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Technical requirements of intrusion alarm system for physical protection of nuclear material and nuclear facilities-Part 2:Bistatic microwave intrusion detector

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Technical requirements of intrusion alarm system for physical protection of nuclear material and nuclear facilities-Part 2:Bistatic microwave intrusion detector

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Foreword

EJ/T 20180 Technical requirements of intrusion detection alarm system for physical protection of nuclear material and nuclear facilities is composed of the following two parts:

——Part 1:General

——Part 2:Bistatic microwave intrusion detector

This part is Part 2 of EJ/T 20180 Technical requirements of intrusion alarm system for physical protection of nuclear material and nuclear facilities.

In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

Technical requirements of intrusion alarm system for physical protection of nuclear material and nuclear facilities-Part 2: Bistatic microwave intrusion detector

1 Scope

This part specifies the general technical requirements for bistatic microwave intrusion detectors applied to the intrusion alarm system of the physical protection system of nuclear material and nuclear facilities in fixed locations.

This part is applicable to perimeter-based bistatic microwave intrusion detectors for physical protection system of nuclear material and nuclear facilities in fixed locations.

2 Normative references

The following normative documents contain provisions which through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments (excluding corrections), or revisions, of any of these publications do not apply to this standard. However parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

GB 4208-2008 Degrees of protection provided by enclosure (IP code)

GB 15407-2010 Specification of microwave interruption intrusion detector

GB/T 17626.2-2006 Electromagnetic compatibility - Testing and measurement techniques - Electrostatic discharge immunity test

GB/T 17626.3-2016 Electromagnetic compatibility - Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test

GB/T 17626.4-2008 Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test

GB/T 17626.5-2008 Electromagnetic compatibility - Testing and measurement techniques - Surge immunity test

3 Terms and definitions

For the purpose of this part, the followingterms and definitions apply.

3.1

bistatic microwave intrusion detector

an intrusion detector composed of transmitting devices and receiving devices that generates alarm signals as a result of the occlusion of the microwave beam

3.2

reference target

a normal human being or an equivalent reference object that has a height between 150 cm and 190 cm and a body weight between 50 kg and 80 kg, whose ground equivalent reference object is a metal ball with a diameter of 30 cm to 40 cm

3.3

boundary of detection coverage

the set of alarm points furthest from the axis formed by the transmitter and receiver antennas when the detector alarm is triggered by the reference target moving vertically along the axis at different locations between the transmitter and the receiver

3.4

detection distance

the maximum distance between the transmitter and the receiver that can effectively detect the reference target

3.5

detection width

the horizontal and vertical widths of the cross section formed by the intersection of a vertical plane on the axis formed by the mutually aligned transmitterandreceiver antennas and the boundary of detection coverage

3.6

detection range

the area within the boundary of detection coverage

3.7

detection height

the vertical distance of detection coverage

3.8

tampering

the act of deliberately disabling the physical protection deviceor equipment

3.9

isolation zone

a specific zone within or in the periphery of the physical barrier with no objects inside that can hide or mask the human body, located usually between two fences

3.10

disarm mode

a mode allowing entry to the detection belt without sounding the alarm while effectively monitoring the signal lines between the detectors and the alarm equipment, and ensuring effective operation of the tamper-proof switches on detectors

3.11

balanced protection

a concept used in the design of physical protection systems to refer to the capability of providing equally effective protection on all possible intrusion paths of adversaries

3.12

blind area /dead zone

an area in the detection belt not covered by the detector

3.13

fortification mode

an operation state allowing the detection device to be triggered to generate an alarm once a human intrudes the detection belt, under which it is necessary to maintain safe operation of the signal transmission lines between all detectors and alarm equipment and the tamper-proof switches on all detectors

3.14

probe segment/ detecting section

a section of the isolation zone with independent detection alarm and check to alarm

3.15

detection belt

a detection range formed by the combination of all detecting sections

3.16

probability of detection(PD)

the probability of the detection unit successfully detecting an intrusion activity within the coverage area of the sensor

