend should be as close as possible. If flex fatigue and outdoor weathering resistance are important factors, the split masterbatch mixing technique should be specified for intimate blending. This involves preparation of separate masterbatches based on each blending polymer, with filler and plasticizer levels adjusted to obtain a similar viscosity in each polymer masterbatch. The masterbatches are then blended together thoroughly when the curatives are added.

NR, SBR and NBR in Neoprene blends all adversely affect the ozone resistance of Neoprene. It is essential to include at least 2 parts of antiozonant, preferably one of the mixed diaryl types. When preparing blends with diene rubbers, Neoprene W-types are preferred to G-grades since residual thiuram disulphide in the latter causes poor processing safety. For blends with NR a combination of 0.7 MBTS, 0.3 DPG, 2.0 sulphur is suggested. For SBR blends cure systems based upon 0.5–1.0 TMTM, 0.5–1.0 DPG, 1.0–1.5 sulphur are normal. An EV system based upon 1.0 DPG, 2.5 Tetrone® A will give improved heat resistance.

Blends with NBR are normally limited to 25 parts with a G-type of Neoprene using 0.25–0.5 parts TETD as curative.

For polarity (compatibility) reasons, EPDM is normally limited to 15–30 parts in blends with Neoprene to improve nonstaining static ozone resistance. Because of the incompatible nature of the polymers, the split

masterbatch mixing technique is considered essential. Curing systems for each polymer are added after blending and the following may be used: 0.5 parts MTD, 1.0 parts MBTS, 0.3 parts TMTM, 1.0 parts sulphur.

The addition of up to 10 parts Neoprene W to resin cured heat resistant IIR (butyl) compounds, e.g., for tire curing bags, greatly reduces the tendency of the compounds to soften and lose mechanical strength during use.

Building Tack

The use of low viscosity Neoprene GRT provides the highest levels of building tack. Where a W-type must be used, WRT is preferred. Aromatic plasticizers provides more tack than naphthenic or ester types. Other tack promoters include coumarone-indene resins, especially liquid types, wood resin and phenolic resins such as Koresin. Aromatic oils are more prone to cause troublesome roll sticking than other types. As noted under Processing Aids, 3–5 parts high-cis 1,4-polybutadiene can alleviate problems of excessive roll sticking. To maintain building tack dusting agents should not be applied to sheeted stocks. Batch-off liners should be of a nonstick type.

Compression Set Resistance, Stress Relaxation, Compression Recovery

Tight cure of a crystallization resistant Neoprene grade is fundamental to optimization of these properties. Use Neoprene WRT or blends with WD for moldings, and WB if extrusion is involved. For the most demanding specifications, 3–4 parts TBTU is preferred or 1.5 parts TMTU with 0.5–1.0 part epoxy resin to extend shelf life. TBTU also confers nonstaining ozone resistance when used together with 2.0 parts octylated diphenylamine. Most requirements can be met by using 1.0 part ETU, with DETU or DBTU for very fast cures.

As in other areas, selection of the correct grade of magnesia is important. With respect to carbon blacks, N990 medium thermal usually provides the lowest set/stress relaxation values for a given level of addition but reinforcing blacks as previously listed, or blends, may be required to meet tensile or tear property requirements. Mineral fillers should be avoided except where necessary and then used at low levels, e.g., to 15 parts precipitated silica when added for tear strength or bonding.

For recovery from compression at low temperatures (–30 to –40°C) the minimum level of ester plasticizer, such as 10 parts DOS, should be used, with any additional plasticizer being an aromatic oil. This is to balance the crystallization-accelerating effect of the ester with the retarding characteristic of the aromatic oil.

Creep Resistance

For optimum creep resistance, normal compounding considerations apply except that plasticizers should be confined to minimum levels of esters such as DOS. Extended cures at moderate temperatures, for example 30 min or more at 148–153°C, will ensure maximum cross-link density from the vulcanization system selected.

Chemical Resistance

To enhance resistance to swelling and degradation in aqueous aggressive chemicals and hot water or steam, use up to 20 parts active red lead as a dispersion, 90% in EPDM.

To avoid potential scorch problems, a W- or T-type polymer should be selected, typically cured with 1.0 part TMTM and 1.0 part sulphur. To maintain processing safety, acidic fillers should be avoided. For best acid resistance, use 100 parts or more of barytes or blanc fixe. High plasticizer levels should be avoided particularly against oxidizing agents.

See also Water Resistance.

Crystallization Resistance

For the best possible crystallization resistance, compounds based upon Neoprene WRT or WD are recommended. Should a G-type be necessary, Neoprene GRT is preferred but is not quite as resistant.

Preferred plasticizers are aromatic oils, or hydrocarbon resins such as Kenflex[®] A-1. The hydrocarbon resins are more effective as crystallization inhibitors in the uncured state. Ester plasticizers should be avoided but, if necessary for flexibility near the second order transition point (–30 to –40°C), use the minimum amount of DOS. Inclusion of up to 1 part sulphur will also retard vulcanizate crystallization at the

expense of heat aging and compression set resistance. Blends of Neoprene, with up to 30% high cis-1,4-polybutadiene also show improved crystallization resistance, with predictable decrease in tensile strength, oil, ozone and flame resistance.

Electrical Properties

Owing to its higher polarity versus totally hydrocarbon based elastomers, Neoprene is not normally considered a primary insulating material. To optimize its capabilities, mineral fillers should be specified due to their higher insulation resistance and dielectric strength as compared with carbon blacks. Platy talcs such as Mistron[®] Vapor are recommended for dielectric strength. Ester plasticizers should be avoided. Up to 15 parts naphthenic oil may be incorporated but a hydrocarbon resin, such as Kenflex[®] A-1, will optimize insulation resistance.

Where antistatic properties are essential, incorporation of conductive furnace blacks such as N283 (CF) or N472 (XCF) is recommended, as in other elastomers. Care must be taken to select a safe processing cure system and a Neoprene grade of sufficiently low viscosity to minimize heat generation during processing.

Flex Cracking Resistance

Neoprene G-types, especially GW or GRT, have the best inherent flex fatigue resistance properties. Neoprene GW may be preferred where cut growth resistance is the primary requirement. Wherever possible, compounds should contain N772 or N774 (SRF) carbon blacks, or blends with N990 (MT carbon black), for low modulus and high elongation. Up to 20 parts precipitated silica with a dispersing aid will also assist. Acceleration of any polymer grade with thioureas should be avoided.

Compounds should contain a good antioxidant/antiozonant system such as 2 parts octylated diphenylamine, 1 part mixed diaryl p-phenylene diamine. All grades, G- or W-type, benefit from inclusion of up to 2 parts zinc 5-methylmercaptobenzimidazole (ZMMBI). This also acts as a heat stabilizer but may decrease compound bin storage stability. Plasticizer should be present at the minimum level of aromatic oil.

Excellent dispersion is essential if optimum flex fatigue properties are to be achieved.

Flame Resistance

The inherent self-extinguishing characteristics of all Neoprene grades may be enhanced or diminished by compounding. Solid or liquid chlorinated paraffins having combined chlorine contents between 40 and 70% may be used both to plasticize the compound and to increase the available chlorine level. To minimize mill stickiness the use of these additives induces, it is recommended that higher viscosity W-types such as WD be used. Blends of solid and liquid chlorinated paraffins also reduce sticking tendencies.

Hydrated alumina enhances self-extinguishing characteristics and raises auto-ignition temperatures. It may be used in combination with carbon blacks to achieve tensile requirements. China clays and calcium silicate are also useful but do not provide the specific effects of hydrated alumina.

Other additives to enhance self-extinguishing include antimony trioxide, alone or preferably as a synergistic 3:1 combination with decabromo biphenyl ether. Unacceptable afterglow promoted by antimony trioxide can be prevented by inclusion of an intumescent crust forming agent such as zinc borate to exclude oxygen. Magnesium hydroxide finds use as a smoke suppressant. Hydrocarbon-based plasticizers and process aids should be avoided or severely restricted since they support combustion.

Food Contact

For an actual list of rubber grades of Neoprene suitable for use in compounds to meet the requirements of U.S. FDA Regulation 21.CFR.177.2600 (rubber articles intended for repeated use) see "Guide for Safe Handling and FDA Status of Neoprene Solid Polymers."

Attention is drawn to limitations on compounding ingredients imposed in both FDA and BGA regulations and to permissible extraction limits. ETU is not an acceptable accelerator. Information on alternatives to ETU are available on request. Neoprene GW offers a potential route to accelerator-free practical compounds where the required balance of properties permits.

Heat Resistance

W- or T-type polymers are essential as they do not contain free or combined sulphur. Use of 4–6 parts high-activity magnesia (with up to 10 parts zinc oxide) is essential to achieve the highest level of acid acceptance, especially where the Neoprene vulcanizate is in contact with natural or most synthetic fibers.

The preferred antioxidant is 4–6 parts octylated diphenylamine, with 1.5 parts mixed diaryl-p-phenylene diamine if high-ozone resistance is also required. A tight cure is often essential to meet end-user specifications and achieved with thiourea accelerators.

Fillers are typically carbon blacks such as N550 (FEF) or N772 (SRF) or similar blacks, alone or as blends or in conjunction with precipitated silica or reinforcing clays. Fine particle size calcium carbonate confers good heat resistance but impairs physical properties, weathering and water resistance.

Selection of plasticizer type is important. Rapeseed oil or polyesters are recommended for permanence. Among monoesters, DOS is a preferred type for its balance of high and low temperature performance. Plasticizers to be avoided include butyl oleate and naphthenic oils for their volatility, and aromatic oils. Use of 5 parts IIR rubber in a Neoprene compound helps counter the natural hardening of the polymer on long term exposure to high temperatures, as does 5.4 parts calcium stearate substituted for the standard 4 parts of high activity magnesia. Neither approach is commonly adopted.

High Resilience

Specify a G-type polymer, tightly cured. Neoprene GW is a good candidate and may meet requirements without additional acceleration. Among carbon blacks, N990 (MT) provides the highest resilience. Where reinforcing types are essential, low structure variants should be specified.

Naphthenic oils or monoester plasticizers up to 15 parts are preferred. Polyesters, resins of all types and factices should be avoided.

If the overall required property balance permits its inclusion, up to 20% of the polymer base as high cis-1,4-polybutadiene will enhance resilience. The split masterbatch mixing technique is likely to be necessary and the possibility of problems due to scorch should be considered.

See also Vibration Damping.

High Strength at Elevated Temperatures

Precipitated silica up to 40 parts, preferably with up to 3 parts triethanolamine or other surface-active dispersing aid, is particularly effective in retaining vulcanizate physical properties at temperatures up to 200°C short term. Where extended exposure to elevated temperatures is also likely, the recommendations for optimum heat resistance should be followed.

Low-Gas Permeability

Permeability constants for atmospheric gases such as methane and hydrogen are lower for Neoprene than NR or SBR at both 25 and 50°C. In practice, rate of permeation of a given gas may be significantly affected by compounding. Tight cure is a prerequisite. Therefore, a Neoprene W-type compound with thiourea accelerator is preferred. Platy fillers such as mica or Mistron Vapor talc reduce permeability anisotropically. With significant loadings of mica a lower viscosity polymer grade is likely to be required. Plasticizer levels should be kept low and preferably avoided altogether.

Low-Temperature Resistance

Both immediate stiffening as temperature is reduced and the slower effects of crystallization should be considered. As temperatures decline, immediate stiffening occurs reaching a second order transition at approximately –45°C where a phase change occurs from the rubbery to the glassy state. When this occurs, Neoprene vulcanizates become brittle.

Crystallization is slower and occurs most rapidly at approximately –10°C. A rapid drop in temperature can prevent crystallization altogether, even in a fast crystallizing grade, due to molecular immobilization. Both effects are reversible on warming but at different rates.

During processing, crystallization may impair building tack after cool storage and result in ply adhesion problems. A typical example of an in-service deficiency caused by crystallization would be a conveyor belt

that fails to track adequately due to the resulting stiffening, thereby reducing its load carrying capacity. A degree of crystallization can be beneficial for wire braided high pressure hoses since the stiffer unvulcanized extrudate better resists cutting in by the wire.

The principle factor in controlling the crystallization rate in Neoprene is polymer selection, with W-type copolymers as described under Types of Neoprene, and *Table 3* being recommended for the very best resistance. As previously indicated, aromatic oils, polymeric or resinous plasticizers help retard crystallization. Monoester plasticizers, essential for limiting short term stiffening and lowering the brittle point, accelerate crystallization. Therefore, use of such plasticizers should be restricted to the minimum level necessary. Di 2-ethyl-hexyl (dioctyl) sebacate is very effective at low temperatures and nonvolatile up to 120°C.

In a 50 I.R.H.D. compound, approximately 15 parts are necessary for development of full flexibility at –40°C, 25 parts at 70 + I.R.H.D. Phthalate and phosphate based plasticizers are less effective but cheaper. Butyl carbitol formol (e.g., Thiokol TP90B) and butyl oleate are very effective but more volatile. The latter also tends to retard cure.

Given the wide range of plasticizer types and variants available, this discussion should be viewed only as an outline guide. If alternatives to those mentioned are desired, suppliers technical information should be reviewed.

