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GUIDELINES FOR WELL STIMULATION VESSELS

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CONTENTS

FOREWORD

Well stimulation vessels mean the offshore support vessels (OSVs) which are capable of injecting stimulation substances into the oil/gas wells at sea while offshore support vessels mean those vessels with the special functions to provide transportation services, performance activities and emergency responses in support of offshore engineering or exploration, exploitation or production of offshore energy resources or alternative energy resources.

The offshore support vessels are also known as oil/gas field service vessels or offshore service vessels.

A well stimulation vessel mainly provides services for production of wells, injects stimulation substances into wells through the operation of well stimulation installations and equipment to improve the productivity of oil and/or gas and support the offshore engineering production.

Currently, several well stimulation substances are commonly used, such as acids, liquid nitrogen, additives, gel fluids and proppants, with different properties. The Guidelines are developed based on the property requirements for well stimulation substances and focus on the specifications for noxious and hazardous substances (e.g. acids and liquid nitrogen).

Chapter 1 General

1.1 General requirements

1.1.1 The requirements of the Guidelines apply to the offshore support vessels (OSVs) designed to carry and operate well stimulation substances.

1.1.2 The well stimulation vessels are to meet the requirements of the Guidelines. In addition, the applicable requirements of CCS Rules for Classification of Sea-going Steel Ships are to be complied with, unless expressly specified in the Guidelines.

1.1.3 The well stimulation vessel is to be operated in an environment in which the risk to the vessel and personnel on board is minimized.

1.1.4 For vessels intended to carry well stimulation substances, the relevant safety provisions of IMO Guidelines for the Transportation and Handling of Limited Amounts of Hazardous and Noxious Liquid Substances in Bulk on Offshore Support Vessels are to be taken into consideration.

1.2 Definitions

1.2.1 The commonly used well stimulation substances are as follows:

(1) Acids;

(2) Liquid nitrogen;

(3) Additives;

(4) Gel fluids; and

(5) Proppants, etc.

1.2.2 Well stimulation vessels are the offshore support vessels to be designed for carrying or operating well stimulation substances. Well stimulation vessels may operate stimulation substance systems installed on board or operate stimulation substances carried by other vessels as to inject the substances into wells.

1.2.3 Well stimulation systems are the facilities intended for operating stimulation substances, i.e. well stimulation installations, equipment and operation system. Well stimulation systems may include acidizing equipment, fracturing blenders, pumping units, hydration and chemical additive systems, supporting equipment, lifting appliances, well control equipment, pressure vessels, piping and electrical components, control systems, etc.

1.2.4 Vessels carrying well stimulation substances are the vessels carrying stimulation substances on board. Well stimulation substances may be carried either by specialized well stimulation vessels or by other ships (such as chemical tankers).

1.3 Class notation

1.3.1 Upon request of the shipowner or ship's operator, well stimulation vessels may be assigned the class notation Well Stimulation.

1.3.2 Where no request for class notation in 1.3.1 is made by the shipowner or ship's operator, the design, operation and survey of the well stimulation vessels may be referred to the applicable requirements of the Guidelines.

1.3.3 For other vessels having operation facilities to inject stimulation substances into wells and complying with the requirements of the Guidelines, the class notation Well Stimulation will be assigned to the vessels affixed to functional notation by CCS, at the request of the shipowner or ship's operator, subject to survey and testing.

1.3.4 In the implementation of the Guidelines, special provisions for well stimulation vessels required by the flag State Administrations or local authorities are also to be considered.

1.4 Submission of drawings, documents and data

1.4.1 Considering the actual conditions of the well stimulation vessel, the following plans are to be submitted for approval:

(1) General arrangement of the vessel;

(2) Arrangement of well stimulation system, including:

① Arrangement of spaces for stimulation substance storage tanks;

② Pumping system for stimulation substances;

③ Arrangement of vent pipes for stimulation substance tanks;

④ Ventilation system of enclosed spaces or semi-enclosed spaces for stimulation substance tanks, pipes, pumps, mixers/blenders;

⑤ Provision and arrangement of electrical installations in spaces for uninhibited acid storage tanks, equipment zones and operation zones;

⑥ Decontamination showers and eyewashes;

⑦ Hazardous areas and division of hazard levels;

⑧ Arrangement of personnel protective equipment storage;

⑨ Structural fire protection details.

