NORAC®
ADDITIVES
A PETER GREVEN GROUP COMPANY

SPECIALISTS for Plastic Additives

NORAC® ADDITIVES
A PETER GREVEN GROUP COMPANY

Metallic Stearates

Norac EL® Ester Lubricants

Norac XL® Specialty Lubricant Blends

Norstab® Heat Stabilizers

The Norac Additive team is made up of highly experienced plastic additive professionals with particular expertise for PVC applications. Our highly efficient COAD® manufacturing process allows us to offer a broad range of metallic stearates. Supplemented by specially formulated lubricant blends and calcium/zinc heat stabilizers, our product portfolio is tailored to the specific needs of our customers in the plastics industry.

RESEARCH.
QUALITY.
SERVICE.

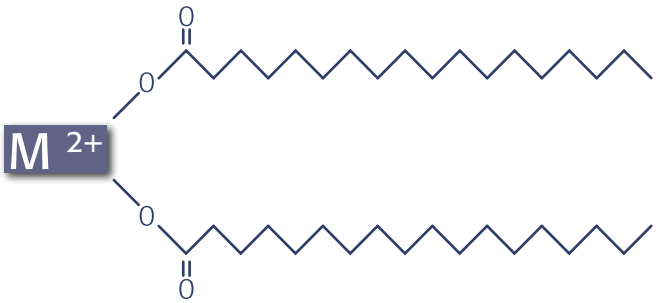
These are our priorities and what sets us apart.

METALLIC SOAPS Technical introduction

Metallic soaps are salts of fatty acids, especially of stearic acid. Often metallic soaps are called all-round talents as they can be used in many different applications and offer several advantages:

- Excellent lubricating properties
- Good stabilizing properties
- Good gelling properties
- Very good release properties
- Outstanding hydrophobing properties
- Good fusion promotion in PVC

Fig. 1: Composition and structure of Metallic Soaps

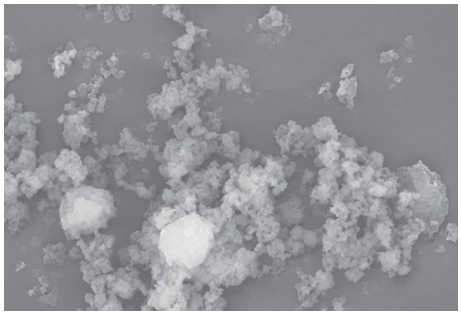


There are three important technological processes for the production of the metallic soaps:

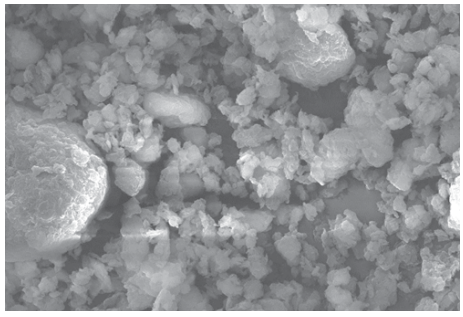
Fig. 2: Production processes of metallic soaps

	Precipitation process	Direct process	COAD® process
Description	Two reaction steps: 1. Production of a soap 2. Precipitation of the metallic soap by adding the metal base	Metallic based powders are added to the fatty acid. Reaction temperature is below the melting point of the metallic soap.	Continuous modified fusion process Uses fluidization to achieve precipitation like quality
Properties & Advantages	· Very fine particles · High specific surface area · Low bulk density · Neutral pH · Possible high salt	· Lower degree of fineness · Good flowability · Higher bulk density · pH > 7 · No salt	· Tighter specifications · Lower degree of fineness · Neutral pH · No salt

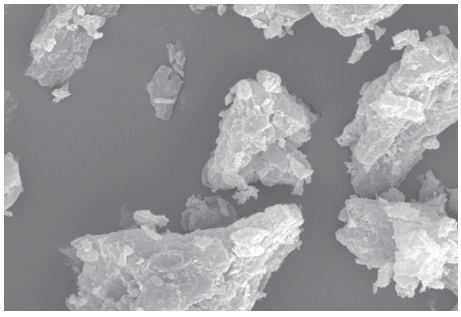
Fig. 3: Comparison of grain structures



Precipitated process



Direct process



COAD® process

PVC – METALLIC SOAPS

PVC (polyvinyl chloride) is one of the oldest and most commonly used plastics. PVC is durable and light, exhibits a low permeability, is fire resistant and offers good insulation properties. In addition PVC rarely absorbs water and is stable towards acid, alkali, alcohol, oil and petrol.