Ozone Resistance

The inherent ozone resistance of Neoprene may be optimized by incorporation of antiozonants in combination with selected waxes, e.g., for external applications such as cable sheathing, structural gaskets and bridge bearing pads. Antiozonants should be nonvolatile and non-extractable by water and have minimum effect upon compound bin storage stability.

For moderate ozone test requirements, e.g., to 70 hr at 50 pphm, 38°C, 20% elongation, 2 parts octylated diphenylamine with 3–5 parts of selected wax is usually adequate. For more demanding tests, e.g., to 100 hr at 100 or 300 pphm, a mixed diaryl-PPD antiozonant should be specified, with the same level of wax to maintain a protective surface film. Both types of the chemical antiozonant confer slight paint staining.

Suppliers of specialized waxes for use as antiozonants usually offer various grades depending upon test and service temperatures. It is advisable to ensure that the most suitable grade has been selected.

Most monoester plasticizers adversely affect the ozone resistance of Neoprene vulcanizates, with the exception of butyl oleate. The use of this plasticizer can be beneficial, as is the use of raw linseed oil as a non-staining antiozonant. Linseed oil may, however, promote fungus growth. As noted in *Blending*, 15–30% EPDM may be substituted for part of the Neoprene polymer for nonstaining static ozone resistance where other considerations allow.

Minimum Staining and Discoloration

All colored Neoprene vulcanizates, especially light pastel shades, discolor rapidly particularly when exposed to strong sunlight. This may be acceptable with solid colors obtained using 10–15 parts or more of inorganic pigments such as red or yellow iron oxides or chromium oxide green. Rutile titanium dioxide is the most effective UV screening pigment, used up to 50 parts to mask discoloration in pastels. Eventually, some discoloration will occur.

For minimum discoloration, use W-types of Neoprene with a phenolic nonstaining antioxidant. The G-types should be avoided.

Resistance to Lead Press Discoloration

The primary cause of discoloration in lead cured colored cable jacket compounds is interaction between the metal and any available sulphur in the compound to produce black lead sulphide. Hence a W-type polymer is recommended and any compounding ingredient containing or liberating sulphur during cure, e.g., TMTD-cured factice, must be avoided. ETU/MBTS is the preferred accelerator system. If discoloration still occurs, consider using 3.0 salicylic acid, 0.5 DOTG, 3.0 epoxy resin as the curing system or add 1.5 parts calcium stearate.

Tear Resistance

The tear resistance of Neoprene G-types is inherently better than that of W-types, with GW being outstanding. Neoprene G-types possess excellent flex fatigue resistance usually with adequate compression set resistance. Among fillers, precipitated silica with a dispersing aid is generally recommended but other minerals such as silicates and hard clays may also give better tear values than most carbon blacks, at the expense of poorer compression set resistance.

N326 (HAF-LS) carbon black can give a good balance of tear and set properties provided that good dispersion is achieved. To assist this, oil addition should be avoided during incorporation of the black. Resinous plasticizers such as coumarones or alkyl aromatic, at 5 parts also help achieve optimum tear strength. Natural rubber, 10–20 parts, may also assist but inevitably diminishes oil and ozone resistance.

Vibration Damping

High-mechanical damping is diametrically opposite to the requirements for high resilience. A typical application is machinery mountings in a hot and/or oily environment. Appropriate compounds are usually highly filled with soft black, china clay and aromatic oil. Hence, high Mooney Neoprene WHV or WHV-100 are indicated. ETU acceleration is required for practical cure times and minimum creep in service.

Water Resistance

Acid acceptance systems based upon 4 parts active magnesia are often satisfactory for long term performance at or near ambient temperatures, especially in salt-containing sea water or similar. As previously emphasized, magnesia should be purchased as powder in sealed sachets, not as dispersed pastes unless carefully checked for possible effects upon swell.

Precipitated silica used in amounts to 25 parts is useful for long term water resistance. Silica is most effective with magnesia/zinc oxide cure systems. For periods up to 20 days at 70°C, water absorption of Neoprene compounds containing silica is fairly high followed by desorption to an equilibrium. Its use is not recommended in composites such as cable jackets.

For optimum swell and degradation resistance in hot water up to 20 parts red lead Pb_3O_4 should replace the magnesia and zinc oxide, as described in Chemical Resistance.

While red lead offers the best water resistance, using 20–30 parts of hydrotalcite in place of red lead also yields improved water resistance.

Weather Resistance

The main atmospheric factors are UV light and ozone with temperature and humidity as contributors. UV light promotes surface crazing but a minimum 15 parts furnace black such as N772 or 774 (SRF) provides complete protection. For colored Neoprene vulcanizates, the most effective screening pigments in order are rutile titanium dioxide (30 parts) and red or yellow iron oxides (15 parts) but they are far less efficient than carbon black. It is better to avoid long term direct sunlight exposure of colored Neoprene or to use a veneer based upon Hypalon®.

Provision against ozone attack should follow recommendations. Attention is again drawn to the risk of fungal growth on black or colored compounds containing raw linseed oil as antiozonant, which can lead to surface crazing.

Processing

General

Careful control of all mixing and processing operations with Neoprene is essential if trouble-free, reproducible production is to be achieved. The effects of heat exposure or history upon scorch times and flow from all operations, including raw polymer storage, especially with G-types, is cumulative. Mixing temperatures for fully compounded stocks should never exceed 110°C. Thorough cooling of sheeted stocks to the center is an important factor. Another is the selection of the correct viscosity grade of Neoprene at the outset as this affects all subsequent processing operations.

Open Mill Mixing

Salient points are:

- Use correct batch weight, eg., at S.G. 1.4, 28 kg for 1.06 m rolls, 56 kg for 1.52 m, 95 kg for 2.13 m
- Ensure a good supply of cooling water to the rolls preferably temperature controlled or refrigerated in hot weather
- Where chilled water can cause surface condensation on rolls before or between mixes, dry rolls with scrap or a non-accelerated mix based on a hydrocarbon elastomer
- Band the Neoprene on cool rolls (35–50°C) then the magnesia followed by antioxidants, retarders, stearic acid, silica, dispersion aids and color pigments. Unless the polymer is a G-type being separately peptized, no mastication period is required
- Add reinforcing fillers such as carbon blacks and silica as soon as possible after this to ensure maximum shear for good dispersion. Follow by soft fillers such as thermal blacks and minerals
- Depending on the amount of liquids to be incorporated, either mix with the soft fillers or add separately after powders have dispersed
- Add release agents such as waxes, petrolatum or low-molecular-weight polyethylene slowly to avoid breaking the band
- Finally, add zinc oxide and accelerator preferably as dispersions. After incorporation, cut and blend side to side a minimum of ten times. After slabbing off, cool thoroughly in forced air, a water spray or dipping in an antitack solution. Do not allow the stock to soak
- Store cooled stock at 30°C or less, totally dry; water milled into compounds may cause serious lamination problems in subsequent extruding, calendaring or molding operations

Two potential difficulties with open mill mixing are roll sticking and poor dispersion. Roll sticking may be caused by poor cooling, insufficient roll release agent, caking of powdered magnesia especially on rolls made damp by condensation, use of certain types of hard clay, excessively soft and/or tacky stocks and pitted roll surfaces. Neoprene G-types are more prone to roll sticking than W- or T-grades. Where sticking is persistent, addition of 3–5 parts high-cis 1,4-polybutadiene usually resolves it with some loss of processing safety. Sticking may also be countered by dusting the back roll with zinc stearate. Note, however, that zinc stearate should not be used for dusting Neoprene compounds after slabbing off. It is not as soluble in Neoprene as in hydrocarbon rubbers. Hence, its use can cause poor knitting in molding or plying up.

Poor dispersion may result from addition of plasticizers with fine particle blacks or silica, or cutting back when loose fillers remain in the nip. Magnesia or fillers that have caked on the rolls are also difficult to disperse subsequently.

Internal Mixing

This is preferred to open mill mixing since less heat history is normally involved. Salient points are:

- Ensure the mixer is clean by running a clean-out batch of unaccelerated W-type Neoprene or nitrile rubber before starting
- Start with a load factor of 0.6 in calculating the approximate correct batch weight, ie., water capacity of the mixer x compound S.G. x 0.6. As an example, this gives batch weights of approximately 60 kg for a 3A Banbury, 145 kg for a No. 9 mixer, at S.G. 1.4. Depending upon the extent of chamber and rotor wear, and the nature of the mix, theoretical loadings may require adjustment (usually upwards) to ensure that the ram bottoms towards the end of the mixing cycle with normal air pressure
- Use moderate rotor speeds and full flow of temperature-controlled water to minimize temperature rise. Start with a mixer temperature of approximately 50°C
- Adopt the same order of ingredient addition as with open mill mixing. Where blends are used, allow 1 min extra polymer blending time. It is especially important to add magnesia and antioxidant early in the mixing cycle after the polymer chips have massed or, in the case of G-types after peptization, if practiced as a separate step
- Provided indicated stock temperatures do not exceed 100°C and the cure system is not too active, zinc oxide and accelerator may be added to the mixer, preferably as dispersions, 1 minute before dumping. If in doubt, they should be added on the dump mill or in a second pass

- Where machine wear is moderate, upside-down mixing may be considered, particularly for Neoprene W compounds with moderate filler and oil loadings. Properly used, this procedure can reduce mix times by 50%
- Regardless of loading method, dump the batch at a maximum 110°C
- Dump mills fitted with stock blenders are recommended to complete dispersion mixing

In internal mixing, dispersion of soft fillers may not be affected by simultaneous addition of oils. This achieves shorter cycles with less risk of the batch breaking up. Highly extended Neoprene WHV compounds may require a full upside-down procedure, a 2-stage method and/or a loading factor of 0.65 to obtain sufficient initial volume in the chamber. A dump temperature above 105°C for clay loaded compounds helps minimize the content of cure-retarding moisture.

Potential problems in internal mixing of Neoprene include incipient scorch, failure to mass and contamination. Adherence to the established principles for the efficient internal mixing of any elastomer will usually avoid them.

Incipient scorch may result from incorrect batch weight, insufficient cooling water flow or too high water temperature. Where a degree of wear is known to exist, zinc oxide and accelerator dispersions should be added on the mill.

Failure to mass or breakup during the cycle may result from the machine being too cold, inadequate initial loading, the addition of lubricants too early in the cycle or excessive rotor to chamber clearance.

Cured pieces in the stock may result by contamination from debris caught in the chute or a worn gate or dust seal. Apart from use prior to mixing Neoprene, a clean-out batch run between compound changes is good practice. Good maintenance of the mixer and its cooling and temperature indicating systems is an important factor.

Calendering

Sheeting

For preparation of calendered sheet or skim coating fabric, compounds based upon Neoprene T-types, or blends containing WB, are preferred since the presence of particulate gel reduces nerve and gives smoother sheets. Compound should be uniformly warmed up on an open mill and ideally fed to the calender nip by oscillating conveyor to ensure continuous, even distribution across the full roll width, with a small rolling bank.

Salient points are:

- Accurate roll temperature control is essential. Typical temperature ranges for Neoprene G- and W- or T-type compounds for a 3-roll calender are shown in *Table 7*
- To ensure release from the center roll, 1-4 parts low molecular weight polyethylene should be incorporated as the release agent
- Specify a scorch-resistant cure system
- Re-rolling of calendered sheet is good practice as it reduces any tendency of soft stocks to stick to the liner cloth and reduces heat history
- Embossed polyethylene film is not recommended as a liner as the pattern can print onto the calendered sheet and cause air entrapment. This can result in poor ply adhesion in subsequent building operations. Cotton process liners are preferred
- Where the desired sheet thickness is too great to achieve in one pass without air entrapment, plying up on the bottom bowl with an auxiliary squeeze roll may be adopted. With tough, tack-free stocks, a bottom bowl temperature of 90–100°C improves tack and ply adhesion and reduces shrinkage

Potential problems in sheet calendering include roll sticking, crows feet surface marking, variable gauge, shrinkage, surface blisters, ply blisters and ply separation. Sticking is generally due to incorrect roll temperature, insufficient release agent or inappropriate choice of base polymer, fillers and plasticizers. Owing to their surface smoothness, Neoprene T-types may be more prone to roll sticking. Addition of 3–5 parts high-cis, 1,4-polybutadiene will generally prevent this.

Crows feet, variable gauge and high or erratic shrinkage can result from variable rate and/or temperature of feed, excessive amounts of stock in the nip causing variations in feed stock temperature, a nervy or high viscosity mix, incipient scorch or a combination of these.

Surface blisters can be caused by attempting to calender too thick a gauge in one ply, by excessive roll temperature and/or low viscosity compound. Ply blisters are usually the result of insufficient squeeze roll pressure or chilling of the plied sheet by too cold a bottom roll. Tight wrapping in cloth liners for 24 hr will eliminate many small surface blisters.

Ply separation suggests too low a temperature on the calender rolls, too high compound viscosity, incipient scorch, inadequate building tack or squeeze roll pressure, the use of embossed polyethylene liners or a combination of these factors.