1.4.2 Plans of well stimulation substance tanks, including:

(1) Structural plan of tanks, including materials, structures, weld inspection and non-destructive testing, strength and tightness testing and specification of protective linings;

(2) Plans of installation, securing, support and staying of independent tanks for carrying stimulation substances in bulk;

(3) Liquid nitrogen tanks, complying with the relevant requirements for type C independent tanks in Chapter 4 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, including materials, structures, inspections (welds inspection and non-destructive testing) and tests (strength and tightness testing).

1.4.3 Plans of pumping and piping systems:

(1) Plan of piping for acid, nitrogen and liquid additives, including the details of flange connection and pipe clamping/securing;

(2) Plan of pump, mixer/blender;

(3) Plan of high-pressure flexible hoses with connections, and pipe end connections;

(4) Plan of liquid nitrogen evaporator.

1.4.4 Documents of control and monitoring systems:

(1) Level measurement, indication and alarm systems of well stimulation substance tanks;

(2) Overflow alarm and control systems of well stimulation substance tanks;

(3) Emergency shutdown system;

(4) Hydrogen content measuring device and indicator;

(5) Hydrogen chloride content measuring device and indicator;

(6) Oxygen content measuring device and indicator.

1.4.5 Calculations:

(1) Calculations demonstrating the adequacy of the vessel's stability;

(2) Calculations demonstrating adequacy of propulsion power required for the vessel to maintain station during well stimulation operations;

(3) Stress analysis of supporting structure in way of flexible hose storage reels;

(4) Stress analysis of liquid nitrogen piping and heat exchangers;

(5) Stress analysis of high pressure piping.

1.4.6 Miscellaneous

(1) Notwithstanding the above-mentioned provisions for submission of drawings, documents and data, additional and supplementary documentation may still be required by CCS according to the actual conditions of well stimulation installations and equipment;

(2) Drawings of pumps and mixers/blenders;

(3) Drawings and particulars of nitrogen vaporizer and heat exchangers;

(4) Operation manual for well stimulation procedures;

(5) Personnel protective equipment scope and types.

Chapter 2 Vessel's Station Keeping

2.1 Seakeeping

2.1.1 Well stimulation vessels are to have sufficient capabilities to resist wind and wave at sea in order to maintain their positions during well stimulation operations.

2.1.2 In general, the means to maintain position may be:

(1) an anchoring/mooring system; or

(2) a dynamic positioning system.

2.2 Anchoring/mooring positioning system

2.2.1 Where a positioning system with anchors, cables and mooring winches are used, the anchors, cables and mooring winches are to comply with the relevant requirements of Chapter 3, PART TWO of CCS Rules for Classification of Sea-going Steel Ships, as to prevent the potential excessive movement (shifting).

2.2.2 The following factors of anchoring positions are to be taken into consideration for the design of anchors and cables:

(1) wind;

(2) current;

(3) tide;

(4) surge due to passing ships;

(5) wave and swell;

(6) additional force due to change of draft; and

(7) icing.

2.2.3 For well stimulation vessels operating in non-restricted service, if the positioning system with anchors, cables and mooring winches is used during well stimulation operations, the environmental design criteria of the system are to be such that they are capable of resisting a sustained wind speed not less than 36 m/s.

2.2.4 For well stimulation vessels operating in restricted service, the environmental design criteria of the system may be reduced as appropriate. In any case, the system is to be capable of resisting a sustained wind speed not less than 25.8 m/s.

2.2.5 Attention is to be given for vessels using anchors and cables for positioning that safety precautions are to be taken to prevent damaging seabed equipment during its operations, such as anchor deployment, recovery and station keeping.

2.2.6 For vessels using anchors and cables for positioning, it is recommended that the diameter of cables is to be taken at least two grades above the equipment number as required in Chapter 3, PART TWO of CCS Rules for Classification of Sea-going Steel Ships, and the length of cables is to be provided according to the increased diameter.

