

Starting Tests for Main Engines

Amended Rules and Guidance

Rules for the Survey and Construction of Steel Ships Part D
Rules for High Speed Craft
Rules for the Survey and Construction of Inland Waterway Ships
Guidance for the Survey and Construction of Steel Ships Part D
Guidance for the Survey and Construction of Inland Waterway Ships

Reasons for Amendment

IACS Unified Requirement (UR) M61 specifies the number of times that main engines are to be capable of being consecutively started as the total capacity of air reservoirs used for starting such engines. Furthermore, this number of starts refers to starting main engines under the cold and ready-to-start condition, without there being a need to charge air reservoirs with air during starting tests. UR M61 has already been incorporated into ClassNK's Rules.

IACS recently reviewed the UR to re-assess whether such starting tests really needed to be performed in the cold condition. During its review, IACS found the difference in starting test results from testing in the warm condition and testing in the cold condition was not significant because main engines typically tend to be warmed up before starting. Therefore, IACS agreed that starting tests may also be performed in the warm condition and adopted IACS UR M61 (Rev.1) in February 2022.

Accordingly, relevant requirements are amended based on the IACS UR M61(Rev.1).

Outline of Amendment

The main details of the amendment are as follows:

- (1) Deletes the condition that starting tests for main engines need to be performed in the cold and ready-to-start condition with respect to the number of starts.
- (2) Transfers requirements related to IACS UR M61(Rev.1) from the Guidance to the Rules.

“Rules for the survey and construction of steel ships” has been partly amended as follows:

Part D MACHINERY INSTALLATIONS

Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES

2.5 Associated Installations

Paragraph 2.5.3 has been amended as follows.

2.5.3 Starting Arrangements*

1 The starting air mains are to be protected against explosion caused by back-fire from the cylinders or excessive temperature rise in the starting air manifold at the time of starting by the following (1) through (5) arrangements:

- (1) An isolating non-return valve or equivalent thereto is to be provided at the starting air supply connection to each engine.
- (2) An adequate rupture disc device or a flame arrester is to be fitted at the starting valve on each cylinder for direct reversing engines having a starting air manifold. At least one such device is to be fitted at the supply inlet to the starting air manifold for each non-reversing engine. However, the above mentioned device may be omitted for engines having cylinder bore not exceeding 230 *mm*.
- (3) An adequate rupture disc device is to be fitted at an appropriate position on the starting air manifold as an emergency means of relieving a pressure caused by explosion for direct reversing engines fitted with flame arresters in accordance with (2) above.
- (4) For rupture disc devices of which ruptured discs cannot be easily replaced, a mechanism of blocking up the exhaust way is to be provided for the purpose of quick restart of the engine. This blocking mechanism is to be fitted with a means of indicating whether it is blocking or not.
- (5) An effective arrangement to prevent the accumulation of combustibles (fuel oil, lubrication oil, system oil, etc.) in the starting air manifold or to prevent the excessive temperature rise in the starting air manifold is to be provided for direct reversing engines.

2 Where main propulsion engines are arranged for starting by compressed air, at least two starting air reservoirs are to be provided. These reservoirs are to be connected so that usage can be readily switched from one to the other. In this case, the total capacity of the starting air reservoirs is to be sufficient to provide, without replenishment, the number of consecutive starts not less than that specified in (1), (2) and (3) below. Where the arrangements of the main propulsion engines and shafting systems are other than shown below, the required number of starts is to be as deemed appropriate by the Society. When other consumers such as auxiliary machinery starting systems, control systems, whistles, etc. are to be connected to starting air reservoirs, their air consumption is also to be taken into account.

- (1) For direct reversible engines

$$Z = 12C$$

where

Z : Total number of starts of engine

C : Constant determined by the arrangement of main propulsion engines and shafting systems, where the following values are to be referred to as the standard;

C = 1.0 For single screw ships, where one engine is either coupled with the shaft directly or through reduction gears.

$C = 1.5$ For twin screw ships, where two engines are either coupled with the shafts directly or through reduction gear. Or, for single screw ships, where two engines are coupled with the shaft through declutchable coupling provided between engine and reduction gear.

$C = 2.0$ For single screw ships, where two engines are coupled with one shaft without any declutchable coupling between engine and reduction gear.

