WÄRTSILÄ

Wärtsilä Finland Oy

Energy Solutions

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Description:	Wärtsilä Energy Solutions Preferred Suppliers		
Type:	List		

This document is based on the Wärtsilä Energy Solutions preferred suppliers list WDAAA182128. The latest revision of WDAAA041238 hard copy document can be submitted upon request.

Wärtsilä Energy Solutions mainly select suppliers from the latest revision of preferred suppliers list WDAAA182128. Additionally Wärtsilä Energy Solutions may select and qualify suppliers project specifically, according to validated product / supplier approval procedures (procedures are described in the project Quality plan).

Wärtsilä Energy Solutions Supply Management department must be contacted for approval of the supplier before added to this list.

System	Section	Equipment	Supplier name	Country
A1 EG-SET	A1.1 Genset / Engine	Engine	Wärtsilä Companies	Finland, Italy
	A1.1 Genset / Engine related equipment	Engine related equipment	Profiweld Oy Ab	Finland
			Tarkmet Oy	Finland
	A1.2 Genset / Alternator	Generator	ABB Oy Motors and Generators	Finland
			ABB Oy, Motors & Generators, Global service center Finland	Finland
			Indar Electric S.L.	Spain
	A1.3 Genset / Base frame	Base frame	Fortaco Oy	Finland
	A1.4 Genset / Elastic mounts	Elastic mounts	Vibratec Akustikprodukter Ab	Sweden
	A1.5 Genset / Coupling, flywheel	Coupling	Centa-Antriebe Kirschey GmbH	Germany
			Geislinger GmbH	Germany
			GKN Stromag AG	Germany
			Renold Power Transmission Limited	U.K.
		Flywheel cover	Profiweld Oy Ab	Finland
	A1.6 Genset / Flexible connections	Flexible connections	EagleBurgmann Bredan A/S	Denmark
			KE-Burgmann Finland Oy	Finland
			Masino Trading Oy Vantaa	Finland
	A1.7 Genset / Platform	Platforms	Manor Oy	Finland
			Polimex-Mostostal.S.A	Poland
	A2 Auxiliary module	Wärtsilä Designed Units and Modules	Lakeuden Hydro Oy	Finland
			Maviteknik Oy	Finland
			MV-Tuotteet Oy	Finland
			Onkilahden Metalli Oy	Finland
			Procons Oy Ab	Finland
			Steel Master Finland Oy	Finland
			Wärtsilä India Ltd. (Khopoli)	India
			Aslemetals Oy	Finland
			JTK-Power Oy	Finland
			JTK-Power Finmec AS	Estonia
	A2.0.1 Auxiliary module / components	Auxiliary module control panels	ABB Oy Power Generation Systems	Finland
			Fibox tested systems Oy	Poland
			Rikta Oy	Finland
			Escarmat Oy Ltd	Finland
			Malux Finland Oy	Finland
			VEO Oy	Finland
			Wärtsilä India Ltd. (Khopoli)	India
		Centrifugal pumps	Grundfos Pumput Oy Ab	Finland
			Kolmeks Oy Ab Pump Business	Finland

System	Section	Equipment	Supplier name	Country
A2 AUXILIARY MODULES	A2.0.1 Auxiliary module / components	Filters	Boll & Kirch Filterbau GmbH	Germany
			Hydac	Germany
			Parker Hannifin Oy	Finland
			Tamrotor Kompressorit Oy Vantaa	Finland
			Teho Filter Oy	Finland
		Flow meters	Kytölä Instruments Oy	Finland
			Endress+Hauser Oy	Finland
			Emerson Process Management Oy	Finland
			Säätö Oy Ab	Finland
			Sarlin Oy Ab	Finland
		Heaters	Alfa Laval Aalborg AS	Denmark
			Irca S.p.A. Division Rica	Italy
			Loval Oy	Finland
			Midland Combustion Ltd.	U.K.
		Other auxiliary module components	ABB Oy Domestic Product Sales Vaasa	Finland
			Danfoss Oy Ab	Finland
			Dunlop Hiflex Oy Turku	Finland
			Festo Oy	Finland
			Helkama Bica Oy Kaarina	Finland
			Kongsberg Maritime AS	Norway
			Kontram Oy, Espoo	Finland
			Lyth-Instrument Oy Ab	Finland
			Metertronic Oy	Germany
			Pistesarjat Oy	Finland
			Sarlin Oy Ab	Finland
			Sondex Tapiro Oy Ab	Finland
			Spirotech B.V.	Finland
			Teca Oy	Finland
		Plate heat exchangers	Alfa Laval Nordic Oy	Finland
			SPX Flow Technology Danmark A/S	Denmark
		Pre-heating units	Alfa Laval Aalborg AS	Denmark
			Midland Combustion Ltd.	U.K.
		Pumps	AxFlow Oy	Finland
			IMO Ab	Sweden
			Leistritz	Germany
			Kral	Germany
			Mako Osakeyhtiö	Finland
			YTM-Industrial Oy	Finland
		Thermostatic valves	Amot Controls UK Roper Industries	U.K.
			Konwell Oy Ab	Germany
		Valves	Armatec Finland Oy	Finland
			Askalon Ab filial i Finland	Finland
			Burkert Finland Oy	Finland
			Uni-Geräte	Germany
			AVS-Yhtiöt Oy	Finland
			Jouka Oy Ltd.	Finland
			Konwell Oy Ab	Finland
			King Mechanical Specialty, Inc.	USA
			Milocraft Oy	Finland
			Starline Valves Oy	Finland
			Säätö Oy Ab	Finland
			Tecalemit Flow Oy	Finland
			VEXVE Oy	Finland
A2.1 FUEL SYSTEM	A2.0.1 Auxiliary module / components	Flow meters	Endress+Hauser Oy	Finland (Switzerland)
	A2.1.1/A2.1.2 Light / Heavy fuel oil system	Boosters	Auramarine Oy LTd	Finland/ China
		Flow meters	Emerson Process Management Oy	Finland (USA)
			Endress+Hauser Oy	Finland (Switzerland)
			Sarlin Oy Ab	Finland
		Tanks	U-Cont Oy Ltd	Finland
			Estanc AS	Estonia
			Saarijärven Säiliövalmiste Oy	Finland

System	Section	Equipment	Supplier name	Country
			Säätö Oy Ab	Finland
	A2.1.2 Heavy fuel oil system	Separator modules	Alfa Laval Nordic Oy	Finland
			GEA AG	Germany, Finland, France

System	Section	Equipment	Supplier name	Country
A2.1 FUEL SYSTEM	A2.1.5 Gas system	Gas compressors	M.T.M. s.r.l.	Italy
			Emerson Process Management Oy	UK
			TM.C. S.p.A.	Italy
		Gas pressure reduction station	Pietro Fiorenteni S.p.A	Italy
			Totalgaz Srl	Romania
		Relief valves	Armatec Finland Oy	Finland
		Gas valves	King Mechanical Specialty, Inc.	USA
A2.2 LUBE OIL SYSTEM	A2.2 Lube oil system	Oil mist separator	Alfa Laval Nordic Oy	Finland
		Separator modules		Finland
			GEA AG	Germany, Finland, France
		Tanks	U-Cont Oy Ltd	Finland
			Estanc AS	Estonia
			Säätö Oy Ab	Finland
			Tiger Tanks, Inc.	USA
			Saarijärven Säiliövalmiste Oy	Finland
A2.3 COMPRESSED AIR SYSTEM	A2.3 Compressed air system	Control and working air comp. units	Tamrotor Kompressorit Oy Vantaa	Finland
			Atlas Copco Compressors LLC	USA
			Kaeser GmbH	Germany
		Starting air pressure vessels	Neuenhauser Kompressorenbau GmbH	Germany
			Aurajoki Oy	Finland
			Tiger Tanks, Inc.	USA
			UWIRA Oy	Finland
		Starting air units	Atlas Copco Kompressorit Oy	Finland
			Neuenhauser Kompressorenbau GmbH	Germany
			Sperre Industri A/S	Norway
A2.4 COOLING SYSTEM	A2.4 Cooling system	Centrifugal pumps	IRON Pump A/S	Denmark
			Kolmeks Oy Ab Pump Business	Finland
			Sulzer Pumps Finland Oy	Finland
		Cooling towers	SCAM T.P.E	Italy
		Radiators	Alfa Laval Vantaa Oy	Finland
			Sutton Stromart Limited	Canada
			Kelvion S.A.S	Poland, France
A2.5 CHARGE AIR SYSTEM	A2.5 Charge air system	3-way damper	Sammet Dampers Oy	Finland
		Charge air filters	AAF S.A.	France
			Leimec Oy	Finland
			Energent Oy	Finland
		Charge air silencers	Universal AET	Mexico, India, Czech rep.
			JTK Power Oy	Finland, Estonia
A2.6 EXHAUST GAS SYSTEM	A2.6 Exhaust gas system	Exhaust gas 3-way damper	Sammet Dampers Oy	Finland
		Exhaust gas silencers	JTK Power Oy	Finland, Estonia
			Universal AET	Mexico, India, Czech rep.
		Exhaust gas system equipment	Fike Europe b.v. b.a.	Belgium
			Kilkanen Oy	Finland
			Ventur Finland Oy Ab	Finland
	A2.8.1 Oily water treatment system	Incinerators	Atlas Incinerators A/S	Denmark
			Teamtec A/S	Norway
		Oily water and sludge treatment	Wärtsilä UK	China
			WatMan Engineering Ltd Oy	Finland
			U-Cont Oy Ltd	Finland