2.2.7 For non-propelled vessels, use of steel wires instead of cables may be acceptable, provided that the minimum breaking load (MBL) of steel wires complies with the cable requirements of CCS Rules for Classification of Sea-going Steel Ships.

2.3 Dynamic positioning system

2.3.1 Where vessels are installed with a dynamic positioning system, the system is at least to comply with the relevant requirements of DP-2 or DP-3 of Chapter 11, PART EIGHT of CCS Rules for Classification of Sea-going Steel Ships.

Chapter 3 Arrangement of Well Stimulation Installations and Equipment

3.1 Arrangement of storage tanks and piping for well stimulation substances

3.1.1 The well stimulation substances are generally acids, liquid nitrogen, additives, gel fluids, proppants, etc.

3.1.2 Generally, piping conveying well stimulation substances is to be joined by welding, unless special measures are allowed as per CCS Rules for Classification of Sea-going Steel Ships.

3.1.3 Tanks for acid(s) and liquefied nitrogen are to be carried in independent compartments and located at least 760 mm from the vessel's side shell and bottom shell respectively.

3.1.4 Tanks for other well stimulation substances may be carried in integral or independent compartments of which the boundaries are to be at least 760 mm from the vessel's side shell and bottom shell respectively.

3.1.5 Tanks for well stimulation substances are to be segregated from machinery spaces, propeller shaft tunnels, dry cargo spaces, accommodation and service spaces, as well as from drinking water and stores for human consumption by means of cofferdam, void space, cargo pump room, empty tank, oil fuel tank or similar spaces.

3.1.6 Piping for the well stimulation operating system and processing plant is not to pass through any accommodation, service or machinery space other than cargo pump-room or pump-rooms.

3.1.7 Piping system for the well stimulation is to be separated from the vessel's machinery and marine piping systems.

3.1.8 Remote control of the well stimulation processing plant is to be arranged at an accessible position outside the operation area of well stimulation.

3.1.9 The arrangement and installation of storage tanks, pumping and piping systems for liquid additives having a flashpoint below 60℃ are to comply with the relevant requirements of Chapter 2 and Chapter 5, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

3.1.10 Notwithstanding the requirements for segregation of tanks containing well stimulation substances, in no case is necessary to provide a cofferdam between the cargo pump room serving liquid substances with a flashpoint below 60℃ and tanks containing other low flashpoint cargo.

3.1.11 Cargoes that react in a hazardous manner with other cargoes are to be segregated from them by means of a cofferdam, void space, cargo pump room, empty tank, fuel oil tank or similar space.

3.1.12 Tanks for other purposes may be accepted as cofferdams for these cargo tanks provided that the spacing between these tanks and all cargo tank boundaries is a minimum of 600 mm.

3.1.13 Fresh water and lubricating oil tanks are not to be used as cofferdams.

3.1.14 Independent tanks stowed on deck or installed in otherwise empty holds are considered satisfactory in terms of segregation requirements.

3.1.15 The arrangement of tanks, pumping and piping systems for chemicals other than acids and liquid nitrogen are to be considered according to the properties of the chemicals and by reference to the requirements in Chapter 5 of CCS Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk.

3.2 Tanks venting

3.2.1 Outlets from safety valves of liquid nitrogen tanks are to be led to open deck. Outlet pipes are to be arranged and supported such as to allow for thermal expansion during cold gas release, taking into account the thermal stress for installation of venting pipes.

3.2.2 Vent outlets from acid tanks are to be led to open deck.

3.2.3 Vent outlets from acid tanks are to have a minimum height of 4 m above deck and located at a minimum horizontal distance of 5 m from openings to accommodation and service spaces.

3.2.4 Vents from acid tanks are to be installed with pressure/vacuum release valves.

3.2.5 Vent outlets from acid tanks are to be fitted with flame arrestors.

3.3 Spaces for acid and liquid nitrogen storage and handling

3.3.1 Enclosed spaces containing tanks, pumps, blenders and associated piping for uninhibited acid are to have entrances direct from open deck or through air lockers from other spaces.