(2) For non-reversible type engines using a separate reversing gear or controllable pitch propeller, 1/2 of the total number of starts specified in (1) above may be accepted.

(3) For electric propulsion ships:

$$Z = 6 + 3(k - 1)$$

where

Z : Total number of starts of engine

k : Number of engines (In the case of more than 3 engines, the value of k to be used is 3.)

3 The capacities of the reservoirs specified in -2 above are to be about the same.

~~**54** The Starting air reservoirs and starting air systems are also to comply with the requirements in 13.13.~~

~~**35** Internal combustion engines which are arranged for electrical starting are to comply with the requirements specified in Part H, in addition to the following (1) to (3):~~

~~(1) Two separate batteries are to be fitted to starting arrangements for main propulsion machinery. Arrangements are to be such that the batteries cannot be connected in parallel, and each battery is to be capable of starting the main propulsion machinery under the cold and ready-to-start condition. The combined capacity of the batteries is to be sufficient (without recharging) to provide the number of consecutive starts specified in -2 above within 30 minutes.~~

~~(2) Electric starting arrangements for internal combustion engines driving generators and auxiliary machinery are to have two separate batteries but may be supplied by separate circuits from the batteries for main propulsion machinery. In the case of single auxiliary engines, only one battery needs to be fitted. The capacity of each set of batteries is to be sufficient for at least three starts for each engine.~~

~~(3) Starting batteries are to be used for starting and engine self-monitoring purposes only. Provisions are to be made to continuously maintain stored energy at all times.~~

~~Where main propulsion engines are arranged for starting by battery, 2 sets of batteries are to be provided. The total capacity of the batteries is to be sufficient, without recharging, to provide the number of starts of the main propulsion engine required in -2 within 30 minutes.~~

~~**4** The starting arrangements of reciprocating internal combustion engines which drive generators or auxiliaries are to be as deemed appropriate by the Society.~~

Chapter 4 GAS TURBINES

4.4 Associated Installations

4.4.3 Starting Arrangements*

Sub-paragraph -2 has been amended as follows.

2 Where compressed air is used for starting, the starting arrangement is to comply with ~~the requirements specified in 13.13~~, in addition to the following (1) to (5):

~~((1) is omitted.)~~

(2) The arrangement for the air starting of main propulsion machinery is to be provided with at least two starting air reservoirs which may be used independently. The total capacity of the air reservoirs is to be sufficient to provide, without their being replenished, the number of consecutive starts of main propulsion machinery ~~under cold and ready to start conditions~~ not less than the following (a) and (b). Where the arrangements of the main propulsion machinery and shafting systems are other than those shown below, the required number of starts is to be as deemed appropriate by the Society. ~~In any case, an additional number of starts may be required when the gas turbine is in the warm running condition.~~ When other consumers such as auxiliary machinery starting systems, control systems, whistles, etc., are to be connected to ~~the~~ starting air reservoirs, their air consumption is also to be taken into account.

(a) Ships other than electric propulsion ships

$$Z = 6C$$

where

Z: Total number of starts of gas turbines

C: Constant determined by the arrangement of gas turbines and shafting systems, where the following values are to be referred to as the standard

C = 1.0: Single screw ships, where one gas turbine is either coupled with the shaft directly or through reduction gears.

C = 1.5: Twin screw ships, where two gas turbines are either coupled with the shafts directly or through reduction gear, and for single screw ships, where two gas turbines are coupled with the shaft through declutchable coupling provided between gas turbines and reduction gear.

C = 2.0: Single screw ships, where two gas turbines are coupled with one shaft without any declutchable coupling between gas turbines and reduction gear.

(b) Electric propulsion ships

$$Z = 6 + 3(k-1)$$

where

Z: Total number of starts of gas turbines

k: Number of engines (In the case of more than three gas turbines, the value of k to be used need not exceed three.)

(3) The capacity ~~ies~~ of the reservoirs specified in (2) above ~~is~~ are to be about ~~equal~~ the same.