System	Section	Equipment	Supplier name	Country
A2.8 STATION SUPPORT SYSTEM		Tanks	Estanc AS	Estonia
			Säätö Oy Ab	Finland
			Saarijärven Säiliövalmiste Oy	Finland
	A2.8.2 Treated water system	Water treatment	Eurowater	Denmark
			WatMan Engineering Ltd Oy	Finland
	A2.8.3 Fire fighting system	Fire fighting equipment	Onninen Oy Vaasa	Finland
			LVI-Dahl Vaasa	Finland
			Rauplan Oy	Finland
		Mechanical protection and fighting	Sanco S.p.a	Italy
			FS Engineering Ltd.	U.K.
A2.9 AUX. STEEL STRUCTURES, PIPING, ETC.	A2.9 Aux. Steel structure, piping, etc.	Pipe material	LVI-Dahl Vaasa	Finland
			Fipe AG	Switzerland
			Manor Oy	Finland
			Onninen Oy Vaasa	Finland
			Vestas Pipecon A/S	Denmark
		Piping & building signs	Signwell / Stell Oy	Finland

System	Section	Equipment	Supplier name	Country
A3 ELECTRICAL EQUIPMENT	A3.1 MV-Equipment	Earthing Transformer	ABB Oy Power Transformers	Finland
			B.E.S.T - A.S	Turkey
			Schneider Electric Finland Oy	France
		MV-cables	Kabelwerk Eupen AG	Belgium
			TF Kables	Poland
			Nexans France	France
			Reka Kaapeli Oy	Finland
			Okonite	USA
		MV-switchgear	ABB Inc.- Power Technologies	USA
			Siemens Industry, Inc.	Mexico
			M&I Electric Industries, Inc.	USA
			ABB Oy Power Generation Systems	Czeck
			Schneider Electric Finland Oy	France/ Hungary
		Neutral point cabinet	Elkamo Oy Ab	Finland
			M.S. Resistances S.A.S.	France
			Metal Deploye Resistor S.A.	France
			Hubbell Industrial Controls (Powerohm Resistors, Inc.)	USA
			Schneider Electric Finland Oy	France
		Unit (block) transformer	B.E.S.T - A.S	Turkey
			Hyundai Heavy Industries Co.	Bulgaria
			Siemens	Italy
	A3.2 Station service system	Black start unit	kW-Set Oy	Finland
			Ziegler Power Systems	USA
			JFTCO, Inc.	USA
			Agco Oy	Finland
		Distribution Transformer	ABB Domestic sales Oy	Finland
			B.E.S.T - A.S	Turkey
			Schneider Electric Finland Oy	France
		Frequency converter		Austria
			ABB Domestic sales Oy	Estonia
			Vacon Oyj	Finland
		LV-cables	Kabelwerk Eupen AG	Belgium
			TF Kables	Poland
			Nexans France	France
			Reka Kaapeli Oy	Finland
			Okonite	USA
		LV-Switchgear	ABB Oy Low Voltage Systems	Finland
			Elkamo Oy Ab	Finland
			ABB Inc.	USA
			Siemens Industry, Inc.	USA
			M&I Electric Industries, Inc.	USA
			VEO Oy	Finland
			ARNON	Finland
	A3.3 DC system	DC system	Efore Oyj Espoo	Finland
			Alpha Technologies Services, Inc.	USA
			Benning Power Electronics	USA
			Eltek	Slovakia
			Ellego Powertec Oy	Finland
			Elcon Solutions Oy	Finland
	A3.5 Outdoor switchyard	HV-cables	Nexans France	France
			Reka Kaapeli Oy	Finland
		Outdoor switchyard	ABB Oy Power Generation Systems	Finland, Sweden
		Power transformers	ABB Oy Power Transformers	Finland
			Hyundai Heavy Industries Co.	Bulgaria
			ABB Inc.	USA
			B.E.S.T - A.S	Turkey
			Siemens Industry, Inc.	Mexico
			Niagra Transformer Corp.	USA
			Siemens Transformers S.p.A.	Italy
			Siemens Energy S.A.S	Colombia

System	Section	Equipment	Supplier name	Country
A4 AUTOMATION EQUIPMENT	A4.2 Control panels	Control panel main components	ABB Switzerland Ltd	Switzerland
			Klinkmann Automaatio Oy	Finland
			Arcteq Oy	Finland
			ABB Oy Gridautomations (realys)	Finland
			Schneider Electric Finland Oy	France
			Siemens Osakeyhtiö	Germany
			Vaisala Oyj	Finland
			Wago Finland Oy	Finland
			Schneider Electric Finland (Vamp)	Finland
		Control panels	ABB Oy Power Generation Systems	Finland
				Sweden
			VEO Oy	Finland
	A4.3 Operators station	Control networks	Ironnet Oy	Finland
			Moxa (Movetec Oy)	Finland
		Operator panels	Beijer Electronics Oy	Finland
A5 HEAT RECOVERY SYSTEM	A5.1 Steam generation system	Full heat recovery boilers	Alfa Laval Aalborg Oy	Finland, China, Estonia
			Greens Power Ltd.	U.K.
			Aprovis Energy System GmbH	Germany
		Hot water boilers	Alfa Laval Aalborg Oy	Finland, China, Estonia
			Aprovis Energy System GmbH	Germany
A5 HEAT RECOVERY SYSTEM	A5.1 Steam generation system	Own consumption boilers	Alfa Laval Aalborg Oy	Finland, China, Estonia
			Aprovis Energy System GmbH	Germany
		Steam equipment	Konwell Oy Ab	Finland
			Spirax Oy Helsinki	Finland
		Steam online monitoring	General impianti S.R.L./ Loccioni	Italy
			Kontram Oy, Espoo	Finland
		Steam turbines	Shin Nippon Machinery	Japan
			Peter Brotherhood Ltd.	U.K.
			Triveni Engineering o Industries Ltd	India
		Tanks	Nordpipe Composite Engineering	Finland
		Turbogenerators	Bowman Power Group	U.K.
	A5.1 Thermal Oil Generation Systems	Waste heat recovery system	Aprovis Energy System GmbH	Germany
			Alfa Laval Aalborg B.V.	Netherlands
	A5.2 Hot water generation system	Exhaust gas heat recovery heat exchanger / Hot water boiler	Alfa Laval Aalborg Oy	Finland, China, Estonia
			Aprovis Energy System GmbH	Germany
	A5.3 Pressure maintaining system		Termovent Finland Oy	Finland
A6 EMISSION CONTROL SYSTEM	A6 Emission control system	Emission Monitoring	Sick Oy	Switzerland/ Finland
			Opsis Ab	Sweden
			Suomi Analytics Oy	Finland, Norway, Sweden
		Oxidation catalysts	Dinex Ecocat Oy	Finland
			Hug Engineering AG	Switzerland
		Selective catalytic reduction (SCR) and oxidation catalyst	Wärtsilä Finland	Finland
			Haldor Topsoe	USA
			YARA Environmental Technologies	Germany
		Doors	Forssan Metallityöt Oy	Finland
			Saajos Oy	Finland
		Electrical installation material	Summit Electric Supply	USA
			Wholesale Electric Supply Co. of Houston, Inc.	USA
			Onninen Oy Vaasa	Finland