3.3.2 Air lockers are to have independent mechanical ventilation with positive pressure. The air lockers are to be installed in accordance with the relevant requirements of 3.6, Chapter 3 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

3.3.3 The clear opening for access to enclosed spaces is to be as follows:

(1) not less than 600 mm × 600 mm for horizontal openings;

(2) not less than 600 mm × 800 mm for vertical openings.

3.4 Acid spill protection

3.4.1 Tanks, pumps, valves, sealing arrangement and piping of uninhibited acid are to be made of acid resistant materials or fitted with acid resistant linings or coating. The flexible hose connectors are to comply with recognized standards.

3.4.2 Floors or decks under acid storage tanks, pumps and piping for uninhibited acid are to have a lining or coating of acid resistant material extending up to a minimum height of 500 mm in the bounding bulkheads or coamings.

3.4.3 Hatches or similar openings on those floors and decks where acid storage tanks, pumps and piping are routed are to have watertight coamings having a minimum height of 500 mm. Special consideration may be given if this height is regarded impracticable.

3.4.4 On acid installations, spray shields are to be provided to cover flanges or other detachable connections.

3.4.5 Portable shield covers are to be provided for connecting the flanges of the loading manifold. Portable drip trays of acid resistant material are to be provided under manifolds.

3.4.6 A permanent spill coaming of 150 mm in height is to be provided on cargo deck, as to keep spills away from accommodation and service areas and maintain them on the deck.

3.4.7 Spaces housing tanks, pumps and piping for acids or additives are to have a separate drainage system not physically connected to the draining of other areas.

3.4.8 Drainage systems or arrangements in acid storage spaces are to be made of acid resistant materials.

3.4.9 Proper drainage arrangements are to be provided for pump rooms, void spaces, any slop tank, double bottom tanks and similar spaces situated entirely within the well stimulation processing area, provided that such tanks or spaces are separated from tanks containing well stimulation substances or residues of such substances by a double bulkhead.

3.5 Ventilation of spaces for acid storage and handling

3.5.1 Spaces containing uninhibited acid storage tanks or their handling devices are to have independent mechanical ventilation with a capacity of minimum 30 air changes per hour.

3.5.2 Spaces containing inhibited acid storage tanks or their handling devices are to have mechanical ventilation with a capacity of minimum 20 air changes per hour.

3.5.3 Ventilation systems for spaces of acid storage tanks or their handling devices are to be independent from the ventilation system for accommodation spaces.

3.5.4 Ventilation of spaces for additive (including solid and liquid additives) storage tanks and their handling devices is to depend on the flammability, toxicity and reactivity of the additives.

3.6 Ventilation and drainage of spaces for liquid nitrogen storage

3.6.1 Spaces containing liquid nitrogen storage tanks and their handling devices are to have mechanical ventilation with a capacity of minimum 20 air changes per hour.

3.6.2 As a liquefied gas, the liquid nitrogen handling is to comply with the relevant requirements of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. Drip trays resistant to cryogenic temperatures are to be provided at manifolds transferring liquefied gases and at other flanged connections in the system in order to mitigate the cold cracking of the ship structure in the event of a liquid nitrogen spill.

3.7 Control and monitoring systems

3.7.1 A control position is to be provided for normal operations as well stimulation substances are dangerous chemicals, and such arrangement is for the purpose of operating procedures and process shutdown which may be fulfilled by automatic and manual control intermittently in a place accessible to operators.

3.7.2 The control and monitoring systems for well stimulation are to meet the following requirements.

(1) Volatile gas detection

① Enclosed or semi-enclosed spaces containing uninhibited acid tanks are to be provided with gas detection and alarm systems for hydrogen and hydrogen chloride gases.

② Spaces containing tanks and piping for liquid nitrogen are to be equipped with an oxygen deficiency monitoring system.

(2) Tank level gauging and alarm systems

① Tanks for liquid nitrogen are to be provided with level gauging and detecting device. The detecting device is to be capable of withstanding the maximum allowable relief valve setting (MARVS) of the liquid nitrogen tanks.

② Tanks for hydrochloric acid are to be provided with a closed gauging system and a high level alarm system. The alarm is to be activated by a level sensing device independent of the gauging system.

③ Spaces housing equipment and storage tanks for the well stimulation are to be provided with a detection and alarm system for liquid leakages.

