

1

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Available executions

Execution No.	Material ID	Attribute 1: Turbocharger amount		Attribute 2: iCER location	
		1	2	off-engine	on-engine
001	PTAA044719	X		X	
002	PTAA044720		X	X	
003	PTAA046756	X			X

NOTE

The above executions can be configured using the Engine Configurator.

Detailed guidance for the executions is provided within the Marine Installation Manual (MIM). If a specific execution of interest is not shown in the above table, then it may still be under development or not available. For further information or in case of a project-specific request, WinGD must be contacted directly.

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Prod.	X72DF-2.1 X72DF-2.2								
Change History	B	sde101				Drawing Updated			
	A	mhu019	mhu019	19.12.2022	CNAA002926	Drawing Updated		-	-
	-	mhu019	dst009	12.11.2021	CNAA001002	new Design		-	-
	Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis		Activity Code	E C

WIN GD
Winterthur Gas & Diesel

EXHAUST SYSTEM
MIDS master drawing

separate BOM available

Dimension

Scale	-		NX	Units [mm] [kg]	Basic Material	Net Weight	0.001		
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Qty per	A4	Item ID	PTAA014179		Drawing Page/s	1/1			

1

2


3

4

SEQ NO	QTY	Item ID	Item Name	Dimension	Standard-ID	Basic Material	Net Weight
001	1	PTAA044711	EXHAUST SYSTEM	with one turbocharger			0
002	1	PAAD327310	SPECIFICATION				0.001
003	1	DAAD139643	GUIDELINES				



Prod.	5,6,7,8 X72DF-2.1							
	5,6 X72DF-2.2							
Change History								
	-	dkl021	mhu019	23.11.2022	CNAA002662	Main Design/Drawing Introduced	-	-
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Activity Code	E	C

 WIN GD <i>Winterthur Gas & Diesel</i>	EXHAUST SYSTEM
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Bill Of Material		Dimension						
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Main Design		Yes	Design Group	9726	Q-Code	XXXXX	Standard	WDS
Qty per	Engine	A4	Item ID	PTAA044719		BOM Page/s	01/01	

Specifications which must be met:

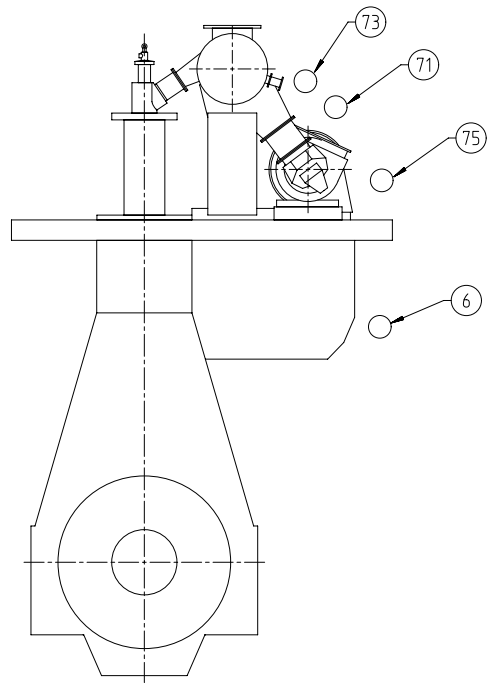
- 73** OUTLET - Exhaust gas manifold waste gate
 - Size and layout of connection flange is provided in the "Pipe Connection Plan"
 - The pipe diameter must be selected according to the guidance as provided on the drawing "Specification for waste gate selection".
 - The waste gate connection pipe, as connected to the main exhaust gas pipe, must be kept as short as possible to avoid swirl and extensive back pressure.
- 75** INLET - Recirculated exhaust gas turbocharger

Exhaust temperature:

 - Controlled by the EGC
 - Must be always below the scavenge air temperature

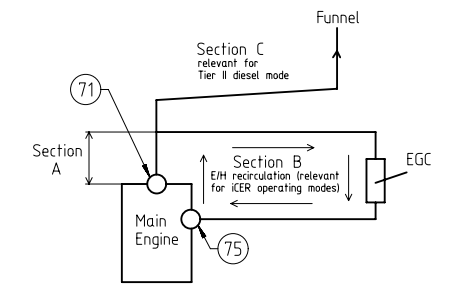
Exhaust gas piping:

 - Piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid condensation draining to the turbocharger suction.
 - The piping between the exhaust gas cooler outlet and turbocharger inlet must be insulated to avoid condensation of the humid recirculating exhaust gas on the pipe wall. The same insulation standard, as used on the hot side before the cooler, must be applied on the exhaust gas return pipe accordingly.
 - The exhaust gas return pipe must be purged by air in the counterflow direction through the SOV. The purging flow must be the total iCER casing volume, to be exchanged 4.5 times per hour with a maximum back pressure of 80 mbar.
- 6** OUTLET - Exhaust gas return pipe condensate water drain
 - Drain to the iCER waste water holding tank



- 71** OUTLET - Exhaust gas turbocharger
 - Exhaust gas temperature and volume flow: according to GTD
 - If the iCER diesel option is selected a NOx sensor must be installed in the exhaust gas pipe between Back Pressure Valve (BPV) and turbocharger.
 - The total back pressure of the exhaust gas system must be kept within the following ranges:
 - Diesel Tier II mode in section A and C
 - Design limit: From max. 30 mbar to max. 60 mbar
 - Operational limit: max. 80 mbar
 - iCER gas Tier III mode in section A and B
 - With exhaust gas return pipe to the TC connection from above, i.e. layout with water mist catcher
 - Design limit: From max. 20 mbar to max. 35 mbar
 - Operational limit: max. 45 mbar
 - With exhaust gas return pipe to the TC connection from below, i.e. compact layout without water mist catcher
 - Design limit: From max. 30 mbar to max. 45 mbar
 - Operational limit: max. 55 mbar
 - iCER diesel Tier III mode in section A and B
 - Design limit: Not relevant for layout
 - Operational limit: max. 55 mbar

Remark: The available back pressure range provided in this drawing refers to the differential pressure between the pipe connections #71 and #75. An additional layout back pressure of 10 mbar is caused by the water mist catcher which is integrated into the engine. In the GTD, the available back pressure range refers specifically to the back pressure between the turbocharger inlet and outlet. As a result, the GTD provides a back pressure range which is 10 mbar higher.



- The exhaust gas pipe must be insulated according to applicable rules, e.g. SOLAS.
- Recommended pipe dimensions in relation to the exhaust gas mass flow rates are provided by table 1 on page 2.
- The exhaust piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid gases from accumulating.
- The piping layout must consider the thermal expansion and vibration from the turbocharger (TC) and main engine (ME). Thermal expansion of the ME is to be calculated according to the formula in MIM. TC specific thermal expansion is provided by the TC supplier.
- Explosion relief devices, examined and certified by the maker, with flameless pressure relief (rupture discs or self-closing, spring-loaded valves) must be selected and installed within the exhaust system in accordance with class requirements. The exact position and number of explosion relief devices must be determined by the system designer or the shipyard through calculation. Independently, which type of explosion relief devices is selected, the distance of the explosion relief device to gangways, working areas and system components must be at least 3 m to not endanger personnel and/or to avoid material damage.
- A continuous (extensive) exhaust gas leakage must be avoided.
- Supports (fixation points) for the mass of piping and exhaust gas system components must be installed in sufficient size and amount. Inadmissible tensions in the piping and forces acting on the turbocharger are not acceptable.
- Exhaust gas pipes of several engines must not be connected.
- Drains of adequate size and amount must be installed in the exhaust gas piping.
- When the noise level on the bridge wing exceeds the class requirement (normally 60 - 70 dB(A)) a silencer must be applied.
- During iCER operation, the recirculated exhaust gas must be cooled by EGC circulation water. This water must be cleaned and treated by the water treatment unit to fulfill the following requirements: A maximum solids content of 150 mg/l and a proper pH value (e.g. above pH 6).

Prod.	X72DF-2,1 X72DF-2,2								
Change History	D	dkl021	ch09	15.12.2023	0A00484	Drawing updated.		4	3
	C	sde101	mhu019	24.03.2023	CNAA003456	Drawing Updated		4	3
	B	sde101	mhu019	23.12.2022	CNAA003013	Drawing Updated		4	3
	-	dkl021	mhu019	23.11.2022	CNAA002662	new Design		-	-
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis			Approved	Activity Code
WIN GD Winterthur Gas & Diesel		EXHAUST SYSTEM 1 TC, iCER off-engine							
Dimension		1 TC, iCER off-engine							
Scale	-	Units [mm] [kg]		Basic Material		Net Weight		0.001	
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Main Design	Design Group		9726		Q-Code X X M		Standard		WDS
Qty per	A2		Item ID		PTAA044711		Drawing Pages		1/5

SYSTEM PROPOSAL

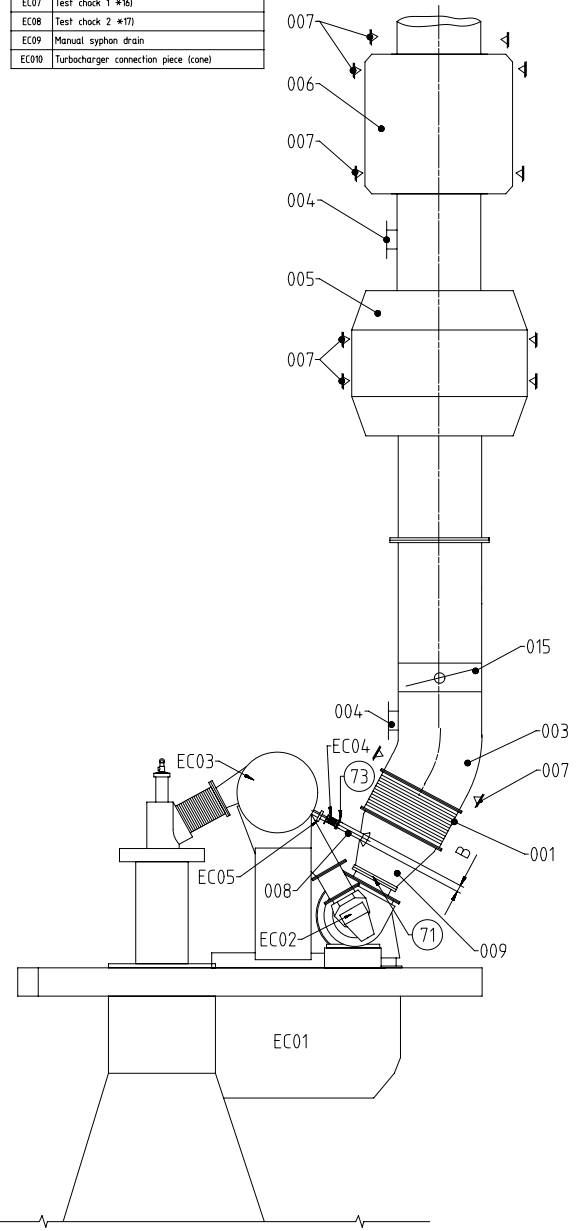
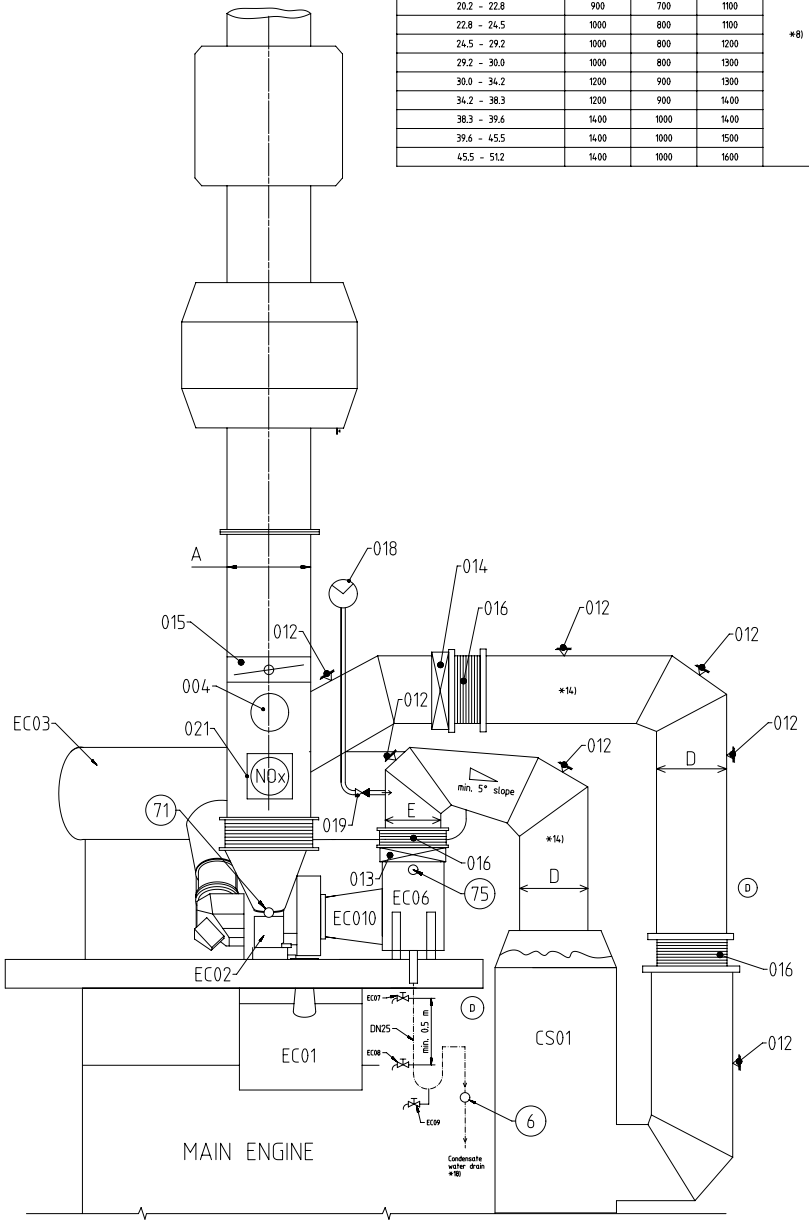
NOTE
 Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Short Route
 - Exhaust gas branch-off after turbocharger

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (mEgr from GTD) kg/s	D	E	A*18	B
11.5 - 12.9	700	500	800	*8)
12.9 - 14.4	700	500	900	
14.4 - 16.4	800	600	1000	
16.4 - 18.3	800	600	1000	
18.3 - 20.2	900	700	1000	
20.2 - 22.8	900	700	1100	
22.8 - 24.5	1000	800	1100	
24.5 - 29.2	1000	800	1200	
29.2 - 30.0	1000	800	1300	
30.0 - 34.2	1200	900	1300	
34.2 - 38.3	1200	900	1400	
38.3 - 39.6	1400	1000	1400	
39.6 - 45.5	1400	1000	1500	
45.5 - 51.2	1400	1000	1600	

Pos.	ENGINE COMPONENTS *3)
EC01	Scavenge air receiver
EC02	Turbo Charger (TC)
EC03	Exhaust gas manifold
EC04	Waste gate compensator *7) *8)
EC05	Waste gate valve
EC06	Water mist catcher (WMC)
EC07	Test cock 1 *16)
EC08	Test cock 2 *17)
EC09	Manual syphon drain
EC010	Turbocharger connection piece (cone)



Pos.	SYSTEM COMPONENTS *2)
001	Compensator between engine and exhaust gas system *7)
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) *5)
005	Main Economiser
006	Silencer (with spark arrester) *9)
007	Support *4)
008	Waste gate pipe
009	Transition piece *6)
012	iCER support *4)
013	Flow Regulating Valve (FRV) *11)
014	Shut-off valve (SOV) *11)
015	Back Pressure Valve (BPV) *11)
016	Compensator in the exhaust system *15)
017	Compensator in the purge air supply pipe *12)
018	Purging and sealing air blower *19)
019	Non-return valve
021	NOx Sensor (as delivered by the engine builder) *20)

Pos.	ENGINE CONNECTIONS *1)
④	OUTLET - Exhaust gas return pipe condensate water drain
⑪	OUTLET - Exhaust gas turbocharger
⑬	OUTLET - Exhaust gas manifold waste gate
⑮	INLET - Recirculated exhaust gas turbocharger

Pos.	COMPONENTS from certified suppliers *12)
CS01	Exhaust Gas Cooler (EGC)

- Remarks:**
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise). The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1:1.16, taper angle $\leq 40^\circ$
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Variations of the pipe after the compensator must be lower than 45 mmis RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection". The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Valve size to be selected in accordance with actual exhaust gas mass flow.
 - *12) To be supplied by a certified supplier. Ordering to be coordinated between shipyard and engine builder.
 - *13) Based on a design velocity of max. 40 m/s
 - *14) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *15) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *16) By opening of test cock 1 the following conditions can be checked:
 Normal condition: Water flow, water samples can be taken.
 Abnormal condition: No water flow but air suction, which is the indication that the drain valve is blocked in closed position.
 - *17) By opening of test cock 2 the following conditions can be checked:
 Normal condition: Water flow, water samples can be taken.
 Abnormal condition: No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *18) Condensate water drain to the iCER waste water holding tank.
 - *19) For the selection of the blower capacity and the arrangement of the purging and sealing air supply line refer to the guidance as provided in the MIM and iCER installation Guideline. The purging and sealing air system is controlled by the engine control system.
 - *20) A dedicated air supply must be connected to the sensor to provide compressed air for cleaning, with air quality level of ISO 8573-12:016 (15/2).