System	Section	Equipment	Supplier name	Country
B CIVIL WORKS & STRUCTURES	B Civil works & Structures		Rexel Finland Oy	Finland
			SLO Oy Vaasa	Finland
		Furnitures	Isku Interior Oy	Finland
			Treston Oy	Finland
		HVAC and Piping material	LVI-Dahl Vaasa	Finland
			Onninen Oy Vaasa	Finland
		Insulation and Suspended Ceilings	Inlook Oy	Finland
			Saint Gobain / Isover Oy	Finland
			Paroc Oy Ab	Finland
		Miscellaneous civil material	Hartman Rauta Oy Ab	Finland
			Hilti (Suomi) Oy	Finland
			Pohjanmaan Rauta Oy	Finland
			Pur-Ait Oy	Finland
			Wurth Oy Riihimäki	Finland
		Overhead travelling cranes and workstation cranes	Konecranes Finland Corporation	Finland
		Roofing sheets, wall panels, flashings	Rautaruukki Oyj Ruukki Construction	Finland
		Steel structures	Polimex-Mostostal.S.A	Poland
			K.Liaromatis	Greece
			Rautaruukki Oyj Ruukki Construction	Finland
			Van Sluisveld	Netherlands
			Ruukki Polska Sp. Z o.o.	Polen
			Teräselementti Oy	Finland
		Substructure material	Anstar Oy	Finland
			Peikko Oy	Finland
			Viapipe Oy	Finland

System	Section	Equipment	Supplier name	Country
B CIVIL WORKS & STRUCTURES	B Civil works & Structures	Surface treatment	Tikkurila Oyj	Finland
		Ventilation	Energent Oy	Finland
			Global Cool Consultants	Finland
			Leimec Oy	Finland
			HVAC Consult B2B Oy	Finland
			LVI-Dahl Vaasa	Finland
			Onninen Oy Vaasa	Finland
			Vaasan Lämpöeristys Oy	Finland
		Windows	Alavus Alufront Oy	Finland
			Rautaruukki Oyj Ruukki Construction	Finland
		Office It	Creative PC Systems Oy Ab	Finland
		PV & HVAC	Escarmat Oy Ltd	Finland
		Trace heating	Onninen Oy Vaasa	Finland
			SLO Oy Vaasa	Finland
			Prohoc Oy	Finland
C4 COMMISSIONING AND TESTING	C4 Commissioning and testing	Commissioning Engineers	Commissioning engineers from Wärtsilä companies and suppliers listed in this document	Finland
				Finland
				Finland
C6 DOCUMENTS	C6 Documents	Design	Citec Oy AB	Finland
			Wärtsilä Companies	
		O&M Manuals	Citec Oy AB	Finland
			Wärtsilä Companies	

Subtitle	Product	Made	09.10.1998	K. Juoperi / P. Hanstén	Page	Document No	Rev
Instruction	20, 26, 31, 32, 38, 46, 46F, 50, 64, 32LG, 31SG, 34SG, 34LPG, 50SG, 20DF, 31DF, 32DF, 34DF, 46DF, 50DF	Appd.	12.10.1998	E. Fontell	1 (4)	V92A0765	o

Made	29.08.2019	Checked	29.08.2019	Approved	29.08.2019	CN-message No.: CN-A130840
	K. Juoperi / D. Sjöholm		K. Juoperi		T. Kuoppala	

RAW WATER QUALITY AND VALIDATED COOLING WATER ADDITIVES AND TREATMENT SYSTEMS

FOR WÄRTSILÄ® VASA 32/32LN, WÄRTSILÄ® 20, WÄRTSILÄ® 26, WÄRTSILÄ® 31, WÄRTSILÄ® 32, WÄRTSILÄ® 38, WÄRTSILÄ® 46, WÄRTSILÄ® 46F, WÄRTSILÄ® 50, WÄRTSILÄ® 64, WÄRTSILÄ® 32LG, WÄRTSILÄ® 20DF, WÄRTSILÄ® 31DF, WÄRTSILÄ® 32DF, WÄRTSILÄ® 34DF, WÄRTSILÄ® 46DF, WÄRTSILÄ® 50DF, WÄRTSILÄ® 31SG, WÄRTSILÄ® 34SG, WÄRTSILÄ® 34LPG AND WÄRTSILÄ® 50SG ENGINE TYPES

RAW WATER QUALITY

Raw water quality to be used in the closed cooling water circuits of engines has to meet the following specification.

Property	Unit	Limits for chemical use	Limits for WWCU*) use	Test method reference
pH 1)	-	6,5 – 8,5	6,5 – 8,5	ASTM D 1287 or D 1293
Hardness	°dH	max. 10	max. 10	ASTM D 1126
Chlorides 1)	mg/l	max. 80	max. 40	ASTM D 512 or D 4327
Sulphates	mg/l	max. 150	max. 100	ASTM D 516 or D 4327

*) Wärtsilä Water Conditioner Unit

Use of raw water produced with an evaporator as well as a good quality tap water will normally ensure that an acceptable raw water quality requirement is fulfilled, but e.g. sea water and rain water are unsuitable raw water qualities.

1) If a Reverse Osmosis (RO) process is used, min. limit for pH is 6,0 based on the RO process operational principle. The use of water originating from RO process further presumes that a max. content of 80 mg/l for chloride content is achieved.

VALIDATED COOLING WATER ADDITIVES

Manufacturer	Additive name	Additive type
Alm International S.A.	Diaprosim RD11 (RD11M)	Sodium nitrite + borate
S.A. Arteco N.V.	Havoline XLI	Organic Acid Technology
Drew Marine	Liquidewt Maxigard	Sodium nitrite + borate Sodium nitrite + borate

Manufacturer	Additive name	Additive type
Chevron (Texaco + Caltex)	Delo XLI Corrosion Inhibitor Concentrate (supersedes Havoline XLI) XL Corrosion Inhibitor Concentrate	Organic Acid Technology Organic Acid Technology
GE Water and Process	CorrShield NT 4293 CorrShield NT 4200	Sodium nitrite + borate Sodium nitrite + borate
Korves Oy	Pekar J	Organic Acid Technology
Kuwait Petroleum (Danmark) AS	Q8 Corrosion Inhibitor Long-Life	Organic Acid Technology
Marine Care B.V.	Caretreat 2 Diesel	Sodium nitrite + borate
Maritech AB	Marisol CW	Sodium nitrite + borate
Motul	HD Cool Power Ultra	Organic Acid Technology
Nalco Chemical Company	TRAC102 TRAC118	Sodium nitrite + borate Sodium nitrite + borate
Solenis	Drewgard 4109	Sodium nitrite + borate
Total	WT Supra	Organic Acid Technology
Vecom Marine Alliance B.V.	Cool Treat NCLT	Sodium nitrite + borate
Wilhelmsen Chemicals AS	Dieselguard NB Rocor NB liquid Cooltreat AL Engine Water Treatment 9-108 Nalfleet 2000	Sodium nitrite + borate Sodium nitrite + borate Organic Acid Technology Sodium nitrite + borate Sodium nitrite + borate

In order to prevent corrosion in the cooling water system, the instructions of right dosage and concentration of active corrosion inhibitors should always be followed. The information can be found in the table below.