3.17

false alarm

an alarm generated due to failure of the equipment itself

3.18

alarm response/ alert response

the action taken by the security forces against the intruder to stop its intrusion activities

3.19

nuisance alarm

an alarm activated by some signal not related to a human intrusion attempt

3.20

confidenceinterval

statistically a range of values so defined that there is a specified probability that a certain parameter falls within it

3.21

confidence level

a statistical term associated with confidence interval to indicate the degree of confidence of a parameter, i.e., the probability of the value of a parameter falling within the confidence interval, usually expressed as a percentage

3.22

perimeter

signs surrounding a protected area to demarcate the protected area, usually composed of the physical barrier and the isolation zone

4 Technical requirements

4.1 Visual and mechanical structures

4.1.1 Visual

The overall dimension of the intrusion detector shall be as specified in the product specification. In the case of non-metal enclosure, the surface of the enclosure shall be free of cracks, fading and permanent stains as well as obvious deformation and scratches. For metal enclosures, the surface coating shall be such that the

underlying metal is not exposed and the surface is free of blistering, corrosion, chipping, burrs, etches, scratches, coating peeling and die casting holes. The control mechanism shall be flexible, reliable and durable, and the signs shall be clear.

4.1.2 **Grading of protection provided by enclosure**

The grading of protection provided by the enclosure shall comply with the requirements of IP65 specified in GB 4208-2008.

4.1.3 **Enclosure strength and resistance to pressure**

The enclosure and the frame shall have sufficient mechanical strength and rigidity to ensure the surface of the enclosure is not permanently deformed or damaged after the pressure and impact test.

4.1.4 **Firmness of the binding posts and lead-out wires**

4.1.4.1 Measures shall be in place to prevent the binding posts from rotating and loosening. The lead-out wires and binding posts shall not fall off after the tensile test.

4.1.4.2 The lead-out wires shall be able to withstand 20 right-angle bends without breaking. In addition, the lead-out wires of the DC power supply shall be able to withstand a tensile force of 14.7N for 60s without damage.

4.2 **Performance**

4.2.1 **Alignment instructions**

The detector shall have an alignment apparatus to facilitate the alignment of the transmitting antenna axis and the receiving axis. Applicable instructions shall be provided on the receiver or the commissioning tools.

4.2.2 **Operating frequency**

The frequency band selected for the detector is 9GHz~25GHz.

4.2.3 **Modulation frequency**

The modulation frequency performance requirements are as follows:

a) The microwave beam shall be modulated and the response of the receiver shall be limited to the selected frequency so as to reduce nuisance alarms caused by atmosphere radio-frequency signals;
b) The modulation frequency shall be no lower than 400Hz;
c) The detector shall have at least 8 modulation channels;
d) The detector shall have a synchronous working mode to support multiple sets of detectors working in coordination in a master-slave manner to prevent detectors from interfering with each other.

4.2.4 **Working voltage**

The working power of the detector shall be wide dynamic DC power with a voltage range of 10V~24V.

4.2.5 **Applicability of detector to power supply**

If DC power is supplied, the detector shall be functional without adjustment and its performance indicators are in compliance with the provisions of the product manual, when the power supply voltage varies within the band of 85% and 125% of the rated value.

4.2.6 **Overvoltage operation**

If DC power is supplied, the detector alarm will repeat 50 times at the rate of no more than 15 times per minute when the power supply voltage is 130% of the rated value, in a manner that the alarm function shall be accomplished each time.

4.2.7 **Power consumption**

The power consumption performance requirements are as follows:

a) Low power consumption products shall be used for the detector, with the power consumption of the detector under the alert status to be no more than 2W;
b) The power consumption of the detector under alarm status shall not exceed 1.5W;
c) The power consumption of the detector under alert and alarm status shall be clearly specified in the product manual.

4.2.8 **Lightning protection characteristics**

The external input of the detector shall be equipped with lightning protection measures.

The power supply and communication port of the detector shall have two levels of lightning protection measures, and the lightning protection characteristics shall not be lower than the following indicators:

a) Primary level is GDT:2kA@8/20μs±5times;
b) Secondary level is TVS: the maximum pulse power is 600W.

