A Study on the Revision of Korean Nuclear Regulation Guidelines under the Assuming the Introduction of nuclear ships: reference to Russian classification regulations

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1. Introduction

Research is underway to replace ship-propelled fuels from fossil fuels to eco-friendly fuels as the level of environmental regulations in the marine sector worldwide. Various energies can be considered as these energy sources but nuclear energy could be the most efficient alternative energy if greenhouse gases are considered throughout the entire process from the production to consumption of the fuel [1,2].

Assuming the introduction of Korean nuclear ships, the subject of this study is selected the Russian classification regulation because Russia is the only country where nuclear ships operated now except for militaty perpose [2].

This study was conducted on the assumption that nuclear ships were introduced in South Korea. The contents related to nuclear ships among the objects of Russian classification rules and the matched contents of the Korean nuclear regulation guidelines are analyzed. The analysis items consisted of general design, reactor-related design, power system, fire protection, and design for emergency cases and specified which items were applied to Korean nuclear regulation guidelines.

2. Korean nuclear regulation guidelines and Russian classification

2.1 Korean nuclear regulation guidelines

Nuclear Safety and Security Commission(NSSC) is a vice-ministerial administrative agency under the Prime Minister in accordance with the revised government organization amendment in March 2013. It is responsible for the inspection and regulation of nuclear facilities, radioactive materials and wastes, and nuclear security to prevent nuclear accidents in South Korea and abroad [3].

The Nuclear Safety Act established by the NSSC was enacted in March 2013 to regulate safety management matters related to nuclear safety, its development, production and use. According to the Nuclear Safety Act, there are the Enforcement Decree of the Nuclear Safety Act, the Enforcement Regulations of the Nuclear Safety Act and 39 administrative regulations for delegation including the Regulations on Technical Standards as shown in Table 1 [3].

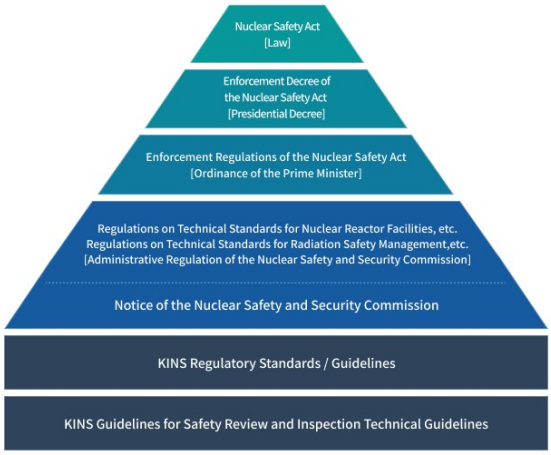

Fig. 1. Korean Nuclear Safety Standards System [3]

The technical standards of KINS, a specialized institution, include regulatory standards describing the interpretation or details of technical standard requirements and regulatory guidelines describing acceptable methods, conditions and specifications to meet technical standard requirements [3].

2.2 Russian classification

Russian Maritime Register of Shipping(RS) is Russian ship classification institute established in 1913. RS is recognized by maritime administrations of so many flag states which are different types, large scale and including nuclear ships. The main objectives of RS are improvement of standards of safety of life at sea, ship safe navigation standards, standards of safety carriage of goods by sea and in inland waters and development of measures and standards to prevent environment pollution [4].

RS has enacted many rules related to the registration and classification of ships, and rules related to nuclear ships are “Rules for the classification and construction of nuclear ships and facilities(No. 2-020101-168-E) [5].”

3. Revision of Korean regulation guidelines

3.1 General Design

All bulkheads, deck, and other structures forming the shielding barrier should be watertight, steel and specified for collision protection at table I (1). The

subdivision shall consider a damage along the length of the ship at table I (2).

The maximum ships degrees of stability are specified at table I (3) and (4). The maximum heel angle of asymmetric flooding shall be 15° before measures on righting are taken. This angle can be up to 17° provided that bulkhead deck is not submerged. The maximum permissible angle of ship at three kinds of condition at table I (4) and table II.

Stand-by diesel generators use the same fuel and fuel tanks shall allow mutual transfer. The fuel can operate generators for 30 days after accident at table I (5).

Table I: Direction of revision

Content	Classification regulation (Russia)	Regulation guidelines (Korea)
(1) General conditions of the shieding barrier	Part IV 7	13.1
(2) Anti-collision design	Part V 1.2	3.23
(3) Requirements to stability	Part V 2.3	3.23
(4) Heels and trims	Part VII 2.1	3.23
(5) Design requirements of the diesel generators	Part VII 6	10.7

Table II: Heels and trims

Conditions /heels and trims	Steam supply system	Main/ auxiliary machinery	Emergency equipment
Long-term heel	30°	15°	22.5°
Roll	45°	22.5°	22.5°
Long-term pitch	10°	5°	10°
Pitch	15°	7°	10°

3.2 Reactor-related design

The length of protection forward and aft bulkhead near reactor compartment shall be at least 0.2 of compartment length. Double bottom in the reactor compartment shall be installed to ensure protection the reactor, safety systems and core facilities against grounding and standing and bottom facility shall be 2m apart from the lower part of the shielding barrier. The containment shall withstand inertial force at sea state and the reactor foundation shall be capable of withstanding up to capsizing at table III (1).