Product designation	Dosage per 1 m^3 of system capacity	Concentration of active corrosion inhibitor
Diaprosim RD11 (RD11M)	5 kg	1250 ppm as NO_2
Havoline XLI	50 - 100 litres	1,8 – 3,7 Brix° of active compounds measured with a supplier's refractometer
XL Corrosion Inhibitor Concentrate	50 - 100 litres	1,8 – 3,7 Brix° of active compounds measured with a supplier's refractometer
Drewgard 4109	16 – 30 litres	640 – 1200 ppm as NO_2
Liquidewt Maxigard	8 – 12 litres 16 – 30 litres	470 – 700 ppm as NO_2 640 – 1200 ppm as NO_2
Delo XLI Corrosion Inhibitor Concentrate	50 - 100 litres	1,8 – 3,7 Brix° of active compounds measured with a supplier's refractometer
Corrshield NT 4293 CorrShield NT 4200	10 litres 10 litres	670 – 1000 ppm as NO_2 670 – 1000 ppm as NO_2
Pekar J	20 litres	30 ppm as Mo
Q8 Corrosion Inhibitor Long-Life	50 – 100 litres	1.8 – 3.7 Brix° of active compounds measured with a supplier's refractometer
Caretreat 2 Diesel	6 - 10 litres	1500 – 2500 ppm as NO_2
Marisol CW	6 – 9 litres	1000 – 1500 ppm as NO_2
HD Cool Power Ultra	50 – 100 litres	1,8 – 3,7 Brix° of active compounds measured with a supplier's refractometer

Product designation	**Dosage per 1 m³ of system capacity**	**Concentration of active corrosion inhibitor**
TRAC102 TRAC118	32 – 48 litres 2.25 - 3.4 litres	1000 - 1500 ppm as NO_2 670 - 1000 ppm as NO_2
WT Supra	50 - 100 litres	1,8 – 3,7 Brix° of active compounds measured with a supplier's refractometer
Cool Treat NCLT	6 - 10 litres	1500 – 2500 ppm as NO_2
Dieselguard NB Rocor NB Liquid Cooltreat AL Engine Water Treatment 9-108 Nalfleet 2000	2,0 – 4,8 kg 9,5 - 24 litres 50 – 100 litres 2,25 – 3,4 litres 32 - 48 litres	1000 - 2400 ppm as NO_2 1000 - 2400 ppm as NO_2 1,8 – 3,7 Brix° of active compounds measured with a supplier's refractometer 670 - 1000 ppm as NO_2 1000 - 1500 ppm as NO_2

Note 1: For many products the recommended minimum and maximum limits are listed in the table above. Since the amount of active corrosion inhibitors, especially nitrites, is decreasing during the service of engines, the engine manufacturer recommends to start the dosage from the upper level of indicated range.

Note 2: The nitrite content of nitrite-based cooling water additives tends to decrease in use. The risk of local corrosion increases substantially when nitrite content goes below the recommended limit.

Note 3: Cooling water additive manufacturers can indicate the required nitrite content measured either as sodium nitrite, $NaNO_2$ or as nitrite, NO_2. 1 mg/l as NO_2 equals to 1.5 mg/l as $NaNO_2$.

Note 4: Nitrite based cooling water additives are not offering a good protection against corrosion for aluminium and its alloys and thus the use of such products can't recommended for cooling systems containing those construction materials.

Note 5: Different cooling water additives shall not be mixed with each other, but if it is desired to start to use another cooling water additive, the one being used shall be drained from the system before filling another product. If the cooling water system is dirty, it shall be flushed with good quality water or if needed use additional chemicals to remove possible deposits, like grease, oil, rust, etc. Though many cooling water additives are chemically compatible with each other, these can contain e.g. polymers which can loosen existing deposits from the cooling water system. When the loose deposits become suspended in the cooling water, they can attach to engine component surfaces, e.g. cylinder head and will then cause detrimental effects in terms of heat transfer decline, clogging of small diameter water channels and deposit formation leading to local overheating and corrosion.

VALIDATED COOLING WATER TREATMENT SYSTEMS

WÄRTSILÄ WATER CONDITIONER UNIT

As an alternative to the validated cooling water additives, the Wärtsilä Water Conditioner Unit (WWCU) can also be used to treat cooling water of engines' closed water circuits. WWCU is based on the Enwamatic EMM cooling water treatment system, but includes a number of new features based on Wärtsilä design. The WWCU protects the engine from corrosion without any chemicals. It acts as a side stream filtration and water treatment unit and includes the following functions: corrosion protection, scale control, filtration, control of bacterial growth and air separation.

The stricter raw water quality requirements compared to what is specified when cooling water additives are used shall be taken into account, see page 1. Due to a severe corrosion risk WWCU can´t be used in the cooling water

systems containing aluminium or aluminium alloys as a construction material. More information can also be found from the document DAAF017522.

The WWCU can be a sensible alternative for the installations in which environmentally friendly solutions are appreciated.

The assembly, installation, operation and maintenance instructions of Wärtsilä shall always be followed. The contact details are included in the following table.

Distributor	Manufacturer	Treatment system
Wärtsilä Finland Oyj Services Tarhaajantie 2 FI-65380 Vaasa Finland	Enwa AS PO Box 257 Forus N-4066 Stavanger Norway	Wärtsilä Water Conditioner Unit (WWCU)

USE OF GLYCOL

If a freezing risk exists, glycol needs to be added to cooling water. However, in case there is no freezing risk, the use of glycol in cooling water shall be avoided due to its detrimental effect on heat transfer. Since glycol alone does not protect the engine and cooling water system against corrosion, additionally a validated cooling water additive must always be used. All validated cooling water additives are compatible with glycol.

Ready-to-use mixtures containing both glycol and corrosion inhibitors are not allowed to use, since those are normally designed to be used as strong (30 –) 50% / 50% mixtures. However, in Wärtsilä engines normally a much lower glycol amount is adequate to protect the cooling water system against freezing. But when decreasing the glycol amount, simultaneously also the concentration of corrosion inhibitors will decrease to too low level resulting in an increased risk of corrosion.

The amount of glycol in closed cooling water system shall always be minimized since heat transfer of water containing glycol has deteriorated significantly. The engine may therefore be subject to additional output derating when using glycol in the cooling water, see document DAAE062266 for more information.

There are commercially available two types glycol qualities, monopropylene glycol (MPG) and monoethyleneglycol (MEG). So called industrial qualities of both glycol types can be used, but MPG is considered to be a more environmental alternative.

1.2.5 REQUIREMENTS AND OIL QUALITY

LUBRICATING OIL REQUIREMENTS AND QUALITY FOR WÄRTSILÄ 32 AND WÄRTSILÄ 32GD ENGINES

Viscosity & Viscosity Index (VI)
Viscosity grade SAE 40 and VI of min. 95

Alkalinity (BN)
The required lubricating oil alkalinity is tied to the fuel specified for the engine, which is shown in the table below.

FUEL STANDARDS AND LUBRICATING OIL REQUIREMENTS				
Cate-gory	Fuel standard		Lube oil BN	Fuel S con-tent [% m/m]
A	ASTM D 975-17 BS MA 100: 1996 CIMAC 2003 ISO 8217: 2017(E)	GRADE NO. 1-D, 2-D, 4-D DMX, DMA, DMB DX, DA, DB ISO-F-DMX –> DMB, DFA -> DFB	10 – 20 21 – 30 *)	< 0,40
B	ASTM D 975-17 BS MA 100: 1996 CIMAC 2003 ISO 8217: 2017(E)	GRADE NO. 1-D, 2-D, 4-D DMX, DMA, DMB DX, DA, DB ISO-F-DMX –> DMB, DFA -> DFB	15 – 20 (10 - 14) **) (21 – 30 *)	0,40 – 1,50
C	ASTM D 975-17 ASTM D 396-17 BS MA 100: 1996 CIMAC 2003 ISO 8217: 2017(E)	GRADE NO. 4-D GRADE NO. 5-6 DMC, RMA10 - RMK55 DC, A30-K700 RMA 10 - RMK 700	30 - 55	≤ 3,50 or staturory require-ments ***)
D	ISO 8217: 2017(E)	RMA 10 - RMK 700	20	≤ 0,10
E	CRUDE OIL (CRO)		30 - 55	≤ 4,50
F	LIQUID BIO FUEL (LBF)		10 - 20	≤ 0,05
G	NATURAL GAS ****)		10 - 55	~ 0

*) Though the use of BN 21 – 30 lubricating oils is allowed in distillate fuel operation, there is no technical reason for that but a lower BN level shown in the above table is well enough.

**) BN 10 – 14 lubricating oils cannot be recommended in the first place when operating on > 0,40 % m/m sulphur distillate fuels due to shortened oil change interval resulting from BN depletion.

