



GUIDE FOR

AIR LUBRICATION SYSTEM INSTALLATION

OCTOBER 2018

**American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862**

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Foreword

ABS recognizes the increasing capability of energy saving devices adopted by the industry and supports improvements in energy efficiency in marine and offshore operations. Air lubrication is an innovative energy saving system utilizing microbubbles to reduce hull skin friction. The consistent release of microbubbles forms an air-water layer around the hull that can result in reduced skin friction for vessels. This Guide provides requirements and reference standards to facilitate effective installation of Air Lubrication Systems.

IMO has recognized air lubrication technology and its potential impact on energy savings, and has included the effects of air lubrication into the EEDI calculation in MEPC.1/Circ. 815, in which air lubrication technology is considered a method of reducing main engine power requirements.

This Guide is applicable to three air lubrication technologies: air bubble, air layer and air cavity methods, which are currently in various degrees of development by the industry. These technologies are continuously evolving. Alternative arrangements, designs and technologies may be acceptable on a case-by-case basis provided they can be demonstrated, through either satisfactory service experience or a systematic analysis based on sound engineering principles, to meet the overall requirements of this Guide.

The effective date of this Guide is the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.



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SECTION 1 General

1 Introduction

ABS recognizes the increasing uses of Air Lubrication Systems on marine vessels to reduce skin friction resistance on the hull. The three primary air lubrication technologies that are currently developed by the industry to various degrees are the air bubble method, air layer method and air cavity method. These approaches all use air bubbles to reduce the skin friction resistance, with the main differences being the dispenser design.

This Guide provides requirements on the installations of the Air Lubrication Systems on newbuild and retrofit marine vessels. The Guide is to be used in conjunction with the *ABS Rules for Building and Classing Marine Vessels*.

3 Scope and Application

This Guide provides the requirements for installing Air Lubrication Systems on marine vessels with regard to the piping system, pneumatic system, electrical system, hull penetration, and stability. The criteria in this Guide are applicable to marine vessel installations. Other vessel type applications will be considered on a case-by-case basis.

When Type Approval for Air Lubrication System is requested, applicants should contact ABS for the approval process. For ABS Type Approval Program requirements, please refer to Appendix 1-1-A3 of the *Marine Vessel Rules*.

5 Terms and Definitions

Bubble Drag Reduction: A skin friction reduction method of dispersing small or microbubbles under the hull that will reduce the density of the flow.

Air Layer Drag Reduction: A skin friction reduction method of dispersing microbubbles at a certain rate to maintain a continuous layer of air that separates the hull from fluid and reduce the density of the two-phase flow.

Partial Cavity Drag Reduction: A skin friction reduction method of building a recess (air cavity) on the hull to allow the separation between hull and fluid, especially for moving vessels.

Air dispensers: Small sea chests installed on the bottom of the hull to dispense air bubbles.

Air Lubrication Machinery Space: Space containing compressors, reservoirs, motors, etc.

7 Symbols and Abbreviations

ABS: American Bureau of Shipping

AMS: An ABS Notation indicating that a vessel's machinery, boilers and systems have been constructed and installed under survey by the Bureau in accordance with the requirements of the ABS Rules.

IMO: International Maritime Organization

SOLAS: International Convention on the Safety of Life at Sea

MARPOL: International Convention for the Prevention of Pollution from Ships

9 References

9.1 ABS

ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules)

ABS Advisory on Ship Energy Efficiency Measures

9.3 Other References

International Convention for the Safety of Life at Sea, SOLAS

MEPC.1/Circ. 815 2013 Guidance on Treatment of Innovative Energy Efficiency Technologies for Calculation and Verification of The Attained EEDI, IMO

International Convention for the Prevention of Pollution from Ships, MARPOL

9.5 Alternative Standards

Air Lubrication Systems may comply with the requirements of an alternative standard, in lieu of the requirements in this Guide, if the standard can achieve an equivalent or higher level of safety for the installations of Air Lubrication Systems. The Air Lubrication System is subject to design review, survey during construction, and tests, as applicable by ABS for purposes of verification of its compliance with the alternative standard.

11 Data and Plans to be Submitted for Review

11.1 General

At a minimum requirement, the following drawings and data associated with the Air Lubrication System are to be submitted to ABS for review.