PVC is difficult to convert and processing additives are needed to improve the melting viscosity and the flow properties of PVC. Furthermore stabilizers are needed for the processing of PVC. Norac has been producing and developing metallic soaps, preblends and lubricants that are used in the PVC industry for many decades.

Metallic soaps in PVC

Metallic soaps are among the most important additives for PVC because they offer excellent stabilizing and lubricating properties.

For the selection of the right metallic soap the particle size is of great importance. Figure 4 and 5 present some products in relation to the degree of fineness:

Fig. 4: Different Calcium Stearates Types with Particle Size

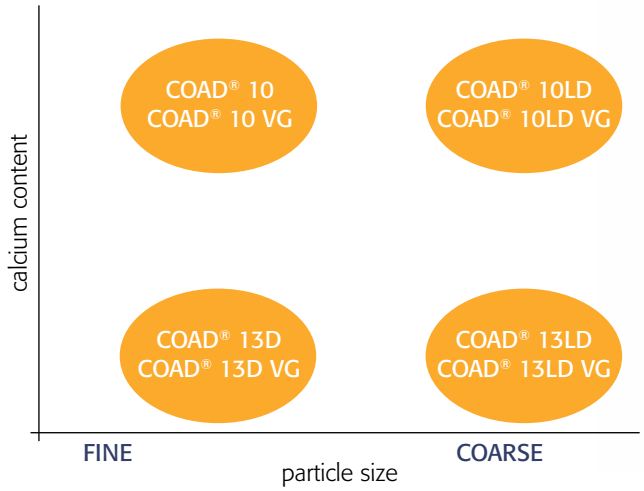
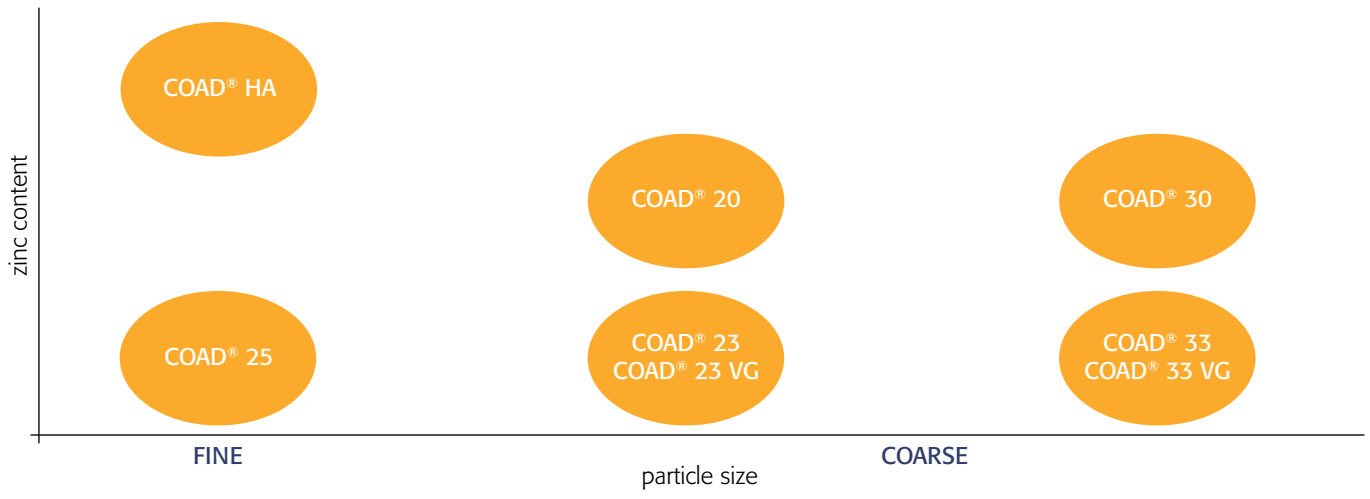


Fig. 5: Different Zinc Stearates Types with Particle Size



PVC – METALLIC SOAPS

Fig. 6: Rigid PVC formulas with varying Calcium Stearate levels

Calcium Stearate dosage, phr		0.2	0.6	1	1.4	1.8
Fusion Time	min:sec	02:22	01:54	01:32	01:34	01:10
Dynamic Thermostability	min:sec	16:34	19:12	20:38	20:22	20:24
Extrusion torque	meter-grams	9193	7678	7838	7818	7559
Extrusion pressure	psi	2364	1838	1867	1888	1838
Output	grams/min	67	72	77	78	78

Increasing calcium stearate speeds fusion, increases thermal stability, reduces extrusion torque and pressure and increases output.