***) Sulphur content can be also higher than 3,50 % m/m

****) For Wärtsilä 32GD. Required BN depends on pilot / back-up fuel quality.

In case a low sulphur (S max. 0,4 % m/m) distillate fuel is used, it's recommended to use a lubricating oil with BN of 10 – 15.

It is recommended to use in the first place BN 50 - 55 lubricants when operating on residual fuel. This recommendation is valid especially for engines having wet lubricating oil sump and using residual fuel with sulphur content above 2,0 % mass. BN 40 lubricants can be used when operating on residual fuel as well if experience shows that the lubricating oil BN equilibrium remains at an acceptable level. In residual fuel operation BN 30 lubricants are recommended to be used only in special cases, like e.g. such as installations equipped with an SCR catalyst. Lower BN products eventually have a positive influence on cleanliness of the SCR catalyst.

With BN 30 oils lubricating oil change intervals may be rather short, but lower total operating costs may be achieved because of better plant availability provided that the maintenance intervals of the SCR catalyst can be increased.

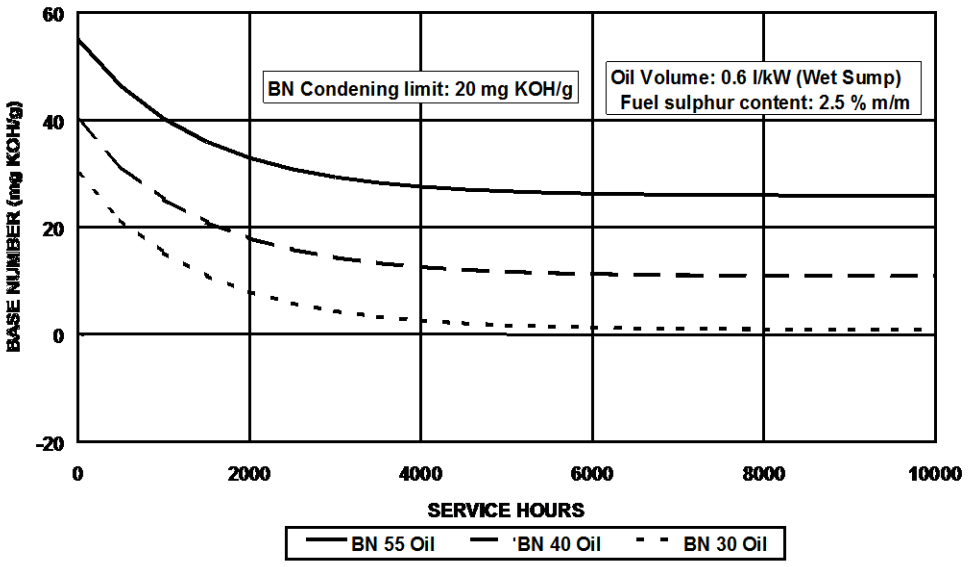
BN 30 oils are also a recommended alternative when operating on crude oil having low sulphur content. Though crude oils many times have low sulphur content, those can contain other acid compounds and thus an adequate alkali reserve is important. With crude oils having higher sulphur content BN 40 – 55 lubricating oils should be used.

If both distillate fuel and residual fuel with sulphur content of > 0,10 % m/m are used in turn as fuel, lubricating oil quality has to be chosen according to instructions being valid for residual fuel operation, i.e. BN 30 is the minimum. Optimum BN in this kind of operation depends on the length of operating periods on both fuel qualities as well as of sulphur content of fuels in question. Thus in particular cases BN 40 or even higher BN lubricating oils should be used.

If Ultra Low Sulphur Fuel Oils (ULSFO) being classed as residual fuels are used, the use of BN 20 lubricating oil is allowed.

In the Wärtsilä 32GD engine type lubricating oil BN shall be chosen according to pilot / back-up fuel quality. If only distillate fuel is used as pilot / back-up fuel, lubricating oils with BN of 10 – 20 shall be used. If residual fuel or crude oil is used as pilot / back-up fuel, lubricating oils with BN of min. 30 shall be used. Optimum BN level depends on engine's lubricating oil consumption, sulphur content of liquid fuels and the lengths of the periods operated on different fuel qualities.

An example of BN depletion curve with different BN lubricating oils is shown below.



Additives
The oils shall contain additives that give good oxidation stability, corrosion protection, load carrying capacity, neutralisation of acid combustion and oxidation residues and should prevent deposit formation on internal engine parts (piston cooling gallery, piston ring zone and bearing surfaces in particular).

Foaming characteristics
Fresh lubricating oil shall meet the following limits for foaming tendency and stability, according to the ASTM D 892-18 test method:

Sequence I: 100/0 ml
Sequence II: 100/0 ml
Sequence III: 100/0 ml

Base oils
Use of virgin base stocks only is allowed, i.e. recycled or re-refined base oils are not allowed.

CONDEMNING LIMITS FOR USED LUBRICATING OIL

When estimating the condition of used lubricating oil, the following properties along with the corresponding limit values must be noted. If the limits are exceeded, measures must be taken. Compare also with guidance values for fresh lubricating of the brand used.

Property	Unit	Limit	Test method
Viscosity	mm²/s at 40 °C	max. 25% decrease max. 45% increase	ASTM D 445
Viscosity	mm²/s at 100 °C	max. 20% decrease max. 25% increase	ASTM D 445
Water	% v/v or % m/m	max. 0,30	ASTM D 95 or D 6304C
Base Number	mg KOH/g	min. 20 in HFO operation, min. 15 for BN 20 oils in ULSFO operation, max. 50% depletion in LFO operation	ASTM D 2896
Insolubles	% m/m in n-Pentane	max. 2,0	ASTM D 893b
Flash Point, PMCC Flash Point, COC	°C °C	min. 170 min. 190	ASTM D 93 ASTM D 92

VALIDATED LUBRICATING OIL QUALITIES FOR WÄRTSILÄ 32 AND WÄRTSILÄ 32GD ENGINES

WÄRTSILÄ 32: OPERATION ON DISTILLATE FUEL OR LIQUID BIO FUEL

If distillate fuel or liquid bio fuel is used as fuel, lubricating oils with a BN of 10 - 20 are recommended to be used. Lubricating oils having fresh oil BN below 15 can be used only if fuel sulphur content is below 0,40 % m/m. Also BN 30 lubricating oils included in Table 3 can be used on distillate fuel operation, though not preferred in the first place.

WÄRTSILÄ 32GD: OPERATION ON NATURAL GAS OR DISTILLATE FUEL AS MAIN FUEL AND DISTILLATE FUEL AS PILOT FUEL

If distillate fuel is used as pilot / back-up fuel in the Wärtsilä 32GD engine, lubricating oils with BN of 10 – 20 shall be used. Note that the use of liquid bio fuels (LBF) is not released for Wärtsilä 32GD.

Table 1.

Validated SAE 40 lubricating oils - fuel categories A, B, F and G, recommended in the first place when operating an engine on distillate fuel or liquid bio fuel as well as when distillate fuel in Wärtsilä 32GD is used as a pilot fuel:

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
ADNOC Distribution	Voyager Marine 410	10	A,B,F,G
	Voyager Marine 412	12	A,B,F,G
	Voyager Marine 415	15	A,B,F,G
	Voyager Marine 420	20	A,B,F,G
	Voyager Mallah 410	10	A,B,F,G
	Voyager Mallah 412	12	A,B,F,G
	Voyager Mallah 415	15	A,B,F,G
	Voyager Mallah 420	20	A,B,F,G
Aegean Marine Petroleum S.A.	Alfagen 414	14	A,B,F,G
Castrol	HLX 40	12	A,B,F,G
	MHP 154	15	A,B,F,G
	Seamax Extra 40	15	A,B,F,G
	TLX Plus 204	20	A,B,F,G
Chevron (Texaco + Caltex)	Delo 1000 Marine 40	12	A,B,F,G
	Taro 12 XD 40	12	A,B,F,G
	Taro 20 DP 40	20	A,B,F,G
	Taro 20 DP 40X	20	A,B,F,G
ENI S.p.A.	Cladium 140 S	14	A,B,F,G
ExxonMobil	Delvac 1640	12	A,B,F,G
	Mobilgard ADL 40	12	A,B,F,G
	Mobilgard 412	15	A,B,F,G
	Mobilgard 1 SHC	15	A,B,F,G
Fuchs Petrolub SE	Titan MarWay 1040	10,6	A,B,F,G
Gulf Oil Marine / Sealub Alliance	GulfSea Power MDO 4012	12	A,B,F,G
	GulfSea Power MDO 4015	15	A,B,F,G
	GulfSea Power MDO 4020	20	A,B,F,G
Indian Oil Corporation	Servo Marine 1040	10	A,B,F,G
	Servo Marine 1540	15	A,B,F,G
	Servo Marine 2040	20	A,B,F,G
Irving Blending & Packaging	Irving Marine MTX 1540	15	A,B,F,G
	Irving Marine MTX 2040	20	A,B,F,G
Petrobras	Marbrax CCD-415	15	A,B,F,G
	Marbrax CCD-420	20	A,B,F,G