- i) General arrangement
- ii) Detail specification for Air Lubrication System
- iii) Electrical load analysis
- iv) Cable diagram for power system
- v) Miscellaneous electrical diagrams
- vi) Air lubrication machinery arrangement
- vii) Miscellaneous machinery diagrams
- viii) Piping system including shell valves
- ix) Material specifications
- x) Ventilation diagrams for Air Lubrication System Machinery Space
- xi) Manufacturer's certificate for air compressor attesting that the released air is oil free
- xii) Detail design of air dispensers
- xiii) Welding details of air dispensers
- xiv) Hull outfitting layouts
- xv) Emergency shutdown arrangement

At a minimum, the following drawings and data are to be submitted and kept on board for easy reference by the crew and Surveyor:

- i) Operation and maintenance manual for Air Lubrication System
- ii) Initial testing procedures of Air Lubrication System



SECTION 2 Air Lubrication System Construction

1 General

1.1 Installation Space Containing Compressors

- i) The Air Lubrication System is to comply with the requirements of 3-2-9/3.1 and 4-6-2/9.7.3 of the *Marine Vessel Rules* in the case of being located forward of the collision bulkhead. The collision bulkhead is to be penetrated only as specified therein.
- ii) The Air Lubrication System plans and arrangements are to clearly show the space it occupies and the clearance with other equipment in the room.
- iii) The Air Lubrication Machinery Space is to be designed to allow convenient access for maintenance and repair.
- iv) The Air Lubrication Machinery Space is not to interfere with any essential service or support equipment as defined in 4-8-1/7.3.3 of the *Marine Vessel Rules*.

1.3 Ventilation Systems

- i) A ventilation system is required for equipment in the Air Lubrication Machinery Space. The ventilation system is to have sufficient air exchange capacity as defined in 4-1-1/7.13 of the *Marine Vessel Rules* for proper machinery operation.
- ii) ISO 8861 is an acceptable standard for designing sufficient air exchange capacity for ventilation.

1.5 Fire Safety

Unless the Air Lubrication System is installed in a Category A Machinery Space defined in SOLAS Regulation II-2, it is to be considered as an Other Machinery Space, and subject to the applicable structural fire protection requirements in SOLAS.

For Air Lubrication System machinery not fitted in the engine room, fire extinguishing arrangements are to be provided as required per Section 4-7-2 of the *Marine Vessel Rules*, as applicable.

3 Hull Modification

Installation of an Air Lubrication System requires affixing air dispensers to distribute air bubbles under the hull. This will require modification of the vessel hull with additional openings. The structural modifications and additional openings for the air dispensers on the hull are to be designed in accordance to the requirements of Part 3, Chapters 1 and 2 of the *Marine Vessel Rules* and submitted for review.

- i) The materials used for hull modification are to be verified as per the requirements of 3-1-2/1 of the *Marine Vessel Rules*. The workmanship is to comply with the requirements of 3-1-2/9 of the *Marine Vessel Rules*.
- ii) These openings affect the longitudinal strength members used in the hull girder section modulus calculation. The openings for fitting air dispensers are to be designed in compliance with the requirements in 3-2-1 of the *Marine Vessel Rules* for the structural design details. The effective areas of the affected sections are to be calculated according to the requirements of 3-2-1/9.3 of the *Marine Vessel Rules*. Local stress concentration due to the openings are to be assessed so that they meet applicable strength and fatigue requirements.

- iii) Compensation is to be made where necessary for openings in the shell, all openings are to have well-rounded corners as required in 3-2-2/9 of the *Marine Vessel Rules*.
- iv) For shell valve design and testing requirements, see 3/3.3.4 and 4/1.3 of this Guide.

5 Stability

- i) The intact and damaged stability requirements for vessels fitted with Air Lubrication System are to comply with Part B-1 Regulation 5 of SOLAS and 3-3-1/3 of the *Marine Vessel Rules*.
- ii) For vessels fitting an Air Lubrication System needing modifications, the change in the lightship value is used to determine if an inclining experiment and a revision of the stability calculations may be required based on the additional weights of the Air Lubrication System. The lightship weight calculation is to be reviewed by ABS in compliance with the requirements of 3-3-2/5.11 of the *Marine Vessel Rules*.
- iii) The change in lightship displacement from the most recent approved lightship data and/or the change in lightship Longitudinal Center of Gravity are to be reviewed with the requirements of Part 3, Chapter 3 of the *Marine Vessel Rules* for the appropriate vessel type in accordance. A stability test may be required on the vessel; calling for revision of stability calculations indicating the changes.
- iv) Documentation detailing the effect on Load Line and Stability of the installation of Air Lubrication System, in accordance with the guidance of 2/5ii) of this Guide, is to be submitted.
- v) If the vessel modification of installing Air Lubrication System changes the main data or internal arrangement of the vessel, the stability software calculation is to be modified and submitted for re-approval as per the requirement of 3-3-7/1.3 of the *Marine Vessel Rules*.