Table 7
Typical Neoprene Sheet Calendaring Temperatures

Neoprene Type	G	W or T
Top Roll, °C	70–80	90–100
Center Roll, °C	50–60	70–90
Bottom Roll, °C	30–40	30–40

Frictioning

Guidelines for the successful frictioning of Neoprene compounds include:

- Use a G-type base polymer (low viscosity GRT)
- Moderate load, with up to 60 parts carbon black,
- 35 parts aromatic oil
- Maintain roll temperatures to $\pm 2^\circ\text{C}$. Typical settings are: top roll 80–90°C, middle 60–70°C, bottom 80–90°C. Unlike NR, Neoprene usually adheres to the cooler roll. Where necessary, mill coating can be used to ensure adhesion to the center roll
- As with all elastomers, dry and iron the fabric before introducing to the nip

Potential problems include picking of stock by the fabric, plucking, variable strike through and fabric crushing. Picking usually indicates too hot a center roll. If the top roll tends to pluck stock from the center roll, the top roll may be too cool. In second pass frictioning, plucking of the first side by the bottom roll suggests that this roll is too cold.

Variable strike through may be due to non uniform fabric or feed temperature or variable rate of feed. Ironing of the fabric will overcome the first factor.

Crushed fabric is primarily due to insufficient thickness of stock on the middle roll. This should be approximately twice as thick as the fabric. High viscosity or nery stocks may cause crushing, especially with lightweight fabrics.

Extrusion

Compounding

Gel-containing polymers such as Neoprene WB, TW and TW100, or blends, ideally compounded with N550 (FEF) black, provide collapse resistant, low nerve, low die swell, smooth extruding compounds, with good vulcanized properties. Where high levels of liquid plasticizer are specified, higher viscosity polymers such as TW-100, WHV and WD can maintain collapse resistance. Blends of N550 (FEF) with N772 (SRF) or other softer blacks may be considered for lower cost.

Although popular in Neoprene non-black stocks, china clay can promote die drag necessitating use of internal release agents and/or a higher green strength base polymer. When precipitated silica is used for high vulcanizate tear strength, rough extrusion due to structure formation may be prevented by incorporation of 3% of the silica level of triethanolamine, calcium stearate or other surface-active dispersing aids, added to the mixer with some oil before addition of the silica.

Machine Characteristics and Operation

- Cold feed extruders, typically with L/D ratios of 12:1 to 16:1, are preferred since they avoid labor-intensive variable heat history remilling and deliver stock to the die at uniform temperature and viscosity. This improves consistency of gauge control and finish
- Cold feed vacuum extrusion is essential with fast curing stocks for continuous vulcanization of profiles, e.g., by microwave, LCM or fluidized bed techniques

- Screws should be constant diameter decreasing pitch, with compression ratios to 4:1, preferably cooled with temperature controlled water
- A typical temperature profile would be: feed 20°C, barrel graduated to 60°C, head 70–80°C, die 90–100°C, screw 40–60°C
- If a hot feed extruder must be used, compound should only be milled long enough for uniform plasticization. Avoid running on the rolls during interruptions in extrusion. Mechanical strip feed is preferred to avoid screw starvation or overfeeding
- Dies should have tapered leads to improve flow and profile definition

Potential extrusion problems and possible causes include:

Rough Extrusions

Typically caused by poor dispersion, contamination during prior processing, partial scorch, excessive nerve, cold stock, poor die geometry.

Excessive Die Swell

Typically due to high nerve (possibly from partial scorch), cold stock, lightly loaded compound, poor die geometry. Where the need for a gel-containing polymer is concerned, Neoprene WB has the highest content. Gel contents of T-types are intermediate.

Porosity

May be the result of soft compound, a hot extruder barrel and/or screw or insufficient back pressure behind the die. Possible solutions include use of a higher viscosity polymer, a screen pack behind the die, a die with a longer land or a cooler screw.

Surging

Indicates variable back pressure on the die plate. Causes may include excessive clearance between screw and barrel or too much lubricant in the compound. A screen pack and/or lower temperature on the screw may assist in prevention of surging.

Collapse

Caused by low viscosity compound or too hot an extrudate. A higher viscosity gel polymer such as Neoprene TW-100 or a blend may assist in preventing collapse with or without a cold water quench immediately after the die.

Continuous Vulcanization of Extrusions

Neoprene W-types with active acceleration systems exhibit a characteristic rapid rise of modulus once vulcanization commences. This effect is more pronounced than with most other high-volume elastomers. Coupled with the possibilities to vary green strength and collapse resistance by blending of grades, it is possible to prepare compounds with high resistance to distortion during extrusion and while entering the heating medium. It is also possible to prepare compounds that develop only low levels to porosity from internally-generated vapor pressure.

Four essentially atmospheric pressure profile CV systems exist, i.e., microwave, hot air tunnels, LCM in an eutectic salt mixture and fluidized beds. For best results all require cold feed vacuum extrusion to remove occluded air and addition of 6-10 parts dispersed calcium oxide to the compound as desiccant.

Using microwave or LCM systems, a cure cycle of 1 min at 200°C is not untypical necessitating use of active thiourea-based accelerators. DETU, DPTU or ETU at 1.0 part or more are commonly used. The magnesia may be reduced from 4-2 parts to further enhance cure rate. Obviously, the processing safety of such compounds is very limited necessitating careful control of storage times, temperatures and all processing steps to minimize heat history. Accelerators should be added immediately prior to extrusion and refrigerated storage used for full compounds.

Molding

General

Neoprene is amenable to molding by all three processes of the rubber industry, e.g., compression, transfer or injection. Problems tend to be those of elastomer molding in general and yield to the same solutions.

In accordance with best modern practice, molds should ideally be fitted with vacuum extraction, either internally or by external chamber. In general extruded blanks are preferred for compression molding as

they permit variation of shape and cross section with good gauge and weight control and are relatively air free.

Where high hot tear strength is required for demolding, a Neoprene G-Type (i.e., GW) will often be preferred. As discussed in the section describing compounding, incorporation of precipitated silica, up to 10 parts NR or synthetic polyisoprene or 5 parts of a hydrocarbon resin will optimize demolding tear strength with any Neoprene grade.

Ease of stripping may be enhanced by inclusion of 2–3 parts low molecular weight polyethylene in the compound and/or by light spray or aerosol application of proprietary external mold release agents. Excessive use of these may promote mold deposits hence the desirability of spray application.

Compression Molding Troubleshooting

Some of the problems that can occur in the compression molding of Neoprene and other elastomers, and potential solutions are discussed below. These notes may also be applicable to similar problems in transfer or injection molding.

Air or Pock Marking

May be caused by under cure, very low hot viscosity or occluded air trapped on the surface. Depending on the cause, bumping the press, use of vacuum, faster cure and/or higher polymer viscosity may be beneficial. The tool may need modification to improve venting if vacuum cannot be applied or is ineffective.

Air Blisters Below the Surface

May result from low viscosity stocks or plied-up blanks. Adjustment of the bump program or the blank shape factor to enhance flow may resolve the problem with a given compound.

Backgrinding

This is the phenomenon of tears or distortion at the mold parting line often caused by localized expansion on pressure release. Large articles are more prone to it than small. Accurate blank weights, preheating, lower mold temperatures or a slower curing compound may all be beneficial, as may venting the tool to allow for stock bleed during cure.

Distortion

Generally caused by under cure, partially set up stock or too high a mold temperature.

Excessive Shrinkage

Caused by incorrect allowance in the mold design, precure during flow or incipient scorch in the compound prior to molding. Reduction of molding temperature will normally be of assistance, as may use of hard china clay as a principle filler.

Flow Cracks (poor knitting)

May be due to nerve, precure during flow, or very soft compound giving excessive flow before full clamping pressure is reached, preventing achievement of sufficient molding pressure. Presence in the compound of excess internal process aids or limited compatibility plasticizers can also impair knitting, as can external mold release agents such as silicones, and too much dusting agent on uncured blanks.

Pebbling or Orange Peel

This surface effect occurs mainly in gum or lightly loaded stocks and is typically due to poor accelerator dispersion. If accelerators are added as dispersions the problem is unlikely to occur.

Porosity

Usually due to insufficient blank weight, porosity in the blank, under cure or compound incapable of giving a sufficiently high state of cure (hot modulus) at the molding temperature to resist the internal gas pressure.

Injection Molding

Regardless of polymer base, injection molding can often offer improved productivity. Economics to produce a given part may need careful consideration as tool costs are higher, equipment more expensive making non-operating and down time more critical and overall flexibility versus well-engineered compression molding is less.

Referring to potential problems described under Compression Molding preceding, two of these may be more acute with injection, namely:

Air Trapping

Promoted typically by rapid mold filling. Correct mold venting, usually with vacuum, is a basic requirement. Use of a higher viscosity Neoprene grade or blend is also recommended, sometimes with lower barrel temperatures.

Mold Fouling

Leading to sticking, ejection difficulties and vulcanizate surface marking.

Causes of fouling can be complex but it may be minimized by observing these guidelines:

1. Specify nickel-chrome tool steels.
2. Include at least 4 parts high activity magnesia, selected and stored as advised. If fouling occurs, increase to 6 or 8 parts.
3. Include an effective non-reactive internal mold release agent such as low molecular weight polyethylene.
4. Insure plasticizers do not contain free acid, e.g., phosphoric acid in tricresyl phosphate.
5. Set the highest barrel temperature consistent with safe processing and freedom from precure in the barrel so that the compound injects into the cavity at as high a temperature as possible. Once the cavity is filled, cure as rapidly as possible. One candidate curing system is 1.0 part ETU as a dispersion with 0.75 CBS. The latter acts as a retardant at barrel temperatures (80–90°C) and activator at curing temperatures.
6. Do not specify higher mold temperatures than are necessary for efficient production. Typically, 180–185°C is usually adequate, with an absolute upper limit of 200°C.

Bonding During Molding

With the noted exception of nonferrous metals to which compounds containing 1.5 parts free sulphur (where otherwise acceptable) will directly bond, a proprietary one or two-part primer system is normally required. A selection from various sources is listed in *Table 8*, but this is not exhaustive either in terms of sources or the systems on offer.

Table 8
Primers for Neoprene/Metal Bonding During Molding

Supplier	Trade name	One Coat	Two Coat
Lord Corp.	Chemlok [®]	250, 252, 253, 254	205/220 205/236A 205/252
Rohm & Haas	Thixon [®]	OSN2	P11/511EF
C.I.L. Ltd.	Cibond [®]	21T 22	11 to 12/50 or 58
Chemetall GmbH	Megum [®]	100 10576 11658 14550	3270/100 3270/500 3270/14550

Some general principles include:

1. Ensure the metal surface is degreased and chemically clean. Preparation for primer application may be completed by grit or alumina blasting (ferrous and nonferrous metals) or proprietary phosphate etching/coating processes (ferrous metals).
2. Where indicated use any proprietary metal treatment recommended by the primer supplier.
3. Apply primer(s) as recommended by the supplier to the preferred film thicknesses where this is known to be critical.
4. Store prepared or primed metals under non-humid conditions and use promptly.
5. After introducing primed metals to the mold, quickly load the compound blanks and close the press.

6. With standard (non-positive) compression molds, ensure compound viscosity is sufficiently high to maintain adequate cavity pressure for optimum bonding (this is not necessarily the same as ram pressure).
7. Avoid unnecessarily high molding temperatures.

Note: Bonding primers are solvent-based systems. Suppliers' safe handling information should be consulted prior to use. Also ensure that use of degreasing solvents is in accord with local and national requirements.

Open Steam Curing

As with all elastomers, profiles based upon Neoprene may exhibit water spotting in open steam cure due to poorly located steam entry points, ineffective traps or a cold autoclave. Faster curing compounds are least affected. Curing in a dry preheated talc bed is beneficial. Calendered sheet may be cured on drums wrapped in Nylon or cotton fabric in the conventional way. High pressure CV cure of cable sheathing presents no unusual problems.

Distortion or collapse of extruded profiles, especially thin-walled sections, is minimized by use of gel-containing polymers such as WB or T-types, or blends, preferably compounded with carbon blacks such as N550 (FEF) or N683 (APF).

Porosity may be caused by moisture or entrained air in the compound or too slow modulus rise. Inclusion of calcium oxide desiccant will scavenge the water. Air may be eliminated by increased polymer viscosity, use of a screen pack behind the die to increase back pressure or by vacuum extrusion.

Information on European Union Dangerous Preparations Directive 1999/45/EC related to Colophony Skin Sensitization

Colophony is classified as a skin contact sensitizer under European Union Dangerous Preparations Directive 1999/45/EC effective July 30, 2002. This Directive requires labeling of products that contain colophony at levels equal to or greater than 0.1% (refer to the Directives for specific details). Solid (dry type) Neoprene adhesive grade products manufactured by DuPont Performance Elastomers L.L.C. contain about 4% colophony (CAS No. 8050-09-7). Toxicological tests have demonstrated that dry Neoprene is not a skin sensitizer. Because of this testing, dry Neoprene polymer is not subject to mandatory labeling under the above Directive despite the presence of the colophony. However, when these Neoprene adhesive grade products are dissolved in organic solvents, the colophony may still be present at concentrations up to 0.8% depending on the solids content of the solutions. In the absence of data showing the adhesive is not a skin sensitizer, the adhesive could be subject to the above EU regulation.

