RUSSIAN MARITIME REGISTER OF SHIPPING

Version: 01.11.2022

GUIDELINES

ON SHIP WIND ASSISTED PROPULSION SYSTEMS

ND NO. 2-030101-050-E

St. Petersburg

2022

Guidelines on Ship Wind Assisted Propulsion Systems

Guidelines on Ship Wind Assisted Propulsion Systems (WAPS) of the Russian Maritime Register of Shipping has been approved in accordance with the established approval procedure and come into force on 1 November 2022.

The Guidelines are published in electronic format in Russian and English.

REVISION HISTORY[1]

(purely editorial amendments are not included in the Revision History)

For this version there are no amendments to be included in the Revision History.

[1] Amendments and additions introduced at re-publication or by new versions based on circular letters or editorial amendments.

1 GENERAL

1.1 INTRODUCTION

1.1.1 The Guidelines on Ship Wind Assisted Propulsion Systems (WAPS) (hereinafter referred to as these Guidelines) contain requirements for classification of ships fitted with wind assisted propulsion system (WAPS) and WAPS certification to ensure its installation on board the ship.

1.1.2 Ships fitted with WAPS meeting the requirements of these Guidelines may be assigned distinguishing mark **WAPS** (wind assisted propulsion system) in the class notation.

1.2 DEFINITIONS AND ABBREVIATIONS

For the purpose of these Guidelines the following definitions and abbreviations have been adopted.

Suction wing is an orientable wing with internal ventilated system using boundary layer suction effect.

Apparent wind is a wind representing the combination of the true wind and the wind induced by the ship movement.

Drive unit is the machinery and electrical installation designed to operate, control and/or monitor the auxiliary WAPS.

Essential services are services normal operation whereof ensures safe navigation, safety of human life and safety of cargo on board ship.

Free-standing rig is a mast that does not rely on shrouds and strays. The free-standing mast can be fixed or turned by rotation.

Free standing rotating rig is a free standing rotating rig with integral rigid boom extending fore and aft of the mast supporting the sail tacks. The sails are trimmed to the wind by rotation of the mast.

Wing sail is a wing rigidly fixed to a free rotating mast with integral rigid boom. The wing sails are trimmed to the wind by rotation of the mast.

Material creep is a slow continuous plastic deformation of the solid substance due to continuous load or mechanical stress.

Flettner rotor (rotor sail) is a type of wind assisted propulsion system that usually features a rotating cylinder / rotor to generate thrust from wind force by the Magnus effect.

Drive system is the machinery that drives the operation motions of the wind assisted propulsion system.

Modern rig is a rig with one or further masts supporting mainsail and headsails, equipped with or without spreaders and supported by transverse shrouds and forestay and backstay.

Modern square-rig is a rig with free-standing and rotating masts with curved yards rigidly connected to the mast. The sails furl into the mast and are trimmed to the wind by rotation of the mast.

Traditional rig is a rig with further masts supported by transverse and longitudinal standing rigging shrouds, with yards supporting square sails and with headsails.

Magnus effect is an observable phenomenon in which a lift force is generated on a rotating cylindrical or spherical object when in an air stream.

COLREG-72 — Convention of the International Regulations for Preventing Collisions at Sea, 1972.

WAPS — wind assisted propulsion system.

1.3 APPLICATION

1.3.1 Requirements of these Guidelines apply to WAPS and ships fitted with these propulsion systems. The subject of these Guidelines is rotor sails and wing sails provided the WAPS serve as auxiliary propulsion but not primary propulsion systems in relevant weather conditions.

1.3.2 Environmental conditions

WAPS internal and external parts shall be so designed as to ensure its operation at the following temperature and humidity:

1.3.2.1 for enclosed spaces:

.1 air temperature: 0 °C to +45 °C

.2 relative air humidity: 80 %

1.3.2.2 for open deck:

.1 air temperature for:

WAPS in operation: –10 °C to +45 °C

WAPS out of operation: –25 °C to +45 °C

.2 relative air humidity: 80 %

1.3.2.3 Effect of salt spray shall be taken into account.

1.4 TECHNICAL DOCUMENTATION

In addition to the technical documentation specified in Section 3, Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships (hereinafter referred to as the RS Rules), the following technical data and documents confirming compliance with these Guidelines shall be submitted to the Register. The symbols and their significance used in this Chapter:

Ap — approved;

Ag — agreed;

FI — for information.