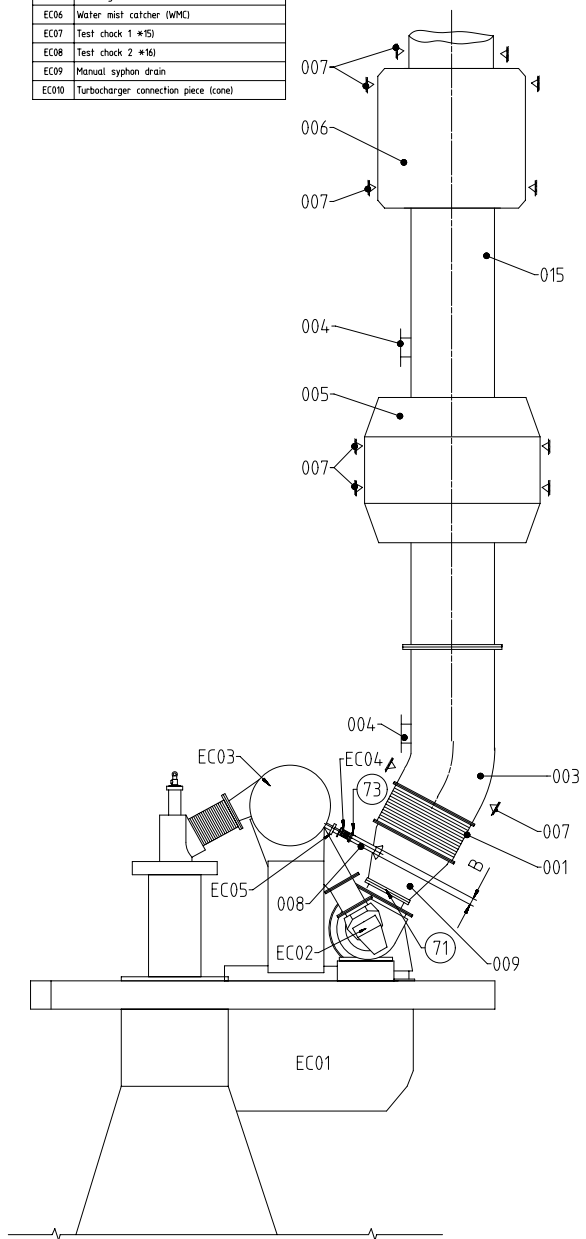
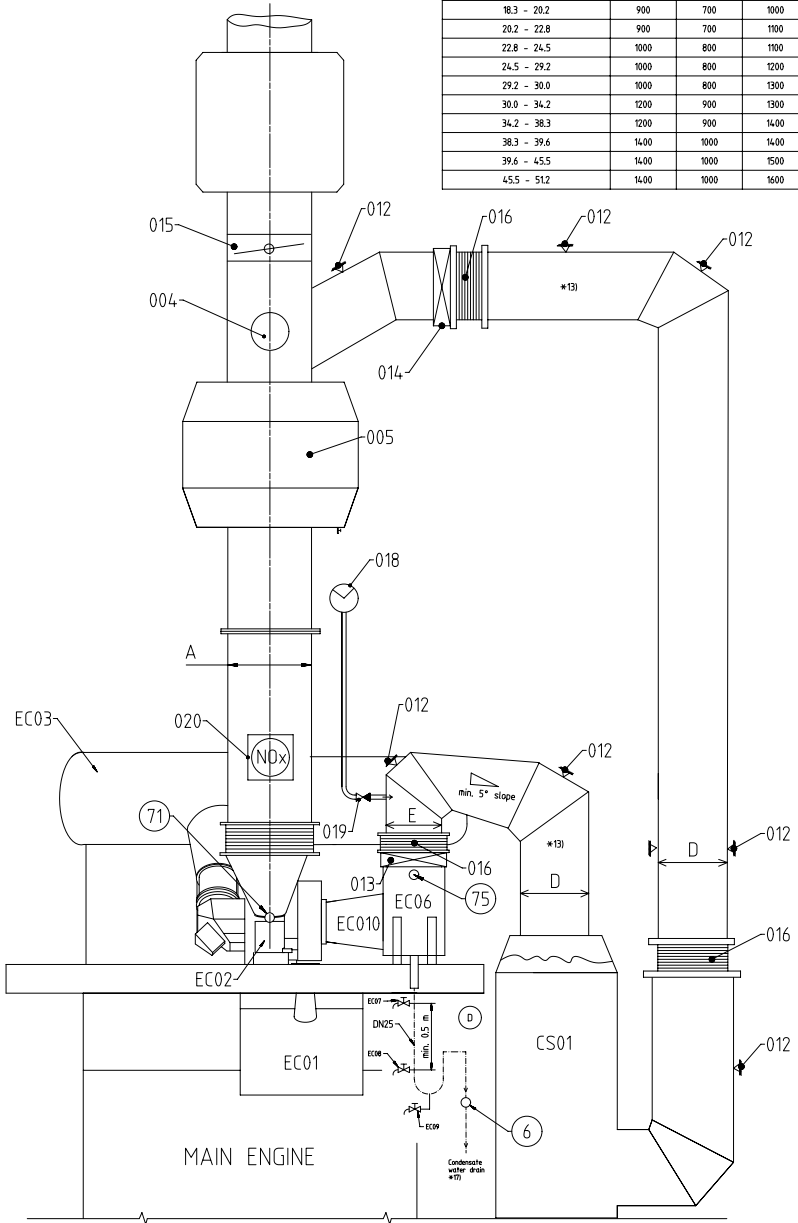
NOTE
Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Long Route
- Exhaust gas branch-off after economizer

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (mEgr from GTD) kg/s	D	E	A**12)	B
11.5 - 12.9	700	500	800	*8)
12.9 - 14.4	700	500	900	
14.4 - 16.4	800	600	1000	
16.4 - 18.3	800	600	1000	
18.3 - 20.2	900	700	1000	
20.2 - 22.8	900	700	1100	
22.8 - 24.5	1000	800	1100	
24.5 - 29.2	1000	800	1200	
29.2 - 30.0	1000	800	1300	
30.0 - 34.2	1200	900	1300	
34.2 - 38.3	1200	900	1400	
38.3 - 39.6	1400	1000	1400	
39.6 - 45.5	1400	1000	1500	
45.5 - 51.2	1400	1000	1600	

Pos.	ENGINE COMPONENTS *3)
EC01	Scavenge air receiver
EC02	Turbo Charger (TC)
EC03	Exhaust gas manifold
EC04	Waste gate compensator *7) *8)
EC05	Waste gate valve
EC06	Water mist catcher (WMC)
EC07	Test cock 1 *15)
EC08	Test cock 2 *16)
EC09	Manual syphon drain
EC010	Turbocharger connection piece (cone)



Pos.	SYSTEM COMPONENTS *2)
001	Compensator between engine and exhaust gas system *7)
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) *5)
005	Main Economiser
006	Silencer (with spark arrester) *9)
007	Support *4)
008	Waste gate pipe
009	Transition piece *6)
012	ICER support *4)
013	Flow Regulating Valve (FRV) *10)
014	Shut-off valve (SOV) *10)
015	Back Pressure Valve (BPV) *10)
016	Compensator in the exhaust system *14)
017	Compensator in the purge air supply pipe *11)
018	Purging and sealing air blower *18)
019	Non-return valve
020	NDX Sensor (as delivered by the engine builder) *19)

Pos.	ENGINE CONNECTIONS *1)
6)	OUTLET - Exhaust gas return pipe condensate water drain
71)	OUTLET - Exhaust gas turbocharger
73)	OUTLET - Exhaust gas manifold waste gate
75)	INLET - Recirculated exhaust gas turbocharger

Pos.	COMPONENTS from certified suppliers *14)
CS01	Exhaust Gas Cooler (EGC)

- Remarks:
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise). The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine, if either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1.1, 1.6, taper angle $\leq 40^\circ$
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection". The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Valve size to be selected in accordance with actual exhaust gas mass flow.
 - *11) To be supplied by a certified supplier. Ordering to be coordinated between shipyard and engine builder.
 - *12) Based on a design velocity of max. 40 m/s
 - *13) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *14) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *15) By opening of test cock 1 the following conditions can be checked:
Normal condition: No water flow but air suction.
Abnormal condition: Water flow, which is the indication that the drain valve is blocked in closed position.
 - *16) By opening of test cock 2 the following conditions can be checked:
Normal condition: Water flow, Water samples can be taken.
Abnormal condition: No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *17) Condensate water drain to the ICER waste water holding tank.
 - *18) For the selection of the blower capacity and the arrangement of the purging and sealing air supply line refer to the guidance as provided in the MIM and ICER Installation Guideline. The purging and sealing air system is controlled by the engine control system.
 - *19) A dedicated air supply must be connected to the sensor to provide compressed air for cleaning, with air quality level of ISO 8573-1:2010 (1:7:2).

SYSTEM PROPOSAL

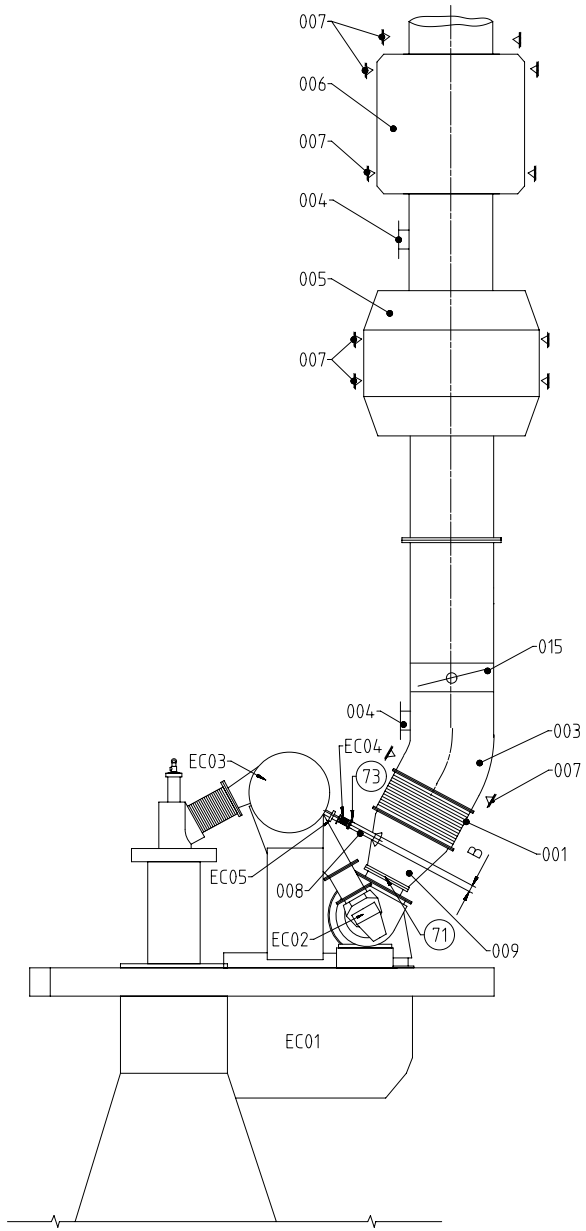
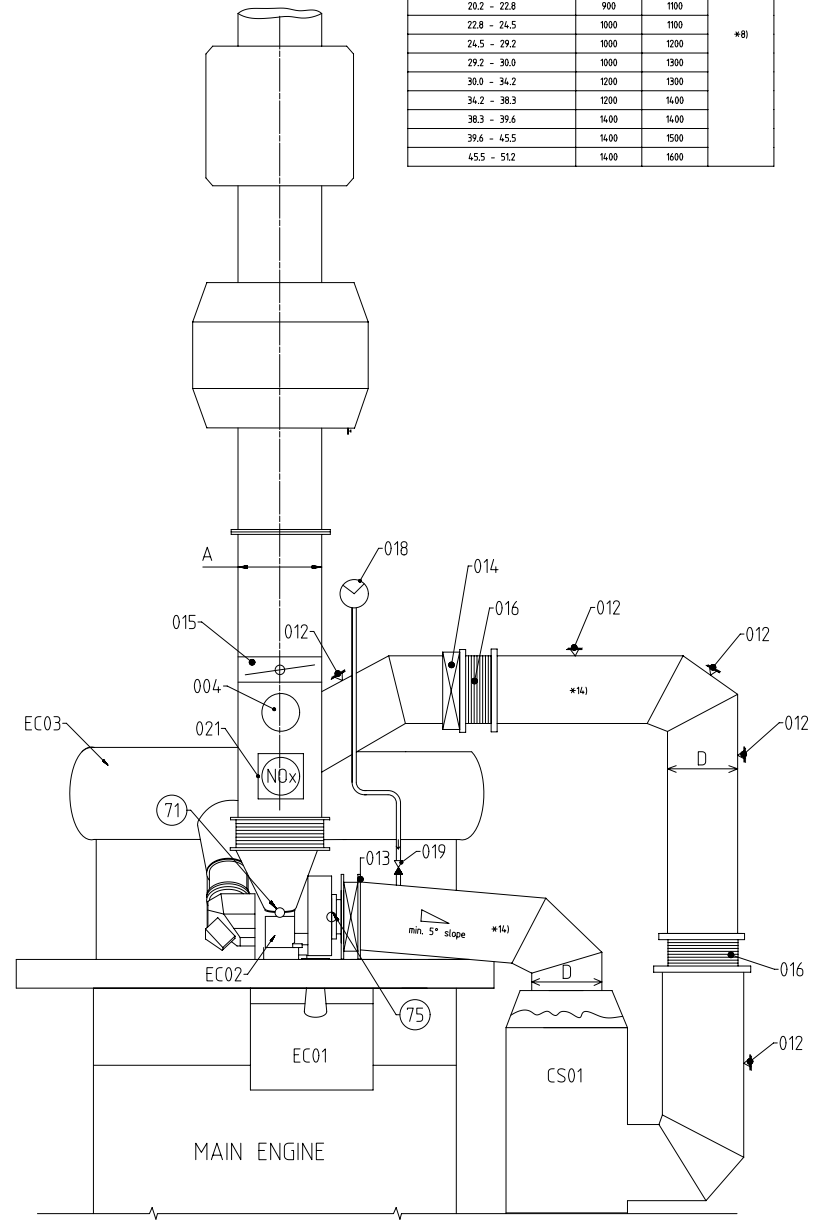
NOTE
 Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Short Route of compact arrangement
 - Exhaust gas branch-off after turbocharger

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (mEgr from GTD) Kg/s	D	A*19	B
11.5 - 12.9	700	800	*8)
12.9 - 14.4	700	900	
14.4 - 16.4	800	1000	
16.4 - 18.3	800	1000	
18.3 - 20.2	900	1000	
20.2 - 22.8	900	1100	
22.8 - 24.5	1000	1100	
24.5 - 29.2	1000	1200	
29.2 - 30.0	1000	1300	
30.0 - 34.2	1200	1300	
34.2 - 38.3	1200	1400	
38.3 - 39.6	1400	1400	
39.6 - 45.5	1400	1500	
45.5 - 51.2	1400	1600	

Pos.	ENGINE COMPONENTS *3)
EC01	Scavenge air receiver
EC02	Turbo Charger (TC)
EC03	Exhaust gas manifold
EC04	Waste gate compensator *7) *8)
EC05	Waste gate valve



Pos.	SYSTEM COMPONENTS *2)
001	Compensator between engine and exhaust gas system *7)
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) *5)
005	Main Economiser
006	Silencer (with spark arrester) *9)
007	Support *4)
008	Waste gate pipe
009	Transition piece *6)
012	ICER support *4)
013	Flow Regulating Valve (FRV) *11)
014	Shut-off valve (SOV) *11)
015	Back Pressure Valve (BPV) *11)
016	Compensator in the exhaust system *15)
017	Compensator in the purge air supply pipe *12)
018	Purging and sealing air blower *19)
019	Non-return valve
021	NOx Sensor (as delivered by the engine builder) *20)

Pos.	ENGINE CONNECTIONS *1)
(71)	OUTLET - Exhaust gas turbocharger
(73)	OUTLET - Exhaust gas manifold waste gate
(75)	INLET - Recirculated exhaust gas turbocharger

Pos.	COMPONENTS from certified suppliers *12)
CS01	Exhaust Gas Cooler (EGC)

- Remarks:**
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise).
The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the sea after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1.1..1.6, taper angle ≤ 40°
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection".
The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Valve size to be selected in accordance with actual exhaust gas mass flow.
 - *12) To be supplied by a certified supplier. Ordering to be coordinated between shipyard and engine builder.
 - *13) Based on a design velocity of max. 40 m/s
 - *14) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *15) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *19) For the selection of the blower capacity and the arrangement of the purging and sealing air supply line refer to the guidance as provided in the MIM and ICER Installation Guideline. The purging and sealing air system is controlled by the engine control system.
 - *20) A dedicated air supply must be connected to the sensor to provide compressed air for cleaning, with air quality level of ISO 8573-1:2010 (1:7:2).

SYSTEM PROPOSAL

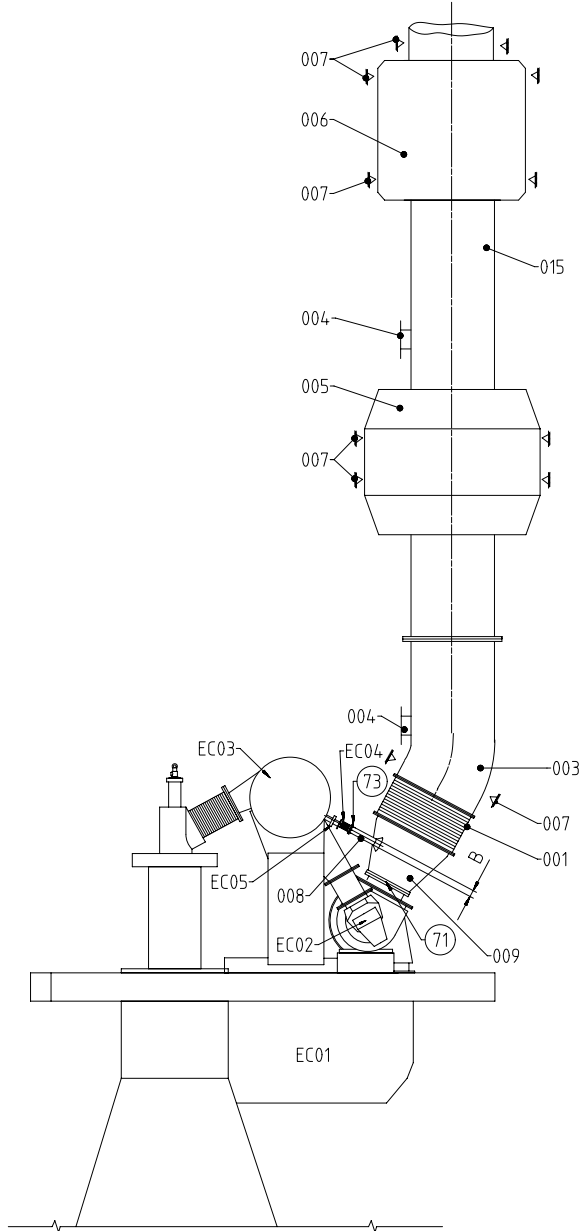
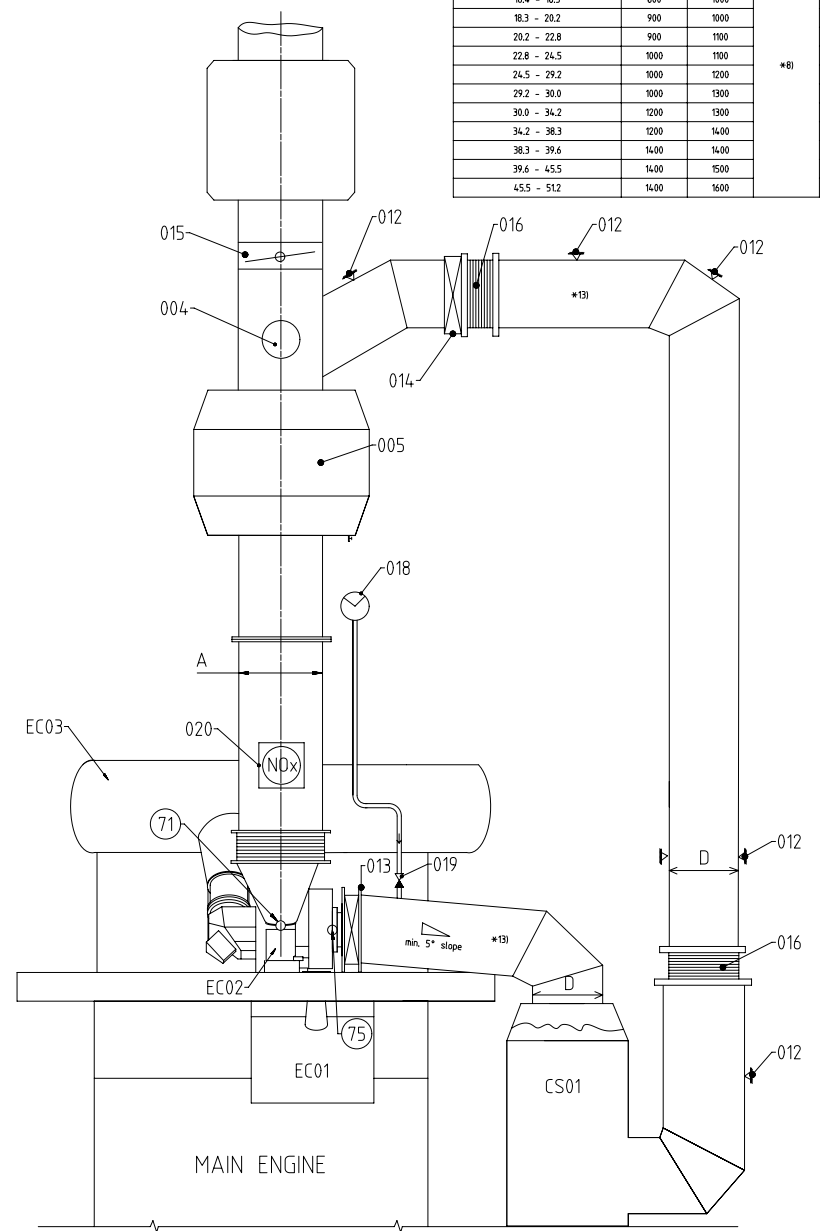
NOTE
 Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Long Route of compact arrangement
 - Exhaust gas branch-off after economizer