We recommend that manufacturers and marketers of adhesive solutions based on DuPont Performance Elastomers' Neoprene (dry type) adhesive grade products determine whether the colophony level is above 0.1%. If the manufactured preparation has a colophony content of less than 0.1% it will not be subject to mandatory labeling (provided no other constituents necessitate mandatory labeling). Manufactured preparations that contain higher colophony contents will require the labeling and/or container notices described in the Directive.

Representative Formulations

Automotive Applications

Constant Velocity Joint Boot 50° Shore A

Neoprene WHV	35
Neoprene WRT	65
High-Activity Magnesia	4
Octylated Diphenylamine	4
5-Methyl Mercaptobenzimidazole	1
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	2
Stearic Acid	0.5
SRF N772 Carbon Black	20
MT N990 Carbon Black	50
Diocetyl Sebacate	15
Rapeseed Oil	10
Zinc Oxide	5
ETU Dispersion [75%]	1
TMTD	1
Cure: 15 min at 153°C	
Tensile Strength, MPa	13.4
Elongation, %	585
Hardness, Shore A	50

Constant Velocity Joint Boot (VW 639) 60° Shore A

Neoprene WHV	35
Neoprene WRT	65
High-Activity Magnesia	4
Octylated Diphenylamine	4
5-Methyl Mercaptobenzimidazole	1
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	2
Stearic Acid	0.5
SRF N772 Carbon Black	50
MT N990 Carbon Black	20
Diocetyl Sebacate	20
Rapeseed Oil	5
Zinc Oxide	5
ETU Dispersion [75%]	1
TMTD	1
Cure: 15 min at 153°C	
Tensile Strength, MPa	14.5
Elongation, %	500
Hardness, Shore A	60

Constant Velocity Joint Boot 70° Shore A

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	4
5-Methyl Mercaptobenzimidazole	1
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	2
Stearic Acid	0.5
Low Structure Furnace Carbon Black	70
Diocetyl Sebacate	25
Zinc Oxide	5
ETU Dispersion [75%]	0.63
TMTD	0.5
Cure: 15 min at 153°C	
Tensile Strength, MPa	16.7
Elongation, %	380
Hardness, Shore A	70

Brake Boots (Girling Specification TD 1472)

Neoprene WRT	50
Neoprene W	50
High-Activity Magnesia	4
Octylated Diphenylamine	4
Microcrystalline Wax	2
Stearic Acid	0.5
SRF N772 Carbon Black	35
Precipitated Silica	10
Diocetyl Sebacate	7
Zinc Oxide	5
ETU Dispersion [75%]	0.5
TMTD	0.5
Cure: 15 min at 153°C	
Tensile Strength, MPa	17
Elongation, %	470
Hardness, Shore A	60

Ball Joint Seals (Ehrenreich 1394 Specification)

Neoprene WD	50
Neoprene GW	50
High-Activity Magnesia	4
Octylated Diphenylamine	3
Mixed Diaryl Para Phenylene Diamine	1.5
Microcrystalline Wax	2
Stearic Acid	0.5
SRF N772 Carbon Black	15
MT N990 Carbon Black	40
Diocetyl Sebacate	15
Butyl Carbitol Formol	5
Zinc Oxide	5
ETU Dispersion [75%]	0.63
TMTD	0.5
Cure: 15 min at 153°C	
Tensile Strength, MPa	15.6
Elongation, %	770
Hardness, Shore A	51

Automotive Applications (continued)

Brake Diaphragm

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1.5
Microcrystalline Wax	3
Stearic Acid	0.5
HAF N330 Carbon Black	30
Diocetyl Sebacate	8
Zinc Oxide	5
MBTS	0.5
Cure: 15 min at 153°C	
Tensile Strength, MPa	20
Elongation, %	700
Hardness, Shore A	65

Spark Plug Boot (Vauxhall Spec. RS 221)

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	4
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	3
Low M.W. Polyethylene	5
Platy Talc	25
SRF N772 Carbon Black	5
Resinous Plasticizer	10
Zinc Oxide	5
ETU Dispersion [75%]	0.5
Cure: 15 min at 153°C	
Tensile Strength, MPa	18
Elongation, %	700
Hardness, Shore A	55

**Rack and Pinion Steering Bellows
(VW 520 66 Specification)**

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	3
Stearic Acid	0.5
MT N990 Carbon Black	125
Diocetyl Sebacate	15
Aromatic Process Oil	15
Zinc Oxide	5
ETU Dispersion [75%]	0.5
CBS	0.75
Cure: 15 min at 153°C	
Tensile Strength, MPa	10.2
Elongation, %	600
Hardness, Shore A	58

**Flocked Channel Profile Continuous Cure
(VW TL 52071)**

Neoprene TW	70
Neoprene WRT	30
High-Activity Magnesia	2
Octylated Diphenylamine	2
Non-Staining Antiozonant	1
Stearic Acid	0.5
FEF N5500 Carbon Black	45
Calcium Silicate	30
Non-Staining Factice	5
Process Oil	15
Calcium Oxide Dispersion	8
Zinc Oxide	5
DETU	1.25
Cure: 15 min at 153°C	
Tensile Strength, MPa	14.5
Elongation, %	500
Hardness, Shore A	60

Extruded Windscreen Wiper Blade

Neoprene WRT	60
Neoprene WB	40
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	1
SRF N772 Carbon Black	50
Diocetyl Sebacate	8
Zinc Oxide	5
ETU Dispersion [75%]	1
Cure: 15 min at 153°C	
Tensile Strength, MPa	17
Elongation, %	400
Hardness, Shore A	65

Molded Windscreen Wiper Blade

Neoprene WRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Non-Staining Antiozonant	1.5
Microcrystalline Wax	1.0
Stearic Acid	0.5
SRF N772 Carbon Black	60
Zinc Oxide	5
3-Methyl Thiazolidine-Thion-2	1.5

Automotive Applications (continued)

Engine Mounting 60° Shore A

Neoprene WRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
MT N990 Carbon Black	20
Precipitated Silica	10
Coumarone Resin (liquid)	8
Zinc Oxide	5
ETU Dispersion [75%]	0.75
CBS	0.75
Cure: 15 min at 153°C	
Tensile Strength, MPa	18
Elongation, %	500
Hardness, Shore A	60

Air Suspension Cell (inner liner and cover)

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	2
Stearic Acid	2
GPF N660 Carbon Black	50
Diethyl Phthalate	10
Zinc Oxide	5
Cure: 15 min at 153°C	
Tensile Strength, MPa	17
Elongation, %	550
Hardness, Shore A	60

Bridge Bearing Pads and Highway Seal Joint

**50° Shore A
Bridge Bearing Pad**

Neoprene WRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1
Stearic Acid	0.5
ISAF N220 Carbon Black	15
Diethyl Sebacate	10
Zinc Oxide	5
ETU Dispersion [75%]	0.7
CBS	1.0
Cure: 15 min at 153°C	
Tensile Strength, MPa	20.0
Elongation, %	570
Hardness, Shore A	50

**70° Shore A
Bridge Bearing Pad**

Neoprene WRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1
Stearic Acid	0.5
ISAF N220 Carbon Black	30
Precipitated Silica	15
Diethyl Sebacate	10
Zinc Oxide	5
ETU Dispersion [75%]	0.7
CBS	1.0
Cure: 15 min at 153°C	
Tensile Strength, MPa	20.6
Elongation, %	460
Hardness, Shore A	70

**60° Shore A
Bridge Bearing Pad**

Neoprene WRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1
Stearic Acid	0.5
ISAF N220 Carbon Black	20
Precipitated Silica	15
Diethyl Sebacate	10
Zinc Oxide	5
ETU Dispersion [75%]	0.7
CBS	1.0
Cure: 15 min at 153°C	
Tensile Strength, MPa	20.9
Elongation, %	580
Hardness, Shore A	60

Highway Seal Joint (continuous care)

Neoprene WRT	20
Neoprene WB	30
Neoprene WD	50
High-Activity Magnesia	2
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1
Stearic Acid	0.5
Petrolatum	2
Low M.W. Polyethylene	3
HAF N330 Carbon Black	10
FEF N550 Carbon Black	20
SRF N772 Carbon Black	15
Diethyl Sebacate	5
Aromatic Process Oil	18
Calcium Oxide Dispersion	6
Zinc Oxide	5
DETU	1
Cure: 1 min at 230°C	
Tensile Strength, MPa	15.6
Elongation, %	335
Hardness, Shore A	60

Cable Jackets

High Physical Strength Cable Jacket

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	3
Mixed Diaryl Para Phenylene Diamine	2
Stearic Acid	1.5
Low M.W. Polyethylene	2
GPF N660 Carbon Black	5
Hard Clay	45
Naphthenic Process Oil	5
Zinc Oxide	5
Cure: 20 min at 153°C	
Tensile Strength, MPa	23.9
Elongation, %	955
Hardness, Shore A	60
Tear, Die C, N/mm	50

Insulation Compound for Extrusion or Molding

Neoprene WRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Microcrystalline Wax	4
FEF N550 Carbon Black	20
Hard Clay	80
Whiting	30
Aromatic Hydrocarbon Resin	20
Petrolatum	3
Naphthenic Process Oil	10
Zinc Oxide	5
ETU Dispersion [75%]	1
MBTS	0.5
Cure: 40 sec at 1.6 MPa [16 Bar] Steam	
Tensile Strength, MPa	11.2
Elongation, %	460
Equivalent Vol. Resistivity, ohm-cms	1.25×10^{12}

Grey-Colored Cable Jacket to VDE 0207:5GM3

Neoprene TW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	5
Stearic Acid	0.5
FEF N550 Carbon Black	0.5
Rutile Titanium Dioxide	10
Platy Talc	90
Polyester Plasticizer	12
Petrolatum	3
Zinc Oxide	5
ETU Dispersion [75%]	1.30
MBTS	1
Cure: 1 min at 1.58 MPa [15.8 Bar] Steam	
Tensile Strength, MPa	14.0
Elongation, %	660

Low-Emission Cable Jacket

Neoprene W	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Non-Staining Antioxidant	1
Paraffin Wax	1.5
Stearic Acid	0.5
Precipitated Fine Whiting	65
Aluminum Hydroxide	65
Antimony Trioxide [90%]	5
Tricresyl Phosphate	20
Zinc Oxide	5
ETU Dispersion [75%]	1.5
MBTS	1
Cure: 3 min in 1.55 MPa (15.5 Bar) Steam	
Tensile Strength, MPa	10.3
Elongation, %	760
Tear, N/mm	8.8
Oxygen Index, BS 2782/1, % O	33.0
Temperature Index, BS 2782/1, °C	310.0
Smoke Emission, BS 6401	
Dm, flaming	360.0
Dm, non-flaming	320.0
Acid Gas Emission (HCl), IEC 754-1, HCl, mg/g (%)	35.9 [3.6]
Corrosivity, VDE 0472 part 813, pH	3.4
Conductivity, micro Siemens	240.0

Yellow Cable Jacket to VDE 0207 5GM5

Neoprene W M1	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
2-Mercaptobenzimidazole	0.5
Paraffin Wax	3.25
Reinforcing Silica	45
Triethanolamine	0.5
40% Active Vinyl Silane A172	1.25
Rutile Titanium Dioxide	5
Tricresyl Phosphate	12
Organic Yellow Pigment	1
Zinc Oxide	5
ETU Dispersion [75%]	1.3
MBTS	0.5
Cure: 8 min at 180°C	
Tensile Strength, MPa	17.8
Elongation, %	890
Tear, DIN 53507, N/mm	22.6
Tear, VDE 0472, N/mm	47.4

Cable Jackets (continued)

**Heavy-Duty Cable Jacket to British Coal Specs
188 and 504**

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	4
Stearic Acid	1.5
GPF N660 Carbon Black	40
Hard Clay	40
Refined Bitumen	10
Antimony Trioxide [90%]	3
Naphthenic Process Oil	5
Zinc Oxide	5
MBTS	1.5
Cure: 25 min at 153°C	
Tensile Strength, MPa	13.2
Elongation, %	840
Hardness, Shore A	77
Tear, ASTM D-470, N/mm	14.4

**Flexible Cable Jacket Compound to Harmonized
Spec HD 22.1S2:1992 Type EM2**

Neoprene TW 100	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	6
Stearic Acid	0.5
GPF N660 Carbon Black	20
Hard Clay	40
Coated Whiting	50
Aromatic Process Oil	35
Zinc Oxide	5
ETU Dispersion [75%]	1.25
TMTD	0.75
Steam Cured in Flash Vulcanizer 90 sec at 1.58 MPa [15.8 Bar]	
Tensile Strength, MPa	11.1
Elongation, %	639
Tear, BS 6899, N/mm	4.7

**Low-Temperature Service Jacket –55°C
(MIL-1-3930D)**

Neoprene WRT	50
Neoprene TW 100	50
High-Activity Magnesia	4
Octylated Diphenylamine	4
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	4
Stearic Acid	0.5
RCF Carbon Black	25
SRF N772 Carbon Black	30
Diocetyl Sebacate	25
Butyl Carbitol Formal	10
Zinc Oxide	5
ETU Dispersion [75%]	2
MBTS	0.5
Cure: 40 sec at 1.55 MPa [15.5 Bar] Steam	
Tensile Strength, MPa	13.0
Elongation, %	410
Hardness, Shore A	55
Tear, ASTM D470, kN/m	4.5