4.3 Function

4.3.1 Trigger alarm

The trigger alarm function requirements are as follows:

a) When the reference target passes through the detection range under the specified conditions, the detector shall generate an alarm signal;
b) In a detection range of less than 100m, when a human weighing over 35kg passes across the detection range by walking, running, jumping, or in a prone crawling/rolling manner, the detector shall generate an alarm signal. Or a 30cm diameter equivalent simulated metal ball is used to pass through the central axis of the detection zone (with a radius of 0.5m), and the detector shall generate an alarm signal.

4.3.2 Alarm time and recovery time

4.3.2.1 The alarm recovery method shall support multiple modes:

a) Send a reset command (manual reset) via the network;
b) Automatic reset after delay (with adjustable reset time) or alarm reset after 3 times of normal bus polling.

4.3.2.2 Alarm time: After the reference target leaves the detection range, the alarm signal of the detector are maintained no less than 3s, with adjustable duration.

4.3.2.3 Recovery time: after the reference target leaves the detection range, the detector shall resume the alert status within 1s.

4.3.3 Tamper protection

The intrusion detector shall be equipped with a tamper protection device. When the enclosure is opened, the intrusion detector shall output an alarm signal.

4.3.4 Alarm output

There are two ways to output alarms:

a) A dry contact alarm output shall be provided (via relay contact or switch contact), with settings of normal open and close, based on triple outputs as a minimum:
   1) Intrusion alarm output: DC, 30V,1A;
   2) Fault alarm output: DC, 30V,1A;
   3) Tamper alarm output: DC, 30V, 2A.
b) A digital signal output alarm should be produced (the signal transmitted via the bus).

4.3.5 Automatic gain stabilization

Automatic gain stabilization may automatically compensate for sensitivity changes caused by wind, rain and snow. The automatic gain shall be no less than 60dB.

4.3.6 Network alarm and network management

The network alarm and network management functions are as follows:

a) Network alarms and network parameter adjustment should be provided. One bus is connected to multiple microwave detection devices at the same time;
b) The function for saving parameter shall be provided, which is able to work automatically according to internal setting parameters after startup;
c) The communication interface may be set to work in duplex 422 and simplex 485 mode;
d) The ability for storing alarm events should be provided, with 200 events recorded as a minimum, which may be remotely accessible;
e) The device has upgradeable features. The device has a function of adjustment without opening the enclosure;

f) The rain sensor interface should be reserved at the transmitting end to adjust the transmitting power according to the rain.

4.4 Boundary of detection coverage

4.4.1 Detection distance

The detection distance shall be no less than 100m.

4.4.2 Detection width/ height

The detection width/ height range boundary requirements are as follows:

a) Installation of the transmitter and receiver requires attention to prevent intruders from jumping over the microwave beam from top of the exterior fence to avoid detection. The microwave beam shall be kept away from the outer fence a certain distance. For a perimeter fence of 2.5 m height, the distance between the center of the microwave beam and the outer fence should be a minimum of 2.0 m;

b) At any position of the detection belt, the distance between the bottom of the detection range and the ground shall normally not exceed 15 cm. The maximum detection height of the detector shall be no less than 2.5m. If a single device cannot meet the detection height requirement, a double-stack or multi-stack microwave detector shall be used.

4.4.3 Detectable speed

The detectable speed is 0.03 m/s～15 m/s.

4.4.4 Detection range

Normally, the transmitter and receiver shall be installed on an embedded metal column with a mounting height of 0.6m to 0.8m. To prevent the detection of blind area beneath the microwave beam, the ground shall be flat without obstructions and gullies, so that the area between the transmitter and the receiver is clear of obstruction and rise and depression is no more than 10cm. The distance between fence and the center of the microwave beam should be no less than 2.0m to prevent an intruder from jumping over the microwave beam. The microwave perimeter detection system shall be capable of detecting an intruder weighing a minimum of 35kg passing through any area between transmitter and receiver (including the area in front of both transmitter and receiver) whether by walking, running, jumping, crawling or rolling.