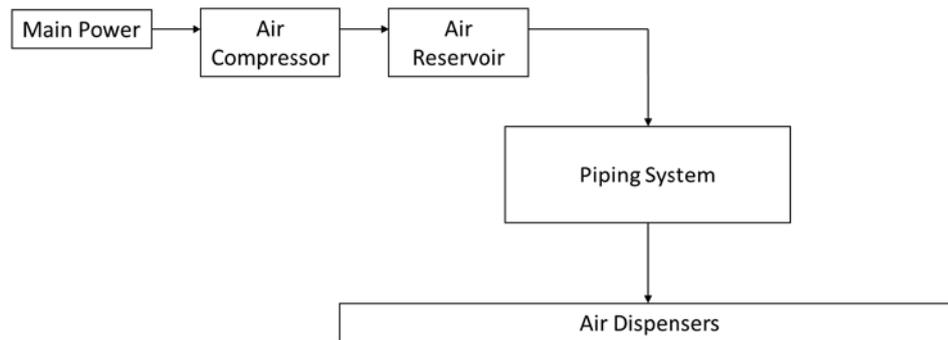


SECTION 3 Air Lubrication System and Machinery

1 General

Air Lubrication Systems generally consist of piping, pneumatic and control systems, and air dispensers (see Section 3, Figure 1 for typical arrangement). Air Lubrication System is a non-essential service according to 4-8-1/7.3.3 of the *Marine Vessel Rules*. The criteria for installation of Air Lubrication System are applicable to features that are permanent and can be verified by plan review, calculation, physical survey or other appropriate means.

FIGURE 1
General Arrangement of Air Lubrication System Main Components



3 Air Lubrication System Machinery

3.1 General

Air lubrication is an innovative technology designed to reduce ship hull resistance and to improve the vessel's energy efficiency. The Air Lubrication System is to be arranged so that, in the event of failure, the power supply to equipment necessary for the propulsion, steering and safety of the vessel will be maintained and be uninterrupted in accordance with 4-8-2/3.11 of the *Marine Vessel Rules* in reference to nonessential services, as stated above.

The following table contains the certification details for air lubrication piping system components. The components are to be reviewed on a case-by-case basis if not certified.

TABLE 1
Certification Details of Air Lubrication System Main Components

<i>Air Lubrication System Components</i>	<i>ABS Type Approval Tier (See 1-1-A4 of ABS Rules for Conditions of Classification)</i>	<i>Guide Reference</i>
1. Compressor Cooling Pump	1	3-3.5
2. Air Lubrication Compressor	1	3-3.5
3. Air Lubrication Reservoir	4/5	4-1-1/Table 5 of MVR

3.3 Piping System

3.3.1 Pipes

The piping system for the Air Lubrication System contains pressurized air delivered from the air compressor to dispenser units under the hull. The following subjects are to be reviewed to meet the requirements of Part 4, Chapter 6 and Part 2, Chapter 3 of the *Marine Vessel Rules*.

- i) Pipe details including diameter, size and schedules
- ii) Design pressure
- iii) Maximum allowable working pressure
- iv) Design temperature
- v) Metallic and non-metallic piping material specifications
- vi) Metallic piping bending test results

3.3.2 Joints

The flanged joints for Air Lubrication System pipe joints are to meet the requirements of 4-6-2/5.5.4 of the *Marine Vessel Rules*. The mechanical joints of the pipes for the Air Lubrication System are to meet the requirements in 4-6-2/5.9 of the *Marine Vessel Rules*.

3.3.3 Valves

- i) Valves used for the Air Lubrication System are to be in accordance with the requirements in 4-6-2/5.11 of the *Marine Vessel Rules*.
- ii) Safety relief valves are to be provided for the air lubrication piping systems to comply with the requirements in 4-6-2/9.9 of the *Marine Vessel Rules*.

3.3.4 Shell Valves

- i) The Air Lubrication System piping connected to the air dispenser units on the vessel's shell is to be provided with positive closing valves providing open or closed indicators in accordance with the requirements of 4-6-2/9.13 of the *Marine Vessel Rules*.
- ii) Air dispensing openings are to be designed with non-return valves locally to prevent sea water ingress and avoid progressive flooding as per the requirements in 4-6-4/3.3 of the *Marine Vessel Rules*.