**Heavy-Duty Cable Jacket to
IPCEA-S-19-814.13 and 7.6.20.1.2**

Neoprene WRT	40
Neoprene TW 100	60
High-Activity Magnesia	4
Octylated Diphenylamine	4
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	4
Stearic Acid	0.5
Low M.W. Polyethylene	1
RCF Carbon Black	30
SRF N772 Carbon Black	30
Aluminum Hydroxide	30
Diocetyl Sebacate	10
Tricresyl Phosphate	30
Zinc Oxide	5
ETU Dispersion [75%]	2
MBTS	0.5
Tensile Strength, MPa	14.0
Elongation, %	325
Hardness, Shore A	60
Brittle Point, °C	–55

**Welding Cable Jacket Harmonized Standard
HD22.1.S2:1992 Type EM5**

Neoprene TW 100	100
High-Activity Magnesia	4
Octylated Diphenylamine	4
Microcrystalline Wax	5
Stearic Acid	0.5
FEF N550 Carbon Black	40
Hard Clay	70
Aromatic Process Oil	40
Zinc Oxide	5
ETU Dispersion [75%]	2
MBTS	1
Cure: 90 sec at 1.55 MPa [15.5 Bar] Steam	
Tensile Strength, MPa	11.2
Elongation, %	440

Cellular Products

Low-Density LCM Cellular Profile

Neoprene TW 100	65
Neoprene WRT	35
High-Activity Magnesia	2
Octylated Diphenylamine	2
Microcrystalline Wax	4
Petrolatum	2
SRF N772 Carbon Black	20
MT N990 Carbon Black	50
Factice	5
Naphthenic Process Oil	20
Calcium Oxide Dispersion	8
Zinc Oxide	5
DETU	1.5
Azodicarbonamide Blowing Agent	4
Cure: 20 m/min at 250°C	
Density, g/cm ³	0.55
Compression Set, %, 22 hr at 70°C [40% Deflection]	29
Water Absorption, % (Ford Method)	0.9

**Chemically Blown, Non Intercellular
Sponge Sheeting**

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	5
Stearic Acid	0.5
SRF N772 Carbon Black	60
Naphthenic Process Oil	10
Aromatic Process Oil	20
Zinc Oxide	5
Azodicarbonamide Blowing Agent	6
P,P'-Oxy-bis Benzenesulphonyl Hydrazide	2
Cure: 1st Stage: 10 min at 140°C 2nd Stage: 25 min at 170°C	

Wet Suit Compound

Neoprene GW	100
High-Activity Magnesia	2
Octylated Diphenylamine	2
Stearic Acid	0.5
SRF N772 Carbon Black	15
Calcium Carbonate	25
Brown Factice	25
Naphthenic Process Oil	15
Zinc Oxide	5
ETU Dispersion [75%]	0.5
CBS	0.5
Azodicarbonamide Blowing Agent	10
Cure: 1st Stage: 8 min at 160°C 2nd Stage: 15 min at 170°C	
Density, g/cm ³	0.25

Low-Density, Open-Cell Sponge

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	5
Stearic Acid	1
Low M.W. Polyethylene (AC 617 A)	3
MT N990 Carbon Black	40
Sodium Bicarbonate (extra fine)	10
Naphthenic Process Oil	10
Aromatic Process Oil	20
Zinc Oxide	5
Cure: 20 min at 160°C	
Minimum Density, g/cm ³	0.3

Coated Fabrics

Airspring Compound

Neoprene GRT	100
High-Activity Magnesia	5
Octylated Diphenylamine	4
Microcrystalline Wax	3
Stearic Acid	2
FEF N550 Carbon Black	40
Coumarone Indene Resin	3
Diocetyl Phthalate	5
Naphthenic Process Oil	5
Zinc Oxide	5
MBTS	0.5
Tensile Strength, MPa	18.7
Elongation, %	620
Hardness, Shore A	65

Military Tarpaulins or Life Rafts

Neoprene WRT	60
Neoprene WB	40
High-Activity Magnesia	4
Octylated Diphenylamine	2
Microcrystalline Wax	2
Stearic Acid	0.5
SRF N772 Carbon Black	30
MT N990 Carbon Black	70
Diocetyl Sebacate	15
Zinc Oxide	5
ETU Dispersion [75%]	0.6
Tensile Strength, MPa	14
Elongation, %	350
Hardness, Shore A	60

Coating Compound

Neoprene WRT	100
High-Activity Magnesia	4
Non-Staining Antioxidant	2
Microcrystalline Wax	1
Stearic Acid	0.5
Low M.W. Polyethylene	2
SRF N772 Carbon Black	1
Precipitated Silica	15
Reinforcing Clay	60
Rutile Titanium Dioxide	10
Diocetyl Sebacate	20
Zinc Oxide	5
ETU Dispersion [75%]	1
MBTS	0.75
Tensile Strength, MPa	13.0
Elongation, %	600
Hardness, Shore A	57

Neoprene Cement or Bonding Primer for Nylon or Polyester

Mill Mix

Neoprene W	100
High-Activity Magnesia	4
Non Staining Antioxidant	2
Zinc Oxide	5
	111

Churn Mix

Mill Mixed Batch	111
Toluene	400
Organic Isocyanate*	40

*add just before use

Seam Adhesive

Component A Mill Mix

Neoprene GNA M1	100
High-Activity Magnesia	4
Non Staining Antioxidant	2
Calcium Silicate	10
Zinc Oxide	5
	121

Churn Mix

Mill Mixed Batch	121
Toluene	359
	480

Component B Parts per Hundred of Component A

Organic Isocyanate (shelf life 6 to 8 hr)	8
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Solution Coating Compound

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	1
Stearic Acid	1.5
SRF N772 Carbon Black	55
Graphite	20
Coumarone Indene Resin (liquid)	10
Aromatic Process Oil	10
Zinc Oxide	5

Flame Retardant Impregnating Solution to NCB 158/1960

For Nylon, Polyester or Blends with Cotton	
Neoprene WRT	50
Neoprene W	50
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
SRF N772 Carbon Black	20
Whiting	20
Antimony Trioxide [90%]	25
Calcium Metaborate	10
Chlorinated Paraffin (liquid)	60
Zinc Oxide	5
ETU Dispersion [75%]	0.95
Organic Isocyanate	7

Mill mix without chlorinated wax and isocyanate. Dissolve compound in toluene, add chlorinated wax and organic isocyanate. Adjust total solids to 20% (by weight).

Flame Retardant Inter Ply Skim Compound to NCB 158/1960

Neoprene WRT	50
Neoprene W	50
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
SRF N772 Carbon Black	25
Reinforcing Clay	40
Whiting	20
Antimony Trioxide [90%]	25
Calcium Metaborate	10
70% Chlorinated Paraffin (liquid)	35
70% Chlorinated Paraffin (solid)	10
Zinc Oxide	5
ETU Dispersion [75%]	0.75

Candidate Anti-Static Cover Colored

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Chlorosiloxane	1
Low M.W. Polyethylene	2
Precipitated Silica	40
56% Chlorinated Paraffin (liquid)	10
Zinc Oxide	5
2-Mercaptobenzimidazole	0.5
MBTS	0.5
Polyethylene glycol	8
Tensile Strength, MPa	19.0
Elongation, %	995
Hardness, Shore A	58
Limiting Oxygen Index, %	31.0
Volume Resistivity, $\mu\text{m}\cdot\text{cm}$	3.6×10^3
Surface Resistance, ohm	8.4×10^{10}

Candidate Anti-Static Cover Black

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Chlorosiloxane	1
Low M.W. Polyethylene	2
Precipitated Silica	40
56% Chlorinated Paraffin (liquid)	10
Zinc Oxide	5
2-Mercaptobenzimidazole	0.5
MBTS	0.5
Extra Conductive Carbon Black	5
Tensile Strength, MPa	18.6
Elongation, %	790
Hardness, Shore A	75
Limiting Oxygen Index	33.7
Volume Resistivity, $\mu\text{m}\cdot\text{cm}$	4.6×10^3
Surface Resistance, ohm	9×10^6

High-Limiting Oxygen Index Flame-Retardant Cover Compound

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
Paraffin Wax	1
Stearic Acid	0.5
High cis Polybutadiene	4
Fatty Alcohols Blend	3
ISAF N220 Carbon Black	40
Aluminium Hydroxide	30
Antimony Trioxide [90%]	10
Brominated Aromatic Oxide	10
56% Chlorinated Paraffin (liquid)	10
70% Chlorinated Paraffin (solid)	25
Zinc Oxide	5
MBTS	1
Cure: 25 min at 153°C	
Tensile Strength, MPa	18.5
Elongation, %	590
Hardness, Shore A	66
Limiting Oxygen Index, %	47

Conveyor Belts (continued)

Lower Cost Cover Compound	
Neoprene GW	60
SBR 1500	40
High-Activity Magnesia	3
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	3
Microcrystalline Wax	1.5
ISAF N220 Carbon Black	45
Aluminum Hydroxide	25
Antimony Trioxide [90%]	1.5
Brominated Aromatic Oxide	5
56% Chlorinated Paraffin (liquid)	10
70% Chlorinated Paraffin (solid)	25
Zinc Oxide	5
Sulphur	0.75
MBTS	1
Cure: 20 min at 153°C	
Tensile Strength, MPa	19.7
Elongation, %	560
Hardness, IRHD	67
Limiting Oxygen Index, %	33

Cover Compound to Meet NCB 158 Requirements	
Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
Paraffin Wax	1
Stearic Acid	0.5
High cis Polybutadiene	4
Fatty Alcohols Blend	3
ISAF N220 Carbon Black	50
Antimony Trioxide [90%]	1
56% Chlorinated Paraffin (liquid)	25
70% Chlorinated Paraffin (solid)	10
Zinc Oxide	5
MBTS	1
Cure: 25 min at 153°C	
Tensile Strength, MPa	20.7
Elongation, %	540
Hardness, Shore A	65
Limiting Oxygen Index, %	28

Candidate Adhesive Layer for Steel-Reinforced Belts	
Neoprene WM 1	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
High cis Polybutadiene	5
ISAF N220 Carbon Black	25
Precipitated Silica	20
Aluminum Hydroxide	30
Antimony Trioxide (90%)	10
Decabromo Biphenyl Ether	10
56% Chlorinated Paraffin (liquid)	10
70% Chlorinated Paraffin (solid)	25
Zinc Oxide	5
TMTM	0.4
DOTG	0.4
Sulphur	2
MBTS	1
Steel-to-Rubber Bonding Agent	5
Tensile Strength, MPa	17.8
Elongation, %	590
Hardness, Shore A	66
Tear Strength, Die C, N/mm	54
Limiting Oxygen Index, %	47

Neoprene Non-Marking Sole

Neoprene W M1	100
High-Styrene Copolymer (85/15)	20
High-Activity Magnesia	4
Octylated Diphenylamine	1
High cis Polybutadiene	3
SRF N772 Carbon Black	1
Precipitated Silica	25
Reinforcing Clay	60
Rutile Titanium Dioxide	5
Naphthenic Process Oil	5
Zinc Oxide	5
ETU Dispersion [75%]	0.75
TMTM	0.5
DOTG	0.5
Sulphur	1
Cure: 10 min at 153°C	
Tensile Strength, MPa	16
Elongation, %	670
Hardness, Shore A	85

Low-Cost Wellington Boot Sole

Neoprene W	50
Natural Rubber	50
High-Activity Magnesia	2
Octylated Diphenylamine	2
Stearic Acid	1.5
Polyethylene Glycol	2
SRF N772 Carbon Black	50
MT N990 Carbon Black	50
Aromatic Process Oil	15
Zinc Oxide	5
ETU Dispersion [75%]	1
Sulphur	1.5
TMTD	0.75
Cure: 10 min at 153°C	
Tensile Strength, MPa	13
Elongation, %	250
Hardness, Shore A	72

Neoprene Non-Marking Heel

Neoprene W M1	100
High-Activity Magnesia	4
Octylated Diphenylamine	1
High cis Polybutadiene	5
SRF N772 Carbon Black	1
Precipitated Silica	50
Rutile Titanium Dioxide	5
Naphthenic Process Oil	10
Zinc Oxide	5
ETU Dispersion [75%]	0.75
TMTM	0.5
Sulphur	1
Cure: 10 min at 153°C	
Tensile Strength, MPa	20
Elongation, %	800
Hardness, Shore A	71

Low-Cost Wellington Boot Upper

Neoprene W	50
Natural Rubber	50
High-Activity Magnesia	2
Octylated Diphenylamine	2
Stearic Acid	1.5
Polyethylene Glycol	2
MT N990 Carbon Black	50
Dark Factice	20
Aromatic Process Oil	15
Zinc Oxide	5
ETU Dispersion [75%]	1
Sulphur	1.5
TMTD	0.75
Cure: 10 min at 153°C	
Tensile Strength, MPa	11
Elongation, %	570
Hardness, Shore A	49

Hoses—Automotive Applications

Brake Hose Cover Compound	
Neoprene GW	70
Neoprene WD	30
High-Activity Magnesia	4
Octylated Diphenylamine	4
Mixed Diaryl Para Phenylene Diamine	2
Stearic Acid	1
FEF N550 Carbon Black	65
Fine Particle Silica	8
Diocetyl Sebacate	15
Rapeseed Oil	8
Zinc Oxide	5
ETU Dispersion [75%]	0.66
MBTS	1
Tensile Strength, MPa	16.5
Elongation, %	380
Hardness, IRHD	70