1.4.1 General:

.1 WAPS specifications (FI);

.2 WAPS structure (FI);

.3 WAPS general view (FI);

.4 operation instructions (Ag);

.5 program of mooring trials (Ap);

.6 program of sea trials (Ap);

.7 for ships covered by the requirements for Energy Efficiency Design Index (EEDI) / Energy Efficiency Existing Ship Index (EEXI) — documentation and test results confirming compliance with the IMO 2021 Guidance on Treatment of Innovative Energy Efficiency Technologies for Calculation and Verification of the Attained EEDI and EEXI (IMO circular MEPC.1/Circ.896), whatever is applicable (Ag);

.8 FMEA for sail control system components (Ag).

1.4.2 Hull documentation:

.1 structural drawings of WAPS foundation structure (Ap);

.2 materials specifications for WAPS foundation structure (Ag);

.3 plan of weld control and WAPS foundation welding table (Ap);

.4 loads for normal operation conditions and survival conditions used for design of foundation structure (FI).

N o t e . WAPS foundation loads shall be calculated by the manufacturer of the system with regard to the operation conditions;

.5 shipboard foundation structure drawings and scantling calculations taking into account the maximum reactions and overturning moments established in the load analysis report, including deck reinforcement details, specifications of materials and joint details, as part of ship structure drawings, as applicable (Ap);

.6 WAPS structural drawings (Ap);

.7 materials specifications for all WAPS structural members (Ag);

.8 plan of weld control and table of WAPS welding (Ap);

.9 WAPS structural load analysis report and loads used for calculation of WAPS supporting structure members (FI).

N o t e . WAPS foundation loads shall be calculated by the manufacturer of the system with regard to the operation conditions;

.10 slewing ring drawings along with static strength calculations and details if applicable (Ap).

1.4.3 Documentation on arrangements:

.1 specifications for anchor and mooring arrangements (Ag);

.2 drawings of standing rigging structure specifying the materials and the connections between the different elements of the standing rigging (Ap);

.3 drawings of running rigging structure specifying the materials and the mechanical properties of the different elements of running rigging, position of winches, belaying cleats and clutches, position of eye plates, lugs, sail sheets and halyards with indication of angle change in the block area, members of deck connection of fixed elements (Ap);

.4 the shrouds and stays pre-tensioning values, where applicable, specifying the pre-tensioning control process under construction and in service (Ag);

.5 halyards and sheet ropes characteristics and sail furling devices (Ag);

.6 characteristics of chain plates, pad eyes, etc. supporting the forces reactions induced by the standing rigging (Ap);

.7 characteristics of winches, clutches, sheet track rails, sheave supports, etc., supporting the forces reactions induced by the running rigging (Ag);

.8 for each element of the running rigging the following documents shall be submitted to the Register:

specifications;

manufacturer's documents on results of testing of the equipment and certificate for the product;

drawings of booms, mast rotating system, wing trimming system, etc., if applicable.

1.4.4 Documentation on stability and subdivision:

.1 preliminary calculation of stability considering WAPS effect (Ag);

.2 preliminary calculation of damage stability considering WAPS effect (Ag).

1.4.5 Documentation on machinery:

.1 drawings and calculation of driving machinery (Ag);

.2 dimensions, materials, welding details, as applicable, of all torque-transmitting components (shafts, gears, clutches, coupling bolts, etc.) and all load bearing components (shaft bearings, cable lifter, sheaves, drums etc.) of the wind assisted propulsion system (Ap).

1.4.6 Documentation on systems and piping:

.1 drawing of hydraulic or pneumatic piping system specifying the design pressure, relief valve arrangement and settings, materials and typical pipe joint details, if applicable (Ap).

1.4.7 Documentation on electrical equipment and automation:

.1 drive unit arrangement plan (Ap);

.2 specification for components of drive unit (Ag);

.3 technical background on integration of electrical equipment of the drive unit with the onboard power supply (Ag);

.4 calculation results of necessary output of the ship's electric power plant providing for the operating conditions related to the use of wind assisted propulsion system (included in the list of mandatory plan approval documentation) (Ag);

.5 results of short-circuit current calculation and analysis of selective properties of protective devices for rated current of the generators or the generators operating in parallel in excess of 1000 A taking into account WAPS consumers (included in the list of mandatory plan approval documentation) (Ag);

.6 diagrams of electric connections for WAPS with indication of cable types and places of installations of all system elements and devices (Ap);

.7 technical documentation on control, indication and alarm systems as well as safety system (including arrangement of sensors, list of alarms, description of redundancy principles and description of operator's interface) (Ag);

.8 list of WAPS controlled parameters with indication of unique identifier, parameter description, type of signal (included in the list of mandatory plan approval documentation) (Ag);

.9 functional diagrams of control, indication and alarm systems (Ap);

.10 functional diagrams of safety system (Ap).