4.5 Installation

There shall be no obstruction objects such as poles, camera bars within 0.5m from the axils of detector's transmitter and receiver. The detection boundary shall be at least 25cm (±10%) away from the physical barrier based on the physical barrier condition, such as the fence. When the microwave detector is used to detect the "crawling intrusion" behavior, the gravel should be laid in the detection range to prevent excessive nuisance alarm when standing water is generated due to raining. At the top of the detection range, where vehicles travel on the road outside the protected area, obstructions or absorbing materials should be equipped with at the boundary of the protected area.

4.6 Environmental adaptability

4.6.1 Grading of detector environmental adaptability

The detector shall satisfy the harsh environment Level Ⅲ in Table 1 of Clause 4 of B15407-2010.

4.6.2 Testing requirements of detector environment temperature and humidity compatibility

The detector shall be subjected to environmental tests in accordance with the appropriate levels. The detector shall be able to work normally after each specific environmental testing. The change of sensitivity or detection distance following testing shall not exceed ±10%, and the enclosure shall not be deformed or damaged.

4.7 Stability

Under normal service condition with no water on the ground, an alarm failure shall not occur to intrusion detector and the false alarm shall be no more than once in every seven days of continuous operation. The variation of sensitivity or detection range shall not exceed ±10%.

4.8 Electromagnetic compatibility

4.8.1 Electrical fast transient burst immunity test

The detector shall be tested in accordance with Testing Level 3 in Table 1 of GB/T 17626.4-2008. During the test, false alarms and alarm failures shall not occur. Flashing of the indicators during testing is acceptable. After testing, the detector shall function normally, functionally verified in accordance with the product standards.

4.8.2 Electrostatic discharge immunity test

The detector shall be tested in accordance with Testing Level 3 in Table 1 of GB/T 17626.2-2006. During the test, false alarms and alarm failures shall not occur. Flashing of the indicators during testing is acceptable. After testing, the detector shall be verified in accordance with the product standards and it shall normally function.

4.8.3 Radiated radio-frequency electromagnetic field immunity test

Detectors shall be tested in compliance with the Level 3 of Table 1 from GB/T 17626.3-2016. No false alarms or alarm failures shall be generated during the test. Flashing of indication devices is acceptable; however, there shall be no output variation. The functions of tested detectors should be verified according to product standards following the test to ensure they are functional.

4.8.4 Surge(impact) immunity test

Detectors shall be tested in compliance with the Level 3 of Table 1 from GB/T 17626.5-2008. No false alarms or alarm failures shall be generated during the test. Flashing of indication devices is acceptable; however, there shall be no output variation. The functions of tested detectors should be verified according to product standards following the test to ensure they are functional.

4.9 Durability

Neither electrical or mechanical failure shall be found nor the equipment damage or contact adhesion when the intrusion detectors are alerted, alarmed and reset at rated voltage and current for 6000 cycles.

4.10 Safety

4.10.1 Safe microwave radiation dose

The power density of microwave radiation, which is 5 cm in front of the generating antenna of the detector, shall be less than 5 mW/cm2.

4.10.2 Protections from abnormal operations

No damage, burning or electric shock shall be found in the detector during the following abnormal operative conditions:

a) Reversed power polarity;
b) Output short circuit;
c) Hand touching input;
d) Misconnection of lead wires.

4.10.3 Flame retardant

The combustion of plastic enclosures shall be no longer than 1 minute with no dripping of melted plastic material when the enclosures of intrusion detectors are subject to fires with flames of 5 seconds plus suspension of 5 seconds for 5 times.

4.11 Reliability

The Mean Time Between Failure (MTBF) of intrusion detectors shall be no less than 60,000 hours at normal working conditions.

5 Testing methods

The testing methods shall be in compliance with Clause 5 of GB15407-2010.

6 Inspection items and rules

Inspection items and rules shall be implementedin compliance withprovisions of Clause 6 of GB15407-2010.