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (mEgr from GTD) kg/s	D	A**10	B
11.5 - 12.9	700	800	*8)
12.9 - 14.4	700	900	
14.4 - 16.4	800	1000	
16.4 - 18.3	800	1000	
18.3 - 20.2	900	1000	
20.2 - 22.8	900	1100	
22.8 - 24.5	1000	1100	
24.5 - 29.2	1000	1200	
29.2 - 30.0	1000	1300	
30.0 - 34.2	1200	1300	
34.2 - 38.3	1200	1400	
38.3 - 39.6	1400	1400	
39.6 - 45.5	1400	1500	
45.5 - 51.2	1400	1600	

Pos.	ENGINE COMPONENTS *3)
EC01	Scavenge air receiver
EC02	Turbo Charger (TC)
EC03	Exhaust gas manifold
EC04	Waste gate compensator *7) *8)
EC05	Waste gate valve



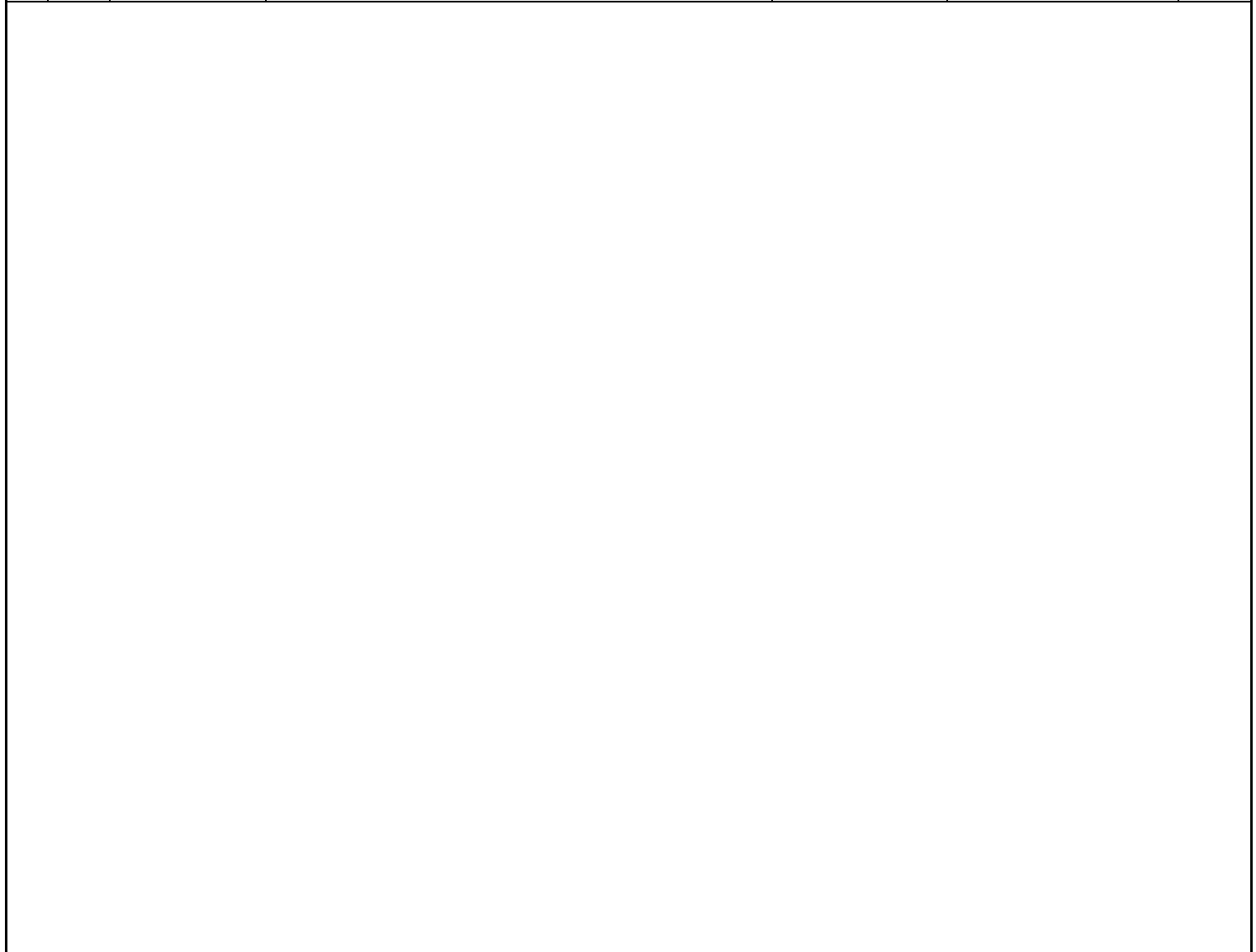
Pos.	SYSTEM COMPONENTS *2)
001	Compensator between engine and exhaust gas system *7)
002	Exhaust gas pipe
003	Explosion relief device (rupture discs or spring-loaded valves) *5)
004	Main Economiser
005	Silencer (with spark arrester) *9)
006	Support *4)
007	Waste gate pipe
008	Transition piece *6)
009	ICER support *4)
010	Flow Regulating Valve (FRV) *10)
011	Shut-off valve (SOV) *10)
012	Back Pressure Valve (BPV) *10)
013	Compensator in the exhaust system *14)
014	Compensator in the purge air supply pipe *11)
015	Purging and sealing air blower *18)
016	Non-return valve
017	NDx Sensor (as delivered by the engine builder) *19)

Pos.	ENGINE CONNECTIONS *1)
⑦1	OUTLET - Exhaust gas turbocharger
⑦3	OUTLET - Exhaust gas manifold waste gate
⑦5	INLET - Recirculated exhaust gas turbocharger


Pos.	COMPONENTS from certified suppliers *14)
CS01	Exhaust Gas Cooler (EGC)

- Remarks:**
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise).
The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventive measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1:1.16, taper angle ≤ 40°
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection".
The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Valve size to be selected in accordance with actual exhaust gas mass flow.
 - *11) To be supplied by a certified supplier. Ordering to be coordinated between shipyard and engine builder.
 - *12) Based on a design velocity of max. 40 m/s
 - *13) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *14) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *18) For the selection of the blower capacity and the arrangement of the purging and sealing air supply line refer to the guidance as provided in the MIM and ICER Installation Guideline. The purging and sealing air system is controlled by the engine control system.
 - *19) A dedicated air supply must be connected to the sensor to provide compressed air for cleaning, with air quality level of ISO 8573-1:2010 (1:1:2).

SEQ NO	QTY	Item ID	Item Name	Dimension	Standard-ID	Basic Material	Net Weight
1	1	PTAA044712	EXHAUST SYSTEM	with two turbocharger			0
2	1	PAAD327310	SPECIFICATION	FOR WASTE GATE SELECTION			0.001
3	1	DAAD139643	iCER INSTALLATION GUIDELINE				



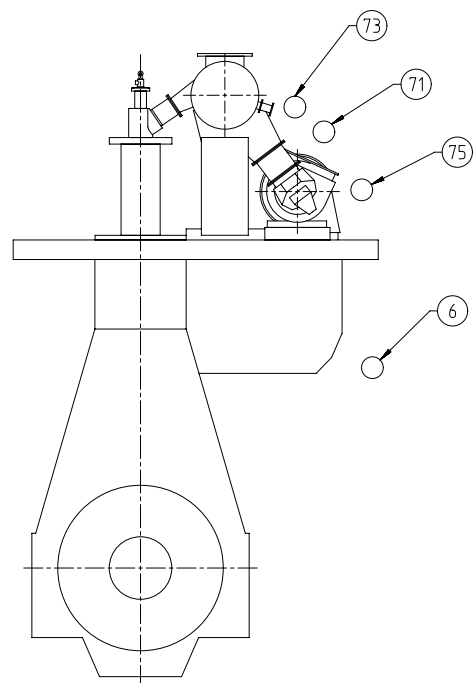
Prod.	5,6,7,8 X72DF-2.1							
	5,6 X72DF-2.2							
Change History								
	-	dkl021	mhu019	23.11.2022	CNAA002662	Main Design/Drawing Introduced	-	-
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Activity Code	E	C

 WIN GD <i>Winterthur Gas & Diesel</i>	EXHAUST SYSTEM
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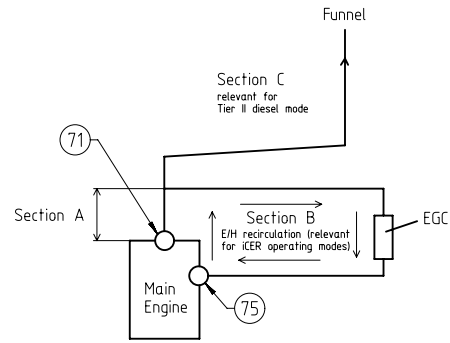
Bill Of Material		Dimension						
Copyright Winterthur Gas & Diesel Ltd. All rights reserved. By taking possession of the document the recipient recognizes and honours these rights. Neither the whole nor any part of this document may be used in any way for construction, fabrication, marketing or any other purpose nor copied in any way nor made accessible to third parties without the previous written consent of Winterthur Gas & Diesel Ltd.	Units	[m] [kg]	Basic Material		Net Weight		0.001	
	Main Design	Yes	Design Group	9726	Q-Code	XXXXX	Standard	WDS
	Qty per	Engine	A4	Item ID	PTAA044720		BOM Page/s	01/01

Specifications which must be met:

- 73** OUTLET - Exhaust gas manifold waste gate
- Size and layout of connection flange is provided in the "Pipe Connection Plan"
 - The pipe diameter must be selected according to the guidance as provided on the drawing "Specification for waste gate selection"
 - Waste gate connection pipe to main exhaust gas pipe must be kept as short as possible to avoid swirl and extensive back pressure.
- 75** INLET - Recirculated exhaust gas turbocharger
- Exhaust temperature:
- Controlled by the EGC
 - Must be always below the scavenge air temperature
- Exhaust gas piping:
- Piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid condensation draining to the turbocharger suction.
 - The piping between the exhaust gas cooler outlet and turbocharger inlet must be insulated to avoid condensation of the humid recirculating exhaust gas on the pipe wall. The same insulation standard, as used on the hot side before the cooler, must be applied on the exhaust gas return pipe accordingly.
 - To prevent water droplets in the exhaust gas flow, or water condensate on the pipe wall, from being carried over to the turbocharger, the exhaust gas return pipe must be routed below the level of the turbochargers. Condensate water drains must be arranged at the lowest point of the horizontal return manifold pipe. Different vessel trim conditions must be considered.
 - The exhaust gas return pipe must be purged by air in the counterflow direction through the SOV. The purging flow must be the total iCER casing volume, to be exchanged 4.5 times per hour with a maximum back pressure of 80 mbar.
- 6** OUTLET - Exhaust gas return pipe condensate water drain
- Drain to the iCER waste water holding tank



- 71** OUTLET - Exhaust gas turbocharger
- Exhaust gas temperature and volume flow: according to GTD
 - If the iCER diesel option is selected a NOx sensor must be installed in the exhaust gas pipe between Back Pressure Valve (BPV) and turbocharger.
 - The total back pressure of the exhaust gas system must be kept within the following ranges:
 Diesel Tier II mode in section A and C
 Design limit: From max. 30 mbar to max. 60 mbar
 Operational limit: max. 80 mbar
 iCER gas Tier III mode in section A and B
 Design limit: From max. 30 mbar to max. 45 mbar
 Operational limit: max. 55 mbar
 iCER diesel Tier III mode in section A and B
 Design limit: Not relevant for layout
 Operational limit: max. 55 mbar
 Remark: The available back pressure range provided in this drawing refers to the differential pressure between the pipe connections #71 and #75.



- The exhaust gas pipe must be insulated according to applicable rules, e.g. SOLAS.
- Pipe dimensions in relation to the exhaust gas mass flow rates are provided by table 1 on page 2.
- The exhaust piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid gases from accumulating.
- The piping layout must consider the thermal expansion and vibration from the turbocharger (TC) and main engine (ME). Thermal expansion of the ME is to be calculated according to the formula in MIM. TC specific thermal expansion is provided by the TC supplier.
- Explosion relief devices, examined and certified by the maker, with flameless pressure relief (rupture discs or self-closing, spring-loaded valves) must be selected and installed within the exhaust system in accordance with class requirements. The exact position and number of explosion relief devices must be determined by the system designer or the shipyard through calculation. Independently, which type of explosion relief devices is selected, the distance of the explosion relief device to gangways, working areas and system components must be at least 3 m to not endanger personnel and/or to avoid material damage.
- A continuous (extensive) exhaust gas leakage must be avoided.
- Supports (fixation points) for the mass of piping and exhaust gas system components must be installed in sufficient size and amount. Inadmissible tensions in the piping and forces acting on the turbocharger are not acceptable.
- Exhaust gas pipes of several engines must not be connected.
- Drains of adequate size and amount must be installed in the exhaust gas piping.
- When the noise level on the bridge wing exceeds the class requirement (normally 60 - 70 dB(A)) a silencer must be applied.
- During iCER operation, the recirculated exhaust gas must be cooled by EGC circulation water. This water must be cleaned and treated by the water treatment unit to fulfill the following requirements: A maximum solids content of 150 mg/l and a proper pH value (e.g. above pH 6).

Prod.	X72DF-2.1								
	X72DF-2.2								
Change History	C	dkl021	dst009	15.12.2023	0A004854	Drawing updated.		4	3
	B	sde101	mhu019	24.03.2023	CNAA003456	Drawing Updated		4	3
	A	npa101	dst009	21.12.2022	CNAA002993	Drawing Updated		4	3
	-	dkl021	mhu019	23.11.2022	CNAA002662	new Design		-	-
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis				

WIN GD Winterthur Gas & Diesel		EXHAUST SYSTEM 2 TC, iCER off-engine		
Dimension		2 TC, iCER off-engine		
Scale	-	Units [mm] [kg]	Basic Material	Net Weight 0.000

SURFACE PROTECTION SEE GROUP 0344		Copyright Winterthur Gas & Diesel Ltd. All rights reserved. By taking possession of the drawing the recipient recognizes and warrants these rights. Neither the whole nor any part of this drawing may be used in any way for construction, fabrication, marketing or any other purpose nor copied in any way nor made accessible to third parties without the previous written consent of Winterthur Gas & Diesel Ltd.		
TOLERANCING PRINCIPLE ISO8015		Main Design	Design Group 9726	Q-Code X X M
GENERAL TOLERANCES ACCORDING TO ISO2768-mK		Qty per	A2 Item ID	PTAA044712
			Standard	WDS
			Drawing Pages	1/3

SYSTEM PROPOSAL

NOTE
Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Short Route - Exhaust gas branch-off after turbocharger

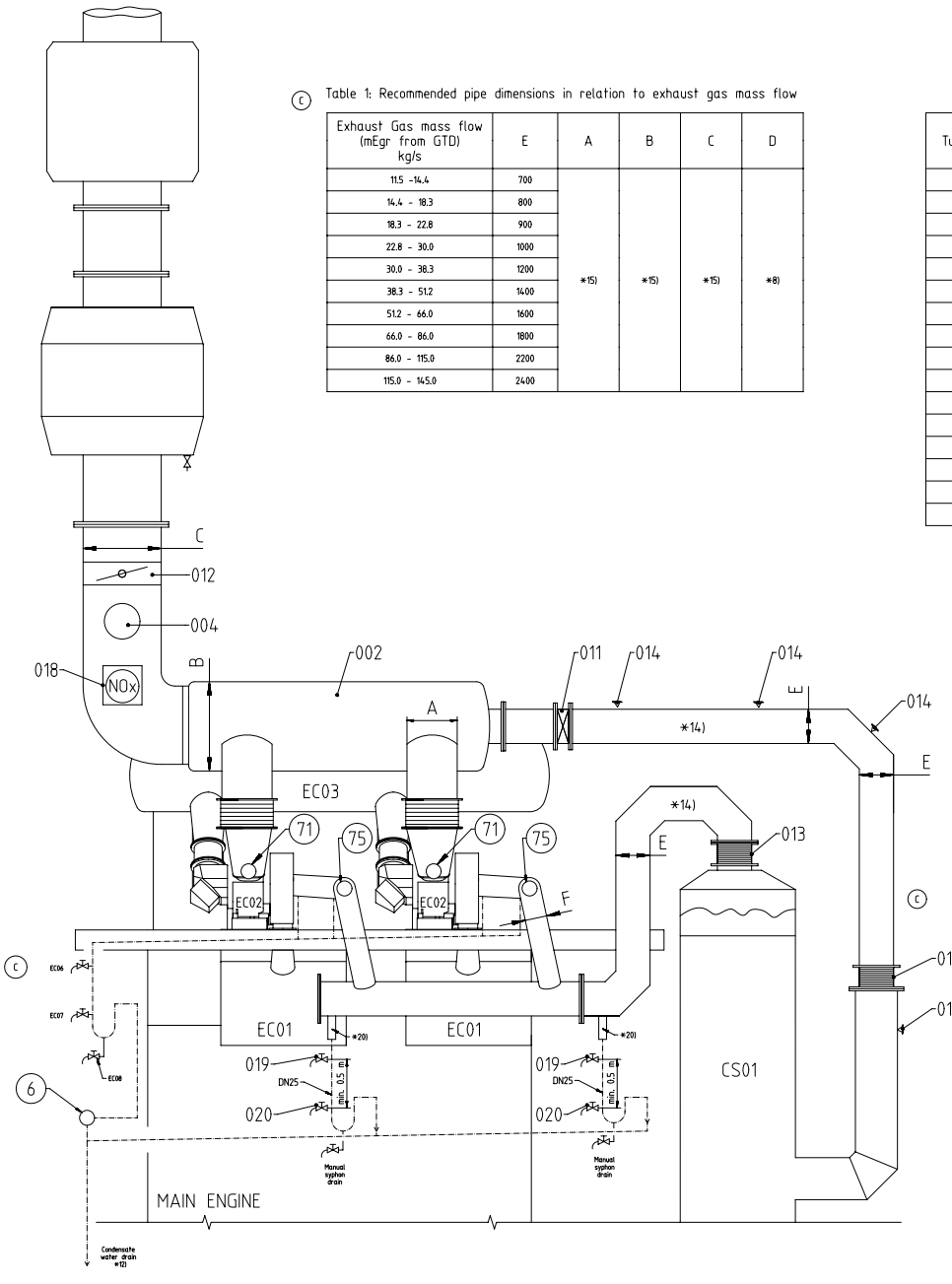
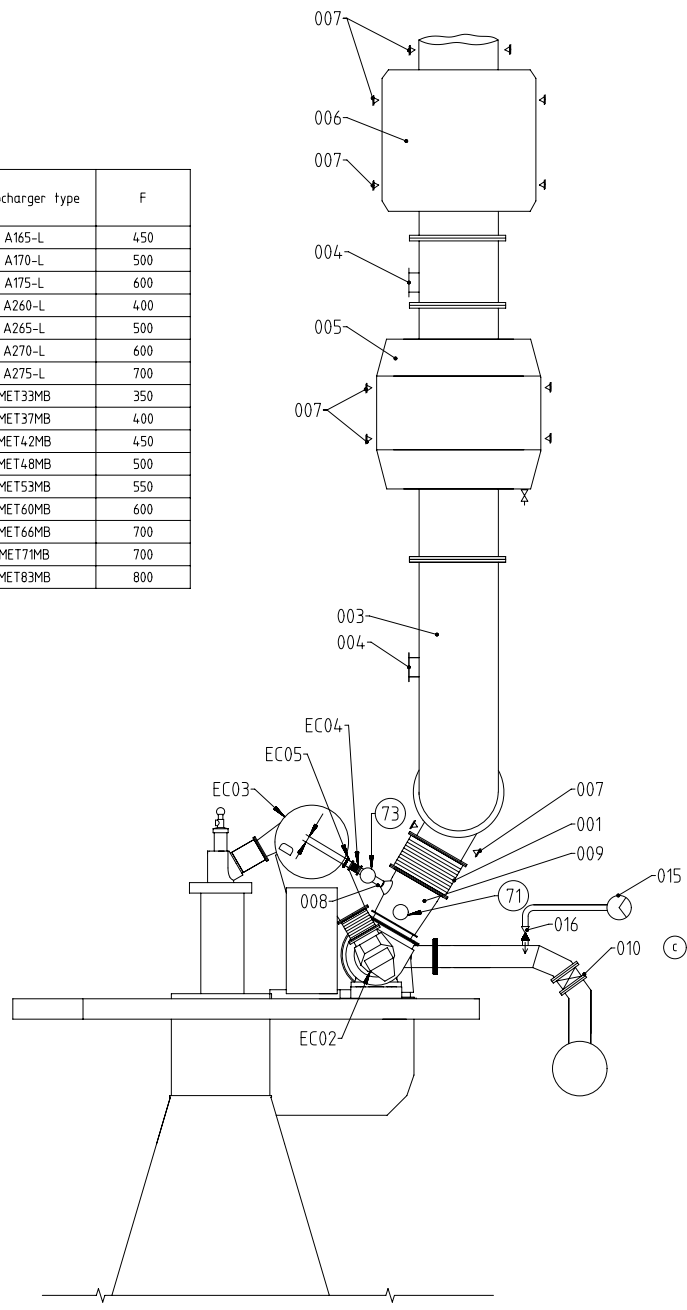


Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (mEgr from GTD) kg/s	E	A	B	C	D
11.5 - 14.4	700				
14.4 - 18.3	800				
18.3 - 22.8	900				
22.8 - 30.0	1000				
30.0 - 38.3	1200	*15)	*15)	*15)	*8)
38.3 - 51.2	1400				
51.2 - 66.0	1600				
66.0 - 86.0	1800				
86.0 - 115.0	2200				
115.0 - 145.0	2400				

Turbocharger type	F
A165-L	450
A170-L	500
A175-L	600
A260-L	400
A265-L	500
A270-L	600
A275-L	700
MET33MB	350
MET37MB	400
MET42MB	450
MET48MB	500
MET53MB	550
MET60MB	600
MET66MB	700
MET71MB	700
MET83MB	800

Pos.	COMPONENTS from certified suppliers
CS01	Exhaust Gas Cooler (EGC)



- Pos. System Components *1)
 - 001 Compensator *4)
 - 002 Exhaust gas collector
 - 003 Exhaust gas pipe
 - 004 Explosion relief device (rupture discs or spring-loaded valves) *5)
 - 005 Main Economiser
 - 006 Silencer (with spark arrester *9)
 - 007 Support *4)
 - 008 Waste gate pipe
 - 009 Transition piece *6)
 - 010 Flow Regulating Valve (FRV)
 - 011 Shut-off valve (SDV)
 - 012 Back Pressure Valve (BPV)
 - 013 Compensator in the exhaust system *13)
 - 014 ICER support *4)
 - 015 Purging and sealing air blower *20)
 - 016 Non-return valve
 - 018 NOx Sensor (as delivered by the engine builder) *21)
 - 019 Test cock 1 *16)
 - 020 Test cock 2 *17)
- Pos. Engine Connections *2)
 - ① OUTLET - Exhaust gas return pipe condensate water drain
 - ⑦ OUTLET - Exhaust gas turbocharger
 - ⑦③ OUTLET - Exhaust gas manifold waste gate
 - ⑦⑤ INLET - Recirculated exhaust gas turbocharger
- Pos. Engine Components *3)
 - EC01 Scavenge air receiver
 - EC02 Turbocharger (TC)
 - EC03 Exhaust gas manifold
 - EC04 Waste gate compensator *7) *8)
 - EC05 Waste gate valve
 - EC06 Test cock 1 *16)
 - EC07 Test cock 2 *17)
 - EC08 Manual syphon drain
- Remarks:
 - Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or aftercast).
 - The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1:1.16, taper angle $\leq 40^\circ$
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection". The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Optional, to be installed if the backpressure from the EGC exceeds the limit.
 - *11) Condensate water drain to the ICER waste water holding tank.
 - *12) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *13) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *14) The exhaust pipe dimension must be selected in accordance with the specific exhaust gas mass flow, as given by the GTD. The pipe size selection must be coordinated respectively agreed in between the shipyard and the engine builder as the valve size selection on engine side must comply accordingly.
 - *15) By opening of test cock 1 the following conditions can be checked:
 - Normal condition: No water flow but air suction.
 - Abnormal condition: Water flow, which is the indication that the drain valve is blocked in closed position.
 - *16) By opening of test cock 2 the following conditions can be checked:
 - Normal condition: No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - Abnormal condition: Water flow. Water samples can be taken.
 - *17) The condensate water collection pocket must be connected at the lowest point of the horizontal return manifold pipe.
 - *18) For the selection of the blower capacity and the arrangement of the purging and sealing air supply line refer to the guidance as provided in the RWV and ICER Installation Guidelines. The purging and sealing air system is controlled by the engine control system.
 - *19) A dedicated air supply must be connected to the sensor to provide compressed air for cleaning, with air quality level of ISO 8573-3:2010 15.2.2.

SYSTEM PROPOSAL

NOTE
Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Long Route
- Exhaust gas branch-off after economizer

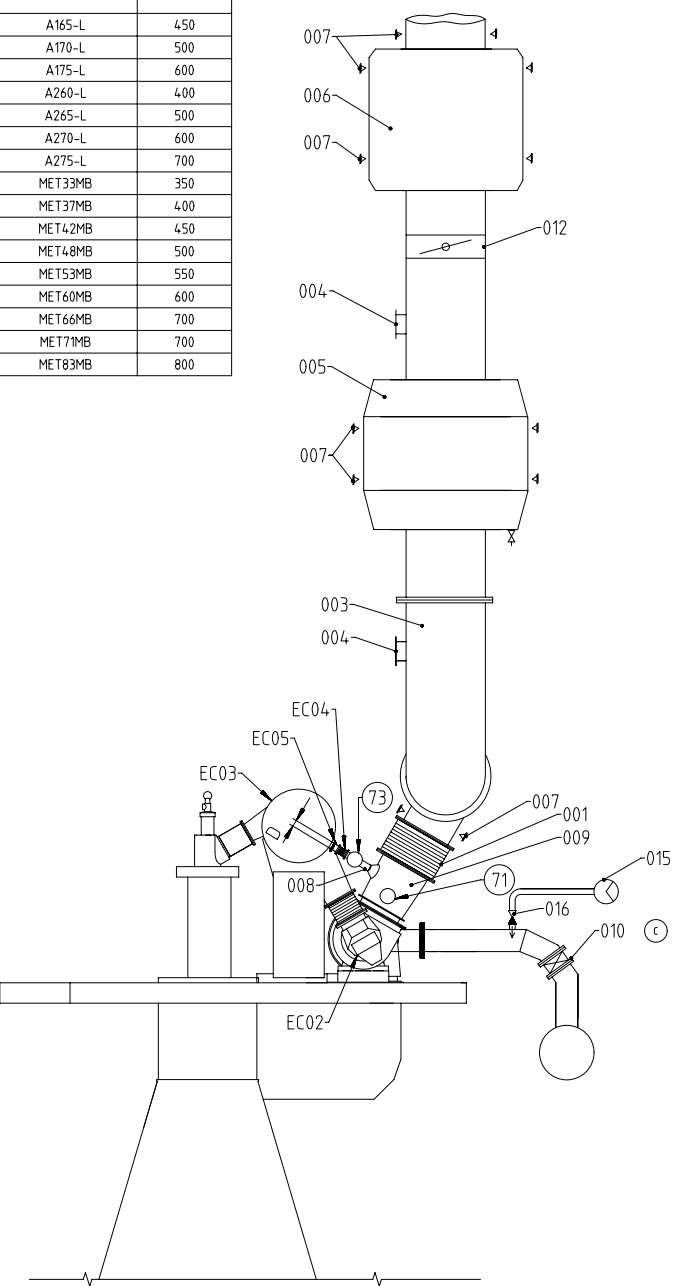
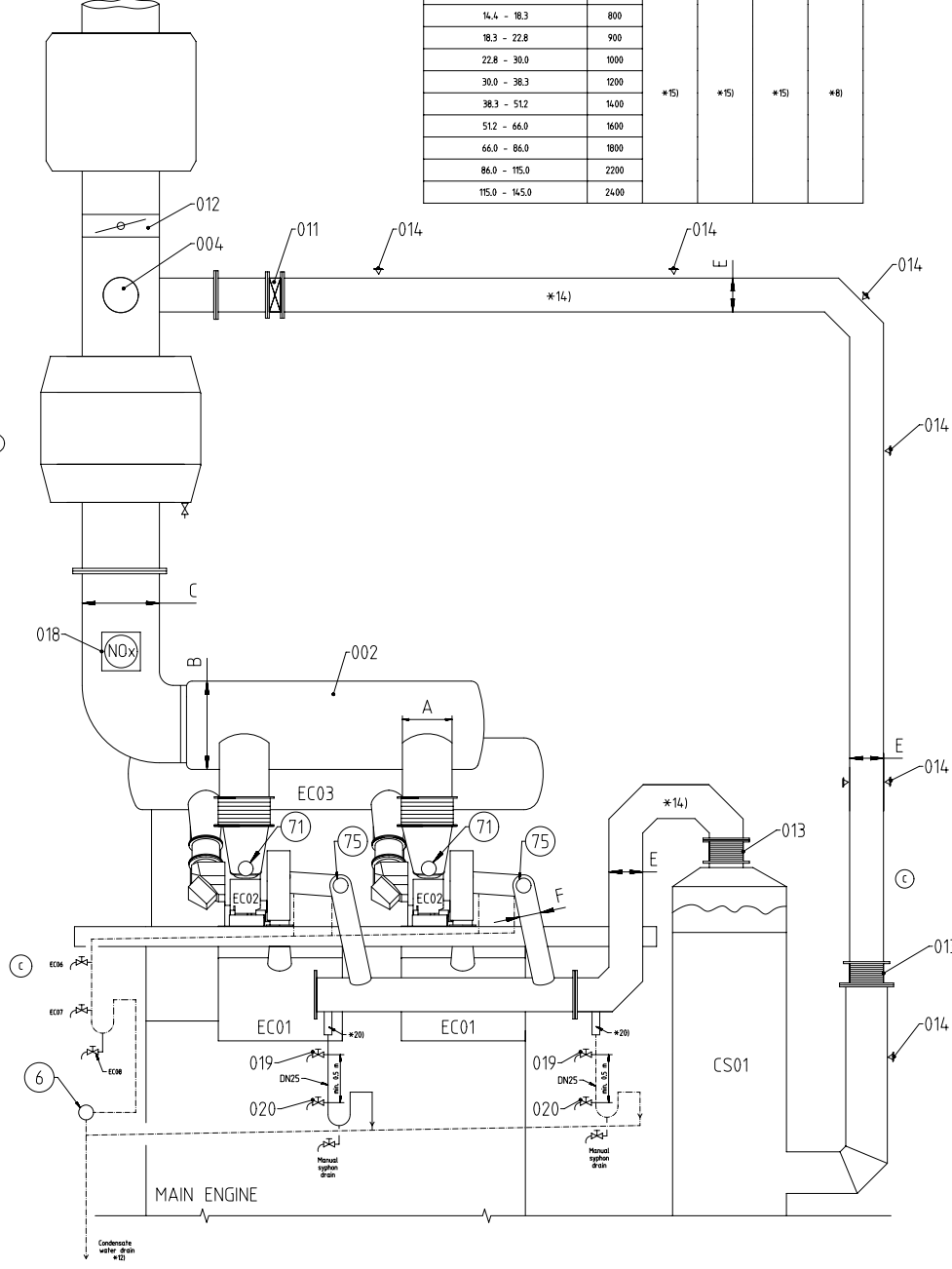
Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (mEgr from GTD) kg/s	E	A	B	C	D
11.5 - 14.4	700				
14.4 - 18.3	800				
18.3 - 22.8	900				
22.8 - 30.0	1000				
30.0 - 38.3	1200				
38.3 - 51.2	1400	*15)	*15)	*15)	*8)
51.2 - 66.0	1600				
66.0 - 86.0	1800				
86.0 - 115.0	2200				
115.0 - 145.0	2400				

Turbocharger type	F
A165-L	450
A170-L	500
A175-L	600
A260-L	400
A265-L	500
A270-L	600
A275-L	700
MET33MB	350
MET37MB	400
MET42MB	450
MET48MB	500
MET53MB	550
MET60MB	600
MET66MB	700
MET71MB	700
MET83MB	800

Pos.	COMPONENTS from certified suppliers
CS01	Exhaust Gas Cooler (EGC)

Pos.	System Components *1)
001	Compensator *4)
002	Exhaust gas collector
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) *5)
005	Main Economiser
006	Silencer (with spark arrester *9)
007	Support *4)
008	Waste gate pipe
009	Transition piece *6)
010	Flow Regulating Valve (FRV)
011	Shut-off valve (SOV)
012	Back Pressure Valve (BPV)
013	Compensator in the exhaust system *13)
014	ICER support *4)
015	Purging and sealing air blower *20)
016	Non-return valve
018	NOx Sensor (as delivered by the engine builder) *21)
019	Test cock 1 *16)
020	Test cock 2 *17)



Pos.	Engine Connections *2)
①	OUTLET - EGC condensate water
②	OUTLET - Exhaust gas turbocharger
③	OUTLET - Exhaust gas manifold waste gate
④	INLET - Recirculated exhaust gas turbocharger

Pos.	Engine Components *3)
EC01	Scavenge air receiver
EC02	Turbocharger (TC)
EC03	Exhaust gas manifold
EC04	Waste gate compensator *7) *8)
EC05	Waste gate valve
EC06	Test cock 1 *16)
EC07	Test cock 2 *17)
EC08	Manual syphon drain

- Remarks:**
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or aftercast).
 - The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrestor must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1.1..1.6, taper angle <= 40°
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 4.5 mm/s RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection". The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Optional, to be installed if the backpressure from the EGC exceeds the limit.
 - *11) To be directed to the bilge water tank. Can be connected to the SAC drain pipe from engine connection 16.
 - *12) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *13) The exhaust pipe dimension must be selected in accordance with the specific exhaust gas mass flow, as given by the GTD. The pipe size selection must be coordinated respectively agreed in between the shipyard and the engine builder as the valve size selection on engine side must comply accordingly.
 - *14) By opening of test cock 1 the following conditions can be checked.
Normal condition:
No water flow but air suction.
Abnormal condition:
Water flow, which is the indication that the drain valve is blocked in closed position.
 - *15) By opening of test cock 2 the following conditions can be checked.
Normal condition:
Water flow. Water samples can be taken.
Abnormal condition:
No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *16) The condensate water collection pocket must be connected at the lowest point of the horizontal return manifold pipe.
 - *17) For the selection of the blower capacity and the arrangement of the purging and sealing air supply line refer to the guidance as provided in the MIM and ICER Installation Guideline. The purging and sealing air system is controlled by the engine control system.
 - *18) A dedicated air supply must be connected to the sensor to provide compressed air for cleaning, with air quality level of ISO 8573-5:2010 [1:3:2].

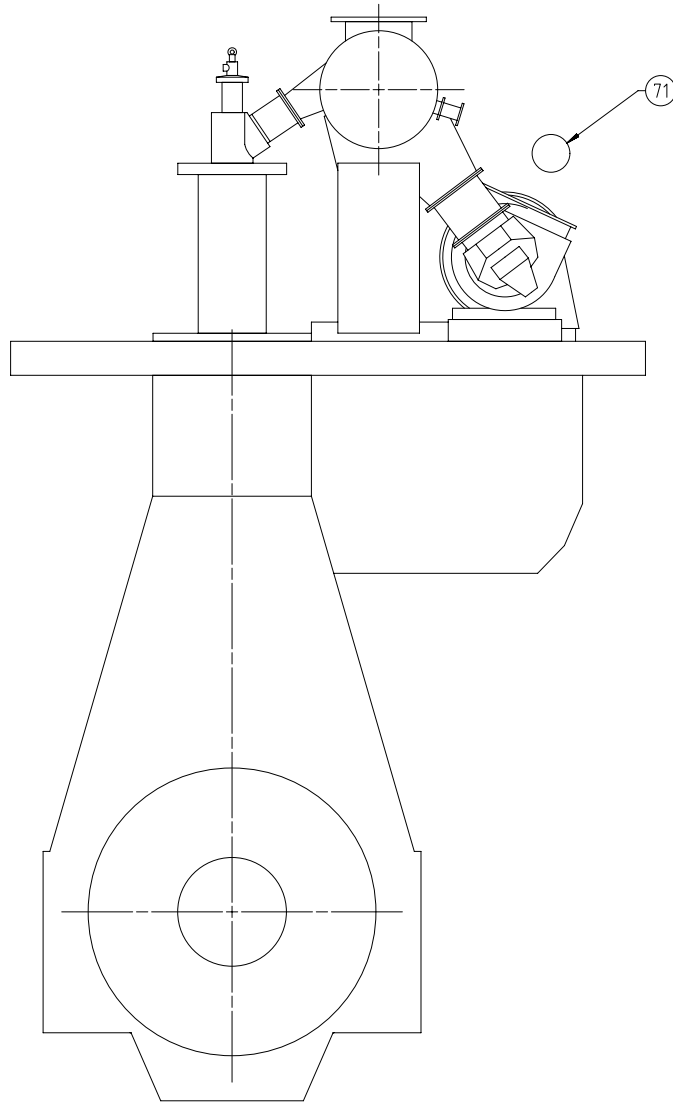
SEQ NO	QTY	Item ID	Item Name	Dimension	Standard-ID	Basic Material	Net Weight
1	1	PTAA046749	EXHAUST SYSTEM				0.001
2	1	DAAD139643	iCER INSTALLATION GUIDELINE				

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Prod.	5,6 X72DF-2.1		5,6 X72DF-2.2				
Change History							
	-	dkl021	mhu019	23.11.2022	CNAA002662	Main Design/Drawing Introduced	-
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Activity Code	E C

	<h1>EXHAUST SYSTEM</h1> <h2>with iCER on engine</h2>
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Bill Of Material		Dimension						
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	Main Design	Yes	Design Group	9726	Q-Code	XXXXX	Standard	WDS
	Qty per	Engine	A4	Item ID	PTAA046756		BOM Page/s	01/01



Specifications which must be met:

71

OUTLET - Exhaust gas turbocharger

- Exhaust gas temperature and volume flow: according to GTD
- The total back pressure of the exhaust gas system must be kept within the following ranges:

Diesel Tier II mode
 Design limit: From max. ≤ 30 mbar to max. ≤ 60 mbar
 Operation limit: max. ≤ 80 mbar

iCER gas Tier III mode
 Design limit: From max. ≤ 30 mbar to max. ≤ 45 mbar
 Operation limit: max. ≤ 55 mbar

iCER diesel Tier III mode
 Design limit: Not relevant for layout
 Operation limit: max. ≤ 55 mbar

- The exhaust gas pipe must be insulated according to applicable rules, e.g. SOLAS.
- Recommended pipe dimensions in relation to the exhaust gas mass flow rates are provided by table 1 on page 2.
- The exhaust piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid gases from accumulating.
- The piping layout must consider the thermal expansion and vibration from the turbocharger (TC) and main engine (ME). Thermal expansion of the ME is to be calculated according to the formula in MIM. TC specific thermal expansion is provided by the TC supplier.
- Explosion relief devices, examined and certified by the maker, with flameless pressure relief (rupture discs or self-closing, spring-loaded valves) must be selected and installed within the exhaust system in accordance with class requirements. The exact position and number of explosion relief devices must be determined by the system designer or the shipyard through calculation. Independently, which type of explosion relief devices is selected, the distance of the explosion relief device to gangways, working areas and system components must be at least 3 m to not endanger personnel and/or to avoid material damage.
- A continuous (extensive) exhaust gas leakage must be avoided.
- Supports (fixation points) for the mass of piping and exhaust gas system components must be installed in sufficient size and amount. Inadmissible tensions in the piping and forces acting on the turbocharger are not acceptable.
- Exhaust gas pipes of several engines must not be connected.
- Drains of adequate size and amount must be installed in the exhaust gas piping.
- When the noise level on the bridge wing exceeds the class requirement (normally 60 - 70 dB(A)) a silencer must be applied.
- During iCER operation, the recirculated exhaust gas must be cooled by EGC circulation water. This water must be cleaned and treated by the water treatment unit to fulfill the following requirements: A maximum solids content of 150 mg/l and a proper pH value (e.g. above pH 6).