Fig. 7: Metallic Stearates overview of properties

Typical properties	Total Ash % (corrected for moisture)	Total Ash	Moisture %	Free Fatty Acid %	Softening Point °C	Apparent Density (LB/FT³)	Mean Partice Size (micron)	Fineness % Thru (Mesh)
Calcium Stearate								
COAD® 10	10.3	10.0	2.5	0.2	155	18	11	99 (325)
COAD® 10 VG	10.3	10.0	2.5	0.2	155	18	11	99 (325)
COAD® 10LD	10.3	10.0	2.5	0.2	155	24	**	95 (20)
COAD® 10LD VG	10.3	10.0	2.5	0.2	155	24	**	95 (20)
COAD® 13D	9.8	9.5	2.5	0.5	155	18	11	99 (325)
COAD® 13D VG	10.2	9.9	2.5	0.5	155	18	11	99 (325)
COAD® 13LD	9.8	9.5	2.5	0.5	155	20	**	95 (20)
COAD® 13LD VG	10.2	9.9	2.5	0.5	155	20	**	95 (20)
Magnesium Stearate								
COAD® 40	**	7.7	4	3	**	24	**	90 (20)
Zinc Stearate								
COAD® 23 (Polymer Grade)	13.6	13.6	0.2	0.2	120	18	11	99 (325)
COAD® 23 VG	13.6	13.6	0.2	0.2	120	18	11	99 (325)
COAD® 33 Prill	13.6	13.6	0.2	0.2	120	40	**	99 (20)
COAD® 33 VG	13.6	13.6	0.2	0.3	120	40	**	99 (20)

PVC – STABILIZERS

Our high level competence in the production of calcium and zinc soaps puts us in an excellent position to offer CaZn based heat stabilizers for PVC. CaZn heat stabilizers are currently used in many applications, especially those requiring nontoxic properties, such as medical and food packaging. In addition, solid CaZn heat stabilizers are very useful for interior applications requiring low VOC's. CaZn heat stabilizers are also being increasingly considered as more environmentally friendly alternatives to BaZn and Tin stabilizers.

Fig. 8: Product range of Calcium / Zinc Heat Stabilizers

		RIGID PVC				FLEXIBLE PVC				
Product	Form	Profile	Sheet	Injection Mold	Film	Extrusion FDA	Extrusion GP	Extruded sheet	Calendered film	Wire cable
Nortsab 47-154	Solid					*				
Norstab 51	Solid					*	*			
Norstab 62 R	Solid						*			*
Norstab 74 S	Solid					*	*			
Norstab 6006	Solid								*	
Norstab 6160	Solid							*		
Norstab 6330	Solid									*
Norstab 7414	Solid				*					
Norstab 7416	Solid	*	*							
Norstab 7802	Solid			*						
Norstab 9160	Solid							*		

SMC/BMC

SMC/BMC is used for molded parts. Typically large surface area parts are used for building products and vehicles. Metallic soaps are used as release agents for the parts, resulting in a good release with no surface defects. Zinc stearate is often preferred because it melts to a low viscosity for better dispersion. Particle size and morphology is critical to viscosity of the compound before molding. COAD® 27D zinc stearate is specifically designed to meet the demands of SMC/BMC molding.

Fig. 9: Metallic Stearates overview of properties

Typical properties	Total Ash % (corrected for moisture)	Total Ash	Moisture %	Free Fatty Acid %	Softening Point °C	Apparent Density (LB/FT³)	Mean Partice Size (micron)	Fineness % Thru (Mesh)
Calcium Stearate								
COAD® 10	10.3	10.0	2.5	0.2	155	18	11	99 (325)
COAD® 13D	9.8	9.5	2.5	0.5	155	18	11	99 (325)
Zinc Stearate								
COAD® 20	15.3	15.3	0.2	0.2	120	18	11	99 (325)
COAD® 27D	13.6	13.6	0.2	0.2	120	18	11	99 (325)

POLYOLEFINS

Next to PVC, the Polyolefins constitute one of most important plastics today. Due to their good chemical consistency and electrical insulation characteristics polyolefins are used in many different applications. Some of their main fields of applications are films (for packaging), household goods, transport containers, sheets, pipes and fibers.