1.4.8 Documentation on navigational equipment:

.1 field of vision drawings in compliance with the requirements of 2.2.4.3 and 2.3.3.3, Part I "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships (Ap). The drawings shall be performed in all operating conditions of the auxiliary wind assisted propulsion system;

.2 calculation diagram indicating radar blind sectors in all operating conditions of the auxiliary wind assisted propulsion system (Ap).

2 HULL, MATERIALS AND WELDING

2.1 GENERAL

2.1.1 All structures regulated by this Section are subject to the Register survey. For this purpose an access shall be provided for their survey.

2.1.2 The structures regulated by this Section shall comply with the approved technical documentation specified in 1.4.2.

2.1.3 It is the designer's responsibility to submit the loads used for the design of all the structural members of the wind assisted propulsion system. The WAPS structure shall be designed to withstand all the ship's operation and survival conditions.

2.2 DESIGN LOADS

2.2.1 Wind loads.

2.2.1.1 Wind loads shall be considered for the WAPS in and out of service as well as in extreme weather conditions.

2.2.1.2 Loads on WAPS categorized as regular service loads shall be derived from wind speeds including gust magnification for cases in which the WAPS is in service. The maximum design wind speed for regular service shall be defined by the designer.

2.2.1.3 The wind load acting on WAPS, shall be calculated from the apparent wind speed, including the effects of gusts with a true wind speed increase by at least 25 %.

2.2.1.4 Technical evidence shall be provided about pertinent lift- and drag-coefficients and how they are used to convert air flow into structural loads, obtained based on the applicable methods such as model tests in wind tunnel, numeral calculations or full-scale tests.

2.2.1.5 The onboard wind anemometer and vane measuring the apparent wind speed and direction shall be located at a position where the air flow is as undisturbed as possible and where it is representative for the highest elevation sail element.

2.2.2 Ice loads.

In case if in compliance with 2.4, Part IV "Stability" of the RS Rules it is required to check the stability under icing. Ice weight on WAPS shall be calculated as follows:

.1 ice thickness of WAPS surfaces shall be taken as 30 mm;

.2 specific ice density is assumed to be 700 kg/m^3;

.3 for consideration of icing effect during calculation of wind load, the windage area shall be extended by 10 % as compared to the windage area without icing in compliance with 1.4.6.1, Part IV "Stability" of the RS Rules.

2.2.3 Inertial loads.

Load effects emerging from the dynamic forces on WAPS, excited due to ship motions in sailing conditions shall be taken into account. Pertinent acceleration values shall be determined for a particular ship.

2.3 REQUIREMENTS FOR THE DECK STRUCTURE

2.3.1 The deck structure of the wind assisted propulsion system shall comply with the requirements of 2.6, Part II "Hull" of the RS Rules and deck structure loads shall be determined taking into account applicable requirements of 6.2 of the Rules for the Cargo Handling Gear of Sea-Going Ships considering loads on the WAPS seating obtained during calculation performed by the manufacturer of such system.

2.4 REQUIREMENTS FOR WAPS SEATING CONSTRUCTION

2.4.1 The construction and dimensions of wind assisted propulsion system seating shall comply with the requirements of 2.11, Part II "Hull" of the RS Rules.

2.5 MATERIALS AND WELDING

2.5.1 Properties of the materials used in the seating construction members shall comply with the requirements of Part XIII "Materials" of the RS Rules.

2.5.2 Welding of WAPS seatings (turbosails) including choice of welding consumables is covered by the requirements of Part XIV "Welding" of the RS Rules.

2.5.3 Welded joints of WAPS seatings shall be checked by visual and measurement testing along the whole length. In case of doubts upon visual and measurement testing results, penetrant testing of welded joint sections may be additionally applied.

2.5.4 All welded joints of WAPS seatings performed with full penetration shall be checked by radiographic or ultrasonic testing (for base metal thickness of 8 mm and above) or their advanced methods along the whole length.

3 EQUIPMENT

3.1 RUDDER AND STEERING GEAR

3.1.1 Rudder and steering gear shall comply with the requirements of Part III "Equipment, Arrangements and Outfit" of the RS Rules. The structure of rudder and steering gear shall take into account counteraction to the WAPS influence within its operating range.

3.2 ANCHOR AND MOORING ARRANGEMENTS

3.2.1 Anchor and mooring arrangements shall comply with the requirements of Part III "Equipment, Arrangements and Outfit" of the RS Rules considering the following.