Prod.	X72DF-2,1										
	X72DF-2,2										
Change History	E	dkl021	ch09	15.12.2023	0A004854	Drawing updated.			4	3	
	D	sde101	mhu019	31.03.2023	CNA003496	Drawing updated			4	3	
	C	sde101	mhu019	24.03.2023	CNA003456	Drawing Updated			4	3	
	-	dkl021	mhu019	23.11.2022	CNA002662	new Design			-	-	
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis			Approved	Activity Code	E	C

WIN GD
 Winterthur Gas & Diesel

EXHAUST SYSTEM

Scale	-		NX	Units [mm] [kg]	Basic Material	Net Weight	0.000
Dimension	iCER on engine + one turbocharger						

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TOLERANCING PRINCIPLE ISO8015		Main Design	Design Group	9726	Q-Code	X X M	Standard	WDS		
GENERAL TOLERANCES ACCORDING TO ISO2768-mK		Qty per	A2	Item ID	PTAA046749		Drawing Pages	1/2		

SYSTEM PROPOSAL

NOTE
 Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

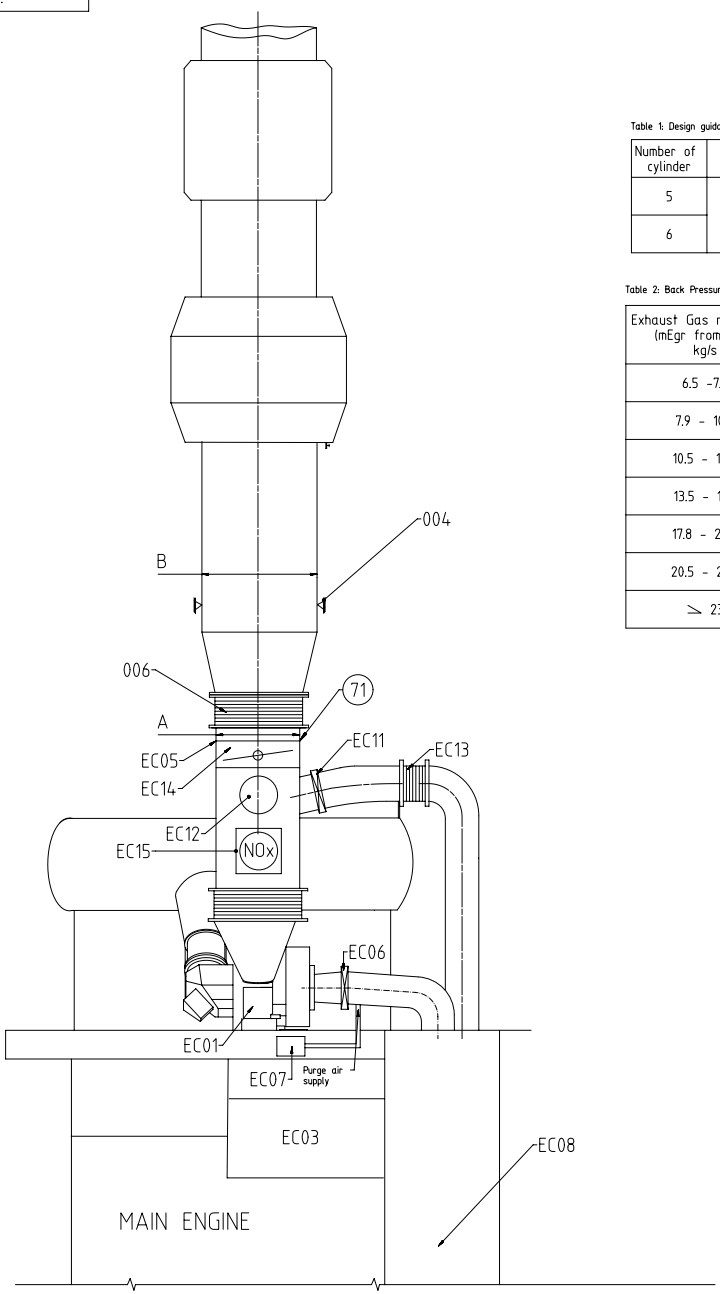
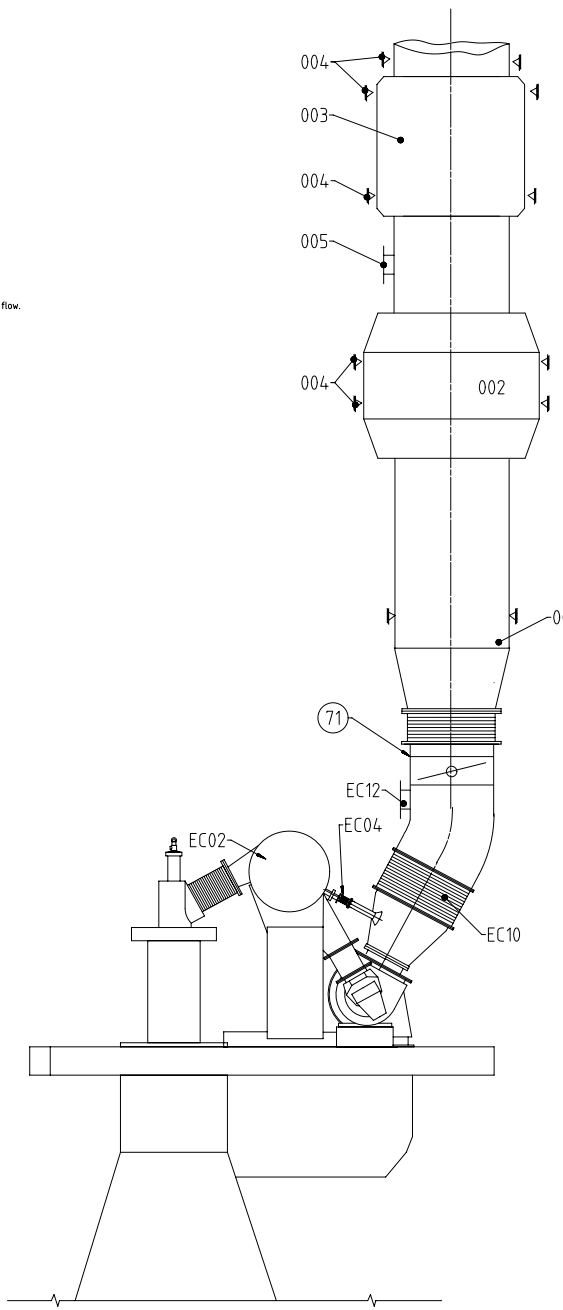


Table 1: Design guidance values for the pipe sizing

Number of cylinder	A (mm)	B (mm) *9)
5	*10)	1400
6		1500

Table 2: Back Pressure Valve (BPV) size in relation to EGR mass flow.

Exhaust Gas mass flow (mEgr from GTD) kg/s	BPV size DN
6.5 - 7.8	700
7.9 - 10.4	800
10.5 - 13.4	900
13.5 - 17.7	1000
17.8 - 20.4	1100
20.5 - 22.9	1200
≥ 23	on request



Pos.	SYSTEM COMPONENTS *2)
001	Exhaust gas pipe on the ship side
002	Main Economiser
003	Silencer (with spark arrester) *5)
004	Support *4)
005	Explosion relief device *6)
006	Compensator in the exhaust pipe on the ship side *7) *10)

Pos.	ENGINE CONNECTIONS *1)
71	OUTLET - Exhaust gas turbocharger

Pos.	ENGINE COMPONENTS *3)
EC01	Turbocharger
EC02	Exhaust gas manifold
EC03	Scavenge air receiver
EC04	Waste gate with waste gate valve, compensator and connection pipe
EC05	Connection piece between the exhaust pipe on engine side and on ship side
EC06	Flow Regulating (shut-off) Valve
EC07	Purging control
EC08	Exhaust Gas Cooler (EGC) with two stages
EC10	Compensator between engine and exhaust gas system
EC11	Shut-off valve
EC12	Explosion relief device
EC13	Compensator in the ICR exhaust gas system
EC14	Back Pressure Valve (BPV)
EC15	NOx Sensor *8)

Remarks:

- Drain plugs and drain cocks to be installed where necessary.
- *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
- *2) To be installed by the shipyard.
- *3) To be delivered by the engine builder, i.e. already equipped on engine side.
- *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise).
The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
- *5) Optional, installed as required to meet noise requirements.
- *6) When rupture discs are installed, preventive measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
- *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
- *8) A dedicated air supply must be connected to the sensor to provide compressed air for cleaning, with air quality level of ISO 8573-1:2009 (1,1,2).
- *9) The provided dimensions are based on the design velocity of max. 40 m/s and consider the volume flow of an R1 rated engine. They serve only as a proposal, project specific optimisations, based on the actual value in GTD, are possible.
- *10) The pipe diameter and corresponding compensator size must be selected in relation to the required back pressure valve (BPV) size, which is defined in table 2, in relation to the EGR mass flow.

Available executions

Execution No.	Material ID	Cylinder No.	Attribute 1: Turbocharger amount		Attribute 2: iCER location	
			1	2	off-engine	on-engine
001	PAAD359869	5-7	X		X	
002	PTAA027995	8		X	X	
003	PTAA025526	5-7	X			X

NOTE

The above executions can be configured using the Engine Configurator. Detailed guidance for the executions is provided within the Marine Installation Manual (MIM). If a specific execution of interest is not shown in the above table, then it may still be under development or not available. For further information or in case of a project-specific request, WinGD must be contacted directly.

This publication is designed to provide accurate and authoritative information with regard to the subject-matter covered as it was available at the time of printing. However, the publication deals with complicated technical matters suited only for specialists in the area, and the design of the subject-products is subject to regular improvements, modifications and changes. Consequently, the publisher and copyright owner of this publication cannot accept any responsibility or liability for any eventual errors or omissions in this document or for discrepancies arising from the features of any actual item in the respective product being different from those shown in this publication. The publisher and copyright owner shall under no circumstances be held liable for any financial consequential damages or other loss, or any other damage or injury, suffered by any party making use of this publication or the information contained herein.

Prod.	X72DF-2.1 X72DF-2.2								
Change History									
	-	mhu019				new Design			
	Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Activity Code	E	C

WIN GD
Winterthur Gas & Diesel

EXHAUST SYSTEM
MIDS master drawing

separate BOM available


Dimension

Scale	-		Units [mm] [kg]	Basic Material	Net Weight	0.006
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Qty per	A4	Item ID	PTAA014179		Drawing Page/s	1/1

SEQ NO	QTY	Item ID	Item Name	Dimension	Standard-ID	Basic Material	Net Weight
1	1	PAAD359572	Exhaust System	with one turbocharger			0.001
2	1	PAAD327310	SPECIFICATION				0.001
3	1	DAAD139643	GUIDELINES				

NOT VALID FOR NEW PROJECTS!
 Provided only as reference for projects
 contracted before April 2022

Prod.	5,6,7 X72DF-2.1		5,6 X72DF-2.2						
Change History	B	mhu019	dst009	14.07.2021	CNAA000233	drawing updated		-	-
	A	mhu019	dst009	05.02.2021	EAAD096015	Legacy information. See corresponding ChangeNotice		4	3
	-	dki021	mhu019	07.12.2020		-		-	-
	Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Activity Code	E	C

	Exhaust System
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Bill Of Material		Dimension						
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	Main Design	Yes	Design Group	9726	Q-Code XXXXX	Standard	WDS	
	Qty per	Engine	A4	Item ID	PAAD359869		BOM Page/s	01/01

Specifications which must be met:

- 73** OUTLET - Exhaust gas manifold waste gate
 - Size and layout of connection flange is provided in the "Pipe Connection Plan"
 - The pipe diameter must be selected according to the guidance as provided on the drawing "Specification for waste gate selection".
 - The waste gate connection pipe, as connected to the main exhaust gas pipe, must be kept as short as possible to avoid swirl and extensive back pressure.
- 75** INLET - Recirculated exhaust gas turbocharger

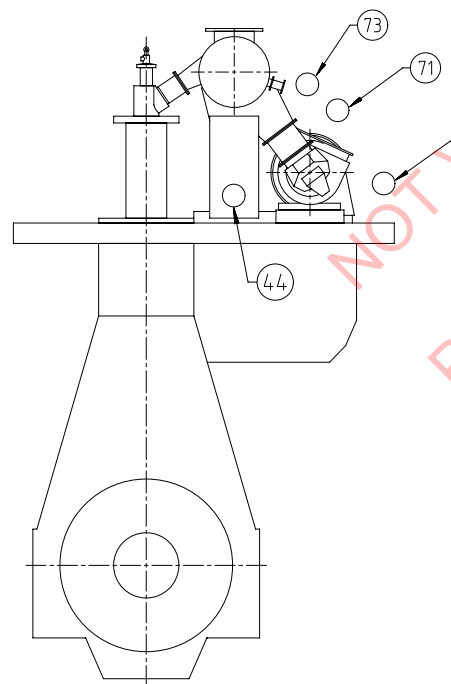
Exhaust temperature:

 - Controlled by the EGC
 - Must be always below the scavenge air temperature

Exhaust gas piping:

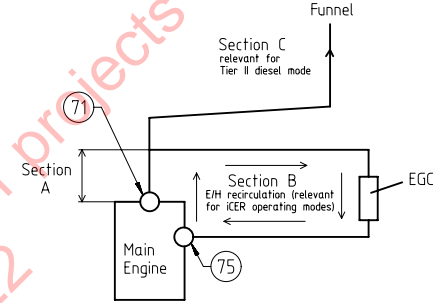
 - Piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid condensation draining to the turbocharger suction.
 - The piping between the exhaust gas cooler outlet and turbocharger inlet must be insulated to avoid condensation of the humid recirculating exhaust gas on the pipe wall. The same insulation standard, as used on the hot side before the cooler, must be applied on the exhaust gas return pipe accordingly.
- 44** OUTLET - EGC purge air supply

The purge air supply line must be connected upstream from the water mist catcher to the EGC exhaust gas return pipe. For the detailed layout of the connection and installation variants please refer to "The iCER Installation Guideline".



- 71** OUTLET - Exhaust gas turbocharger
 - Exhaust gas temperature and volume flow: according to GTD
 - The total back pressure of the exhaust gas system must be kept within the following ranges:
 - Diesel Tier II mode in section A and C
Design limit: From max. 30 mbar to max. 60 mbar
Operational limit: max. 80 mbar
 - iCER gas Tier III mode in section A and B
Design limit: From max. 20 mbar to max. 35 mbar
Operational limit: max. 45 mbar
 - iCER diesel Tier III mode in section A and B
Design limit: Not relevant in layout
Operational limit: max. 55 mbar

Remark: The available back pressure range provided in this drawing refers to the differential pressure between the pipe connections #71 and #75. An additional layout back pressure of 10 mbar is caused by the water mist catcher which is integrated into the engine. In the GTD, the available back pressure range refers specifically to the back pressure between the turbocharger inlet and outlet. As a result, the GTD provides a back pressure range which is 10 mbar higher.



- The exhaust gas pipe must be insulated according to applicable rules, e.g. SOLAS. Recommended pipe dimensions in relation to the exhaust gas mass flow rates are provided by table 1 on page 2.
- The exhaust piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid gases from accumulating.
- The piping layout must consider the thermal expansion and vibration from the turbocharger (TC) and main engine (ME). Thermal expansion of the ME is to be calculated according to the formula in MIM. TC specific thermal expansion is provided by the TC supplier.
- Explosion relief devices, examined and certified by the maker, with flameless pressure relief (rupture discs or self-closing, spring-loaded valves) must be selected and installed within the exhaust system in accordance with class requirements. The exact position and number of explosion relief devices must be determined by the system designer or the shipyard through calculation. Independently, which type of explosion relief devices is selected, the distance of the explosion relief device to gangways, working areas and system components must be at least 3 m to not endanger personnel and/or to avoid material damage.
- A continuous (extensive) exhaust gas leakage must be avoided.
- Supports (fixation points) for the mass of piping and exhaust gas system components must be installed in sufficient size and amount. Inadmissible tensions in the piping and forces acting on the turbocharger are not acceptable.
- Exhaust gas pipes of several engines must not be connected.
- Drains of adequate size and amount must be installed in the exhaust gas piping.
- When the noise level on the bridge wing exceeds the class requirement (normally 60 - 70 dB(A)) a silencer must be applied.
- During iCER operation, the recirculated exhaust gas must be cooled by EGC circulation water. This water must be cleaned and treated by the water treatment unit to fulfill the following requirements: A maximum solids content of 150 mg/l and a proper pH value (e.g. above pH 6).