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
Shell	**Gadinia S3 40**	**12**	**A,B,F,G**
Total / Lubmarine	**Disola M 4012**	**12**	**A,B,F,G**
	Disola M 4015	**14**	**A,B,F,G**
	Aurelia TI 4020	**20**	**A,B,F,G**
	Caprano M 40	**14**	**A,B,F,G**
	Disola SGS 40 *)	**14**	**A,B**

*) Use is limited to EDG applications only

WÄRTSILÄ 32: OPERATION ON RESIDUAL FUEL OR CRUDE OIL

WÄRTSILÄ 32GD: OPERATION ON NATURAL GAS, RESIDUAL FUEL OR CRUDE OIL AS MAIN FUEL AND RESIDUAL FUEL OR CRUDE AS PILOT FUEL

If residual fuel or crude oil is used as pilot / back-up fuel even only occasionally in the Wärtsilä 32GD engine, lubricating oils with BN of 30 – 55 shall be used.

Table 2.

Validated SAE 40 lubricating oils - fuel categories C, E and G, included in the Table 2 are recommended in the first place when operating Wärtsilä 32 engine on residual fuel and or on crude oil having high sulphur content in order to reach longer service intervals. BN 50-55 lubricating oils are preferred in the first place, especially if fuel sulphur content is high and / or lubricating oil consumption is low. The oils included in the Table 2 or 3 shall also be used in the Wärtsilä 32GD engine if residual fuel or crude oil is used as pilot / back-up fuel.

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
ADNOC Distribution	**Voyager Marine 440**	**40**	**C,E,G**
	Voyager Marine 450	**50**	**C,E,G**
	Voyager Marine 455	**55**	**C,E,G**
	Voyager Mallah 440	**40**	**C,E,G**
	Voyager Mallah 450	**50**	**C,E,G**
	Voyager Mallah 455	**55**	**C,E,G**
Aegean Marine Petroleum S.A.	**Alfamar 440**	**40**	**C,E,G**
	Alfamar 450	**50**	**C,E,G**
	Alfamar 455	**55**	**C,E,G**
	Alfamar GII 440	**40**	**C,E,G**
	Alfamar GII 450	**50**	**C,E,G**
	Alfamar GII 455	**55**	**C,E,G**
Avin Oil S.A.	**Avin Argo S 40 SAE 40**	**40**	**C,E,G**
	Avin Argo S 50 SAE 40	**50**	**C,E,G**
	Avin Argo S 55 SAE 40	**55**	**C,E,G**
Castrol	**TLX Plus 404**	**40**	**C,E,G**
	TLX Plus 504	**50**	**C,E,G**
	TLX Plus 554	**55**	**C,E,G**
	TLX Xtra 404	**40**	**C,E,G**
	TLX Xtra 504	**50**	**C,E,G**
	TLX Xtra 554	**55**	**C,E,G**

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
Cepsa	Troncoil 4040 PLUS	40	C,E,G
	Troncoil 5040 PLUS	50	C,E,G
	Larus 4040	40	C,E,G
	Larus 5040	50	C,E,G
Chevron (Texaco + Caltex)	Taro 40 XL 40	40	C,E,G
	Taro 50 XL 40	50	C,E,G
	Taro 40 XL 40X	40	C,E,G
	Taro 50 XL 40X	50	C,E,G
CPC Corporation	Marilube Oil W 404	40	C,E,G
	Marilube Oil W 504	50	C,E,G
ENI S.p.A.	Cladium 400 S SAE 40	40	C,E,G
	Cladium 500 S SAE 40	50	C,E,G
	Cladium 550 S SAE 40	55	C,E,G
ENOC	Strata MSD 440	40	C,E,G
	Strata MSD 450	50	C,E,G
	Strata MSD 455	55	C,E,G
	Strata MSDO 440	40	C,E,G
	Strata MSDO 450	50	C,E,G
	Strata MSDO 455	55	C,E,G
	EPPCO Bahri MSD 440	40	C,E,G
	EPPCO Bahri MSD 450	50	C,E,G
	EPPCO Bahri MSD 455	55	C,E,G
ExxonMobil	Mobilgard M440	40	C,E,G
	Mobilgard M50	50	C,E,G
Fuchs Petrolub SE	Titan PSW 40 SAE 40	40	C,E,G
	Titan PSW 55 SAE 40	55	C,E,G
Gulf Oil International	Gulfgen Supreme 440	40	C,E,G
	Gulfgen Supreme 455	55	C,E,G
	Gulfgen Supreme Plus 440	40	C,E,G
	Gulfgen Supreme Plus 455	55	C,E,G
Gulf Oil Marine / Sealub Alliance	GulfSea Power 4040	40	C,E,G
	GulfSea Power 4055	55	C,E,G
	GulfSea Power II 4040	40	C,E,G
	GulfSea Power II 4055	55	C,E,G
Indian Oil Corporation	Servo Marine K-4040	40	C,E,G
	Servo Marine K-5040	50	C,E,G
	Servo Marine K-5540	55	C,E,G
Irving Blending & Packaging	Irving Marine MTX 4040	40	C,E,G
	Irving Marine MTX 5040	50	C,E,G
JXTG Nippon Oil & Energy Corporation	Marine T404	40	C,E,G
	Marine T504	50	C,E,G
Kuwait Petroleum	Q8 Mozart TM 40 SAE 40	40	C,E,G
	Q8 Mozart TM 55 SAE 40	55	C,E,G
LPC S.A.	Cyclon Poseidon HT 4040	40	C,E,G
	Cyclon Poseidon HT 4050	50	C,E,G
	Cyclon Poseidon HT 4055	55	C,E,G
Lukoil	Navigo TPEO 40/40	40	C,E,G
	Navigo TPEO 50/40	50	C,E,G
	Navigo TPEO 55/40	55	C,E,G

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
Morris Lubricants	Aquamor 140MD	40	C,E,G
	Aquamor 150MD	50	C,E,G
Motor Oil (Hellas)	Emo Argo S 40 SAE 40	40	C,E,G
	Emo Argo S 50 SAE 40	50	C,E,G
	Emo Argo S 55 SAE 40	55	C,E,G
Pertamina	Martron 440	40	C,E,G
	Martron 450	50	C,E,G
	Medripal 440	40	C,E,G
	Medripal 450	50	C,E,G
	Salyx 440	40	C,E,G
	Salyx 450	50	C,E,G
Petrobras	Marbrax CCD-440	40	C,E,G
	Marbrax CCD-450	50	C,E,G
Petro Gulf Oil Manufacturing LLC	Marine TPEO 4040	40	C,E,G
	Marine TPEO 4050	50	C,E,G
	Marine TPEO 4055	55	C,E,G
Petromin Corporation	Petromin Petropower Plus 3-40	40	C,E,G
	Petromin Petropower Plus 4-40	50	C,E,G
	Petromin Petropower Plus 5-40	55	C,E,G
	Petromin Petropower 3-40	40	C,E,G
	Petromin Petropower 4-40	55	C,E,G
	Petromin Petroshield 3-40	40	C,E,G
	Petromin Petroshield 4-40	55	C,E,G
Petron	Petromar XC 4040	40	C,E,G
	Petromar XC 5540	55	C,E,G
	Petromar HF 4040	40	C,E,G
	Petromar HF 5040	50	C,E,G
	Petromar HF 5540	55	C,E,G
Petronas International Lubricants	Disrol 400 SAE 40	40	C,E,G
	Disrol 500 SAE 40	50	C,E,G
	MAEO 4040	40	C,E,G
	MAEO 4050	50	C,E,G
Repsol YPF	Neptuno W NT 4000 SAE 40	40	C,E,G
	Neptuno W NT 5500 SAE 40	55	C,E,G
Shell	Argina S4 40	40	C,E,G
	Argina S4 X 40	50	C,E,G
	Argina S5 40	55	C,E,G
Sinopec	TPEO 4040	40	C,E,G
	TPEO 4050	50	C,E,G
SK Lubricants	Supermar 40TP40	40	C,E,G
	Supermar 50TP40	50	C,E,G
Total / Lubmarine	Aurelia TI 4040	40	C,E,G
	Aurelia TI 4055	55	C,E,G
Valvoline	HFO 4040	40	C,E,G
	HFO 4050	50	C,E,G
	HFO 4055	55	C,E,G

Table 3.

