Rubber Compound Formulation Register

Natural Rubber, SBR, EPDM and Neoprene Compounds — Internal Reference Document

Drawing No.	Revision	Date	Prepared By	Checked By	Status
EA-ENG-MAT-019	**5.2**	**22 October 2025**	**D. Waller — Head of Engineering**	**S. Nakamura — R&D Materials Engineer**	**ISSUED FOR USE**

& CRITICAL
HIGHEST CONFIDENTIALITY — This document contains Elastomers Australia proprietary formulation data developed over 40+ years. Distribution strictly limited to authorised EA engineering personnel. DO NOT share with external parties, clients, or suppliers without written CEO authorisation. Breach of this policy will result in immediate disciplinary action.

1. PURPOSE & CONTROL

This register is the definitive reference for all rubber compound formulations used in Elastomers Australia screen panel, wear liner, and sealing product manufacture. It is maintained by the R&D Materials Engineer and updated under the EA Document Control procedure EA-QMS-DOC-001. All formulation changes require a change request (EA-FORM-CR-001) signed by the Head of Engineering before implementation.

Formulation codes in this register are cross-referenced in product drawings, quality plans, and batch production records. When a production batch record references a compound code (e.g. "NR-45-HA"), all parameters in this register apply unless a specific deviation has been approved in writing.

2. NATURAL RUBBER (NR) COMPOUND FAMILY

2.1 NR-35-SA — Natural Rubber, 35 Shore A, Super Abrasion Grade

Primary application: Heavy-duty wear liners for chutes, hoppers, and high-impact zones at iron ore and gold operations. Also used for anti-drum liners in ball mill feed chutes. Exceptional impact resistance due to natural rubber's high resilience index.

Ingredient	Chemical Name	Supplier Grade	Parts per Hundred Rubber (phr)	Function
Natural rubber SMR20	Polyisoprene	SMR20 / RSS1	100.0	Base elastomer
Carbon black N330	HAF carbon black	Cabot N330	50.0	Reinforcement
Carbon black N550	FEF carbon black	Cabot N550	10.0	Processing / modulu
ZnO (zinc oxide)	Zinc oxide	French Process "e99.5%	5.0	Activator
Stearic acid	Octadecanoic acid	Industrial grade	2.0	Activator / processin
Sulphur	Elemental sulphur	Crystex OT20	2.5	Crosslinker
CBS accelerator	N-cyclohexyl-2-benzothiazolesulphenamide	Lanxess Vulkacit CZ	1.2	Primary accelerator
TMTD	Tetramethylthiuram disulphide	Lanxess Vulkacit Thiuram	0.3	Secondary accelerat
Antioxidant 6PPD	N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine	Santoflex 13	2.0	Antiozonant / antioxi
Antioxidant TMQ	Poly(2,2,4-trimethyl-1,2-dihydroquinoline)	Flectol H	1.5	Thermal antioxidant
Aromatic process oil	Naphthenic / aromatic blend	Shell Risella 923	8.0	Processing / softene
Microcrystalline wax	Paraffin wax blend	Antilux 654	1.5	Ozone protection

Processing Parameters — NR-35-SA

Parameter	Specification	Notes
Internal mixer (Banbury) — 1st stage	60°C drop temp, 4 min mix	Add NR, carbon blacks, ZnO, stearic acid, oil, antioxidants
Internal mixer — 2nd stage	Add sulphur system at <80°C	Sulphur + accelerators added cold to prevent scorch
Mill sheet thickness	8–10 mm	For post-mix sheeting and batch cooling
Mooney viscosity (ML 1+4 at 100°C)	55–75 MU	Test per ASTM D1646 on each batch
Scorch time (t5 at 120°C)	> 12 min	Test per ASTM D5289 — reject if below
Cure temperature	155°C ± 2°C	Compression moulding or injection
T90 cure time (at 155°C)	22–28 min	Oscillating Disc Rheometer — ASTM D2084
Post-cure	Not required — oven cure only for liners >50mm	—

Mechanical Properties — NR-35-SA (Target, Cured)

Property	Minimum	Target	Maximum	Test Method
Hardness (Shore A)	33	35	38	ASTM D2240
Tensile strength (MPa)	"e 18	22	—	AS 1145.1
Elongation at break (%)	"e 550	650	—	AS 1145.1
Tear resistance (kN/m)	"e 45	58	—	ASTM D624 Die C
Abrasion loss (mm³)	—	"d 90	—	DIN 53516
Resilience (Bayshore, %)	"e 72	78	—	ASTM D2632
Compression set (22h/70°C, %)	—	"d 12	"d 15	ASTM D395

2.2 NR-55-HA — Natural Rubber, 55 Shore A, High Abrasion Grade

Application: Standard screen panel backs, conveyor belt wear faces, standard chute liners. Most commonly produced compound by volume — accounts for approximately 40% of EA rubber production output. Balanced abrasion resistance and processability.

