Insulation management methods for low-voltage electric power circuit in Japan

May 20, 2010

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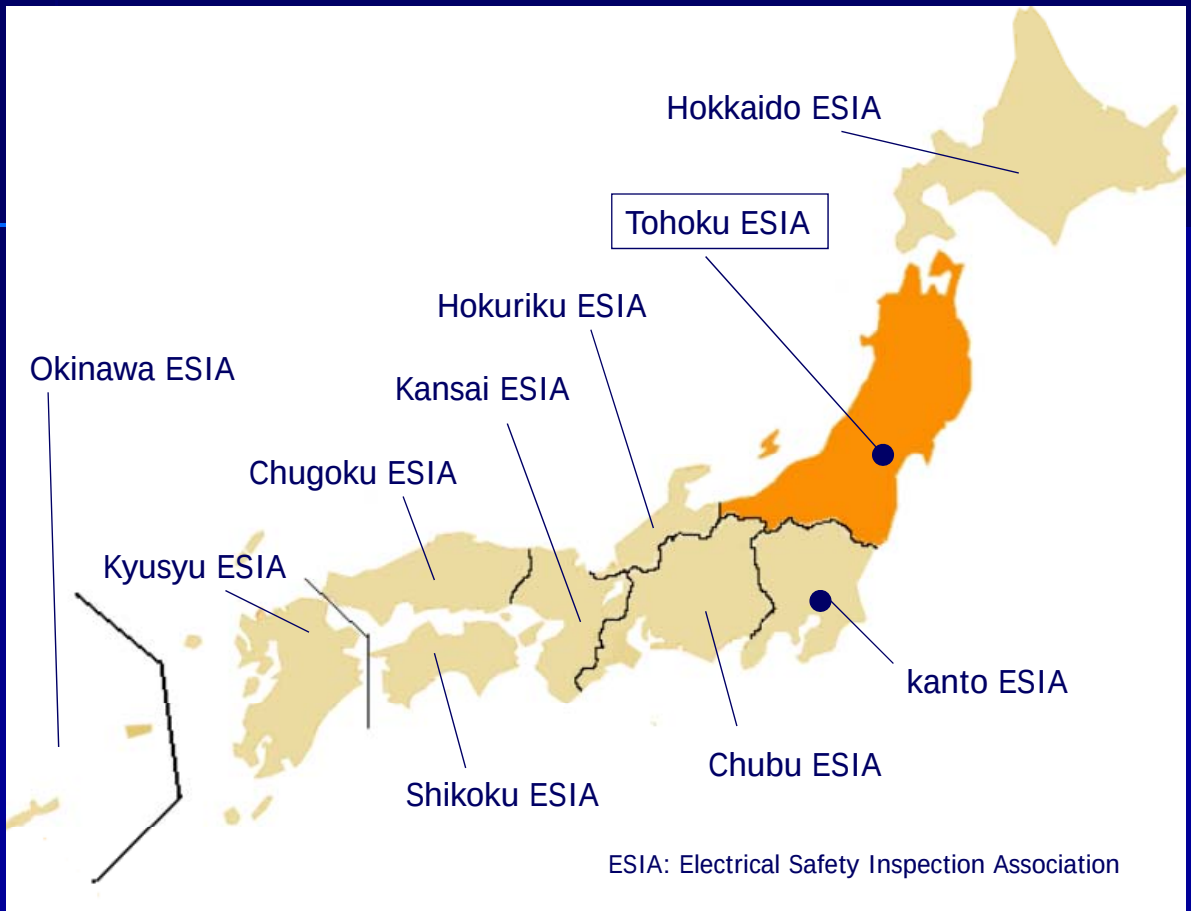
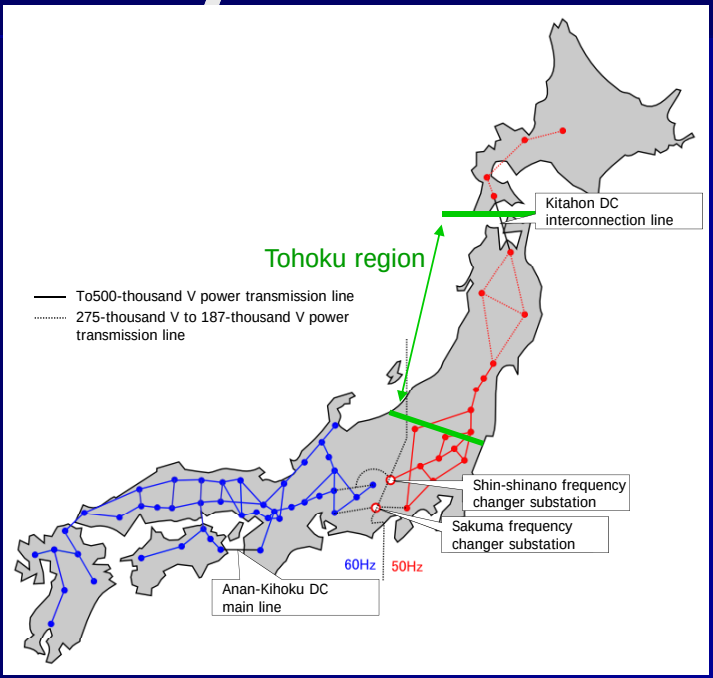
Tohoku Electrical Safety Inspection Association