Validated system oils - fuel categories A, B, C, D, E and G. Lubricating oils with BN 30 included in the Table 3 are designed to be used when operating Wärtsilä 32 engine on residual fuel or crude oil with low sulphur content (< 1,00 % m/m). Further, on residual fuel installations BN 30 lubricants have eventually a positive influence on cleanliness of the SCR catalyst.

However, due to low lubricating oil consumption oil change intervals with BN 30 lubricating oils will be shorter than with higher BN lubricating oils. Lubricating oils included in Table 3 can also be used in the Wärtsilä 32GD engine, if low sulphur residual fuel or crude oil is used as a pilot / back-up fuel.

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
ADNOC Distribution	Voyager Marine 430	30	A,B,C,D,E,G
	Voyager Mallah 430	30	A,B,C,D,E,G
Aegean Marine Petroleum S.A.	Alfamar 430	30	A,B,C,D,E,G
	Alfamar GII 430	30	A,B,C,D,E,G
Avin Oil S.A.	Avin Argo S 30 SAE 40	30	A,B,C,D,E,G
Castrol	TLX Plus 304	30	A,B,C,D,E,G
	TLX Xtra 304	30	A,B,C,D,E,G
Cepsa	Troncoil 3040 PLUS	30	A,B,C,D,E,G
	Larus 3040	30	A,B,C,D,E,G
Chevron (Texaco + Caltex)	Taro 30 DP 40	30	A,B,C,D,E,G
	Taro 30 DP 40X	30	A,B,C,D,E,G
CPC Corporation	Marilube Oil W 304	30	A,B,C,D,E,G
ENI S.p.A.	Cladium 300 S SAE 40	30	A,B,C,D,E,G
ENOC	Strata MSD 430	30	A,B,C,D,E,G
	Strata MSDO 430	30	A,B,C,D,E,G
	EPPCO Bahri MSD 430	30	A,B,C,D,E,G
ExxonMobil	Mobilgard M430	30	A,B,C,D,E,G
Fuchs Petrolub SE	Titan PSW 30 SAE 40	30	A,B,C,D,E,G
Gulf Oil International	Gulfgen Supreme 430	30	A,B,C,D,E,G
	Gulfgen Supreme Plus 430	30	A,B,C,D,E,G
Gulf Oil Marine / Sealub Alliance	GulfSea Power 4030	30	A,B,C,D,E,G
	GulfSea Power II 4030	30	A,B,C,D,E,G
Indian Oil Corporation	Servo Marine K-3040	30	A,B,C,D,E,G
Irving Blending & Packaging	Irving Marine MTX 3040	30	A,B,C,D,E,G
JXTG Nippon Oil & Energy Corp.	Marine T304	30	A,B,C,D,E,G
Kuwait Petroleum	Q8 Mozart TM 30 SAE 40	30	A,B,C,D,E,G
LPC S.A.	Cyclon Poseidon HT 4030	30	A,B,C,D,E,G
Lukoil	Navigo TPEO 30/40	30	A,B,C,D,E,G
Morris Lubricants	Aquamor 130MD	30	A,B,C,D,E,G
Motor Oil (Hellas)	Emo Argo S 30 SAE 40	30	A,B,C,D,E,G
Pertamina	Martron 430	30	A,B,C,D,E,G
	Medripal 430	30	A,B,C,D,E,G
	Salyx 430	30	A,B,C,D,E,G
Petrobras	Marbrax CCD-430	30	A,B,C,D,E,G
Petro Gulf Oil Manufacturing LLC	Marine TPEO 4030	30	A,B,C,D,E,G
Petromin Corporation	Petromin Petropower Plus 2-40	30	A,B,C,D,E,G
	Petromin Petropower 2-40	30	A,B,C,D,E,G
	Petromin Petroshield 2-40	30	A,B,C,D,E,G

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
Petron	Petromar XC 3040 Petromar HF 3040	30 30	A,B,C,D,E,G A,B,C,D,E,G
Petronas International Lubricants	Disrol 300 SAE 40	30	A,B,C,D,E,G
Shell	Argina S3 40	30	A,B,C,D,E,G
Sinopec	TPEO 4030	30	A,B,C,D,E,G
SK Lubricants	Supermar 30TP40	30	A,B,C,D,E,G
Total / Lubmarine	Aurelia TI 4030	30	A,B,C,D,E,G
Valvoline	HFO 4030	30	A,B,C,D,E,G

Table 4.

Validated SAE 40 lubricating oils - fuel category D. Lubricating oils with BN 20 included in the Table 4 are allowed to be used when operating Wärtsilä 32 and Wärtsilä 32GD engines on max. 0,10 % m/m sulphur fuels (ULSFO) which are categorized as residual fuels. Such fuels were introduced to cope with the tightened SO_x emission legislation being valid on the specific SECA areas.

SUPPLIER	BRAND NAME	BN	FUEL CATEG.
Castrol	TLX Plus 204 TLX Xtra 204	20 20	D D
Chevron (Texaco + Caltex)	Taro 20 DP 40 Taro 20 DP 40X	20 20	D D
ExxonMobil	Mobilgard M 420	20	D
Gulf Oil Marine / Sealub Alliance	GulfSea Power MDO 4020	20	D
Irving Blending & Packaging	Irving Marine MTX 2040	20	D
Lukoil	Navigo TPEO 20/40	20	D
Petrobras	Marbrax CCD-420	20	D
Shell	Argina S2 40	20	D
Total / Lubmarine	Aurelia TI 4020	20	D

LUBRICATING OIL LEVEL

The intervals between lubricating oil changes may be extended by adding fresh oil frequently (even daily) to keep the oil level constantly close to the maximum level.

CHANGE OF LUBRICATING OIL BRAND

Top-up with another lubricating oil brand than being filled to the system is not allowed, except if the both two lubricating oils originate from the same manufacturer. E.g. if company A's BN 40 oil is filled into the oil system and top-up with same Company A's BN 50 oil is desired, that can be done provided that both products are based on same base oils and additive technology. Otherwise the lubricating oil system has to be drained and then filled with another brand by following the procedure described here below.

In order to minimize the risk of lubricating oil foaming, deposit formation, blocking of lubricating oil filters, damage of engine components, etc., the following procedure should be followed when lubricating oil brand is changed from one to another:

- If possible, change the lubricating oil brand in connection with an engine (piston) overhaul
- Drain old lubricating oil from the lubricating oil system
- Clean the lubricating oil system in case of an excessive amount of deposits on the surfaces of engine components, like crankcase, camshaft compartment, etc.
- Fill the lubricating oil system with fresh lubricating oil

If the procedure described above is not followed, responsibility of possible damage and malfunctions caused by lubricating oil change should always be agreed between the oil company and customer.

USE OF NON-VALIDATED LUBRICATING OILS

Before using a lubricating oil being not listed in the tables of this document, the engine manufacturer must be contacted. Lubricating oils that are not validated have to be tested according to Wärtsilä procedure.

If non-validated lubricating oils will be used during the engine warranty period and there exists no agreement with Wärtsilä about testing, the engine guarantee will not be valid.