(3) Emergency shutdown system

① Emergency stop of all pumps in the well stimulation system is to be arranged from one or more positions located outside the area for well stimulation operations.

② An emergency shut-off valve is to be provided in the outlet of each liquid nitrogen tank. The shut-off valves are to be remotely controlled from one or more positions outside the area for well stimulation operations.

③ Emergency depressurizing and disconnection of the transfer hose are to be arranged from the center control station and navigation bridge.

④ Where applicable, at least one emergency shutdown panel capable of closing all barrier elements is to be provided for the control system in order to disconnect the subsea blowout pipe sections. A safe and easy access to the panel is to be provided.

(4) Power supply

A reliable power supply is to be provided for the emergency control and shutdown. The emergency power supply may be either electrical or hydraulic/pneumatic power supply.

(5) Communications

① Hardwired means for voice communications are to be provided between the center control station and well stimulation operation station.

② Hardwired means for voice communications are to be provided between the center control station and the vessel's position keeping station.

3.8 Well stimulation equipment and systems

3.8.1 The well stimulation equipment and systems are to be tested after being fitted on board the vessel to verify that the operation is safe and any danger to persons on board and marine pollution due to any damage has been reduced to the minimum.

3.8.2 During the test, special attention is to be given by the site surveyor to moving parts, hot surfaces of the equipment and systems, as well as other and potential hazards to persons on board.

3.8.3 Confirm that the impact of any damage of stimulation systems and essential devices and equipment on the safety of the vessel is minimized.

3.8.4 Each well injection line is to be provided with a check valve located at a flowhead or a test tree.

3.8.5 Confirm that the installations and equipment in well stimulation areas have an appropriate explosion proof level as required for the intended locations.

Chapter 4 Acid and Liquid Nitrogen Systems

4.1 Acid system

4.1.1 Tanks, pumps and piping are to be made of the materials which are suitable to cargo's temperature and pressure, and comply with recognized standards. In general, they are to be made of steel.

4.1.2 Materials of storage tanks, pumps and piping for inhibited acids are to have acid resistant properties.

4.1.3 Storage tanks, pumps and piping for uninhibited acids are to be made of corrosion resistant materials or fitted with corrosion resistant linings.

4.1.4 The manufacturers are to provide the information on compatibility of the equipment with cargoes to the operators on board before the delivery or at the completion of conversion.

4.1.5 In addition to the relevant requirements of 15.11, Chapter 15 of CCS Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, the storage tanks are to comply with the following requirements.

(1) No vessel's structural members are to be used as tanks for acids (mineral acids). For this purpose, the design, installation, inspection and testing of such tanks are to include the relevant requirements for independent tanks.

(2) Acids are generally stored in independent tanks. Where the independent tanks are installed on board, due consideration is to be given to the action of static and dynamic loads of the liquid. For this purpose, precautions are to be taken to prevent the movement of tanks and to avoid the excessive stresses of hull and tanks due to temperature changes and hull deformation.

4.1.6 Materials and construction of pumps are to meet recognized standards based on the working medium and properties (pressure and temperature), and comply with the applicable requirements of 2.6.1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

4.1.7 Materials and construction of piping are to meet recognized standards based on the working medium and properties (pressure and temperature), and comply with the relevant requirements of Chapter 5 of CCS Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk.

4.1.8 Flexible hoses and the attached connectors (flanges) are to meet the following recognized standards:

(1) BS-1435 Standards for flexible hoses;

(2) ANSI B16.5 and BS-1560 Standards for attached flanges of flexible hoses.

4.2 Liquid nitrogen system

4.2.1 Tanks, pumps and piping and associated instruments are to be made of the materials which are suitable to the pressure and cryogenic temperature of the liquid nitrogen system, and comply with recognized standards. In general, they are to be made of steel.

4.2.2 Materials of tanks, piping and associated instruments are to be capable of withstanding the action of high oxygen concentration due to condensation of the liquid nitrogen system and nitrogen concentration.

4.2.3 The manufacturers are to provide the information on compatibility of the equipment with cargoes to the operators on board before the delivery or at the completion of conversion.