~~(4) The compressor to which 13.13.3-2 applies is to have a capacity not less than 50% of the total capacity specified in 13.13.3-3.~~

~~(5) The capacity of starting air compressors fitted for main propulsion machinery (excluding an emergency compressor which is installed to satisfy 1.3.1-5) is to be approximately equally divided between the number of said compressors.~~

Chapter 13 PIPING SYSTEMS

13.13 Pneumatic Piping Systems

Paragraph 13.13.3 has been amended as follows.

13.13.3 Number and Total Capacity of Air Compressors

1 In cases where the main propulsion machinery is designed for starting by compressed air, two or more starting air compressors are to be provided and arranged so as to be able to charge each air reservoir. However, in cases where cylinders are provided with air charging valves, these charging valves will be considered to be equivalent to any air compressors driven by the main propulsion machinery.

2 One of the air compressors specified in -1 above is to be driven by a prime mover that is not the main propulsion machinery. Such compressor is to have a capacity not less than 50 % of the total capacity specified in -3.

3 The total capacity of air compressors is to be sufficient to supply air into the air reservoirs from atmospheric pressure to the pressure required for the consecutive starts prescribed in 2.5.3-2 or 4.4.3-2, corresponding to the type of prime mover, within one *hour*. The capacity is to be approximately equally divided between the number of starting air compressors (excluding emergency compressors installed to satisfy 1.3.1-5) fitted for main propulsion machinery.

“Rules for high speed craft” has been partly amended as follows:

Part 9 MACHINERY INSTALLATIONS

Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES

2.3 Associated Installations

Paragraph 2.3.2 has been amended as follows.

2.3.2 Starting Arrangements

1 The starting air mains are to be in accordance with ~~the requirements specified in 2.5.3-1, Part D of the Rules for the Survey and Construction of Steel Ships.~~

2 Where main propulsion engines are arranged for starting by compressed air, starting air reservoirs are to be provided. These reservoirs are to be connected ready for use. In this case, the total capacity of the starting air reservoirs is to be sufficient to provide, without replenishment, not less than the number of consecutive starts as specified in (1) to (3) below. Where the arrangements of the main propulsion engines and shafting systems are other than shown below, the required number of starts is to be as deemed appropriate by the Society. When other consumers such as auxiliary machinery starting systems, control systems, whistles, etc. are to be connected to starting air reservoirs, their air consumption is also to be taken into account.

(1) For direct reversible engines

$$Z=12C$$

where:

Z: Total number of starts

C: Constant determined by the arrangement of main propulsion engines and shafting systems, where the following values are to be referred to as the standard;

C = 1.0 For single screw craft, where one engine is coupled with the shaft either directly or through reduction gear

C = 1.5 For twin screw craft, where two engines are coupled with the shafts either directly or through reduction gears, or for single screw craft, where two engines are coupled with the shaft through a declutchable coupling provided between engines and reduction gears

C = 1.9 For triple screw craft, where three engines are coupled with the shafts either directly or through reduction gears

C = 2.0 For single screw craft, where one engine is coupled with the shaft without declutchable coupling between engine and reduction gear

C = 2.3 For quadruple screw craft, where four engines are coupled with the shafts either directly or through reduction gears. For twin screw craft, where four engines are coupled with the shafts through declutchable coupling provided between engines and reduction gears

C = 3.0 For twin screw craft, where four engines are coupled with the shafts without declutchable coupling between engines and reduction gears

(2) For non-reversible type engines using a separate reversing gear, controllable pitch propellers or waterjet propulsion systems, 1/2 of the total number of starts specified in (1) above may be accepted.

(3) For electric propulsion craft:

$$Z=6+3(k-1)$$

where:

Z : Total number of starts

k : Number of engines and it is not necessary for the value of k to exceed 3.

~~3 For main propulsion engines which are arranged for starting by battery and for the starting arrangement of reciprocating internal combustion engines driving generators or auxiliaries, the requirements specified in 2.5.3.3 and 4, Part D of the Rules for the Survey and Construction of Steel Ships are to be complied with.~~