As with PVC, Polyolefins belong to the thermoplastics which can be processed in specific temperature ranges. However they are easier to process than PVC, as they offer a very good thermal stability with absence of oxygen. Due to the catalysts used metallic soaps are necessary as additional additives.

Metallic soaps in polyolefins

For stability of polyolefins, antioxidants are predominantly used. However, most catalysts contain chloride and there is a risk of hydrochloric acid formation during processing which can affect performance and easily corrode processing tools. To avoid this 0.05 to 0.20 % calcium or zinc stearate are added to the formulation. Calcium stearate is particularly suitable as it has a higher chemical affinity to chloride.

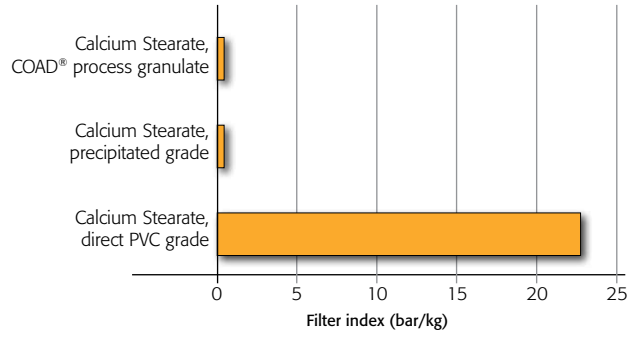
Figure 10 shows the function of metallic soaps as acid scavenger: At the beginning both metal plates were immersed into a PP melt. Without an acid scavenger a metal plate (S235JRC+C) corrodes within 6 days at room temperature and with a relative humidity of 90 %. Only 500 ppm calcium stearate is enough to stop the process of corrosion.

Metallic soaps from different production processes will have different physical characteristics, but all can be used for polyolefin production. In that application it may be preferred to use a 'powder' stearate for the ease of dispersion, but it may be desirable to use a 'granulate/ dust free' grade for easier and cleaner material handling. Depending on the production process, stearates do not only vary in terms of grain size but also grain structure.

Fig. 10: Function as acid scavenger

PP without calium stearate PP with 500 ppm calcium stearate

Fig. 11: Filter Index (ISO 23900-5 at 1400 mesh)



Filter Index tests suitability for thin film and fiber applications in polypropylene. The PVC (standard) grade stearate made with the direct process has a poor Filter Index while Precipitation and COAD® process show very good results.

POLYOLEFINS

Due to globalization and raw material availability it is important to have the possibility of using stearic acid from both, vegetable and animal base. However, the choice of raw material should not have any influence on the products' properties. To evaluate the influence of the raw material base we performed multiple extrusion tests (PP with 500 ppm calcium stearate) and determined the yellowness index as well as the melt flow rate.

The test results are shown in figure 12 and 13. They outline that stearates based on vegetable raw materials offer results comparable with tallow based products.