3.2.1.1 The substructure in way of the windlass shall be designed for the increased load due to WAPS installation.

3.2.1.2 The additional side-projected area and weight introduced by the WAPS installation shall be considered during the equipment number determination for anchoring and mooring equipment.

3.2.2 For existing ships being converted or modified, one shall be guided by the following.

3.2.2.1 Where the Equipment Number (EN) shifts one line downwards in Table 3.1.3-1 of Part III "Equipment, Arrangements and Outfit" of the RS Rules, no change is required.

3.2.2.2 Where the Equipment Number (EN) shifts two lines downwards in Table 3.1.3-1 of Part III "Equipment, Arrangements and Outfit" of the RS Rules, the existing equipment may be accepted provided additional chain of the existing diameter and category is fitted. This additional chain shall meet the length requirement for the new Equipment Number, and the mass of the additional chain shall compensate for the increase in mass of the anchors required by the new Equipment Number.

3.2.2.3 Where the Equipment Number (EN) shifts more than two lines downwards in Table 3.1.3-1 of Part III "Equipment, Arrangements and Outfit" of the RS Rules, new equipment is required. It shall be confirmed that the existing anchor winch may be used with the new chain with specified parameters (weight, length, caliber). Otherwise new anchor winch is required.

3.3 RIGGING

3.3.1 Running rigging.

3.3.1.1 Application.

Requirements of this Chapter cover check of running rigging in the scope necessary to assign distinguishing mark **WAPS** in the class notation.

Elements and parts of the running rigging are specified in Table 3.3.1.1 in compliance with the type of the concerned wind assisted propulsion system.

Table 3.3.1.1

Wind propulsion system	Standing rigging	Running rigging[1]
Modern rig	Masts, shrouds, fore and back stays, running backstays, turnbuckles, spreaders	Booms, sail sheets and halyards, winches, clutches, sheaves
Traditional rig	Masts, shrouds, fore and back stays, running backstays, cable turnbuckles	Yards, sail sheets, winches, stoppers, clutch, sheaves
Free standing rig	Mast	Booms, sail sheets and halyards, winches, clutches, sheaves
Free standing rotating rig	Mast and integrated long boom, fore and back stays, running backstays	Sail sheets, winches, stoppers, sheaves, mast rotating system[2]
Modern square-rig	Mast and yards, yard shrouds	Mast rotating system[2]
Wing sail	Mast and integrated long boom	Wing sail halyards, mast rotating system[2], flap rotation system, telescopic system
Rotor sail	Rotating cylinder	Cylinder rotating system[2]
Suction wing	Wing mast	Air suction system, flap rotation system, wing body rotation system[2]
[1] Elements essential for the integrity and safety of the wind propulsion system shall be checked to assign distinguishing mark **WAPS** in the class notation. [2] When the slewing ring is part of a set of an automatic release system to avoid wind overload on the wind assisted propulsion system considered for the scantling of the standing rigging, the slewing ring scantling shall be checked to assign distinguishing mark **WAPS** in the class notation.		

3.3.1.2 Calculations.

3.3.1.2.1 The forces applied to running rigging elements defined taking into account the different WAPS configurations associated to the wind angle of attack, shall be submitted by the manufacturer.

The maximum static forces considered in this Chapter shall be calculated taking into account the partial safety factor η for design loading conditions.

3.3.1.2.2 Load on sheave block.

The load on a sheave block shall be determined on the basis of vectorial composition of force exerted by the rope taking into account the angle by which the block turns the rope.

The maximum load on a sheave block is obtained for an angle of 180° and is equal to 2 times the tensile rope force.

3.3.1.3 Reference loads for running rigging elements.

.1 for sail sheets and halyards, clutches, sheaves, the breaking load of the element or the SWL shall be taken at least equal to the maximum load in the element in accordance with 3.3.1.2;

.2 for winch — the brake value for winch;

.3 for boom and mechanical elements of mast rotating system — the loads deduced from the calculation approach in accordance with 3.3.1.2.

Note. Long boom integrated to the mast for free standing rotating rig and wing sail systems shall be considered as standing rigging.

The check of elements specified in 3.3.1.3.1, shall fulfill the following criteria:

$$MBF \geq \eta F,$$

where *MBF* is a minimum breaking force, in kN, of the considered element in accordance with 3.3.1.3;

F is the safe working load of the equipment to be taken at least equal to the maximum static tension, in kN, deduced from the model calculation in accordance with 3.3.1.2;

ɳ is a safety factor to be taken not less than:

3,1 for creeping-sensitive elements;

2,1 for non creeping-sensitive elements;

.4 for fiber ropes of materials other than polyester and high modulus polyethylene), the minimum values of safety factors shall be increased in the rope itself (i.e. not including other parts of the line) by 10 %.