3 The capacities of the reservoirs specified in -2 above are to be about the same.

4 Starting air reservoirs and starting air systems are also to comply with 8.12.

5 Internal combustion engines which are arranged for electrical starting are to comply with the following (1) to (3):

- (1) Two separate batteries are to be fitted to starting arrangements for main propulsion machinery. Arrangements are to be such that the batteries cannot be connected in parallel, and each battery is to be capable of starting the main propulsion machinery under the cold and ready-to-start condition. The combined capacity of the batteries is to be sufficient (without recharging) to provide the number of consecutive starts specified in -2 above within 30 *minutes*.
- (2) Electric starting arrangements for internal combustion engines driving generators and auxiliary machinery are to have two separate batteries but may be supplied by separate circuits from the batteries for main propulsion machinery. In the case of single auxiliary engines, only one battery needs to be fitted. The capacity of each set of batteries is to be sufficient for at least three starts for each engine.
- (3) Starting batteries are to be used for starting and engine self-monitoring purposes only. Provisions are to be made to continuously maintain stored energy at all times.

Chapter 3 GAS TURBINES

3.4 Associated Installations

3.4.2 Starting Arrangements*

Sub-paragraphs -2 has been amended as follows.

2 Where compressed air is used for starting, the starting arrangement is to comply with 8.12, in addition to the following (1) to (5):

((1) is omitted.)

(2) The arrangement for the air starting of main propulsion machinery is to be provided with at least two starting air reservoirs which may be used independently. The total capacity of the air reservoirs is to be sufficient to provide, without their being replenished, the number of consecutive starts of main propulsion machinery ~~under cold and ready to start conditions~~ not less than the following (a) and (b). Where the arrangements of the main propulsion machinery and shafting systems are other than those shown below, the required number of starts is to be as deemed appropriate by the Society. ~~In any case, an additional number of starts may be required when the gas turbine is in the warm running condition.~~ When other consumers such as auxiliary machinery starting systems, control systems, whistles, etc., are to be connected to the starting air reservoirs, their air consumption is also to be taken into account.

(a) Ships other than electric propulsion ships

$$Z = 6C$$

where

Z: Total number of starts of gas turbines

C: Constant determined by the arrangement of gas turbines and shafting systems, where the following values are to be referred to as the standard

C = 1.0: Single screw ships, where one gas turbine is either coupled with the shaft directly or through reduction gears.

C = 1.5: Twin screw ships, where two gas turbines are either coupled with the shafts directly or through reduction gear, and for single screw ships, where two gas turbines are coupled with the shaft through declutchable coupling provided between gas turbines and reduction gear.

C = 2.0: Single screw ships, where two gas turbines are coupled with one shaft without any declutchable coupling between gas turbines and reduction gear.

(b) Electric propulsion ships

$$Z = 6 + 3(k-1)$$

where

Z: Total number of starts of gas turbines

k: Number of engines (In the case of more than three gas turbines, the value of k to be used need not exceed three.)

(3) The capacityies of the reservoirs specified in (2) above ~~is~~ are to be about ~~equal~~ the same.

~~(4) The compressor to which 13.13.3 2, Part D of the Rules for the Survey and Construction of Steel Ships applies in accordance with 8.12 is to have a capacity not less than 50% of the total capacity specified in 13.13.3 3 of said Part D.~~

~~(5) The capacity of starting air compressors fitted for main propulsion machinery is to be approximately equally divided between the number of said compressors.~~

“Rules for the survey and construction of inland waterway ships” has been partly amended as follows:

Part 7 MACHINERY INSTALLATIONS

Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES

2.5 Associated Installations

Paragraph 2.5.3 has been amended as follows.

2.5.3 Starting Arrangements

1 The starting air mains are to be protected against explosion caused by back=fire from the cylinders or excessive temperature rise in the starting air manifold at the time of starting by the following arrangements **(1)** and **(2)**:

- (1)** An isolating non-return valve or equivalent thereto is to be provided at the starting air supply connection to each engine.
- (2)** An adequate rupture disc device or a flame arrester is to be fitted at the starting valve on each cylinder for direct reversing engines having a starting air manifold. At least one such device is to be fitted at the supply inlet to the starting air manifold for each non-reversing engine. However, the above mentioned device may be omitted for engines having cylinder bore not exceeding 230 *mm*.