Ingredient	Parts (phr)	Notes vs. NR-35-SA
Natural rubber SMR20	100.0	Same base
Carbon black N330	60.0	+10 phr vs. SA grade — higher modulus
Carbon black N550	5.0	Reduced — less processing oil needed at higher hardness
ZnO	5.0	Same
Stearic acid	2.0	Same
Sulphur	2.8	Increased — higher crosslink density for hardness
CBS	1.5	Increased
TMTD	0.5	Increased
6PPD antioxidant	2.0	Same
TMQ antioxidant	1.5	Same
Aromatic process oil	5.0	Reduced — higher carbon loading reduces need
Microcrystalline wax	1.5	Same

Processing: Same Banbury sequence as NR-35-SA. Mooney viscosity target: 65–85 MU. Scorch time t5 > 10 min. Cure at 155°C, T90: 18–24 min. Shore A target: 53–57.

2.3 NR-70-EA — Natural Rubber, 70 Shore A, Extra Abrasion

Application: High-wear screen panel bodies, pump liners (suction side), chute impact points with coarse feed (>150mm). Highest carbon loading in NR family — significant mixing energy required. Production volume: ~15% of rubber output.

Compound summary: NR SMR20 (100 phr), N330 carbon black (70 phr), N220 carbon black (10 phr — higher structure for stiffness), ZnO (5 phr), stearic acid (2 phr), sulphur (3.0 phr), CBS (1.8 phr), TMTD (0.8 phr), DPG secondary accelerator (0.3 phr), 6PPD (2.5 phr), TMQ (2.0 phr), aromatic oil (3.0 phr — minimal for processability).

Processing note: High carbon loading causes elevated mixing temperatures. Monitor Banbury motor amperage — dump compound if temperature exceeds 130°C. Two-pass mixing recommended: 1st pass without curatives, cool to <60°C, 2nd pass add sulphur system. Mooney viscosity: 85–105 MU.

3. SBR / NATURAL RUBBER BLEND FAMILY

3.1 SBR/NR-60-GP — SBR/NR Blend, 60 Shore A, General Purpose Screen Panel

Application: Standard polyurethane-alternative screen panel body where cost is primary driver. Used for less critical screening applications (non-corrosive, ambient temperature, non-impact). Lower cost than pure NR grades due to SBR content — approximately 35% material cost reduction vs. NR-55-HA.

Ingredient	Parts (phr)	Function
SBR 1502 (cold-polymerised)	60.0	Base elastomer — cost driver, good abrasion resistance
Natural rubber SMR20	40.0	Improves tear strength and resilience vs. 100% SBR
Carbon black N330	55.0	Reinforcement
Carbon black N550	10.0	Processing

ZnO

5.0

Activator

Stearic acid

2.5

Activator / processing aid

Aromatic process oil

10.0

Higher level vs. NR — compensates SBR stiffness

Sulphur

2.5

Crosslinker

1.5

Primary accelerator

0.5

Secondary accelerator

1.5

1.5

Thermal antioxidant

Peptiser (Renacit 11)

0.2

Viscosity reducer for SBR processing

Processing: Mooney viscosity ML 1+4 at 100°C: 60–80 MU. Cure at 155°C, T90: 20–26 min. Shore A target: 58–63. Key limitation: SBR/NR blends have lower resilience (Bayshore ~50–55%) vs. pure NR — not suitable for applications where impact energy return is critical.

4. EPDM COMPOUND FAMILY

4.1 EPDM-55-CR — EPDM, 55 Shore A, Chemical Resistant Grade

Application: Screen panels and liners in acid/alkali processing environments including uranium/gold heap leach, phosphate processing, and copper sulphate circuits. EPDM provides superior resistance to oxidising chemicals vs. NR or SBR. Not suitable for oil/hydrocarbon contact — specify Neoprene or Nitrile for those applications.