Best location of steam supply system shall be the middle part of the ship, minimizing of pipelines passage is recommended and quality requirements of the these passage are stipulated. Containment of steam supply system shall be provided with automatic external and internal pressure balance during flooding of ship at table III (2).

The calculations shall be considered variation in fluid flow with the roll of ship at table III (3). The reactor shall be subcritical state and residual heat can removed for all position including capsizing at table III (4).

Table III: Direction of revision

Content	Classification regulation (Russia)	Regulation guidelines (Korea)
(1) Anti-shock and rollover design	Part IV 5, 6.5, 8.1	3
(2) Steam supply system design requirements	Part VII 3	4, 9.6, 4.12
(3) Thermal hydraulic conditions with the roll	Part VIII 11	3, 6
(4) The reactor static under emergency cases	Part VIII 12.4, 15.1, 19	3, 6

3.3 Power system

It is stipulated two power sources, nuclear power and stand-by power, that distinguish from commercial nuclear power plant. Stand-by power is to cool steam supply system and for fire fighting, buoyancy, signal and communication, escape routes at table IV (1). The important of the emergency generators is prescribed, and manuals of four case group by the main power and ship's condition are prescribed at table IV (2).

The battery which can be transient power supply source shall be located below the bulkhead deck, and charge fully during 8 hours and operate devices of the steam supply system for 30 minutes. these electric equipment can be operated under the conditions of heel up to 30°, roll up to 45° and trim up to 10° at table IV (2).

Table IV: Direction of revision

Content	Classification regulation (Russia)	Regulation guidelines (Korea)
(1) Classification of power sources	Part VII 1	9.13
(2) The safety requirements of electric energy	Part X 2, 5	9.11, 9.18

3.4 Fire protection

The ship shall be separated using cofferdams or class A-60 bulkheads to protect against external fires and explosions at table V (1). 10 fixed fire alarm stations are following at table V (2).

· Solid radioactive waste storage spaces
· Space for equipment and systems for collecting and discharge of radioactive waste
· Space with fitted equipment, pipeline and valves of the primary and tertiary circuits
· Decontamination spaces and stations
· Space used for work with contaminated equipment and radioactive media
· Exhaust ventilation spaces
· Contamination control station spaces
· Automation spaces
· Electric cable route corridors
· Passage corridors, lobbies, etc.

Detectors are not required in the shielding spaces with low fire risk, transit pipeline and steam pipeline corridors, liquid radioactive waste tank space, void spaces, shower rooms, etc. Thermal detectors shall be used in reactor instrument stations, exhaust ventilation spots and the spaces where steam can be present. These detectors can be operated 20℃ higher than maximum air temperature in each spaces. Manual alarm shall be placed in the containment and shielding barrier spaces and control station at table V (2).

CO_2 fire extinguishers shall be placed in containment spaces and the number of emergency escape breathing devices shall be considered members of damage control team and one emergency escape breathing device for training sufficiently at table V (3).

Table V: Direction of revision

Content	Classification regulation (Russia)	Regulation guidelines (Korea)
(1) Cofferdams and bulkheads	Part VI 2.1	10.6
(2) Fixed and manual fire alarm stations	Part VI 4	10.6
(3) Fire fighting applications	Part VI 5	10.6

3.5 Design for emergency cases

the ship shall have sufficient buoyancy in case of flooding of two adjacent compartments at table VI (1). Special parts which remain unflooded in some condition and the reactor can get plugged before immersion of the ship in case of flooding at table VI (2). The considerations of the ship under some accident like grounding/standing, the fire and explosion hazards of cargo are prescribed. Collision followed by fire, the effects of helicopter crash on the ship are prescribed and these case can be main design-basis accidents at table VI (2).

Table VI: Direction of revision

Content	Classification regulation (Russia)	Regulation guidelines (Korea)
(1) Flooding	Part V 1.2	3.23
(2) Emergency	Part VIII 7	14

4. Conclusions

The details of the matters related to nuclear ships among the RS regulations and specified which items were applied to Korean nuclear regulation guideline were analyzed in this study.

The direction of future research shall be to analyze IMO's regulations related to nuclear ships and other countries' regulations which will be revised in the future and to develop related technologies.

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