4.2.4 Liquid nitrogen tanks are to comply with the relevant requirements for the design, installation, inspection and testing of type C independent tanks as specified in Chapter 4 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. In addition, due consideration is to be given to the following where independent liquid nitrogen tanks are installed on board the vessel:

(1) to prevent the movement of tanks caused by the action of static and dynamic loads of the liquid inside the tanks;

(2) to avoid the possible excessive stresses of hull and tanks due to temperature changes and hull deformation.

4.2.5 Materials and construction of pumps are to meet recognized standards based on the working medium and properties (pressure and temperature), and comply with the applicable requirements of 2.6.1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

4.2.6 Materials and construction of piping are to meet recognized standards based on the working medium and properties (pressure and temperature), and comply with the relevant requirements of Chapter 5 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

4.2.7 For liquid nitrogen piping, special consideration is to be given as follows.

(1) Liquid nitrogen is generally kept at atmospheric pressure within temperature range of -210℃ to -196℃.

(2) According to the industry standards, the normal working temperature of liquid nitrogen is -110℃. A complete stress analysis is to be carried out for the weight of pipes, acceleration loads due to ship motions, internal pressure, thermal contraction and loads induced by sinking and bending of the vessel, for each branch of the piping system.

4.2.8 Flexible hoses and the attached connectors (flanges) are to meet the following recognized standards:

(1) BS-1435 Standards for flexible hoses;

(2) ANSI B16.5 and BS-1560 Standards for attached flanges of flexible hoses.

Chapter 5 Personnel Protection, Fire Protection and other Safety Measures

5.1 Personnel protection

5.1.1 Decontamination showers and eyewashes

(1) Decontamination showers and eyewashes are to be provided in a readily accessible and convenient location, generally in a proper place on deck.

(2) Showers and eyewashes are to be operable in all ambient conditions, especially for the cold weather condition.

5.1.2 Personnel protective equipment

(1) Protective equipment is to be provided for the operation personnel engaging in acid solutions handling on board the vessels carrying acid tanks. The personnel protective equipment is to be in compliance with the relevant requirements of CCS Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk.

(2) Protective equipment is to be provided for the operation personnel engaging in liquid nitrogen handling on board the vessels carrying liquid nitrogen tanks. The personnel protective equipment is to be in compliance with the relevant requirements of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

(3) Personnel protective equipment is to be kept in a dedicated cabinet which is in a readily accessible and suitable location outside any accommodation space.

5.2 Fire-fighting system

5.2.1 The arrangements for fire-fighting stations, fixed fire extinguishing systems and portable fire extinguishers are to be in accordance with the applicable requirements of Chapters 1, 2 and 3, PART SIX of CCS Rules for Classification of Sea-going Steel Ships.

5.3 Operation manual

5.3.1 Each well stimulation vessel is to be provided with an operation manual for the stimulation substances carried on board.

5.3.2 The operation manual is to be available on board for ready use.

5.3.3 The operation manual is to give the description and information on all safety aspects of the well stimulation operation.

5.3.4 The operation manual is at least to cover the following details:

(1) Equipment protection;

(2) Storage and operation of solid and liquid additives;

(3) Vessel's transfer operation;

(4) Emergency control and shutdown.

Chapter 6 Surveys and Tests

6.1 General requirements

6.1.1 Surveys are to be carried out during installation of well stimulation equipment and systems on board vessels.

6.2.2 Surveys and testing are also to be carried out after installation of well stimulation equipment and systems on board vessels and prior to the stimulation operation.

6.2 Installation and construction surveys

6.2.1 In addition to the starting and shutdown of well stimulation systems, the requirements for its management, operation and emergency procedures are to cover the vessel's station keeping and stability, fire-fighting process and emergency evacuation.

6.2.2 Effectiveness testing is to be carried out in the presence of the site surveyor after the initial installation of the well stimulation equipment. The testing is to be carried out in accordance with the test procedures agreed by CCS.

6.2.3 The key inspection items of the survey during construction or the classification survey during construction for well stimulation vessels are as follows:

(1) Stimulation systems, including the arrangement, installation and operation safety of tanks and their storage and stowage, pumping, piping, associated instrumentation and control and monitoring devices.

(2) ersonnel protective equipment.