Prod.	X72DF-2,1 X72DF-2,2									
Change History	F	npa101	dst009	20.12.2022	CNA002993	Drawing Updated			4	3
	E	dk021	mhu019	23.11.2022	CNA002662	Drawing Updated			4	3
	D	sna102	mhu019	08.03.2022	CNA001599	Drawing Updated			4	3
	-	dk021	mhu019	07.12.2020	-	-			-	-
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Approved	Activity Code	E	C	

WINGD
Winterthur Gas & Diesel

EXHAUST SYSTEM

Dimension: with one turbocharger

Scale: 1:1 Units [mm] [kg] Basic Material Net Weight 0.001

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TOLERANCING PRINCIPLE ISO8015		Main Design	Design Group 9726 Q-Code XXXXX Standard WDS
GENERAL TOLERANCES ACCORDING TO ISO2768-mK		Qty per	A2 Item ID PAAD359572 Drawing Pages 1/3

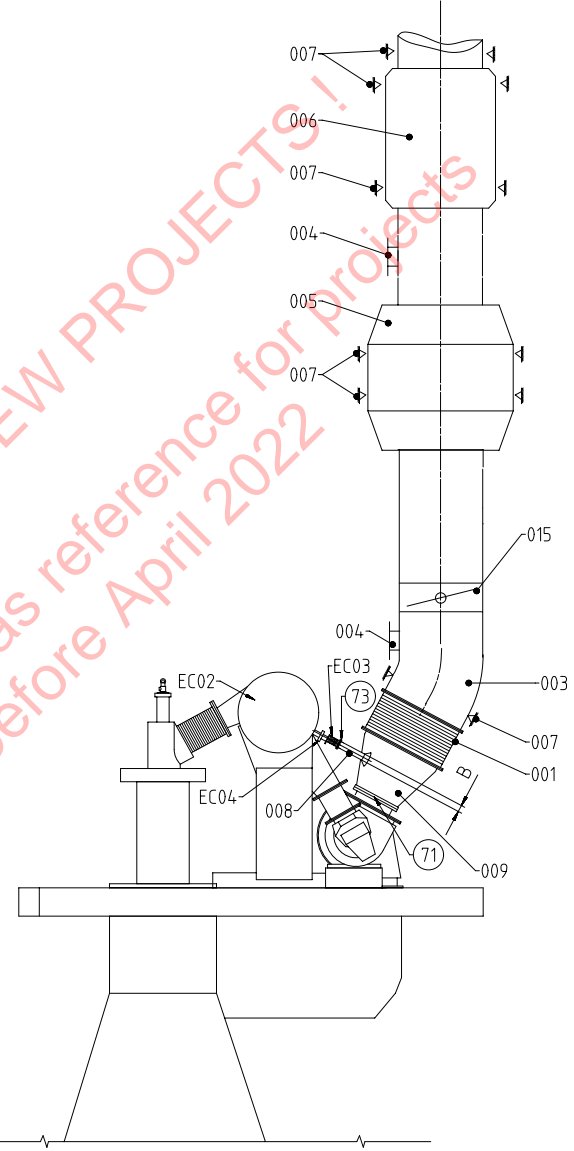
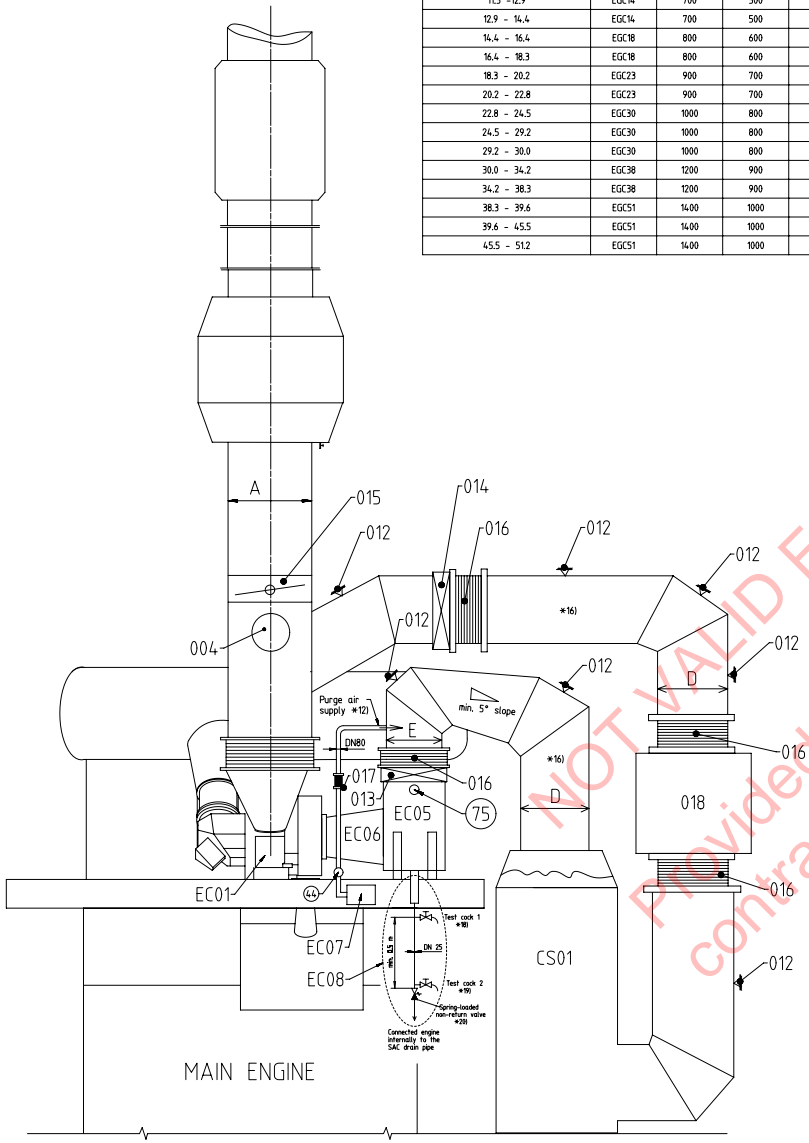
SYSTEM PROPOSAL

NOTE
 Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Short Route
 - Exhaust gas branch-off after turbocharger

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (turbine flow from GTD) kg/s	EGC Size	D	E	A** ¹⁵⁾	B
11.5 - 12.9	EGC14	700	500	800	*9)
12.9 - 14.4	EGC14	700	500	900	
14.4 - 16.4	EGC18	800	600	1000	
16.4 - 18.3	EGC18	800	600	1000	
18.3 - 20.2	EGC23	900	700	1000	
20.2 - 22.8	EGC23	900	700	1100	
22.8 - 24.5	EGC30	1000	800	1100	
24.5 - 29.2	EGC30	1000	800	1200	
29.2 - 30.0	EGC30	1000	800	1300	
30.0 - 34.2	EGC38	1200	900	1300	
34.2 - 38.3	EGC38	1200	900	1400	
38.3 - 39.6	EGC51	1400	1000	1400	
39.6 - 45.5	EGC51	1400	1000	1500	
45.5 - 51.2	EGC51	1400	1000	1600	



Pos.	SYSTEM COMPONENTS *2)
001	Compensator between engine and exhaust gas system *8)
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) *5)
005	Main Economiser
006	Silencer (with spark arrester) *10)
007	Support *4)
008	Waste gate pipe
009	Transition piece *6)
012	(KER support *4)
013	Flow Regulating Valve (FRV) *13)
014	Shut-off valve (SOV) *13)
015	Back Pressure Valve (BPV) *13)
016	Compensator in the exhaust system *17)
017	Compensator in the purge air supply pipe *12)
018	Additional Economiser *11)

Pos.	ENGINE CONNECTIONS *1)
①	OUTLET - Exhaust gas turbocharger
②	OUTLET - Exhaust gas manifold waste gate
③	INLET - Recirculated exhaust gas turbocharger
④	OUTLET - EGC purge air supply

Pos.	ENGINE COMPONENTS *3)
EC01	Turbocharger
EC02	Exhaust gas manifold
EC03	Waste gate compensator *8) *9)
EC04	Waste gate valve
EC05	Water mist catcher (WMC)
EC06	Turbocharger connection piece (cone)
EC07	Engine mounted purging and sealing air blower
EC08	Condensate drain collection pocket with drain pipe, check valves and relief valve

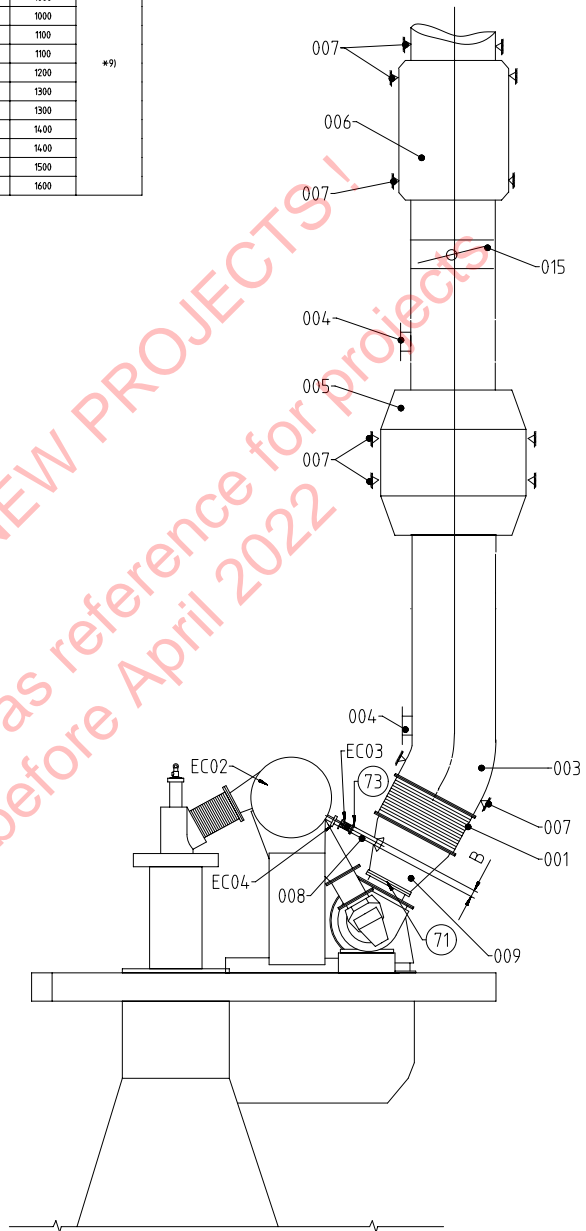
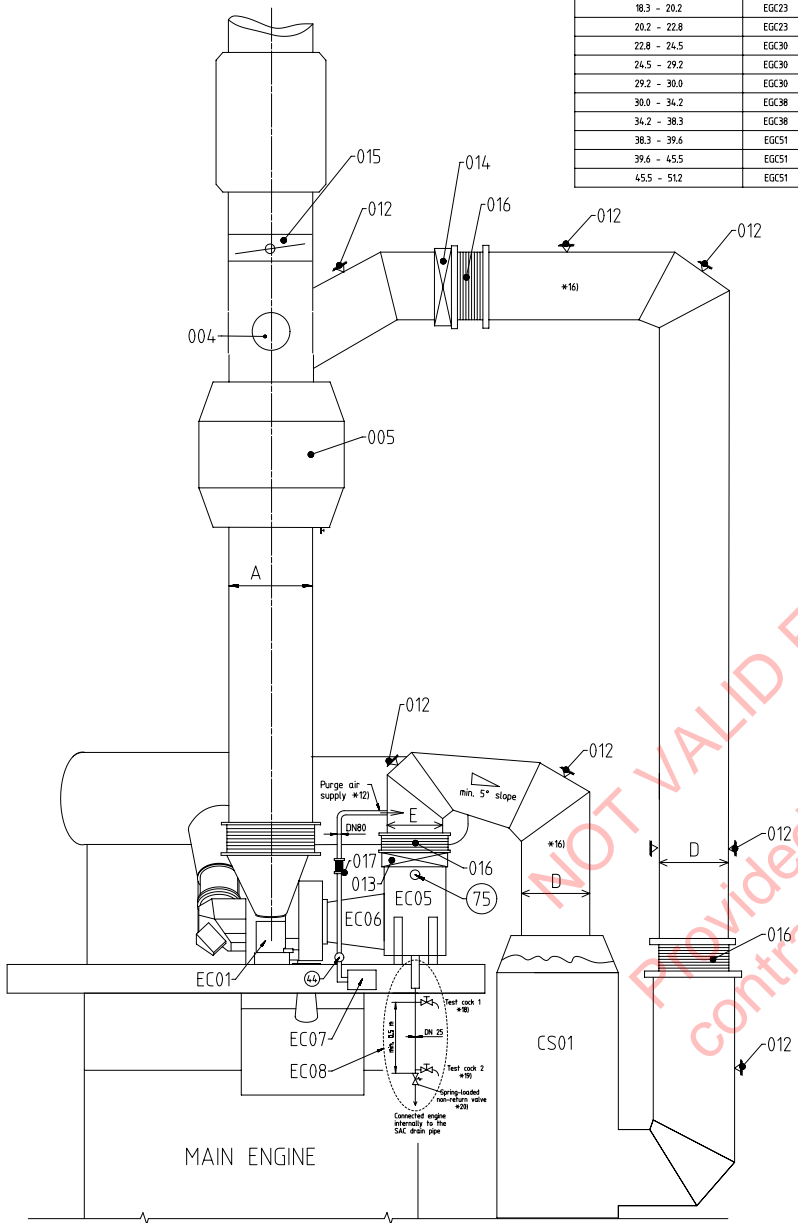
Pos.	COMPONENTS from certified suppliers *14)
CS01	Exhaust Gas Cooler (EGC)

- Remarks:
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise).
 - The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1:1.16, taper angle ≤ 40°
 - *8) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *9) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection". The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side before the compensator.
 - *10) Optional, installed as required to meet noise requirements.
 - *11) Optional, in combination with the main economiser if ship's steam demand cannot be covered by the economiser in the upper exhaust gas pipe after the back pressure valve.
 - *12) The purge air supply line must be connected upstream from the water mist catcher to the EGC exhaust gas return pipe. A compensator must be applied with the shown layout. Other installation variants, as shown in "The KER Installation Guideline", e.g. with connection via intermediate piece between water mist catcher and exhaust pipe and without compensator, are possible.
 - *13) Valve size to be selected in accordance with actual exhaust gas mass flow.
 - *14) To be supplied by a certified supplier. Ordering to be coordinated between shipyard and engine builder.
 - *15) Based on a design velocity of max. 40 m/s
 - *16) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *17) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *18) By opening of test cock 1 the following conditions can be checked:
 Normal condition:
 No water flow but air suction.
 Abnormal condition:
 Water flow, which is the indication that the drain valve is blocked in closed position.
 - *19) By opening of test cock 2 the following conditions can be checked:
 Normal condition:
 Water flow, Water samples can be taken.
 Abnormal condition:
 No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *20) Valve opening at 25 mbar.

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (turbine flow from GTD) kg/s	EGC Size	D	E	A**8	B
11.5 - 12.9	EGC14	700	500	800	*9)
12.9 - 14.4	EGC14	700	500	900	
14.4 - 16.4	EGC18	800	600	1000	
16.4 - 18.3	EGC18	800	600	1000	
18.3 - 20.2	EGC23	900	700	1000	
20.2 - 22.8	EGC23	900	700	1100	
22.8 - 24.5	EGC30	1000	800	1100	
24.5 - 29.2	EGC30	1000	800	1200	
29.2 - 30.0	EGC30	1000	800	1300	
30.0 - 34.2	EGC38	1200	900	1300	
34.2 - 38.3	EGC38	1200	900	1400	
38.3 - 39.6	EGC51	1400	1000	1400	
39.6 - 45.5	EGC51	1400	1000	1500	
45.5 - 51.2	EGC51	1400	1000	1600	

NOTE
Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".



Pos.	SYSTEM COMPONENTS *2)
001	Compensator between engine and exhaust gas system *8)
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) *5)
005	Main Economiser
006	Silencer (with spark arrester) *10)
007	Support *4)
008	Waste gate pipe
009	Transition piece *6)
012	(KER support) *4)
013	Flow Regulating Valve (FRV) *13)
014	Shut-off valve (SOV) *13)
015	Back Pressure Valve (BPV) *13)
016	Compensator in the exhaust system *17)
017	Compensator in the purge air supply pipe *12)

Pos.	ENGINE CONNECTIONS *1)
⑦1	OUTLET - Exhaust gas turbocharger
	OUTLET - Exhaust gas manifold waste gate
	INLET - Recirculated exhaust gas turbocharger
	OUTLET - EGC purge air supply

Pos.	ENGINE COMPONENTS *3)
EC01	Turbocharger
EC02	Exhaust gas manifold
EC03	Waste gate compensator *8) *9)
EC04	Waste gate valve
EC05	Water mist catcher (WMC)
EC06	Turbocharger connection piece (cone)
EC07	Engine mounted purging and sealing air blower
EC08	Condensate drain collection pocket with drain pipe, check valves and relief valve

Pos.	COMPONENTS from certified suppliers *14)
CS01	Exhaust Gas Cooler (EGC)

- Remarks:
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise).
The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventive measures must be taken to ensure that exhaust gas does not continuously flow to the sea after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1:1.16, taper angle ≤ 40°
 - *8) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *9) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection".
The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *10) Optional, installed as required to meet noise requirements.
 - *12) The purge air supply line must be connected upstream from the water mist catcher to the EGC exhaust gas return pipe. A compensator must be applied with the shown layout. Other installation variants, as shown in "The KER Installation Guideline", e.g. with connection via intermediate piece between water mist catcher and exhaust pipe and without compensator, are possible.
 - *13) Valve size to be selected in accordance with actual exhaust gas mass flow.
 - *14) To be supplied by a certified supplier. Ordering to be coordinated between shipyard and engine builder.
 - *15) Based on a design velocity of max. 40 m/s
 - *16) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *17) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *18) By opening of test cock 1 the following conditions can be checked:
Normal condition:
No water flow but air suction.
Abnormal condition:
Water flow, which is the indication that the drain valve is blocked in closed position.
 - *19) By opening of test cock 2 the following conditions can be checked:
Normal condition:
Water flow. Water samples can be taken.
Abnormal condition:
No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *20) Valve opening at 25 mbar.

SEQ NO	QTY	Item ID	Item Name	Dimension	Standard-ID	Basic Material	Net Weight
1	1	PTAA027994	Exhaust System	with two turbocharger			0.001
2	1	PAAD327310	SPECIFICATION	FOR WASTE GATE SELECTION			0.001
3	1	DAAD139643	iCER Installation Guideline				

NOT VALID FOR NEW PROJECTS!
 Provided only as reference for projects
 contracted before April 2022

Proc.	8 X72DF-2.1							
Change History								
	-	mhu019	dst009	08.03.2022	CNAA001600	Main Design/Drawing Introduced	-	-
	Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Activity Code	E C

	EXHAUST SYSTEM
--	----------------

Bill Of Material		Dimension	
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	Main Design	Yes	Design Group
	Qty per	Engine	A4
			Item ID
			PTAA027995
			Net Weight
			0
			Q-Code
			XXXXX
			Standard
			WDS
			BOM Page/s
			01/01

Specifications which must be met:

73 OUTLET - Exhaust gas manifold waste gate

- Size and layout of connection flange is provided in the "Pipe Connection Plan"
- The pipe diameter must be selected according to the guidance as provided on the drawing "Specification for waste gate selection"
- Waste gate connection pipe to main exhaust gas pipe must be kept as short as possible to avoid swirl and extensive back pressure.

75 INLET - Recirculated exhaust gas turbocharger

Exhaust temperature:

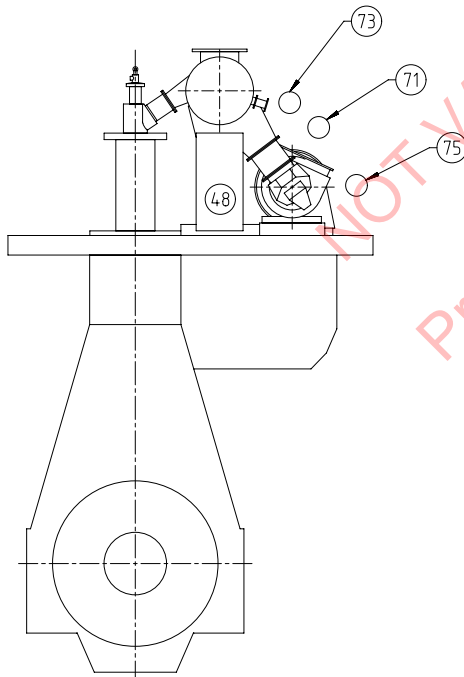
- Controlled by the EGC
- Must be always below the scavenge air temperature

Exhaust gas piping:

- Piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid condensation draining to the turbocharger suction.
- The piping between the exhaust gas cooler outlet and turbocharger inlet must be insulated to avoid condensation of the humid recirculating exhaust gas on the pipe wall. The same insulation standard, as used on the hot side before the cooler, must be applied on the exhaust gas return pipe accordingly.
- To prevent water droplets in the exhaust gas flow, or water condensate on the pipe wall, from being carried over to the turbocharger, the exhaust gas return pipe must be routed below the level of the turbochargers. Condensate water drains must be arranged at the lowest point of the horizontal return manifold pipe. Different vessel trim conditions must be considered.