Fuel Hose Cover Compound	
Neoprene W	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
Stearic Acid	1
Petrolatum	2
GPF N660 Carbon Black	60
Hard Clay	90
Diocetyl Sebacate	10
Aromatic Process Oil	15
Zinc Oxide	5
ETU Dispersion [75%]	0.9
TMTD	0.5
Tensile Strength, MPa	11
Elongation, %	400
Hardness, Shore A	67

Air Brake Hose Cover	
Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	1.5
Paraffin Wax	1.5
Stearic Acid	0.5
MT N990 Carbon Black	170
Butyl Oleate	5
Aromatic Process Oil	20
Zinc Oxide	5
TMTM	1
DOTG	1
Sulphur	1
Tensile Strength, MPa	12.5
Elongation, %	325
Hardness, Shore A	67

Fuel Hose Cover	
	3827
Neoprene TW 100	100
Stearic Acid	1
High Activity Magnesia	4
Zinc Oxide	5
Octylated Diphenylamine	2
Zinc-2-Methyl meroaprobenzimidazole	1
N762	80
Ground Whiting	20
Paraffin	2
Low M.W. polyethylene	2
Vanwax [®] H	2
Tetraethylene Glycodi-2 ethylhexdate	15
ETU dispersion (75%)	1
Total	235.5

Hose Cover (DBL 5561/26)	
Neoprene WHV	50
Neoprene WRT	50
High-Activity Magnesia	4
Octylated Diphenylamine	4
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	2
Stearic Acid	0.5
FEF N550 Carbon Black	75
Aromatic Process Oil	20
Zinc Oxide	5
ETU Dispersion [75%]	0.6
MBTS	0.5
Cure: 25 min at 160°C	
Tensile Strength, MPa	15.7
Elongation, %	275
Hardness, Shore A	77

		30R7
		Spec.
Cured 25' at 160°C		
Tb (MPa)	17	>7
M-100 (MPa)	0.1	
Elongation, %	245	>200
Hardness, Shore A	73	

Tie Gum Compound	
Neoprene W-M1	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Calcium Stearate	4
Low M.W. Polyethylene	4
Precipitated Silica	40
Epoxidized Soybean Oil	5
Calcium Oxide	10
Zinc Oxide	5
TMTU	2

**Hose Cover to BMW 602 00.0/18/29
Heat Resistant**

Neoprene WD	100
High-Activity Magnesia	5
Octylated Diphenylamine	4
5-Methyl Mercaptobenzimidazole	2
Mixed Diaryl Para Phenylene Diamine	2
HAF N326 Carbon Black	55
Butylenglycol Adipate	10
Rapeseed Oil	10
Zinc Oxide	5
ETU Dispersion [75%]	1.5
Cure: 15 min at 170°C	
Tensile Strength, MPa	19.5
Elongation, %	320
Hardness, Shore A	67

**Heater Hose to Ford Specification
ESA-M2D-157A**

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	4
Mixed Diaryl Para Phenylene Diamine	1
Microcrystalline Wax	2
Stearic Acid	1
SRF N772 Carbon Black	30
MT N990 Carbon Black	120
Aromatic Process Oil	40
Zinc Oxide	10
ETU Dispersion [75%]	1.0
TMTD	0.25
Cure: 20 min at 153°C	
Tensile Strength, MPa	12
Elongation, %	340
Hardness, Shore A	60

**Radiator Hose to Ford Specification
ESA-M2D-116A**

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	4
Mixed Diaryl Para Phenylene Diamine	1
Microcrystalline Wax	2
Stearic Acid	1
SRF N772 Carbon Black	40
MT N990 Carbon Black	120
Aromatic Process Oil	45
Zinc Oxide	10
ETU Dispersion [75%]	1.0
TMTD	0.25
Cure: 20 min at 153°C	
Tensile Strength, MPa	11.7
Elongation, %	280
Hardness, Shore A	61

Audi Coupling Hose to VW 522-08

Neoprene WHV	80
Polybutadiene	20
High-Activity Magnesia	4
Octylated Diphenylamine	1
Mixed Diaryl Para Phenylene Diamine	2
Stearic Acid	0.5
FEF N550 Carbon Black	20
SRF N772 Carbon Black	40
MT N990 Carbon Black	30
Diocetyl Sebacate	20
Zinc Oxide	5
TMTM	1
DOTG	1
Sulphur	1.5
Tensile Strength, MPa	16.8
Elongation, %	200
Hardness, Shore A	72

**Hose Cover (Heat Resistant) to DBL 6260
Specification**

Neoprene WD	100
High-Activity Magnesia	4
Octylated Diphenylamine	4
Stearic Acid	0.5
Low M.W. Polyethylene	2
HAF N326 Carbon Black	25
SRF N772 Carbon Black	40
Precipitated Silica	10
Coumarone Indene Resin	5
Polyester Plasticizer	10
Zinc Oxide	5
ETU Dispersion [75%]	0.75
CBS	1
Cure: 15 min at 153°C	
Tensile Strength, MPa	16.8
Elongation, %	375
Hardness, Shore A	65

**Oil Suction and Discharge Hose Tube and Cover
(Heavy Duty)**

Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	1.5
Stearic Acid	1
Low M.W. Polyethylene	2.5
High cis Polybutadiene	3
HAF N339 Carbon Black	50
Coumarone Resin (liquid)	5
Aromatic Process Oil	20
Zinc Oxide	5
MBTS	1
Cure: 20 min at 153°C	
Tensile Strength, MPa	20
Elongation, %	500
Hardness, Shore A	70

Hoses—Non Automotive Applications

Mining Hose Cover

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
Low M.W. Polyethylene	3
FEF N550 Carbon Black	50
MT N990 Carbon Black	40
Precipitated Silica	20
42% Chlorinated Paraffin (liquid)	10
70% Chlorinated Paraffin (solid)	5
Tricresyl Phosphate	10
Aromatic Process Oil	10
Zinc Oxide	5
TMTM	0.6
DOTG	0.6
Sulphur	1
Tensile Strength, MPa	17
Elongation, %	360
Hardness, Shore A	70

**Fire Hose Liner Containing
R/F Bonding Promotor**

Neoprene TW 100	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	1
Low M.W. Polyethylene	3
MT N990 Carbon Black	20
Precipitated Silica	30
Brown Factice	10
Butyl Oleate	7.5
Aromatic Process Oil	7.5
Zinc Oxide	5
TMTM	0.5
DPG	0.5
Sulphur	1.5
Adhesion Promotor	5
Cure: 20 min at 153°C	
Tensile Strength, MPa	16
Elongation, %	800
Hardness, Shore A	58

Hydraulic Hose Cover Compound

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	1
Stearic Acid	1
SRF N772 Carbon Black	30
MT N990 Carbon Black	170
Aromatic Process Oil	15
Rapeseed Oil	25
Zinc Oxide	5
ETU Dispersion [75%]	0.3
TMTM	1
DOTG	1.5
Sulphur	0.3
Tensile Strength, MPa	12.8
Elongation, %	260
Hardness, Shore A	70

Railway Brake Hose

Neoprene WD	40
Neoprene WRT	40
Polybutadiene	20
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	2
GPF N660 Carbon Black	80
Diocetyl Sebacate	20
Epoxidized Soybean Oil	0.5
Zinc Oxide	5
TMTM	1
DOTG	0.75
Sulphur	0.75
Tensile Strength, MPa	14
Elongation, %	280
Hardness, Shore A	63

Steam Hose Lining

Neoprene W	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
FEF N550 Carbon Black	15
Precipitated Silica	25
Aromatic Process Oil	5
Zinc Oxide	5
TMTM	1.5
DOTG	0.5
Sulphur	1
Tensile Strength, MPa	24
Elongation, %	650
Hardness, Shore A	60

Vacuum Tubing (LCM Cure)

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
FEF N550 Carbon Black	30
SRF N772 Carbon Black	50
Clay	30
Diocetyl Sebacate	10
Aromatic Process Oil	35
Calcium Oxide Dispersion	8
Zinc Oxide	15
ETU Dispersion [75%]	1
Cure: 15 min at 153°C	
Tensile Strength, MPa	13
Elongation, %	280
Hardness, Shore A	70

Hoses—Non Automotive Applications (continued)

Welding Hose Tube and Cover

	Table	Cover
Neoprene TW 100	100	100
Stearic Acid	1	2
High Activity Magnesia	4	4
Paraffin Wax		5
Ground Whiting	60	
Microcrystalline Wax	2	2
Octylated Diphenylamine	2	2
N990 Black	140	—
Hard Clay	60	114
40% Chlorinated Paraffin (liq)	10	13
Process Oil	10	5
Zinc Oxide	5	5
TMTM	—	1
DOTG	0.7	1.25
Sulfur	0.4	0.25
MBTS	1.2	—
	396.3	254.5
Original Properties—30' at 320		
Tb (MPa)	8.4	9.7
Elongation, %	211	810
M100 (MPa)	6	1.2
Durometer	89	55

Miscellaneous

Adhesion to Nylon Barrier

Neoprene WRT	100
SBR 1502	3
High Activity Magnesia	8
Diphenylamine Derivative	1
Low M.W. Polyethylene	3
Fine Particle Silica	10
N762	55
Ppt. Hydrated Amorphous Silica	10
Epoxy Resin, 72%	7
Zinc Oxide	2
Calcium Oxide Dispersion	3
ETU Dispersion, 75%	1
Hexamethoxymethylmelamine	5
	263

Physical Properties (RT)

Press Cured: 40 min at 160°C	
M100 (MPa)	2.8
Tensile Strength (MPa)	7.9
Elongation at Break, %	398
Hardness, Shore A, pts	76

Compounds to Meet BS 2752

Hardness Range	41-50	51-60	61-70	71-80	81-88
Neoprene WRT	25	20	20	20	50
Neoprene WD	35	50	50	50	50
Neoprene WB	40	30	30	30	30
High-Activity Magnesia	4	4	4	4	4
Octylated Diphenylamine	2	2	2	2	2
Paraffin Wax	1	1	1	1	1
Stearic Acid	1	1	1	1	1
FEF N550					
Carbon Black	10	25	50	55	75
Brown Factice	5	5	10	10	10
Diocetyl Sebacate	5	5	5	5	5
Diocetyl Phthalate	10	10	10	5	5
Zinc Oxide	5	5	5	5	5
ETU Dispersion [75%]	0.75	0.75	0.60	0.60	0.60
TMTD	0.5	0.5	0.5	0.5	0.5
Cure: 20 min at 153°C					
Tensile Strength, MPa	13	17	19	18.9	19
Elongation, %	660	480	340	310	230
Hardness, IRHD	43	53	64	73	83

Miscellaneous (continued)

Cut Thread	
Neoprene WRT	100
Non-discoloring Antioxidant	2
High Activity Magnesia	6
Stearic Acid	0.5
TiO ₂ -Rutile	8
Hard Clay	10
Petroleum	2
Low Mol. Wt. Polyethylene	3
Zinc Oxide	3
Salicylic Acid	2
Cure: 30 min at 153°C	
Vulcanizate Properties	
500% Modulus, (MPa)	6.9
Tensile Strength, (MPa)	20
Elongation at Break, %	940
Hardness, Durometer A	50

Gas-Mask, High Quality Formulation	
Neoprene GW	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Microcrystalline Wax	2
Stearic Acid	2
HAF N326 Carbon Black	15
Naphthenic Process Oil	5
Zinc Oxide	5
TMTD	1
Cure: 15 min at 160°C	
Tensile Strength, MPa	22
Elongation, %	800
Hardness, Shore A	60

General Purpose	
Neoprene GW	100
N330 Carbon Black	60
Naphthenic Oil	5
Petrolatum	2
Stearic Acid	1
Octylated Diphenylamine	1.5
Mixed Diaryl Para Phenylene Diamine	1.5
Zinc Oxide	5
High Activity Magnesia	4

Total PHRs	180
Specific Gravity	1.4
Original Physical Properties	
Cure Time, min	20
Cure Temperature, °C	160
Modulus at 100% Elongation, MPa	6.57
Tensile Strength at Break, MPa	24.5
Elongation at Break, %	270
Shore A Hardness, pts	80
(G1) Die "B" Tear Resistance, lb/in	313.6

Pump Impellor	
Neoprene WRT	100
Red Lead Dispersion [90%]	22
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1.5
Microcrystalline Wax	2
SRF N772 Carbon Black	70
Naphthenic Process Oil	5
TMTM	1
Sulphur	1
Cure: 20 min at 153°C	
Tensile Strength, MPa	16
Elongation, %	400
Hardness, IRHD	75