Lubricating oil companies listed in this document along with other possible manufacturers and distributors undertake all responsibility for the performance of their validated lubricating oils in service to the exclusion of any liability of any Wärtsilä company belonging to Wärtsilä group. Further, they shall indemnify, compensate and hold harmless Wärtsilä and companies belonging to Wärtsilä group from and against any claims, damages and losses caused by the lubricating oils in question.

LUBRICATING OILS FOR ENGINE TURNING DEVICE

Based on the turning device manufacturer's instructions EP-gear oils having viscosity of 414 - 506 cSt at 40 °C = ISO VG 460 are normally considered as suitable lubricating oils for turning device. The following products are fulfilling the requirements:

Allowed lubricating oils for turning device:

LUBRICATING OILS FOR ENGINE TURNING DEVICE				
SUPPLIER	**BRAND NAME**	**VISCOSITY cSt at 40 °C**	**VISCOSITY cSt at 100 °C**	**VISCOSITY INDEX (VI)**
Castrol	**Alpha SP 460**	**460**	**30,5**	**95**
Chevron (Texaco + Caltex)	**Meropa 460**	**460**	**31,2**	**97**
ENI S.p.A.	**Blasia 320**	**300**	**23,0**	**95**
ExxonMobil	**Mobilgear 600 XP 460**	**460**	**30,6**	**96**
Fuchs	**Renolin CLP 460**	**460**	**30,4**	**95**
Petro-Canada	**Enduratex EP 460**	**452**	**30,4**	**97**
Repsol	**Super Tauro 460**	**460**	**30,0**	**92**
RN-Lubricants	**TNK Reductor CLP 460**	**429**	**27,7**	**87**
Shell	**Omala S2 GX 460**	**460**	**30,8**	**97**
Total / Lubmarine	**Carter EP 460**	**470**	**30,3**	**93**

LUBRICATING OILS FOR GOVERNOR / ACTUATOR

An oil of viscosity class SAE 30 or SAE 40 is suitable and usually the same oil can be used as in the engine. Turbocharger oil can also be used in the governor. At cold ambient conditions it may be necessary to use a multigrade oil (e.g. SAE 5W-40) for better governor response during start-up. Oil change interval: 2000 service hours.

Note 1: Monograde engine oils, multigrade oils or turbocharger oils etc. are not compatible with each other and shall not be mixed. Thus it's important to drain and flush with the new oil both the governor and booster properly if changing the oil quality.

Note 2: In EDG applications the use of multigrade oil (e.g. SAE 10W-30) is mandatory. Oil change interval: See engine Operation and Maintenance Manual.

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Energy Solutions

Specification

Title:	Consumable (reducing agent and compressed air) specification for SCR system	**DocID:**	DBAC197648
		Revision:	b
Created by:	Riitta Raudaskoski / 17-Nov-2017	**Status:**	Finalised
Finalised by:	Riitta Raudaskoski / 28-Nov-2017	**Pages:**	1 (3)
Project:	IN023 - WFI-P PPTECH		
Description:			

This document specifies approved reducing agent and compressed air specifications for engine driven power plants that are equipped with SCR systems.

Reducing agent

The reducing agent is either urea water solution (typically 40 wt-%) or ammonia water solution (typically 19 or 25 wt-%). Whereas 40 wt-% urea solution starts to crystalize at temperature below 0 °C, 32.5 wt% urea solution is in liquid form at temperatures above -11 °C. 32.5 wt-% urea solution is also possible to use as reducing agent but is not commonly used in power plant applications. Approved reducing agent specifications are shown below.

The urea solution quality:
Warning: *urea of agricultural quality cannot be used as reducing agent as it might harm the catalyst. Hard water and high concentrations of cations might also harm the catalyst system.*

40 wt% urea solution (equal to standard ISO 18611-1:2014)

Characteristics	Value
Urea content	39.0–41.0% by weight
Density at 20 °C	1105–1177 kg/m^3
Alkalinity as NH_3	max. 0.5% by weight
Biuret	max. 0.8%
Aldehydes	max. 100 mg/kg
Insoluble matter	max. 50 mg/kg
Phosphate (PO_4)	max. 1 mg/kg
Calcium	max. 1 mg/kg
Iron	max. 1 mg/kg
Magnesium	max. 1 mg/kg
Sodium	max. 1 mg/kg
Potassium	max. 1 mg/kg

32.5 wt% urea solution (equal to standard ISO 22241-1:2006)

Characteristics	Value
Urea content	31.8–33.2% by weight
Density at 20 °C	1087–1093 kg/m^3
Alkalinity as NH_3	max. 0.2% by weight
Biuret	max. 0.3% by weight
Aldehydes	max. 5 mg/kg
Insoluble matter	max. 20 mg/kg
Phosphate (PO_4)	max. 0.5 mg/kg
Calcium	max. 0.5 mg/kg
Iron	max. 0.5 mg/kg
Copper	max. 0.2 mg/kg
Zinc	max. 0.2 mg/kg
Chromium	max. 0.2 mg/kg
Nickel	max. 0.2 mg/kg
Aluminium	max. 0.5 mg/kg
Magnesium	max. 0.5 mg/kg
Sodium	max. 0.5 mg/kg
Potassium	max. 0.5 mg/kg

Ammonia solution

The ammonia solution must be of technical grade. The maximum amount of impurities is the same as for the urea solution.

Concentration 19 or 25 weight % (+/- 0.5%)

Urea solution prepared at site

Urea solution can also prepared at site from urea granulates of technical grade by mixing urea granulates with demineralized water. Water used in urea solution preparation to be according following specification DBAC795168 and the solid urea must be of technical grade, be free from anti-caking agent and fulfil the following specification:

Nitrogen	> 46.5 wt-%
Water	< 0.4 wt-%
Biuret	< 0.5 wt-%
Particle size	1-3 mm
Fe	< 0.3 mg/kg
Substances insoluble in water	< 10 mg/kg

Compressed air

ISO 8573-1 (2010), 6-8 bar, particles class 2, water class 5, oil class 3

Particle size d [µm]	**Maximum number per m^3**
0.1 < d ≤ 0.5	400 000
0.5 < d ≤ 1.0	6 000
1.0 < d ≤ 5.0	100
Characteristics	**Value**
Pressure dew point *	max. +7 °C
Total oil concentration (aerosol, liquid and vapor)	max. 1 mg/m^3

* Outdoor installations and projects with engine hall temperatures below 0°C to be defined separately

CONFIDENTIAL Specification

Title:	Urea and ammonia specifications for SCR	**Doc.ID:**	DBAE140602
		Revision:	a
Author:	Riitta Raudaskoski	**Status:**	Finalised
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Organisation:	- General Energy Solutions		
Project:	IN023 – WFI-P PPTECH		

Urea and ammonia specifications for SCR

This document specifies approved reducing agent specifications for SCR.

The reducing agent is either urea water solution (typically 40 wt-%) or ammonia water solution (typically 19 or 25 wt-%). 32.5 wt-% urea solution is also possible to use as reducing agent but is not commonly used in power plant applications.

Urea solution quality:

Warning: *urea of agricultural quality cannot be used as reducing agent as it might harm the catalyst. Hard water and high concentrations of cations might also harm the catalyst system.*

40 wt-% urea solution (equal to standard ISO 18611-1:2014)

Characteristics	Value
Urea content	39.0–41.0% by weight
Density at 20 °C	1105–1177 kg/m^3
Alkalinity as NH_3	max. 0.5% by weight
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Aldehydes	max. 100 mg/kg
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Phosphate (PO_4)	max. 1 mg/kg
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Sodium	max. 1 mg/kg
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Calcium	max. 0.5 mg/kg
Iron	max. 0.5 mg/kg
Copper	max. 0.2 mg/kg
Zinc	max. 0.2 mg/kg
Chromium	max. 0.2 mg/kg
Nickel	max. 0.2 mg/kg
Aluminium	max. 0.5 mg/kg
Magnesium	max. 0.5 mg/kg
Sodium	max. 0.5 mg/kg
Potassium	max. 0.5 mg/kg

Ammonia solution quality:

The ammonia solution must be of technical grade. The maximum amount of impurities is the same as for the urea solution.

Concentration 19 or 25 weight % (+/- 0.5%)