Ingredient	Parts (phr)	Grade / Supplier	Notes
EPDM (Nordel IP 4770R)	100.0	Dow Chemical	High ENB (5.0%) for sulphur cure compatibility
Carbon black N550	70.0	Cabot	Higher loading vs. NR — EPDM requires more filler
Carbon black N774	20.0	Cabot	SRF grade — processing
Paraffinic process oil	30.0	Sunpar 2280	Higher oil level — EPDM accepts high oil without degradation
ZnO	5.0	French Process	Activator
Stearic acid	1.0	Industrial	Reduced vs. NR compounds
Sulphur (Crystex OT20)	1.5	Solvay	Lower level — EPDM crosslinks more efficiently
CBS (Vulkacit CZ)	1.5	Lanxess	Primary accelerator
TMTD (Vulkacit Thiuram)	1.0	Lanxess	Higher TMTD:CBS ratio vs. NR for EPDM cure
ZDBC accelerator	0.5	Lanxess	Thiazole secondary
Antioxidant TMQ	2.0	Flexsys	Critical for EPDM oxidation resistance
No 6PPD required	—	—	EPDM does not require amine antiozonant

Chemical Resistance — EPDM-55-CR vs. NR-55-HA

Key advantages of EPDM-55-CR in aggressive environments:

Chemical	NR-55-HA Rating	EPDM-55-CR Rating	Notes
Sulphuric acid (5%)	B	A	EPDM preferred for pH < 5
Sulphuric acid (20%)	D	B	Engineering review required even for EPDM at >20%
Nitric acid (5%)	D	B	Gold/copper processing environments
Sodium hydroxide (50%)	B	A	Strong alkali — EPDM significantly better
Hydrogen peroxide (10%)	D	A	Bleaching / paper pulp applications
Ozone resistance	B (requires protection)	A (inherent)	EPDM saturated backbone is ozone-inert
Heat ageing (120°C, 168h)	Significant degradation	Minimal change	EPDM superior for elevated temperature service
Diesel / mineral oil	B	D	NR better — EPDM swells severely in hydrocarbons

5. COMPOUND APPLICATION MATRIX

Use the following matrix to select the correct compound grade for a given application. When multiple grades are suitable, the recommended grade is shown in bold. If the application is not covered, submit a specification query to engineering@elastomers.com.au.

Application	Rec. Compound	Alternative	Exclude	Key Requirement
Screen panel — iron ore, neutral pH	NR-55-HA	SBR/NR-60-GP	EPDM	Abrasion + cost balance

Screen panel — gold (pH 8–10
cyanide)

NR-55-HA

None

Cyanide rated OK for NR

Screen panel — copper sulphate
(pH 3–5)

EPDM-55-CR

NR, SBR

Acid resistance critical

Screen panel — phosphate (pH 2–4)

EPDM-55-CR

NR, SBR

Chute liner — coarse feed, neutral pH

Maximum impact absorption

Chute liner — fine, high-velocity

Sliding abrasion dominant

Screen panel — coal washery

NR-55-HA

EPDM

Standard duty, cost-sensitive

Pump liner — slurry, neutral pH

SBR (alone)

Seals / gaskets — water service

EPDM-55-CR

Compression set and water resistance

Liners — near diesel fuel /
hydraulic oil

Neoprene-CR — See MAT-022

NR, SBR, EPDM

Hydrocarbon contact — different document

6. QUALITY CONTROL — COMPOUND RELEASE CRITERIA

Every rubber compound batch must pass the following tests before release for moulding. Batch records are retained for 7 years per EA quality system requirements. Failed batches are quarantined and dispositioned via EA-NCR system.

Test	Method	Acceptance Criteria	Sample
Mooney Viscosity ML1+4	ASTM D1646 at 100°C	Within ±10 MU of formulation target	Each batch
Mooney Scorch t5	ASTM D1646 at 120°C	> minimum per formulation table	Each batch
ODR cure curve	ASTM D2084 at 155°C	Tc10, Tc90 within ±2 min of target	Each batch
Shore A hardness (cured)	ASTM D2240	Within ±3 units of target	Each batch — from plaque
Tensile strength (cured)	AS 1145.1	> minimum per compound specification	Weekly or per new formulation
Density	ASTM D792	Within ±0.02 g/cm³ of formulation target	Each batch
Carbon black content (muffle)	ASTM D1506	Within ±3% of formulation nominal	Quarterly

7. REVISION HISTORY

Rev	Date	Change Summary	Author
5.2	Oct 2025	EPDM-55-CR paraffinic oil qty increased from 25 to 30 phr — Mooney viscosity compliance. Chemical resistance table updated with hydrogen	S. Nakamura
5.1	Apr 2025	NR-70-EA compound added (previously unregistered). DPG accelerator added to NR-70-EA	D. Waller
5.0	Nov 2024	Full format revision. Compound application matrix added. Neoprene family moved to EA-ENG-MAT-022	S. Nakamura
4.3	Jun 2024	NR-35-SA: aromatic oil reduced from 10 to 8 phr following phase separation in cold storage	S. Nakamura
4.2	Jan 2024	SBR/NR-60-GP added. NR-55-HA sulphur increased 2.5!'2.8 following hardness drift on Line 3.	D. Waller