3.5 Air Compressor and Reservoirs

- i) Details of pneumatic equipment for the Air Lubrication System such as air compressors and air reservoirs are to be submitted for review. Pneumatic equipment is to comply with the requirements in 4-6-7/5 of the *Marine Vessel Rules*.
- ii) Air reservoirs for the Air Lubrication System are to meet the requirements in 4-4-1/1.1vi) and 4-4-1/Table 1 of the *Marine Vessel Rules* (also see item 3 of Section 3, Table 1 above).
- iii) The air supply for the Air Lubrication System shall not compromise or interfere with the starting air supply and reserve requirements in 4-6-5/9 of the *Marine Vessel Rules*.
- iv) A safety device is to be installed in the ventilation system to interlock the air supply fan and the air compressor operations.
- v) Certificates for air compressors are to be provided by the manufacturer showing the discharged air is oil-free in accordance with ISO 8573-1, Class 4 or lower.
- vi) Cooling pumps for the compressor are to meet the manufacturer's guarantee of physical properties and suitability for the intended service, provided the installation is carried out to the satisfaction of the Surveyor.

3.7 Main Power and Electrical System

The electrical systems and electrical equipment requirements for Air Lubrication System installation are to be applied according to Part 4, Chapter 8 of the *Marine Vessel Rules*. The following design details are to be submitted for review:

- i) Cables type, size, capacity, standards of construction
- ii) Motor circuit and protection
- iii) Ventilation system circuit
- iv) Motor controller disconnecting means

3.7.1 Motor Circuit, Controller and Protection

Motors and motor controllers of 100 kW (135 hp) and over are to be certified in accordance with Part 4, Chapter 8 of the *Marine Vessel Rules*.

3.7.2 Electrical Load Analysis

The vessel's number and capacity of generators are to be sufficient under normal seagoing conditions with any one generator in reserve to carry those loads for essential service and for minimum comfortable conditions of habitability as per 4-8-2/3.1.1 of the *Marine Vessel Rules*.

The electrical loads associated with the installation of an Air Lubrication System are to be included in the electrical-plant load analysis in 4-8-1/5.1.5 of the *Marine Vessel Rules* and submitted for review.

5 Control, Monitoring, Alarm and Safety Systems

5.1 General

5.1.1 Automatic Control, Alarm, and Safety Functions

Automatic control, alarm, and safety functions are to be provided for the Air Lubrication System so that the operations remain within the preset parameters for different operation conditions. The temperatures, pressures, and flows in the Air Lubrication System and associated systems are to be controlled and monitored in the following manner:

- i) The control system is to be designed to identify the faults in the equipment and process system. The control and monitoring systems are to comply with the requirements in 4-9-2/3.1 of the *Marine Vessel Rules*.
- ii) The parameters for air lubrication operation shall be provided at the local and, if applicable, remote station and include the following:
 - a) Air pump/compressor operational status
 - b) Status of any Air Lubrication System valves
 - c) Air reservoir pressure indicator
 - d) Status of any Air Lubrication System alarms, shutdowns and Emergency Stop
- iii) The computer-based control system for air lubrication is to comply with the applicable requirements in Section 4-9-3 of the *Marine Vessel Rules* as a Category II system.
- iv) The control, monitoring and safety system for Air Lubrication System is to follow the requirements in 4-9-3/5 of the *Marine Vessel Rules*.
- v) The power supply arrangements for the control and monitoring system are to meet the requirements in 4-9-2/5.3 of the *Marine Vessel Rules*.

The safety system is to be designed to limit the consequence of failures and the Air Lubrication System is to be constructed based on the fail-safe principle. The system is to be designed to avoid a single failure event leading to a potentially dangerous situation for human safety and/or the vessel. In the event of Air Lubrication System failure, an alarm is to be activated.



SECTION 4 Air Lubrication System Surveys

1 Surveys During Construction

1.1 General

An initial survey of the Air Lubrication System is to be conducted by an ABS Surveyor to verify that the installation of the system including any associated structure, fitting, arrangements and materials are in compliance with the requirements of this Guide, as indicated in the approved drawings/plans.

1.3 Testing

The Air Lubrication System testing is to follow the approved Initial Testing Procedures and is to include at least the following items:

- i) Piping system hydrostatic pressure testing and pneumatic leak testing
- ii) Shell valves are to be hydrostatic tested as required in 4-6-2/7.3.2 of the *Marine Vessel Rules*
- iii) Air compressors and air reservoirs hydrostatic pressure testing and pneumatic leak testing
- iv) Operational test for air dispensers
- v) Testing of all the alarms and safety functions
- vi) Testing of fire and gas detection systems as applicable
- vii) Fire extinguishing system as applicable
- viii) Demonstration of correct operation of ventilation and cooling where provided

3 Surveys After Construction

The independent booklet, *ABS Rules for Survey After Construction (Part 7)* is to be referred to.