.5 check of elements specified in 3.3.1.3.2.

The minimum design load applied to the hull supporting structures for the winch and equivalent equipment shall be determined depending on the brake capacity in service conditions.

The minimum brake capacity of the winch shall be at least equal to the values given in Table 3.3.1.3.3.5.

Table 3.3.1.3.3.5

Minimum braking force

P, kN[1]	Minimum braking force, kN[2]
P < 200	1,50 *P*
200 ≤ *P* ≤ 500	1,20 *P* + 60
P > 500	1,32 *P*

[1] Rope tension, in kN.

[2] Minimum rated holding force, inkN, of the static brake system at the reeled layer for which *P* is specified.

3.3.1.4 Check based on the calculation approach.

3.3.1.4.1 The scantling check of the running rigging elements examined on the base of the loads deduced from the calculation approach, shall be carried out by direct calculation according to the dimensions criteria defined in 3.3.1.3 with a safety factor γ, to be taken equal to:

2,1 for creeping-sensitive elements

1,3 for non creeping-sensitive elements.

For components built in composite materials, the main stresses and the combined stresses shall be increased by 10 %.

3.3.1.4.2 Slewing ring.

3.3.1.4.2.1 A certificate from the ring manufacturer fixing the maximum permissible values for overturning moment and vertical force in the working conditions shall be submitted to the Register.

These values shall not be lower than those calculated according to calculation approach defined in 3.3.1.2 increased by 10 %.

3.3.1.4.2.2 The connections of the slewing ring with the mast and the hull support shall be documented specifying the bolt pre-stressing values and the local reinforcement in the composite parts.

3.3.1.4.2.3 When the slewing ring is a part of a set of an automatic release system to avoid wind overload on the wind assisted propulsion system considered for the scantling of

the standing rigging, the slewing ring dimensions shall be checked to the extent necessary to assign a distinguishing mark **WAPS** in the class notation.

3.3.1.5 Check for interface components between the running rigging elements and mast or ship hull.

The interface components between the running rigging elements and mast or ship hull shall comply with the criteria in accordance with 3.3.1.3.

3.3.2 Standing rigging.

Requirements for the standing rigging elements shall comply with 6.2, Part III "Equipment, Arrangements and Outfit" of the RS Rules.

3.4 SIGNAL MASTS

3.4.1 Sailing rig shall not contradict the requirements of COLREG-72 and/or Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships.

4 STABILITY

4.1 INTACT STABILITY

4.1.1 When checking requirements of Part IV "Stability" of the RS Rules, WAPS windage and icing shall be considered.

4.1.2 The heeling lever l_{w1}, in m, given in 2.1.2.1, Part IV "Stability" of the RS Rules, shall be determined by the formula

$$l_{w1} = \mathrm{C} \cdot \frac{z_w}{z_v} \cdot \frac{0{,}82 p_v A_v z_v}{1000 g \Delta} \qquad (4.1.2)$$

where C = side force aerodynamic factor determined based on model tests or calculation upon approach agreed with the Register;

z_w = lever of wind heeling moment to be determined based on model tests or calculation upon the approach agreed with the Register;

z_v = windage area lever, in m, determined in accordance with 1.4.6.3, Part IV "Stability" of the RS Rules;

In any case, the value $C_D \cdot \frac{z_w}{z_v}$ shall not be taken less than 1,22.

p_v = wind pressure, in Pa, to be determined in accordance with Table 2.1.4.1, Part IV "Stability" of the RS Rules;

A_v = windage area, in m^2, to be determined in accordance with 1.4.6, Part IV "Stability" of the RS rules;

Δ = ship displacement, in t;

g = gravitational acceleration, equal to 9,81 m/s^2.

4.1.3 The Stability Booklet shall contain information on WAPS effect on ship stability. In addition, the following operational limits shall be listed and explained:

.1 permissible weather conditions for WAPS application;

.2 restrictions on ship trim;

.3 permissible metacentric height.

4.1.4 Model tests to determine characteristics of aerodynamic force specified in 4.1.2 shall be performed in compliance with Annex 1 to IMO circular MEPC.1/Circ.896 or in accordance with another approach agreed with the Register.