2 Where main propulsion engines are arranged for starting by compressed air, at least two starting air reservoirs are to be provided. These reservoirs are to be connected so that usage can be readily switched from one to the other. In this case, the total capacity of the starting air reservoirs is to be sufficient to provide, without replenishment, the number of consecutive starts not less than that specified in **(1)** to **(3)** below. Where the arrangements of the main propulsion engines and shafting systems are other than shown below, the required number of starts is to be as deemed appropriate by the Society. When other consumers such as auxiliary machinery starting systems, control systems, whistles, etc. are to be connected to starting air reservoirs, their air consumption is also to be taken into account.

- (1)** For direct reversible engines

$$Z = 12C$$

Where:

Z: Total number of starts of engine

C: Constant determined by the arrangement of main propulsion engines and shafting systems, where the following values are to be referred to as the standard;

C = 1.0 For single screw ships, where one engine is either coupled with the shaft directly or through reduction gears.

C = 1.5 For twin screw ships, where two engines are either coupled with the shafts directly or through reduction gear. Or, for single screw ships, where two engines are coupled with the shaft through declutchable coupling provided between engine and reduction gear.

C = 2.0 For single screw ships, where two engines are coupled with one shaft without any declutchable coupling between engine and reduction gear.

- (2)** For non-reversible type engines using a separate reversing gear or controllable pitch propeller, 1/2 of the total number of starts specified in **(1)** above may be accepted.
- (3)** For electric propulsion ships:

$$Z = 6 + 3(k - 1)$$

Where:

Z: Total number of starts of engine

k: Number of engines (In the case of more than 3 engines, the value of k to be used is 3.)

~~3~~ The capacities of the reservoirs specified in -2 above are to be about the same.

~~54~~ The Starting air reservoirs and starting air systems are also to comply with the requirements in 11.13.

~~35~~ Internal combustion engines arranged for electrical starting are to comply with the following (1) to (3):

(1) Two separate batteries are to be fitted to starting arrangements for main propulsion machinery. Arrangements are to be such that the batteries cannot be connected in parallel, and each battery is to be capable of starting the main propulsion machinery under the cold and ready-to-start condition. The combined capacity of the batteries is to be sufficient (without recharging) to provide the number of consecutive starts specified in -2 above within 30 minutes.

(2) Electric starting arrangements for internal combustion engines driving generators and auxiliary machinery are to have two separate batteries but may be supplied by separate circuits from the batteries for main propulsion machinery. In the case of single auxiliary engines, only one battery needs to be fitted. The capacity of each set of batteries is to be sufficient for at least three starts for each engine.

(3) Starting batteries are to be used for starting and engine self-monitoring purposes only. Provisions are to be made to continuously maintain stored energy at all times. ~~Where main propulsion engines are arranged for starting by battery, 2 sets of batteries are to be provided. The total capacity of the batteries is to be sufficient, without recharging, to provide the number of starts of the main propulsion engine required in -2 within 30 minutes.~~

~~4~~ The starting arrangements of reciprocating internal combustion engines which drive generators or auxiliaries are to be as deemed appropriate by the Society.

Chapter 11 PIPING SYSTEMS

11.13 Pneumatic Piping Systems

Paragraph 11.13.3 has been amended as follows.

11.13.3 Number and Total Capacity of Air Compressors

1 In cases where the main propulsion machinery is designed for starting by compressed air, two or more starting air compressors are to be provided and arranged so as to be able to charge each air reservoir. However, in cases where cylinders are provided with air charging valves, these charging valves will be considered to be equivalent to any air compressors driven by the main propulsion machinery.

2 One of the air compressors prescribed in -1 is to be driven by a prime mover that is not the main propulsion machinery. Such compressor is to have a capacity not less than 50 % of the total capacity specified in -3.

3 The total capacity of air compressors is to be sufficient to supply air into the air reservoirs from atmospheric pressure to the pressure required for the consecutive starts prescribed in 2.5.3-2 within one *hour*. The capacity is to be approximately equally divided between the number of starting air compressors (excluding emergency compressors installed to satisfy 1.3.1-5) fitted for main propulsion machinery.

“Guidance for the survey and construction of steel ships” has been partly amended as follows:

Part D MACHINERY INSTALLATIONS

D2 RECIPROCATING INTERNAL COMBUSTION ENGINES

D2.5 Associated Installations

Paragraph D2.5.3 has been amended as follows.