Fig. 12: Results yellowness index

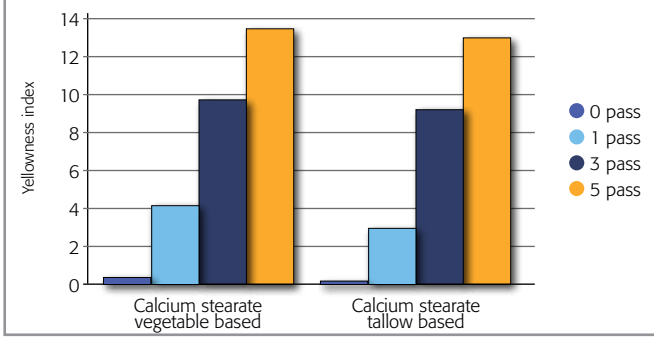


Fig. 13: Results melt flow rate

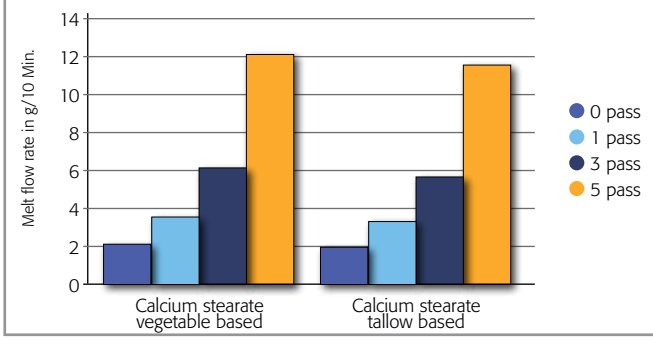


Fig. 14: Metallic Stearates overview of properties

Typical properties	Total Ash % (corrected for moisture)	Total Ash	Moisture %	Free Fatty Acid %	Softening Point °C	Apparent Density (LB/FT³)	Mean Partice Size (micron)	Fineness % Thru (Mesh)
Calcium Stearate								
COAD® 13D	9.8	9.5	2.5	0.5	155	18	11	99 (325)
COAD® 13D VG	10.2	9.9	2.5	0.5	155	18	11	99 (325)
COAD® 13LD	9.8	9.5	2.5	0.5	155	20	**	95 (20)
COAD® 13LD VG	10.2	9.9	2.5	0.5	155	20	**	95 (20)
Zinc Stearate								
COAD® 21 (Clear Melt)	13.6	13.6	0.2	0.2	120	18	11	99 (325)
COAD® 21 VG (Clear Melt)	13.6	13.6	0.2	0.2	120	18	11	99 (325)
COAD® 23 (Polymer Grade)	13.6	13.6	0.2	0.7	120	18	11	99 (325)
COAD® 23 VG	13.6	13.6	0.2	0.2	120	18	11	99 (325)
COAD® 31 Prill (Clear Melt)	13.6	13.6	0.2	0.5	122	40	**	99 (20)
COAD® 31 Prill VG	13.6	13.6	0.2	0.5	122	40	**	99 (20)
COAD® 33 Prill (Clear Melt)	13.6	13.6	0.2	0.2	122	40	**	99 (20)
COAD® 33 VG	13.6	13.6	0.2	0.3	122	40	**	99 (20)

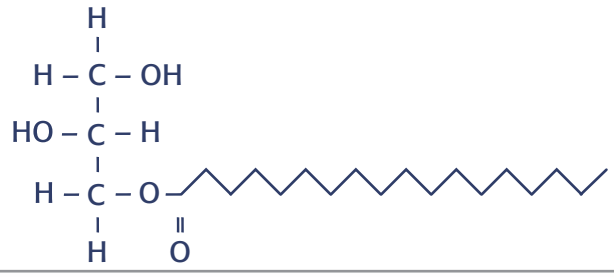
ESTERS Technical introduction

Esters comprise a group of chemical compounds that are formed through the reaction of an acid (e.g. stearic acid, oleic acid) and an alcohol (e.g. glycerin, pentaerythritol). Esters are – like metallic soaps – essential additives in the plastics industry. Their effects and properties are based upon the different characteristics of the functional groups and non-polar parts as well as their ratios.

Esters with short-chain hydrocarbon chains, such as diethyl adipate, exhibit solvent properties. The extension of the hydrocarbon chains results in waxy products. One example is stearyl stearate, which is used as a lubricant in the plastics industry. The influence of polar groups is significantly pronounced if polyols are used for the production of esters. In this way the behavior of lubricants in PVC or ABS can be controlled. Polar esters are more compatible and act as internal lubricants, for example glycerine monostearate. If the polarity is reduced, products with a more external lubricant effect are obtained.

The ratio of the polar proportion and non-polar hydrocarbon chains also leads to surfactant like properties. This effect is exploited in many cases. Esters such as glycerine monooleate or PEG 400 monooleate are used as antifogging agents in PVC. Glycerine monostearate is used as an antistatic agent for polyolefins or to stabilize the foam structure of EPS.