4.2 DAMAGE STABILITY

4.2.1 When checking requirements of Part V "Subdivision" of the RS Rules, WAPS windage shall be considered.

4.2.2 When calculating the factor s_i, specified in 2.5, Part V "Subdivision" of the RS rules, the maximum assumed wind force M_{wind}, in t·m, shall be calculated as follows:

$$M_{wind} = \mathrm{C} \cdot \frac{z_w}{Z} \cdot \frac{0{,}82 P A Z}{9806} \qquad (4.2.2)$$

where C = side force aerodynamic factor determined based on model tests or calculation upon approach agreed with the Register;

z_w = lever of wind heeling moment to be determined based on model tests or calculation upon the approach agreed with the Register;

Z = distance from centre of lateral projected area above waterline to respective draught (d_s, d_p or d_l);

In any case the value $C_D \cdot \frac{z_w}{z_v}$ shall not be taken less than 1,22;

P — wind pressure, to be taken equal to 120 N/m^2;

A — projected lateral area above waterline.

4.2.3 The Damage Stability Booklet shall contain instructions on reduction of WAPS effect on ship stability in case of damage.

5 FIRE PROTECTION

5.1 The structure, materials and equipment of WAPS shall be covered by the requirements of Part VI "Fire Protection" of the RS Rules.

6 SYSTEMS AND PIPING

6.1 APPLICATION

6.1.1 Requirements of this Section shall cover hydraulic and pneumatic systems used for WAPS operation.

6.2 HYDRAULIC SYSTEM

6.2.1 Hydraulic systems and units shall comply with the applicable requirements of Section 7, Part IX "Machinery" and Sections 1 — 5, Part VIII "Systems and Piping" of the RS Rules.

6.2.2 WAPS hydraulic systems shall not be connected to other hydraulic systems.

6.2.3 Pipelines servicing hydraulic machinery of WAPS drive shall be serviced by two separate pump units, each of which shall ensure machinery operation with nominal pull and at nominal shifting speed. The exemption may be made for WAPS the position of which is controlled by hydraulic system and does not affect ship stability and reported in the stability booklet.

6.2.4 A low-level alarm for hydraulic fluid reservoirs serving the system and a low pressure alarm for hydraulic accumulators shall be provided. These alarms shall be audible and visual and shall be situated on the operating console at the navigation bridge.

6.2.5 Hydraulic reservoir interiors shall be accessible for examination and cleaning.

6.2.6 The hydraulic systems shall be provided with the filters of appropriate capacity and filtration purity of the working fluid. Provision shall be made for filter cleaning without interruption of the system operation.

6.2.7 If the terminal position of hydraulic cylinder or hydraulic motor is limited by the terminal switch and in case the motion beyond the terminal position may result in danger to personnel or failure of the equipment, additional mechanical stoppers shall be installed to restrict the motion.

6.3 PNEUMATIC SYSTEM

6.3.1 The structure of pneumatic system shall ensure its operation similar to the hydraulic system.

6.3.2 It shall be demonstrated that level of system reliability and safety is not less than that which may be achieved by the hydraulic equipment.

6.3.3 Measures shall be provided to expulse compressed air or neutral gas of solid and liquid substances used in the system. For this purpose, filters, separators and dryers shall be provided. Filtration purity shall prevent formation of condensate and its freezing in the system. In case of dangerous situation due to filter contamination, an alarm on inadmissible contamination level shall be provided.

7 MACHINERY

7.1 WAPS rotating machinery is covered by the applicable requirements of Part IX "Machinery" of the RS Rules.

In the area of moving parts relevant protective devices to restrict access of personnel shall be provided in order to prevent an accidental contact of a person with moving parts.

8 ELECTRICAL EQUIPMENT

8.1 GENERAL

8.1.1 Electrical equipment designed for installations on ships covered by the requirements of these Guidelines, shall be covered by the requirements of Part XI "Electrical Equipment" of the RS Rules.

8.2 MAIN SOURCE OF ELECTRICAL POWER

8.2.1 In case when the ship's main source of electrical power is used for WAPS supply, it shall be of sufficient capacity to ensure simultaneous operation of the following consumers:

WAPS at its maximum permissible power consumption;

essential services and arrangements specified in 1.3.2, Part XI "Electrical Equipment" of the RS Rules;

ballast system where applicable.

Consumers of the WAPS drive unit shall be considered when determining content and power of generators of the ship's main source of electrical power.

8.3 EMERGENCY SOURCE OF ELECTRICAL POWER

8.3.1 In case when the ship's emergency source of electrical power is used for WAPS members supply required for navigation safety in case of accident, it shall be of sufficient capacity to ensure simultaneous operation of all these consumers in addition to the consumers specified in 9.3, Part XI "Electrical Equipment" of the RS Rules.