Heat-Resistant Compounds to Meet DTD 5514 Specification					
Hardness Range	Hardness				
	45±4	55±4	65±4	75±4	85±4
Neoprene WRT	60	70	80	80	80
Neoprene WB	40	30	20	20	20
Calcium Stearate	5	5	5	5	5
Octylated Diphenylamine	4	4	4	4	4
Petrolatum	1	1	1	1	1
SAF N110	—	—	—	—	—
Carbon Black	—	—	—	35	50
FEF N550	—	—	—	—	—
Carbon Black	—	35	45	—	—
SRF N772	—	—	—	—	—
Carbon Black	25	—	—	—	—
Precipitated Silica	—	—	—	15	25
Diocetyl Sebacate	10	10	5	8	8
Rapeseed Oil	15	10	7.5	—	8
Peptizing Agent	2	—	—	—	—
Zinc Oxide	5	5	5	5	5
ETU Dispersion	—	—	—	—	—
[75%]	0.75	0.63	0.75	0.75	0.75
TMTD	—	—	0.70	0.70	0.70
Cure: 20 min at 153°C					
Tensile Strength, MPa	11.7	14.2	16	17.5	15.7
Elongation, %	520	400	340	380	300
Hardness, IRHD	41	54	65	73	83

Miscellaneous (continued)

Low Cost	
	5273
Neoprene WHV	100
Paraffin Wax	1
Petrolatum	1
Octylated D, phenylamine	2
High Activity Magnesia	2
N990	200
N774	150
Aromatic Process Oil	100
Low M.W. polyethylene	3
Zinc Oxide	5
ETU Dispersion [75%]	1
Total Parts	565
Cured 26' at 160°C	
Tb (MPa)	10.3
M100 (MPa)	8.8
Elongation at Break, %	115
Hd (A)	81
ML [1+4] 100°C [μ]	74

Power Transmission Belts

Timing Belt Compound	
Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	3
Mixed Diaryl Para Phenylene Diamine	1.5
Stearic Acid	2
Low M.W. Polyethylene (AC 617 A)	3
SRF N772 Carbon Black	50
Zinc Oxide	5
TMTM	1
Tensile Strength, MPa	20.5
Elongation, %	350
Hardness, Shore A	75

Rib Compound for V-Ribbed Belts	
Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	3
Mixed Diaryl Para Phenylene Diamine	2
Microcrystalline Wax	1
Stearic Acid	1
FEF N550 Carbon Black	50
Process Oil	5
Zinc Oxide	5
ETU Dispersion [75%]	0.3
MBTS	0.75

Adhesion Compound for V-Ribbed Belts	
Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	3
Stearic Acid	1
FEF N550 Carbon Black	20
SRF N772 Carbon Black	20
Precipitated Silica	20
Process Oil	5
Zinc Oxide	5
ETU Dispersion [75%]	0.3
Sulphur	0.5
MBTS	0.75
Resorcinol Bonding Promoter	5
Formaldehyde Donor	2

Adhesion Compound for Raw Edge V- Belts	
Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	3
Stearic Acid	1
FEF N550 Carbon Black	20
SRF N772 Carbon Black	20
Precipitated Silica	20
Process Oil	10
Zinc Oxide	5
ETU Dispersion [75%]	0.3
Sulphur	0.5
MBTS	0.75
Resorcinol Bonding Promoter	5
Formaldehyde Donor	2

Power Transmission Belts (continued)

**Bottom Rubber Formulation
for Raw Edge V-Belts**

Neoprene GRT	90
Neoprene WHV	10
High-Activity Magnesia	4
Octylated Diphenylamine	3
Stearic Acid	1.5
FEF N550 Carbon Black	20
SRF N772 Carbon Black	20
Polyester/Cotton Fibers (8 mm)	15
Process Oil	5
Zinc Oxide	5
ETU Dispersion [75%]	0.3
Sulphur	1.0
MBTS	0.75

**Adhesion Compound
for Wrapped V-Belts**

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	3
Stearic Acid	1.5
HAF N330 Carbon Black	20
SRF N772 Carbon Black	25
Fine Particles Silica	25
Aromatic Process Oil	20
Zinc Oxide	5
Sulphur	1.5
MBTS	0.5
Tensile Strength, MPa	13.2
Elongation, %	260
Hardness, Shore A	79

**Bottom Rubber Formulation
for Wrapped V-Belts**

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	0.5
Stearic Acid	1.5
Low M.W. Polyethylene (AC 1702)	2
SRF N772 Carbon Black	30
MT N990 Carbon Black	130
Aromatic Process Oil	20
Zinc Oxide	5
Sulphur	1.5
MBTS	0.5
Tensile Strength, MPa	10.4
Elongation, %	180
Hardness, Shore A	84

Friction Compound for Wrapped V-Belts

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	1
Stearic Acid	2
MT N990 Carbon Black	60
Coumarone Resin (liquid)	5
Aromatic Process Oil	10
Zinc Oxide	10
Calendaring Temperatures °C	
Top	125
Middle	100
Bottom	125

Profiles

Pipe Gaskets (Not for Potable Water)

Hardness Range	45±4 55±4 65±4 75±4 85±4				
	Neoprene WRT	80	100	100	100
Neoprene WHV	20	—	—	—	—
Red Lead MB 90%	22	22	22	22	22
Octyl. Diphenylamine	2	2	2	2	2
Mixed DPPD	1.5	1.5	1.5	1.5	1.5
Microcrystalline Wax	2	2	2	2	2
Stearic Acid	0.5	0.5	0.5	0.5	0.5
Low M.W. PE	2	2	2	2	2
Petrolatum	1	1	1	1	1
SRF N772	—	35	60	50	80
MT N990	50	—	—	40	30
Aromatic Process Oil	30	12	15	12	12
TMTM	0.75	0.75	0.75	0.75	0.5
Sulphur	0.75	0.75	0.75	0.75	0.5
Tensile Strength, MPa	12	17	16	15	15
Elongation, %	680	640	420	320	200
Hardness, Shore A	44	53	61	71	81

Flame Retardant Profile

Neoprene WRT	20
Neoprene WB	30
Neoprene TW-100	50
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1
Stearic Acid	0.5
Low M.W. Polyethylene (AC 617 A)	3
FEF N550 Carbon Black	30
Platy Talc	60
70% Chlorinated Paraffin (liquid)	25
Tricresyl Phosphate	10
Zinc Borate	5
Calcium Oxide Dispersion	7.5
Zinc Oxide	5
DETU	1.25
CBS	0.5
Tensile Strength, MPa	13.4
Elongation, %	410
Hardness, IRHD	66

Profiles (continued)

Continuously Cured Profiles

Neoprene TRT	50	35	20	35 →
product discontinued!!!				
Neoprene WB	30	-	30	-
Neoprene TW 100	50	65	50	65
High-Activity Magnesia	2	2	2	2
Octylated Diphenylamine	2	2	2	2
Microcrystalline Wax	2	2	2	2
Stearic Acid	0.5	0.5	0.5	0.5
Low M.W. PE (AC 617 A)	-	2	2	2
FEF N550 Carbon Black	-	20	50	70
MT N990 Carbon Black	55	25	-	-
Aromatic Process Oil	50	25	15	20
Calcium Oxide Dispersion	10	8	5	8
Zinc Oxide	5	5	5	5
DETU	1	1	1	1
Tensile Strength, MPa	10.0	14.4	15.5	14.4
Elongation, %	595	420	305	170
Hardness, Shore A	25	55	67	70

Roll Covers

Low-Hardness Printing Roll (15° Shore A)

Neoprene WHV	70
SBR 1000	30
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	1
Petrolatum	1
MT N990 Carbon Black	30
Aromatic Process Oil	60
Zinc Oxide	5
ETU Dispersion [75%]	0.75
Cure: 20 min at 153°C	
Tensile Strength, MPa	7
Elongation, %	760
Hardness, Shore A	16

Printing Machine Roll (25° Shore A)

Neoprene GRT	60
Neoprene WHV	40
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	1.5
Low M.W. Polyethylene	2
MT N990 Carbon Black	20
Factice	50
Aromatic Process Oil	75
Zinc Oxide	5
Cure: 30 min at 160°C	
Tensile Strength, MPa	6.8
Elongation, %	600
Hardness, Shore A	25

Low-Hardness Roll Non-Black (20° Shore A)

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
Low M.W. Polyethylene	2
Diatomite (surface treated)	20
Triethylene Glycol Ester	50
Zinc Oxide	5
TMTU	1.5

Paper Mill Roll (40° Shore A)

Neoprene GRT	70
Neoprene WHV	30
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	1.5
Low M.W. Polyethylene	2
MT N990 Carbon Black	30
Factice	20
Aromatic Process Oil	40
Zinc Oxide	5
Cure: 30 min at 160°C	
Tensile Strength, MPa	10.7
Elongation, %	500
Hardness, Shore A	40

Roll Covers (continued)

Paper Mill Roll (60° Shore A)

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	1.5
Low M.W. Polyethylene	2
MT N990 Carbon Black	50
Aromatic Process Oil	10
Zinc Oxide	5
Cure: 30 min at 160°C	
Tensile Strength, MPa	14.3
Elongation, %	450
Hardness, Shore A	60

Water Repellent Rolls Non-Black (65° Shore A)

Neoprene WB	50
Neoprene WD	50
Dibasic Lead Phosphate	20
Non-Staining Antioxidant	2
Microcrystalline Wax	2
High cis Polybutadiene	3
Rutile Titanium Dioxide	15
Platy Talc	60
Epoxy Resin	3
Naphthenic Process Oil	10
Zinc Oxide	10
TMTU	0.75
DOTG	0.5
Cure: 20 min at 153°C	
Tensile Strength, MPa	16
Elongation, %	700
Hardness, Shore A	65
% Volume increase 14 days at 70°C	6

Water Repellent Rolls (65° Shore A)

Neoprene W M1	100
Red Lead Dispersion [90%]	20
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1
Microcrystalline Wax	3
Petrolatum	2
FEF N550 Carbon Black	20
SRF N772 Carbon Black	20
Reinforcing Clay	40
Aromatic Process Oil	15
TMTM	1
Sulphur	0.75
Cure: 20 min at 153°C	
Tensile Strength, MPa	15
Elongation, %	720
Hardness, Shore A	65

Abrasion Resistant Roll Cover (85° Shore A)

Neoprene GRT	100
High Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	1.5
Low M.W. Polyethylene	2
HAF N330 Carbon Black	30
MT N990 Carbon Black	20
Precipitated Silica	20
Coumarone Resin (liquid)	5
Aromatic Process Oil	10
Zinc Oxide	5
TETD	1
Cure: 30 min at 160°C	
Tensile Strength, MPa	17.8
Elongation, %	400
Hardness, Shore A	85

Roll Cover Non-Black (85–90° Shore A)

Neoprene GRT	100
High Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	1
Low M.W. Polyethylene	3
Calcium Stearate	3
Precipitated Silica	35
Reinforcing Clay	55
Coumarone Resin (liquid)	5
Aromatic Process Oil	5
Zinc Oxide	5
ETU Dispersion [75%]	0.33

High Hardness Roll Cover (90° Shore A)

Neoprene WRT	100
High Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
SRF N772 Carbon Black	100
MT N990 Carbon Black	40
Naphthenic Process Oil	8
Zinc Oxide	5
TMTM	0.75
DOTG	0.75
Sulphur	1
Cure: 20 min at 153°C	
Tensile Strength, MPa	18
Elongation, %	150
Hardness, Shore A	93

Sheeting

Sheet Packing (50° Shore A)

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	1
Petrolatum	1
SRF N772 Carbon Black	50
MT N990 Carbon Black	100
Aromatic Process Oil	50
Zinc Oxide	5
ETU Dispersion [75%]	0.6
Cure: 20 min at 153°C	
Tensile Strength, MPa	12
Elongation, %	300
Hardness, Shore A	52

Sheet Packing (70° Shore A)

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	1
Petrolatum	1
SRF N772 Carbon Black	150
MT N990 Carbon Black	100
Aromatic Process Oil	75
Zinc Oxide	5
ETU Dispersion [75%]	0.6
Cure: 20 min at 153°C	
Tensile Strength, MPa	10
Elongation, %	150
Hardness, Shore A	70

Sheet Packing (60° Shore A)

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	1
Petrolatum	1
SRF N772 Carbon Black	100
MT N990 Carbon Black	100
Aromatic Process Oil	75
Zinc Oxide	5
ETU Dispersion [75%]	0.6
Cure: 20 min at 153°C	
Tensile Strength, MPa	12
Elongation, %	240
Hardness, Shore A	60

Sheet Packing (80° Shore A)

Neoprene WHV	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Paraffin Wax	1
Petrolatum	1
SRF N772 Carbon Black	150
MT N990 Carbon Black	200
Aromatic Process Oil	100
Zinc Oxide	5
ETU Dispersion [75%]	0.6
Cure: 20 min at 153°C	
Tensile Strength, MPa	7
Elongation, %	180
Hardness, Shore A	80

Red Sheeting (60° Shore A)

Neoprene TW	75
Neoprene TW 100	25
High-Activity Magnesia	4
Non-Staining Antioxidant	2
Microcrystalline Wax	2
Stearic Acid	1
Low M.W. Polyethylene	3
Clay	60
Platy Talc	25
Naphthenic Process Oil	15
Red Iron Oxide	5
Zinc Oxide	5
ETU Dispersion [75%]	1
MBTS	0.5
Cure: 20 min at 153°C	
Tensile Strength, MPa	12
Elongation, %	350
Hardness, Shore A	60

Cork Sheet

Neoprene W M1	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Stearic Acid	0.5
Clay	45
Coumarone Resin	15
Aromatic Process Oil	20
Zinc Oxide	5
ETU Dispersion [75%]	0.75
TMTM	0.5
DOTG	0.5
Sulphur	0.75
Ground Cork	100

Sheeting (continued)

Cork Sheet (Black)

Neoprene W M1	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1.5
Stearic Acid	0.5
MT N990 Carbon Black	35
Coumarone Resin (liquid)	5
Aromatic Process Oil	10
Zinc Oxide	5
ETU Dispersion [75%]	0.75
TMTM	0.5
DOTG	0.5
Sulphur	0.75
Ground Cork	100

Moisture Vapor Barrier Sheeting

Neoprene TW	100
Red Lead Dispersion [90%]	22
Octylated Diphenylamine	2
Mixed Diaryl Para Phenylene Diamine	1.5
Microcrystalline Wax	3
Stearic Acid	0.5
Petrolatum	1
FEF N550 Carbon Black	60
Aromatic Process Oil	12
TMTM	1
Sulphur	1
Cure: 20 min at 153°C	
Tensile Strength, MPa	12
Elongation, %	400
Hardness, Shore A	65

Tank Linings

Tie Gum

Neoprene WHV	100
Neoprene W	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
Calcium Stearate	4
Low M.W. Polyethylene	6
Precipitated Silica	40
Epoxy Resin	5
Calcium Oxide	10
Zinc Oxide	5
TMTU	2
Hardness, Shore A	75

Above is used as tie gum for Neoprene/Viton® laminates also for adhesion to brass and stainless steel wire reinforcement and for bonding Neoprene to Nylon and low-temperature nitriles.