D2.5.3 Starting Arrangements

~~1~~ The wording “effective arrangement to prevent the accumulation of combustibles” specified in 2.5.3-1~~(5)~~, **Part D of the Rules** means a construction of the starting air manifold from which combustibles can be easily (e.g. the starting air manifold has a gentle slope and a well at the lowermost position) discharged through a drain pipe which is normally open.

~~2~~ ~~For main propulsion machinery starting arrangements operated by compressed air, the following requirements, in addition to those in 2.5.3, **Part D of the Rules**, are to be complied with:~~

~~(1) Starting air reservoirs for main propulsion machinery are to be of approximately the same capacity.~~

~~(2) For ships designed to use the compressed air stored in starting air reservoirs for main propulsion machinery for purposes other than starting, the capacity of such air reservoirs is to take into account total compressed air consumption.~~

~~(3) For main propulsion machinery starting arrangements operated by compressed air, at least one of the starting air compressors is to be driven by power source other than the main propulsion machinery, and its capacity is to be 50 % or more of the total capacity specified in the requirements of 2.5.3-2, **Part D of the Rules**.~~

~~(4) Starting air compressors for main propulsion machinery are to be of approximately the same capacity.~~

~~3~~ ~~For reciprocating internal combustion engines starting arrangements operated by batteries, the following requirements, in addition to 2.5.3-3, **Part D of the Rules**, are to be complied with:~~

~~(1) Two sets of batteries provided for starting main propulsion machinery are to be arranged so that no parallel connections can be made, and so that each battery is capable of starting main propulsion machinery in a cold state after all of the starting preparations have been completed.~~

~~(2) The starting arrangements for reciprocating internal combustion engines driving main generators are to be such that either they are provided with two sets of separate batteries; or a single battery set in cases where power for starting can also be fed through a separate circuit from those batteries used for the starting of main propulsion machinery. However, a single battery set may only be accepted in cases where only one main generator engine is provided. The capacity of this single battery set is to be such that it is sufficient for starting the engine at least three *times*.~~

~~(3) Batteries for starting are to be used only for starting and for monitoring reciprocating internal combustion engines. Arrangements are to be made so that the energy stored in the batteries can be maintained at all times.~~

“Guidance for the survey and construction of inland waterway ships” has been partly amended as follows:

Part 7 MACHINERY INSTALLATIONS

Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES

2.5 Associated Installations

Paragraph 2.5.3 has been deleted.

~~2.5.3 Starting Arrangements~~

~~1 For main propulsion machinery starting arrangements operated by compressed air, the following requirements, in addition to those in 2.5.3, Part 7 of the Rules, are to be complied with:~~

- ~~(1) Starting air reservoirs for main propulsion machinery are to be of approximately the same capacity.~~
- ~~(2) For ships designed to use the compressed air stored in starting air reservoirs for main propulsion machinery for purposes other than starting, the capacity of such air reservoirs is to take into account total compressed air consumption.~~
- ~~(3) For main propulsion machinery starting arrangements operated by compressed air, at least one of the starting air compressors is to be driven by a power source other than one used for the main propulsion machinery, and the capacity of this compressor is to be 50% or more of the total capacity specified in 2.5.3-2, Part 7 of the Rules.~~
- ~~(4) Starting air compressors for main propulsion machinery are to be of approximately the same capacity.~~

~~2 For reciprocating internal combustion engine starting arrangements operated by batteries, the following requirements, in addition to 2.5.3-3, Part 7 of the Rules, are to be complied with:~~

- ~~(1) Two sets of batteries provided for starting main propulsion machinery are to be arranged so that no parallel connections can be made, and so that each battery is capable of starting main propulsion machinery in a cold state after all of the starting preparations have been completed.~~
- ~~(2) The starting arrangements for reciprocating internal combustion engines driving main generators are to be such that either they are provided with two sets of separate batteries; or a single battery set in cases where power for starting can also be fed through a separate circuit from those batteries used for the starting of main propulsion machinery. However, a single battery set may only be accepted in cases where only one main generator engine is provided. The capacity of this single battery set is to be such that it is sufficient for starting the engine at least three times.~~
- ~~(3) Batteries for starting are to be used only for starting and for monitoring reciprocating internal combustion engines. Arrangements are to be made so that the energy stored in the batteries can be maintained at all times.~~