Fig. 15: Composition and structure of an ester (glycerol monostearate)



PVC – ESTERS

Lubricants are essential additives for PVC production. Internal and external lubricants are distinguished which results in the following characteristics:

Internal lubricants

- Improved compatibility due to polar groups in the C chain
- No formation of single lubricant phases
- Decrease the softening temperature of PVC
- Acts as macromolecular binder

External lubricants

- Low compatibility with PVC
- Reduction of adhesion of hot plastics with other material surfaces
- Act as release agent without degradation on plate-out properties

Fig. 16: Product portfolio of ester lubricants for PVC incl. Applications

			Function		RIGID PVC					FLEXIBLE PVC		
Chemical Type	Product	Form	internal	external	Profile	Sheet	Pipe	Injection Mold	Film	Extrusion	Calender	Injection Mold
Fatty Acid	**Norac TPSA**	Solid	**		x	x	x			x	x	x
	Norac 95V	Solid	**		x	x	x			x	x	x
Glycerol Esters	**Norac EL 11**	Solid	*	***	x	x	x					
	Norac EL 15	Solid	**									
Alcohol Esters	**Norac EL 10**	Solid	*****		x	x	x					
	Norac EL 33	Solid	**	***	x	x	x					
	LIGALUB 45 ITD	Liquid	****							x	x	x
Polyol Esters	**LIGALUB 50 PE**	Liquid	***	**								
Complex Esters	**Norac EL 70**	Solid	*	****	x	x	x		x			
	Norac EL 71	Liquid	*	****						x	x	x
Specialty Esters	**Norac XL 53**	Solid	***	*	x					x	x	x
Blends	**Norac XL 65 A**	Solid		****			x					
	Norac XL 63	Solid	*	***		x						
	Norac XL 157	Solid	*	****				x				
	Norac XL 175	Solid	***	*	x							
	Norac XL 454	Solid	***	**		x						

ENGINEERING PLASTICS

Engineering plastics represent a group of thermoplastic, which differ in mechanical and technical characteristics or chemical stability from standard plastics. Especially efficient polymers are listed together in the subgroup of "high performance polymers". In many cases the mechanical properties are optimized by the addition of glass fibres. Representatives of engineering plastics are for example:

Polystyrene (PS/EPS)

This is a thermoplastic polymer that becomes soft while heating and is converted to semi-finished products, like films or transparency films as well as a large range of finished products. Polystyrene has a comparatively good thermal stability and mostly gets along without stabilizers. This is not the case for co-polymers, therefore the use of antioxidants is required. The use of olechemical additives is limited to the range of lubricants and mould release agents, which have to be added to the plastic mainly to guarantee an optimal processability. The influences of lubricants are similar to those seen with PVC.

Acrylonitrile-butadiene-styrene-copolymer (ABS)

This is a non-transparent thermoplastic polymer material made from the monomers acrylonitrile, 1,3 butadiene and styrene. Strong and enduring even under low temperatures it offers a high resistance against heat and chemicals and it is easy to process.

Polycarbonate (PC)

The term polycarbonate describes a polymer which is put together out of many (poly) identical unities of bisphenol A connected through carbonate compounds in its basic structure. Polycarbonate is moulded in the desired form by melting or under pressure into a form or matrix.

Polyethylene terephthalate (PET)/polybutylene terephthalate (PBT):

PET and PBT also belong to the polyesters. They are characterized by their breaking strength and high temperature resistance. Pentaerythritol esters can be used as processing aids. As PET and PBT are often used for applications with food contact, the additives also need to be approved accordingly. We have a food contact notification of the FDA (FCN 001963) at our disposal for our saturated pentaerythritol esters.

Polyamide (PA)

Polyamides are macromolecules where monomers are interlinked by amide bonds or peptide formation. Natural polyamides are peptides or proteins like hair, wool, silk and egg albumen. Synthetically produced, long-chain aliphatic polyamides are also called nylon after the first pure synthetic fibre, which was brought to market by Du Pont in 1939.

Polymethylmethacrylate (PMMA)

PMMA is a synthetic, glass-like thermoplastic material and arises as the result of polymerization of monomeric methacrylic acid methyl ester.

Product portfolio for the application in engineering plastics

Product	PS/EPS	ABS	PC	PET/PBT	PA	PMMA
COAD® 10	x	x	x		x	x
COAD 21 (Clear Melt)	**x**	**x**				
COAD® 23	x	x	x		x	x
COAD® 40	x	x	x		x	x
LIGASTAR AL D2			x		x	x
PALMSTAR NAV	x					x
Norac EL 11	x	x				
Norac EL 15		x				
Norac EL 33	x		x		x	
LIGALUB 50 PE		x	x	x	x	x
Norac EL 70		x		x	x	
Norac EL 71		x		x	x	

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