48 OUTLET - EGC purge air supply

- The purge air supply must be connected upstream from the flow regulating valve in the aftmost exhaust gas return branch.



71 OUTLET - Exhaust gas turbocharger

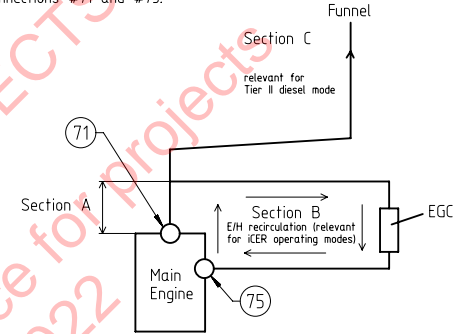
- Exhaust gas temperature and volume flow: according to GTD
- The total back pressure of the exhaust gas system must be kept within the following ranges:

Diesel Tier II mode in section A and C
Design limit: From max. 30 mbar to max. 60 mbar
Operational limit: max. 80 mbar

iCER gas Tier III mode in section A and B
Design limit: From max. 30 mbar to max. 45 mbar
Operational limit: max. 55 mbar

iCER diesel Tier III mode in section A and B
Design limit: Not relevant in layout
Operational limit: max. 55 mbar

Remark: The available back pressure range provided in this drawing refers to the differential pressure between the pipe connections #71 and #75.



- The exhaust gas pipe must be insulated according to applicable rules, e.g. SOLAS.
- Recommended pipe dimensions in relation to the exhaust gas mass flow rates are provided by table 1 on page 2.
- The exhaust piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid gases from accumulating.
- The piping layout must consider the thermal expansion and vibration from the turbocharger (TC) and main engine (ME). Thermal expansion of the ME is to be calculated according to the formula in MIM. TC specific thermal expansion is provided by the TC supplier.
- Explosion relief devices, examined and certified by the maker, with flameless pressure relief (rupture discs or self-closing, spring-loaded valves) must be selected and installed within the exhaust system in accordance with class requirements. The exact position and number of explosion relief devices must be determined by the system designer or the shipyard through calculation. Independently, which type of explosion relief devices is selected, the distance of the explosion relief device to gangways, working areas and system components must be at least 3 m to not endanger personnel and/or to avoid material damage.
- A continuous (extensive) exhaust gas leakage must be avoided.
- Supports (fixation points) for the mass of piping and exhaust gas system components must be installed in sufficient size and amount. Inadmissible tensions in the piping and forces acting on the turbocharger are not acceptable.
- Exhaust gas pipes of several engines must not be connected.
- Drains of adequate size and amount must be installed in the exhaust gas piping.
- When the noise level on the bridge wing exceeds the class requirement (normally 60 - 70 dB(A)) a silencer must be applied.
- During iCER operation, the recirculated exhaust gas must be cooled by EGC circulation water. This water must be cleaned and treated by the water treatment unit to fulfill the following requirements: A maximum solids content of 150 mg/l and a proper pH value (e.g. above pH 6).

Prod.		Rev.		Date		Change ID		Change Synopsis		Approved	Activity Code	E	C
Change History	B	hpa101	dst009	20.12.2022	CNA002993	Drawing Updated				4	3		
	A	dkl021	mhu019	23.11.2022	CNA002662	Drawing Updated				4	3		
	-	mhu019	dst1009	08.03.2022	CNA001600	New Design				-	-		
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Approved		Activity Code		E	C		
WIN GD Winterthur Gas & Diesel		EXHAUST SYSTEM											
Dimension											with two turbocharger		
Scale	-	NX		Units [mm] [kg]	Basic Material	Net Weight		0.000					
SURFACE PROTECTION SEE GROUP 0344				Copyright Winterthur Gas & Diesel Ltd. All rights reserved. By taking possession of the drawing the recipient recognizes and transfers these rights. Neither the whole nor any part of this drawing may be used in any way for construction, fabrication, marketing or any other purpose nor copied in any way nor made accessible to third parties without the previous written consent of Winterthur Gas & Diesel Ltd.									
TOLERANCING PRINCIPLE ISO8015				Main Design		Design Group		9726		Q-Code XXXXX		Standard WDS	
GENERAL TOLERANCES ACCORDING TO ISO2768-mK				Qty per		Item ID		A2		PTAA027994		Drawing Page/s 1/3	

SYSTEM PROPOSAL

NOTE
Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Short Route
- Exhaust gas branch-off after turbocharger

Pos.	COMPONENTS from certified suppliers
CS01	Exhaust Gas Cooler (EGC)

Pos.	System Components *1)
001	Compensator *4)
002	Exhaust gas collector
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) *5)
005	Main Economiser
006	Silencer (with spark arrester) *9)
007	Support *4)
008	Waste gate pipe
009	Transition piece *6)
010	Flow Regulating Valve (FRV)
011	Shut-off valve (SOV)
012	Back Pressure Valve (BPV)
013	Compensator in the exhaust system *13)
014	KEER support *4)
015	Additional Economiser *10)

Pos.	Engine Connections *2)
(48)	OUTLET - EGC purge air supply
(71)	OUTLET - Exhaust gas turbocharger
(73)	OUTLET - Exhaust gas manifold waste gate
(75)	INLET - Recirculated exhaust gas turbocharger

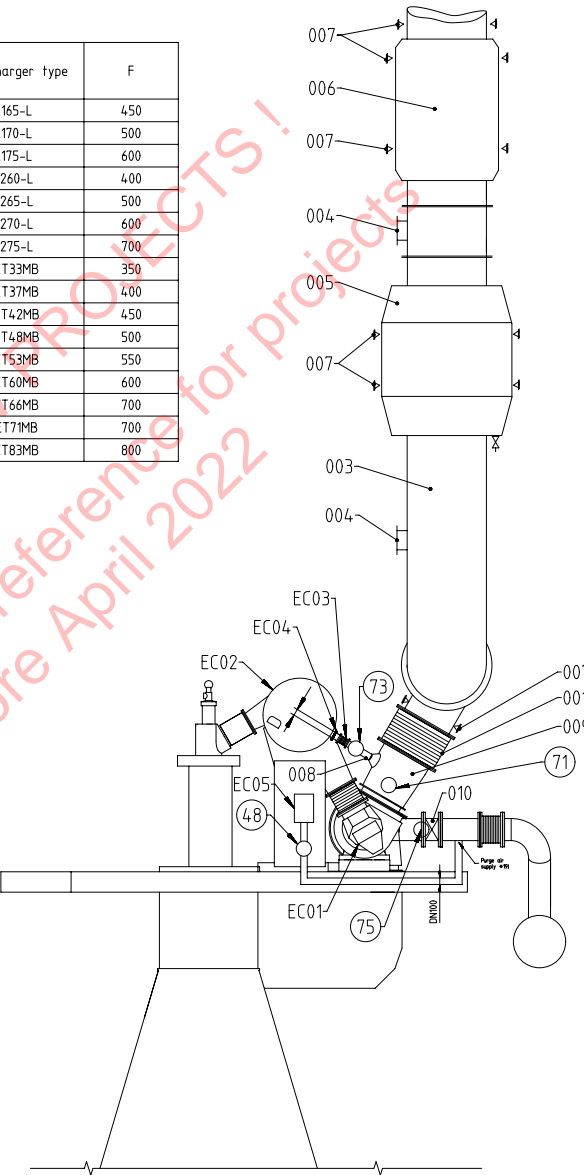
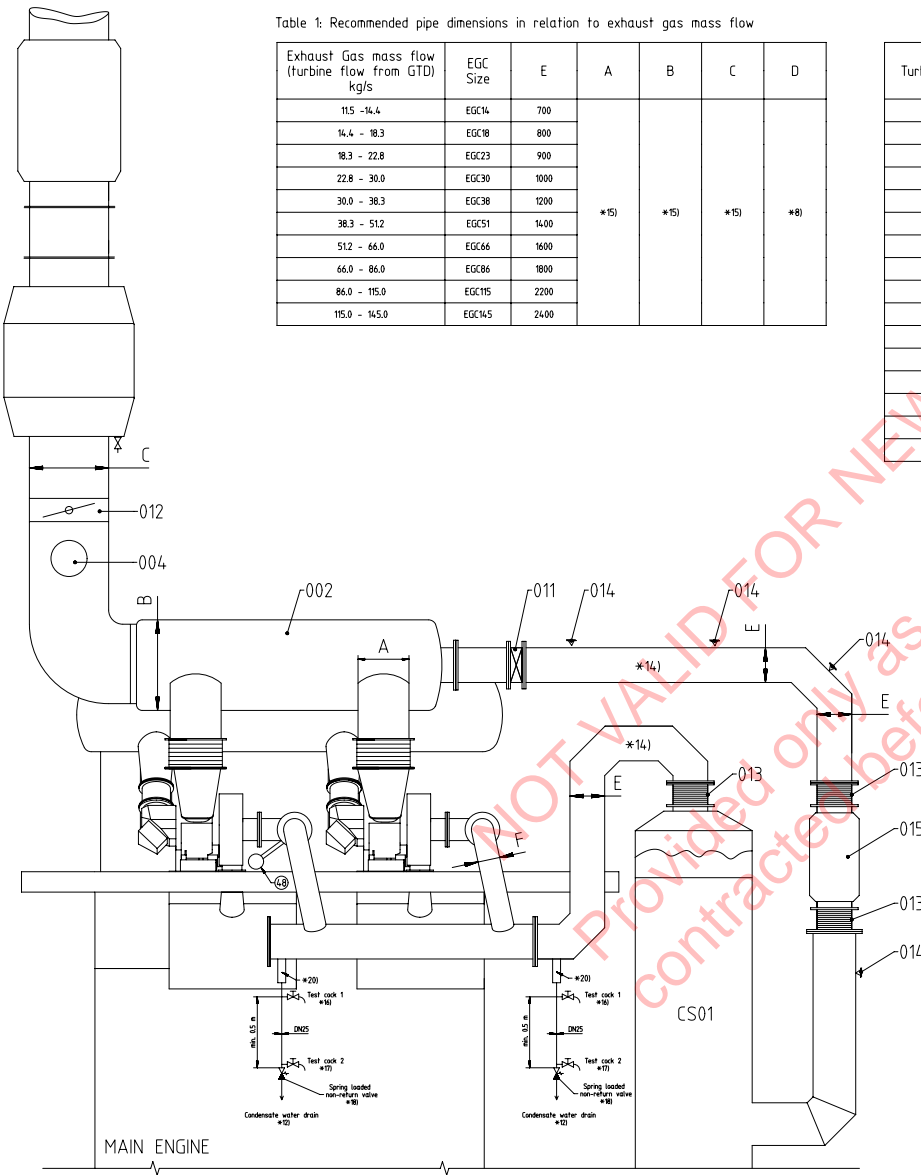
Pos.	Engine Components *3)
EC01	Turbocharger
EC02	Exhaust gas manifold
EC03	Waste gate compensator *7) *8)
EC04	Waste gate valve
EC05	Engine mounted purging and sealing air blower

- Remarks:
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or alternator).
The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1.1, 1.6, taper angle $\le 40^\circ$
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe.
Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection". The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Optional, in combination with the main economiser if ship's steam demand cannot be covered by the economiser in the upper exhaust gas pipe after the back-pressure valve.
 - *11) Optional, to be installed if the backpressure from the EGC exceeds the limit.
 - *12) To be directed to the bilge water tank. Can be connected to the SAC drain pipe from engine connection 16.
 - *13) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *14) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *15) The exhaust pipe dimension must be selected in accordance with the specific exhaust gas mass flow as given by the GTD. The pipe size selection must be coordinated respectively agreed in between the shipyard and the engine builder as the valve size selection on engine side must comply accordingly.
 - *16) By opening of test cock 1 the following conditions can be checked:
Normal condition:
No water flow but air suction.
Abnormal condition:
Water flow, which is the indication that the drain valve is blocked in closed position.
No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *17) By opening of test cock 2 the following conditions can be checked:
Normal condition:
Water flow, Water samples can be taken.
Abnormal condition:
No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *18) Valve opening of 25 mbar
 - *19) The purge air supply must be connected upstream from the flow regulating (010) in the exhaust gas return branch.
 - *20) The condensate water collection pocket must be connected at the lowest point of the horizontal return manifold pipe.

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (turbine flow from GTD) kg/s	EGC Size	E	A	B	C	D
11.5 - 14.4	EGC14	700				
14.4 - 18.3	EGC18	800				
18.3 - 22.8	EGC23	900				
22.8 - 30.0	EGC30	1000				
30.0 - 38.3	EGC38	1200	*15)	*15)	*15)	*8)
38.3 - 51.2	EGC51	1400				
51.2 - 66.0	EGC66	1600				
66.0 - 86.0	EGC86	1800				
86.0 - 115.0	EGC115	2200				
115.0 - 145.0	EGC145	2400				

Turbocharger type	F
A165-L	450
A170-L	500
A175-L	600
A260-L	400
A265-L	500
A270-L	600
A275-L	700
MET33MB	350
MET37MB	400
MET42MB	450
MET48MB	500
MET53MB	550
MET60MB	600
MET66MB	700
MET71MB	700
MET83MB	800



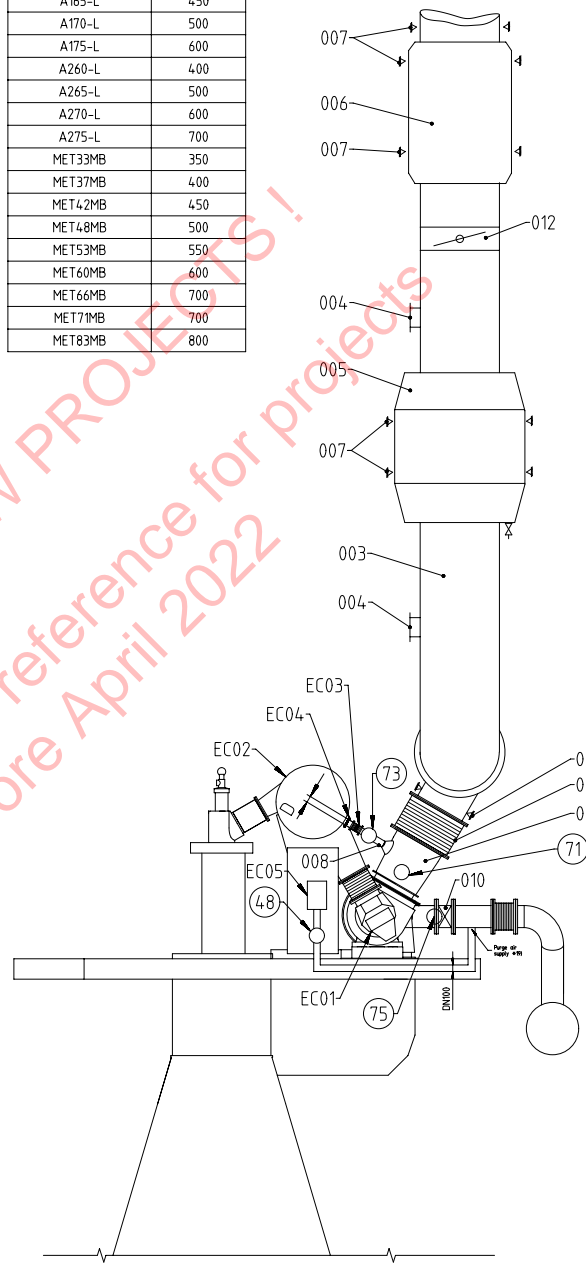
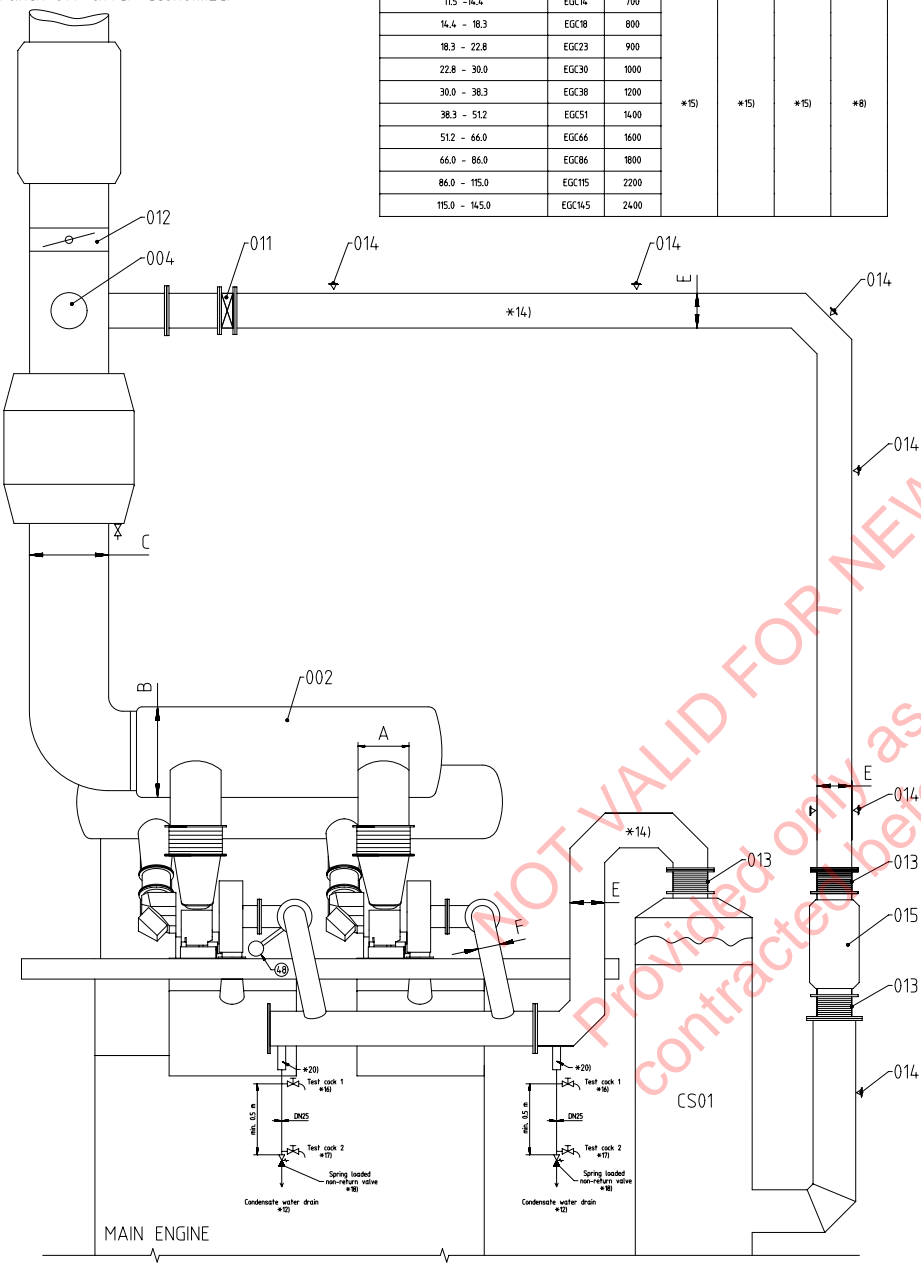
NOTE
Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".