8.4 DANGEROUS ZONES, SPACES AND AREAS

8.4.1 As far as practicable, electrical equipment intended for the WAPS shall not be located in dangerous zones. When it is not possible, the electrical equipment installed in dangerous zones 1 or 2 shall comply with the requirements specified in 19.2.4, Part XI "Electrical Equipment" of the RS Rules.

8.5 LIGHTING PROTECTION

8.5.1 Lighting protection of WAPS equipment shall be performed in compliance with the requirements specified in 2.6, Part XI "Electrical Equipment" of the RS Rules.

9 AUTOMATION

9.1 GENERAL

9.1.1 Provisions of Part XV "Automation" of the RS Rules shall apply to automation equipment designed for installation on ships covered by the requirements of these Guidelines.

9.1.2 Automation systems and their components and arrangements shall ensure reliable operation in different operation modes and at different climate conditions related to the particulars of WAPS operation.

9.2 OPERATING MODES SELECTION

9.2.1 WAPS operating modes shall be selected from the navigation bridge.

9.3 FAILURE BEHAVIOR

9.3.1 The WAPS automation systems shall have non-critical behaviour in the event of power supply failure, faults or restoration of operating condition following a fault.

9.4 AUTOMATION POWER SUPPLY

9.4.1 Control, indication and alarm systems and safety system shall be supplied from an uninterrupted power source, with an alarm being activated upon loss of its input voltage.

9.5 CONTROL, INDICATION AND ALARM SYSTEMS

9.5.1 Where the ship, the cargo and the sails are so sized and combined that a total or partial trouble in the control system may result in emergency situation, some suitable automatic safety arrangements shall be made, such as:

self automatic sail furling;

self orientation of sails in the less wind-resistant position.

9.5.2 Propulsion machinery orders from the navigation bridge shall be indicated in the main machinery control room, and at the manoeuvring platform (if available).

The WAPS main control station shall be equipped with the following indicators:

tilt-up mast (if applicable);

wind speed indicator;

alarm system with clearly identified signals in compliance with 4.1, 4.2, and 5.1, Table 9.5.5.

9.5.3 The control shall be performed by a single control device for independent wind assisted propulsion system, with automatic performance of all associated services, including means of preventing overload of the propulsion machinery. Where multiple wind assisted propulsion systems are designed to operate simultaneously, they shall be controlled by one control device.

9.5.4 The main propulsion machinery of WAPS shall be provided with an emergency stopping device on the navigation bridge which shall be independent of the navigation bridge control system. In the event that there is no reaction to an order to stop, provision shall be made for an alternative emergency stop that may consist of a push-button. This fitting shall be capable of putting the wind assisted propulsion system in the less wind resistant position or

sail furling, whatever the cause of the failure may be. This function shall remain operable at the loss of power supply to the control system.

The design of the remote control system shall be such that in case of its failure an alarm shall be given.

In the event of monitored system supply parameters (voltage, working fluid pressure, etc.) in wind assisted propulsion system reaching set values, remote control shall activate an alarm at the control position.

9.5.5 Alarm system shall comply with the requirements of 2.4.1, Part XV "Automation" of the RS Rules. Table 9.5.5 contains non-exhaustive list of monitored parameters of automated WAPSs with limiting values and types of automatic protection and indication.

Table 9.5.5

Nos.	Monitored parameter		Group 1: remote indication, alarm	Group 2: automatic start of stand-by machinery with alarm	Group 3: automatic shutdown of system with alarm
1	**Sails**		–	–	–
1.1	Automatic safety furling, folding or equivalent action		Alarm	–	–
1.2	Overload		Alarm	–	Stop
2	**Hydraulics**		–	–	–
2.1	Oil tank level		Low	–	–
2.2	Oil pressure	**Low**	Indication/Low	Start	–
2.3		**Very low**	Indication /Very low	–	–
2.4	Oil temperature		Indication /High.	–	–
3	**Pneumatics**		–	–	–
3.1	Air pressure		Indication /Low	–	–
4	**Electrical equipment and automation**		–	–	–
4.1	Failure of control, alarm and safety systems		Alarm	–	–
4.2	Failure of WAPS electric drive unit		Alarm	–	–
4.3	WAPS supply voltage		Low	–	–
4.4	Instrumentation supply voltage		Low	–	–
4.5	Instrumentation supply insulation		Low	–	–
5	**Ballast system**		–	–	–
5.1	Failure of ballast system		Alarm	–	–

9.6 SAFETY SYSTEMS

9.6.1 Safety systems are intended to protect the wind assisted propulsion system against overloads related to environmental conditions. They may include devices such as circuit breakers, safety valves, sail furling equipment, etc.