General Purpose Tank Lining

Neoprene WRT	60
Neoprene WB	40
Red Lead Dispersion [90%]	22
Octylated Diphenylamine	2
Stearic Acid	1
SRF N772 Carbon Black	30
MT N990 Carbon Black	60
Coumarone Resin (liquid)	5
Aromatic Process Oil	15
TMTM	1
Sulphur	1
Cure: 20 min at 153°C	
Tensile Strength, MPa	12
Elongation, %	350
Hardness, Shore A	65

High Quality Tank Lining

Neoprene WRT	80
Neoprene WB	20
Red Lead Dispersion [90%]	22
Octylated Diphenylamine	2
Stearic Acid	1
SRF N772 Carbon Black	50
Aromatic Process Oil	10
TMTM	1
Sulphur	0.75
Cure: 20 min at 153°C	
Tensile Strength, MPa	14
Elongation, %	800
Hardness, Shore A	60

Tie Cement

Neoprene GRT	100
High-Activity Magnesia	4
Octylated Diphenylamine	2
FEF N550 Carbon Black	10
Precipitated Silica	10
Naphthenic Process Oil	4
Zinc Oxide	5
MBTS	0.5

Dissolve above in equal volumes of Toluene/Hexane/Ethyl Acetate to 25% total solids content.

Tank Linings (continued)

High Abrasion Resistance Tank Lining		Self Curing Tank Lining	
Neoprene WRT	60	Neoprene WRT	40
Neoprene WB	40	Neoprene WB	60
Red Lead Dispersion [90%]	20	Red Lead Dispersion [90%]	20
Octylated Diphenylamine	2	Octylated Diphenylamine	2
Stearic Acid	0.5	Low M.W. Polyethylene	2
Low M.W. Polyethylene	2	MT N990 Carbon Black	50
ISAF N220 Carbon Black	40	Clay	15
Aromatic Process Oil	15	Process Aid	3
TMTM	1	Cond. Product of Acroleine and Aromatic Bases	2
Sulphur	1	DPTU	2
Cure: 20 min at 153°C		ETU Dispersion [75%]	1
Tensile Strength, MPa	20		
Elongation, %	450		
Hardness, Shore A	60		

Commercial Names of Ingredients

Specific compounding ingredients mentioned in this guide are listed below in alphabetical order. This is not to infer that comparable ingredients from other sources might not be equally satisfactory. Two sources are given for most materials, the first is European and the second is North American.

Compounding Ingredient	Commercial Name	Supplier
Aluminum Hydroxide	Hydral [®] 710	Alcoa
Antimony Trioxide (90%)	Garoflam Sb 90 P Fireshield H	Omya UK Harwick Chemical Co.
Aromatic Hydrocarbon Resin	Kenflex [®] A-1	Kenrich
Aromatic Process Oil	Sundex 790 Sundex 790	Shell Oil R.E. Carrol
Azodicarbonamide Blowing Agent	Multisperse E-Azok-75P Celogen AZ	Omya UK Uniroyal
Blanc Fixe	Barytes Barytes	Sachtleben Chemie Whitacre
Brominated Aromatic Oxide	Saytex [®] 102 Saytex [®] 102E	Ethyl Corporation Albemarle Corp.
Butyl Carbitol Formal	Thiokol [®] TP 90B	Thiokol Corporation
Butyl Oleate	Estol [®] 1414 PlastHall 503	Unichema C.P. Hall
Butylenglycol Adipate	Nycoflex ADB 30	Safic Alcan
Calcium Metaborate	Busari 11	Buckman
Calcium Oxide Dispersion	Deosec Desical P	Deutsche Oelfabrik Harwick Chemical Corp.
Calcium Silicate	Ultrasil [®] 880	Degussa
Calcium Stearate	Unem 4850 Calcium Stearate	Unilever Harwick Chemical Co.
CBS	Vulcafor CBSICI Durax [®]	R.T. Vanderbilt
40% Chlorinated Paraffin (liquid)	Cereclor [®] 42 Chloro-flo 42	ICI Dover Chemical
56% Chlorinated Paraffin (liquid)	Cereclor [®] 56 L Paroil [®] 5510	ICI Dover Chemical

Compounding Ingredient	Commercial Name	Supplier
70% Chlorinated Paraffin (liquid)	Cereclor [®] 70 L Paroil [®] 170LV	ICI Dover Chemical
70% Chlorinated Paraffin (liquid)	Cereclor [®] 70 Chlorez [®] 700	ICI Dover Chemical
Chloropropyl-Triethoxi Silane	Silane [®] SI 230	Degussa
Clay	Speswhite Dixie Clay [®]	English China Clay R.T. Vanderbilt
Coated Whiting	Omya BSH	Omya
Cond. Prod. Of Acroleine and Aromatic Bases	Vulkacit [®] 576	Bayer
Coumarone Indene Resin	Anchor MP 65P	Anchor
Coumarone Resin (liquid)	PLCT	Anchor
DBTU	Thiate [®] U	R.T. Vanderbilt
DETU	Robot [®] DETU PM Thiate [®] H	Robinson Bros. R.T. Vanderbilt
Decabromo Bipheny Ether	Flammex B 10	Berk
Diatomite (surface treated)	Celite [®] PF	Lehmann & Voss
Dicumyl Peroxide	Perkadox [®] BC Varox [®] DCP-R	Akzo Chemicals R.T. Vanderbilt
Dimethyl Ammonium Diphenylamine Derivative	Wingstay [®] 29	Goodyear
Hydrogen Isoththalate	Vanax [®] CPA	Vanderbilt
DPG	Vanax [®] DPG	Vanderbilt
DPTU	A-I Thiocarbanilide	Flexys
Dibasic Lead Phosphate	Naftovin [®] T90	Chemson
Dioctyl Phthalate	Bisoflex [®] DOP PlastHall DOP	BP Chemicals C.P. Hall
Dioctyl Sebacate	Reomol [®] DOS PlastHall DOS	FMC C.P. Hall
DOTG	Vanax DOTG	R.T. Vanderbilt
Epoxidized Soybean Oil	Reoplast [®] 39 Paraplex G62	Ciba Geigy C.P. Hall
Epoxy Resin	Epikote [®] 828	Shell Chemicals
ETU Dispersion (75%)	Robac 22 PM Poly-Dispersion END-75	Robinson Bros. Rhein Chemie
Extra Conductive Carbon Black	Ketjen Black EC Ensaco [®] 350	Ketjen Carbon R.T. Vanderbilt
Fatty Alcohols Blend	Vanfre [®] IL-2	R.T. Vanderbilt
Fine Particles Silica	Ultrasil [®] VN3 Ultrasil [®] 7000GR	Degussa Degussa
Formaldehyde Donor	Cohedur [®] A	Bayer
Graphite	Asbury 4078	Asbury Graphite
Hard Clay	Suprex Clay Dixie Clay	Marlow Chemical R.T. Vanderbilt
Hexamethoxymethylmelamine	Cyrez 963	Cytec Industries
High Activity Magnesia	Maglite [®] D	C.P. Hall
High Cis Polybutadiene	Buna CB 10 Buna H	Hols A. G. Huls America Inc.
High Styrene Copolymer	Duranit 15 Pliolite S6B	Bayer Goodyear

Compounding Ingredient	Commercial Name	Supplier
Low M.W. Polyethylene	AC 617A or AC 1702	Allied Chemicals
Magnesium Hydroxide	Marinco [®] H	Merck Chemicals
MBTS	Altax [®]	R.T. Vanderbilt
5-Methyl Mercaptobenzimidazole	Vanox [®] MTI	R.T. Vanderbilt
3-Methyl Thiazolidine-Thion-2	Rhenocure CRV LG	Rhein Chemie
2-Mercaptobenzimidazole	Naugard [®] MB	Uniroyal
Microcrystalline Wax	Vanwax [®] H	R.T. Vanderbilt
Mixed DPPD	Wingstay [®] 100	Goodyear
Napthenic Oil	Sunthene [®] 4240	Sun Oil
Napthenic Process Oil	Circo [®] Light Process Oil	Sun Oil
N,N-m-Phenylenedimaleimide	HVA-2	DuPont Perf. Elastomers
Non-Staining Antioxidant	Antioxidant 2246 Vanox [®] MBPC	American Cyanamid R.T. Vanderbilt
Non-Staining Antiozonant	Vulkazon [®] AFS	Bayer
Octylated Diphenylamine	Octamine Agerite [®] Stalite S	Uniroyal R.T. Vanderbilt
Paraffin Wax	Vanwax [®] H Special	R.T. Vanderbilt
P,P-Oxy-bis Benzenesulphony Hydrazide	Celogen [®] OT	Uniroyal
Peptizing Agent	Vanax [®] 552	Vanderbilt
Phenolic Resin	Koresin Koresin	BASF/Strucktol Strucktol of America, Inc.
Platy Talc	Mistron Vapor [®] Mistron Vapor [®]	Cyprus Chemicals Luzenac America, Inc.
Polyethylene Glycol Fatty Ether	Antistaticum RC 100	Rhein Chemie
Polyester Plasticizer	Diolpate [®] 214	Briggs & Townsend
Polyethylene Glycol	Carbowax [®] 3350 Carbowax [®] 3350	Union Carbide Harwick Chemical Corp.
Precipitated Fine Whiting	Calofort [®] U Multifex MM	Sturge Specialty Minerals Inc.
Precipitated Silica	Perkasit [®] KS 300	Akzo Chemie
Ppt. Hydrated Amorphous Silica	Silene 732D	PPG
RCF Carbon Black	Raven 1040	Columbian Carbon
Red Iron Oxide	Stan-Tone [®]	Harwick
Red Lead Dispersion (90%)	Kenmix [®] Red Lead/P Poly-Dispersion TRD-90	Kenrich-Stillmake Rhein Chemie
Refined Bituman	Mineral Rubber Mineral Rubber	Lehmann & Voss Sovereign Chemicals Co.
Reinforcing Clay	M501 Dixie Clay	English China Clay R.T. Vanderbilt
Resorcinol Bonding Promoter	Cohedur RS	Bayer
Rutile Titanium Dioxide	Ti-Pure [®] R-960	DuPont
Salicylic Acid	Retarder TSA Retarder SAX	Monsanto Akrochem
Sodium Bicarbonate (extra fine)	Natrimbikarbonat	Malmsten & Bergvall
Steel-to-Rubber Bonding Agent	Manobond [®] C	Manchem Inc. UK
TBTU	Robac TBTU	Robinson Bros.
TETD	Robac TET Ethyl Tuads	Robinson Bros. R.T. Vanderbilt

Compounding Ingredient	Commercial Name	Supplier
Tetraethylene Glycol 2-ethylhexoate	TegMer [®] 804	C.P. Hall
TMTD	Robac [®] TMT Methyl Tuads	Robinson Bros. R.T. Vanderbilt
TMTM	Robac TMS UNADS	Robinson Bros. R.T. Vanderbilt
TMTU	Thiate [®] EF-2	R.T. Vanderbilt
Tricresyl Phosphate	Pliabrac TCP Kronitex [®] TCP	FMC C.P. Hall
Triethanolamine	Triethanolamine	Harwick
Triethylene Glycol Ester	Bisflex [®] 102 Tegmer [®] 903	BP Chemicals C.P. Hall
Vinyl Silane	Vinyl Silane A 172 Vinyl Silane A 172	Union Carbide Harwick Chemical Co.
Zinc Borate	Firebrake [®] ZB 2335	Harwick
Zinc 5-Methyl Mercaptobenzimidazole	Vanox [®] ZMTI	R.T. Vanderbilt
Zinc Stearate	Unem 4840 Zinc Stearate	Unilever Synpro

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