Long Route
- Exhaust gas branch-off after economizer

Table 1: Recommended pipe dimensions in relation to exhaust gas mass flow

Exhaust Gas mass flow (turbine flow from GTD) kg/s	EGC Size	E	A	B	C	D
11.5 - 14.4	EGC14	700				
14.4 - 18.3	EGC18	800				
18.3 - 22.8	EGC23	900				
22.8 - 30.0	EGC30	1000				
30.0 - 38.3	EGC38	1200				
38.3 - 51.2	EGC51	1400	*15)	*15)	*15)	*8)
51.2 - 66.0	EGC66	1600				
66.0 - 86.0	EGC86	1800				
86.0 - 115.0	EGC115	2200				
115.0 - 145.0	EGC145	2400				

Turbocharger type	F
A165-L	450
A170-L	500
A175-L	600
A260-L	400
A265-L	500
A270-L	600
A275-L	700
MET33MB	350
MET37MB	400
MET42MB	450
MET48MB	500
MET53MB	550
MET60MB	600
MET66MB	700
MET71MB	700
MET83MB	800



Pos.	COMPONENTS from certified suppliers
CS01	Exhaust Gas Cooler (EGC)

Pos.	System Components *1)
001	Compensator #4)
002	Exhaust gas collector
003	Exhaust gas pipe
004	Explosion relief device (rupture discs or spring-loaded valves) #5)
005	Main Economiser
006	Silencer (with spark arrester #9)
007	Support #4)
008	Waste gate pipe
009	Transition piece #6)
010	Flow Regulating Valve (FRV)
011	Shut-off valve (SOV)
012	Back Pressure Valve (BPV)
013	Compensator in the exhaust system #13)
014	KEER support #4)
015	Additional Economiser #10)

Pos.	Engine Connections *2)
(48)	OUTLET - EGC purge air supply
(71)	OUTLET - Exhaust gas turbocharger
(73)	OUTLET - Exhaust gas manifold waste gate
(75)	INLET - Recirculated exhaust gas turbocharger


Pos.	Engine Components *3)
EC01	Turbocharger
EC02	Exhaust gas manifold
EC03	Waste gate compensator #7) #8)
EC04	Waste gate valve
EC05	Engine mounted purging and sealing air blower

- Remarks:
- Drain plugs and drain cocks to be installed where necessary.
 - *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
 - *2) To be installed by the shipyard.
 - *3) To be delivered by the engine builder, i.e. already equipped on engine side.
 - *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or alternative).
 - The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
 - *5) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
 - *6) Area ratio between outlet/inlet = 1.1..1.6, taper angle $\le 4^\circ$
 - *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).
 - *8) Guidance regarding the selection of the waste gate pipe size is provided by the drawing "Specification for waste gate selection". The waste gate pipe on the shipside is one nominal pipe size larger than the waste gate pipe on the engine side (before the compensator).
 - *9) Optional, installed as required to meet noise requirements.
 - *10) Optional, in combination with the main economiser if ship's steam demand cannot be covered by the economiser in the upper exhaust gas pipe after the back-pressure valve.
 - *11) Optional, to be installed if the backpressure from the EGC exceeds the limit.
 - *12) To be directed to the bilge water tank. Can be connected to the SAC drain pipe from engine connection 16.
 - *13) The final amount and position have to be defined by the shipyard considering the system layout and requirements based on installation specific calculation.
 - *14) The exhaust gas pipes upstream and downstream of the EGC must be insulated.
 - *15) The exhaust pipe dimension must be selected in accordance with the specific exhaust gas mass flow as given by the GTD. The pipe size selection must be coordinated respectively agreed in between the shipyard and the engine builder as the valve size selection on engine side must comply accordingly.
 - *16) By opening of test cock 1 the following conditions can be checked:
Normal condition:
No water flow but air suction.
Abnormal condition:
Water flow, which is the indication that the drain valve is blocked in closed position.
 - *17) By opening of test cock 2 the following conditions can be checked:
Normal condition:
Water flow. Water samples can be taken.
Abnormal condition:
No water flow but air suction, which is the indication that the drain valve is blocked in open position.
 - *18) Valve opening of 25 mbar
 - *19) The purge air supply must be connected upstream from the flow regulating (FRV) in the atmost exhaust gas return branch.
 - *20) The condensate water collection pocket must be connected at the lowest point of the horizontal return manifold pipe.

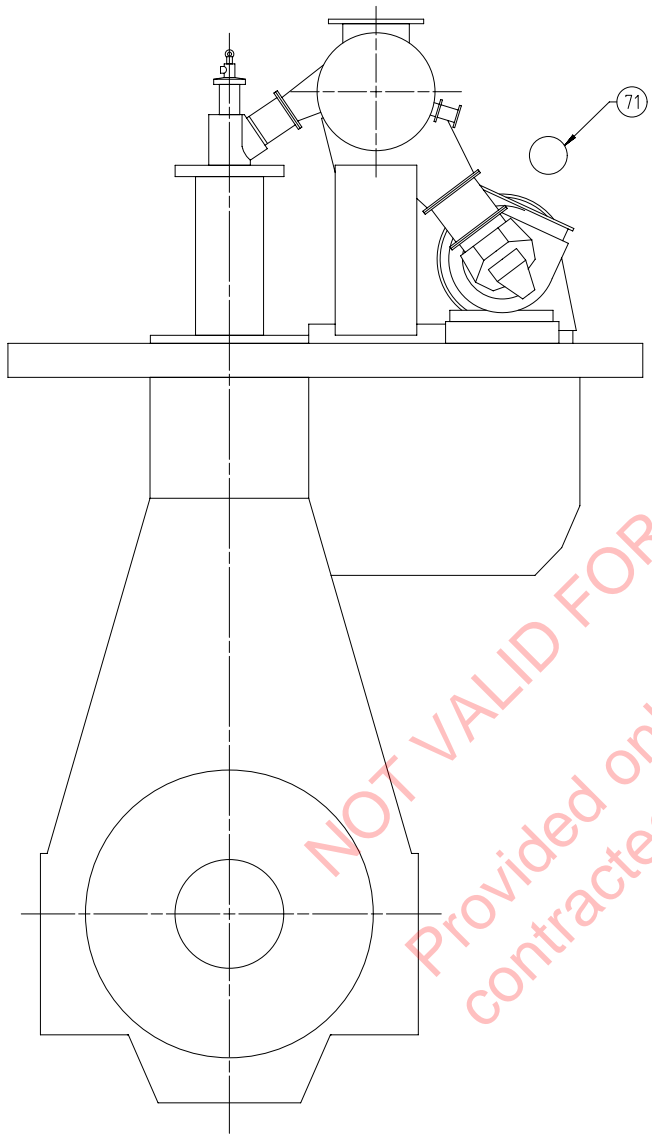
SEQ NO	QTY	Item ID	Item Name	Dimension	Standard-ID	Basic Material	Net Weight
1	1	PTAA025525	Exhaust System	iCER on engine + one turbocharger			0.001
2	1	DAAD139643	iCER Installation Guideline				

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Proc.	5,6,7 X72DF-2.1							
	5,6 X72DF-2.2							
Change History								
	-	mhu019	dst009	25.02.2022	CNAA001494	Main Design/Drawing Introduced	-	-
	Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis	Activity Code	E C

	<h2>Exhaust System</h2> <p>with iCER on engine</p>
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Bill Of Material			Dimension								
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			Main Design	Yes	Design Group		9726	Q-Code	XXXXX	Standard	WDS
			Qty per	Engine	A4	Item ID	PTAA025526			BOM Page/s	01/01



Specifications which must be met:

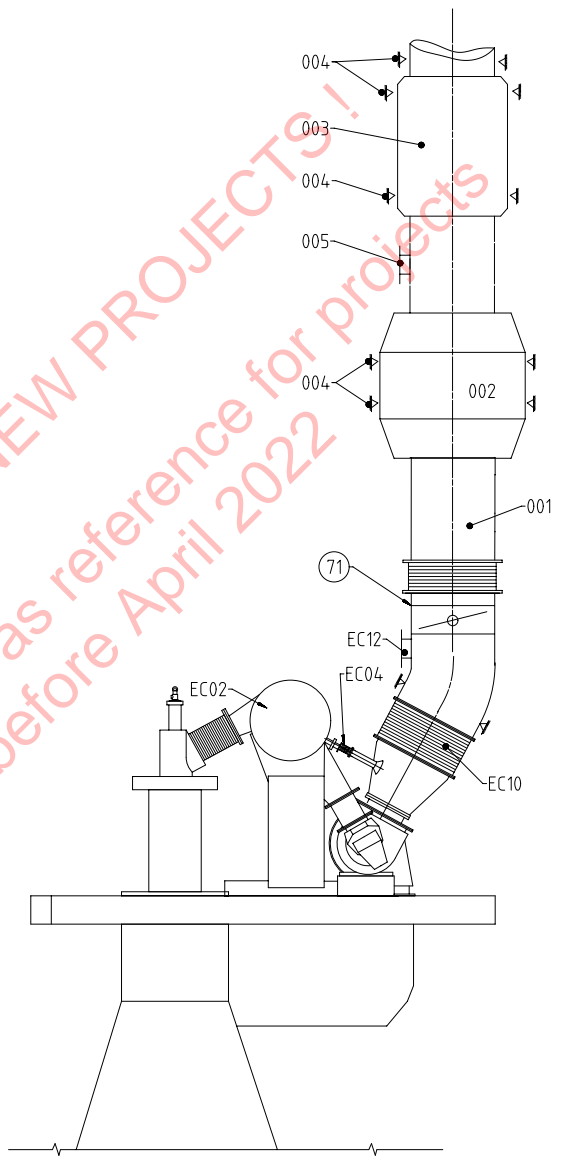
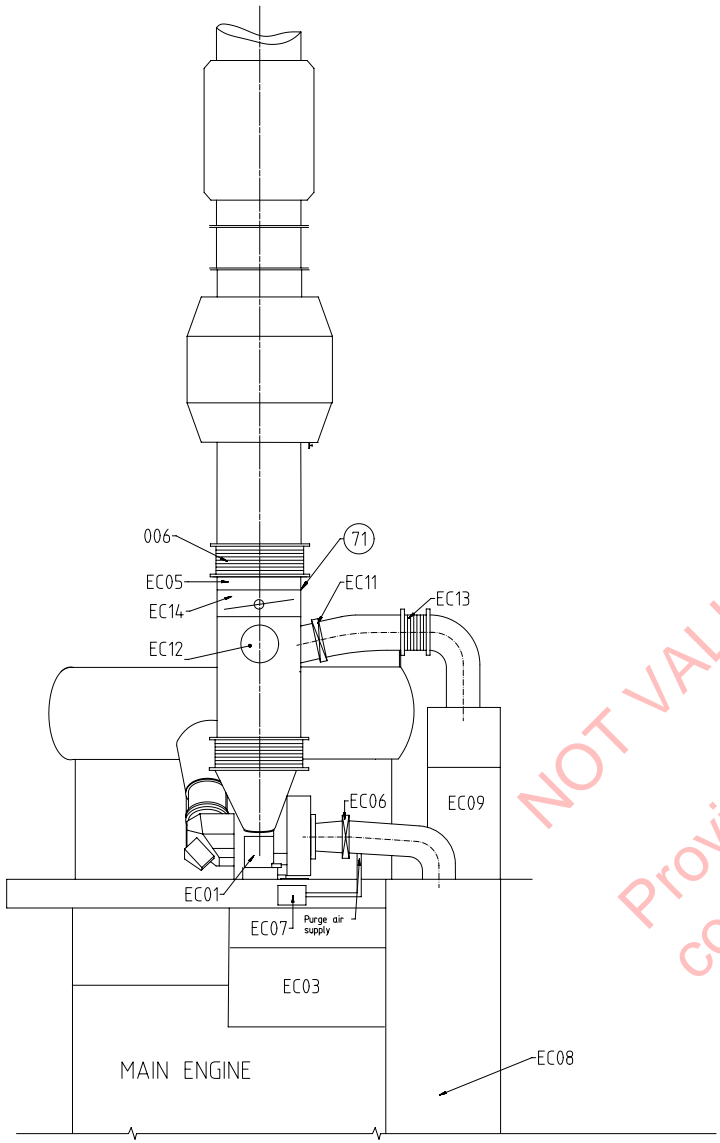
- ⑦① OUTLET - Exhaust gas turbocharger
- ① ② - Exhaust gas temperature and volume flow: according to GTD
- ③ - The total back pressure of the exhaust gas system must be kept within the following ranges:
 Diesel Tier II mode
 Design limit: From max. ≤ 30 mbar to max. ≤ 60 mbar
 Operation limit: max. ≤ 80 mbar
 iCER gas Tier III mode
 Design limit: From max. ≤ 30 mbar to max. ≤ 45 mbar
 Operation limit: max. ≤ 55 mbar
 iCER diesel Tier III mode
 Design limit: Not relevant for layout
 Operation limit: max. ≤ 55 mbar
- The exhaust gas pipe must be insulated according to applicable rules, e.g. SOLAS.
- Recommended pipe dimensions in relation to the exhaust gas mass flow rates are provided by table 1 on page 2.
- The exhaust piping with cones, bends and pipe connections must be flow optimised and arranged in a way to avoid gases from accumulating.
- The piping layout must consider the thermal expansion and vibration from the turbocharger (TC) and main engine (ME). Thermal expansion of the ME is to be calculated according to the formula in MIM. TC specific thermal expansion is provided by the TC supplier.
- Explosion relief devices, examined and certified by the maker, with flameless pressure relief (rupture discs or self-closing, spring-loaded valves) must be selected and installed within the exhaust system in accordance with class requirements. The exact position and number of explosion relief devices must be determined by the system designer or the shipyard through calculation. Independently, which type of explosion relief devices is selected, the distance of the explosion relief device to gangways, working areas and system components must be at least 3 m to not endanger personnel and/or to avoid material damage.
- A continuous (extensive) exhaust gas leakage must be avoided.
- Supports (fixation points) for the mass of piping and exhaust gas system components must be installed in sufficient size and amount. Inadmissible tensions in the piping and forces acting on the turbocharger are not acceptable.
- Exhaust gas pipes of several engines must not be connected.
- Drains of adequate size and amount must be installed in the exhaust gas piping.
- When the noise level on the bridge wing exceeds the class requirement (normally 60 - 70 dB(A)) a silencer must be applied.
- During iCER operation, the recirculated exhaust gas must be cooled by EGC circulation water. This water must be cleaned and treated by the water treatment unit to fulfill the following requirements: A maximum solids content of 150 mg/l and a proper pH value (e.g. above pH 6).

NOT VALID FOR NEW PROJECTS
 Provided only as reference
 contracted before April 2022

Prod.													
Change History	C	dsde101	dst009	20.12.2022	CNAA002993	Drawing Updated					4	3	
	B	dsde101	mhu019	06.12.2022	CNAA002916	Drawing Updated					-	-	
	A	dkid021	mhu019	23.11.2022	CNAA002662	Drawing Updated					-	-	
	-	mhu019	dst009	25.02.2022	CNAA001494	new Design					-	-	
Rev.	Creator	Approver	Approval Date	Change ID	Change Synopsis					Approved	Activity Code	E	C
WIN GD Winterthur Gas & Diesel		EXHAUST SYSTEM iCER on engine + one turbocharger											
		Dimension iCER on engine + one turbocharger											
Scale	-	Units [mm] [kg]		Basic Material		Net Weight		0.000					
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SURFACE PROTECTION SEE GROUP 0344		TOLERANCING PRINCIPLE ISO8015		Main Design		Design Group		9726		Q-Code XXXXX		Standard WDS	
Qty per		A2		Item ID		PTAA025525		Drawing Page/s		1/2			

SYSTEM PROPOSAL

NOTE
 Further installation details and variants can be found listed in the Marine Installation Manual (MIM), which provides also the acronyms used in this drawing set. The piping symbols are explained by the piping symbol key as included in the drawing set "Various Installation Items".



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Pos.	SYSTEM COMPONENTS *2)
001	Exhaust gas pipe on the ship side
002	Main Economiser
003	Silencer (with spark arrester) *5)
004	Support *4)
005	Explosion relief device *6)
006	Compensator in the exhaust pipe on the ship side *7)

Pos.	ENGINE CONNECTIONS *1)
(71)	OUTLET - Exhaust gas turbocharger

Pos.	ENGINE COMPONENTS *3)
EC01	Turbocharger
EC02	Exhaust gas manifold
EC03	Scavenge air receiver
EC04	Waste gate with waste gate valve, compensator and connection pipe
EC05	Connection piece between the exhaust pipe on engine side and on ship side
EC06	Flow Regulating (shut-off) Valve
EC07	Purging control
EC08	Exhaust Gas Cooler (EGC) with two stages
EC09	Economiser (in the ICER system, optional)
EC10	Compensator between engine and exhaust gas system
EC11	Shut-off valve
EC12	Explosion relief device
EC13	Compensator in the ICER exhaust gas system
EC14	Back Pressure Valve (BPV)

Remarks:

- Drain plugs and drain cocks to be installed where necessary.
- *1) Refer to the "Pipe Connection Plan" for the execution and location of the engine pipe connections.
- *2) To be installed by the shipyard.
- *3) To be delivered by the engine builder, i.e. already equipped on engine side.
- *4) The piping of the exhaust gas system must be structurally supported to withstand the mass and to minimise vibrations across the system (e.g. by connecting the support to the ship hull or otherwise).
 The type of these supports (fixed or sliding type), their final amount and position have to be defined by the shipyard under consideration of system layout and requirements based on installation specific calculation.
- *5) Optional, installed as required to meet noise requirements.
- *6) When rupture discs are installed, preventative measures must be taken to ensure that exhaust gas does not continuously flow to the out after rupture. This can be achieved with an exhaust gas duct leading to the open deck, or in the case of a twin-engine installation, by sending a control signal that initiates a shutdown of the engine. If either of these options are not possible, a self-closing, spring-loaded valve with flame arrester must be used. This would remove the peak pressure of an explosion, while ensuring that the exhaust gas does not continuously flow out.
- *7) The dimension of the expansion piece (compensator) must be defined by the shipyard in accordance with the thermal growth of the exhaust manifold and the exhaust pipe. Vibrations of the pipe after the compensator must be lower than 45 mm/s RMS (root mean square).

MIDS - Exhaust System (DG9726)

WinGD X72DF-2.1/-2.2

TRACK CHANGES

DATE	SUBJECT	DESCRIPTION
2020-12-10	DRAWING SET	First web upload
2021-02-08	DAAD132467 DAAD132303	Main and system drg – new revision
2021-03-19	DAAD132303	System drg – new revision
2021-07-16	PAAD359869	Main drg – new revision
2021-12-21	PAAD359572	System drgs – new revision
2022-03-09	PAAD359572 PTAA025526 PTAA027995 PTAA025525 PTAA025525	System and main drgs – new revision/new drgs
2022-12-01	PAAD359572 PTAA027994 PTAA044719 PTAA044720 PTAA046756	System drgs – new revision New drg. sets as replacement of previous ones - added
2022-12-20	PAAD359572 PTAA027994 PTAA046749 PTAA044712 PTAA044711 PTAA025525	System drgs – new revision
2023-03-31	PTAA046749 PTAA044712 PTAA044711 PTAA025525	System drgs – new revision

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2023-12-19	PTAA044711D PTAA044712C PTAA046749E	New reision
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