9.6.2 Safety systems and devices shall operate separately from the control, alarm and indication systems. Their operation shall give a suitable alarm.

9.6.3 Safety systems shall be so designed as to limit the consequence of failures. They shall be constructed on the fail-to-safety principle. In addition, these systems shall be of the self-check type; failure within the safety system, including the outside connection, shall activate an alarm.

9.6.4 Safety system shall be activated automatically in the event of identified conditions which can lead to damage of associated machinery or equipment so that:

normal operating conditions are restored (e.g., by the starting of the standby unit);

the operation of the wind assisted propulsion system is temporarily adjusted to avoid overloading (e.g., by reducing the tension in kite tension lines);

the wind assisted propulsion system is protected, as far as possible, from critical conditions by automatically arranging the system in a configuration appropriate for such conditions (e.g., by furling the soft sails, stopping Flettner rotors, folding or trimming the windsails in such a way the combination lift/drag is as small as possible).

9.6.5 Safety system shall activate an alarm at all WAPS control stations with clear indication of the cause of the safety action.

9.6.6 When safety system stops the machinery, the machinery shall not start again automatically while the emergency condition is corrected.

9.7 INTERCONNECTION DURING JOINT OPERATION WITH THE MECHANICAL PROPULSION PLANT

9.7.1 In joint operation mode of the main propulsion plant with the auxiliary wind assisted propulsion system, the power distribution may be automatically achieved. In this case, the choice of the adjustment parameters shall be left to the operator in order to improve the joint operation mode depending on the operation and economic needs of the ship during operation.

9.7.2 When the ship operates in joint operation mode of the main propulsion plant with wind assisted propulsion system with automatic power load distribution, an alarm shall be provided on the navigation bridge in case the engine operating load remains too low close to the idle mode during an excessive period of time specified by the manufacturer of the engine.

9.7.3 When the ship operates in joint operation mode of the main propulsion plant with wind assisted propulsion system without automatic power load distribution, an alarm shall be provided on exceeding rated power of the main propulsion plant.

9.7.4 Where it is necessary to perform "crash astern" manoeuvre in join operation mode of main propulsion plant with wind assisted propulsion system depending on the ship and sail type, it may be required that WAPS be automatically adjusted into optimal configuration (e.g., stopping Flettner rotors, folding or setting up the windsails for wind vane steering, etc.).

10 NAVIGATION SAFETY

10.1 BRIDGE VISIBILITY

10.1.1 In all operation conditions of the auxiliary wind assisted propulsion system the requirements of 3.2.3 — 3.2.14, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships shall be met.

10.2 RADAR AERIALS

10.2.1 Location of radar aerials shall meet the requirements of 4.2, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships under all operation conditions of the wind assisted propulsion system.

11 TECHNICAL SUPERVISION OF WAPS EQUIPMENT DURING CONSTRUCTION OF SHIPS AND DURING MANUFACTURE OF PRODUCTS

11.1 GENERAL

11.1.1 Relevant checks and testing shall be performed within the survey during manufacture of materials and products and construction of ships. Tests on board the ship shall be carried out upon completion of installation of WAPS equipment. Technical supervision of WAPS equipment shall include the following:

review of technical documentation;

survey of WAPS materials and products;

survey of WAPS on board.

11.2 SURVEY OF PRODUCTS

11.2.1 WAPS materials and products shall be surveyed in compliance with the applicable provisions of Part IV "Technical Supervision during Manufacture of Products" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.

11.2.2 Technical supervision during manufacture of WAPS materials and products shall be performed in compliance with the requirements for the codes of the RS Nomenclature (refer to Appendix 1 to Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships).

11.3 SURVEY AND TESTS ON BOARD THE SHIP

11.3.1 Technical supervision during construction of a ship with a distinguishing mark **WAPS** in the class notation relating to the electrical equipment shall be carried out in compliance with the applicable provisions of the Guidelines on Technical Supervision of Ships under Construction.

11.3.2 The interaction between WAPS control system, main propulsion plant and steering system of a ship shall be checked in compliance with the program of mooring and sea trials attended by a system integrator.

Russian Maritime Register of Shipping

Guidelines on Ship Wind Assisted Propulsion Systems

FAI "Russian Maritime Register of Shipping"
8, Dvortsovaya Naberezhnaya, 191186, St. Petersburg
www.rs-class.org/en