Power-supply-system and frequency



Contents of presentation

1. Classification of electrical facilities
2. Electric system of low-voltage electric power circuit
3. Insulation management for low-voltage electric power circuit
4. Earth fault protection for low-voltage electric power circuit

1. Classification of electrical facilities

Electrical facilities for general use
(including houses, stores, etc.)

→ Electrical power suppliers are under obligation to carry out periodical inspection and to notify the users of the facilities of the results

Electric safety regulation by the Electricity Utilities Industry Law

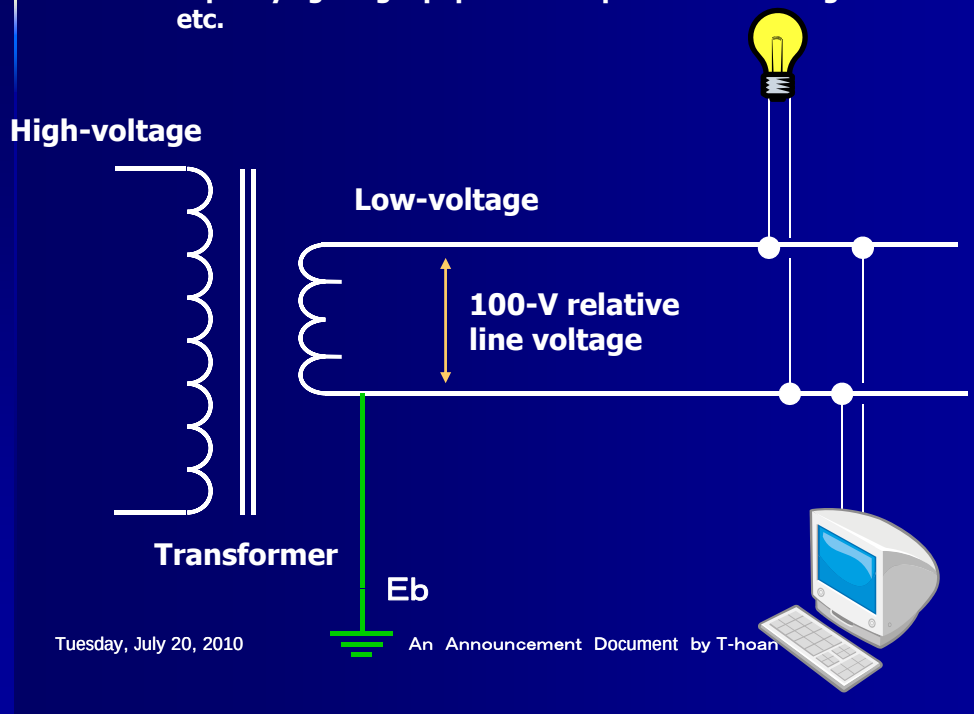
Electrical facilities for business use
(including power stations, substations, buildings, factories, etc.)

→ Users of the facilities are under obligation to have the facilities conform to technical standards

2. Electric system of low-voltage electric power circuit

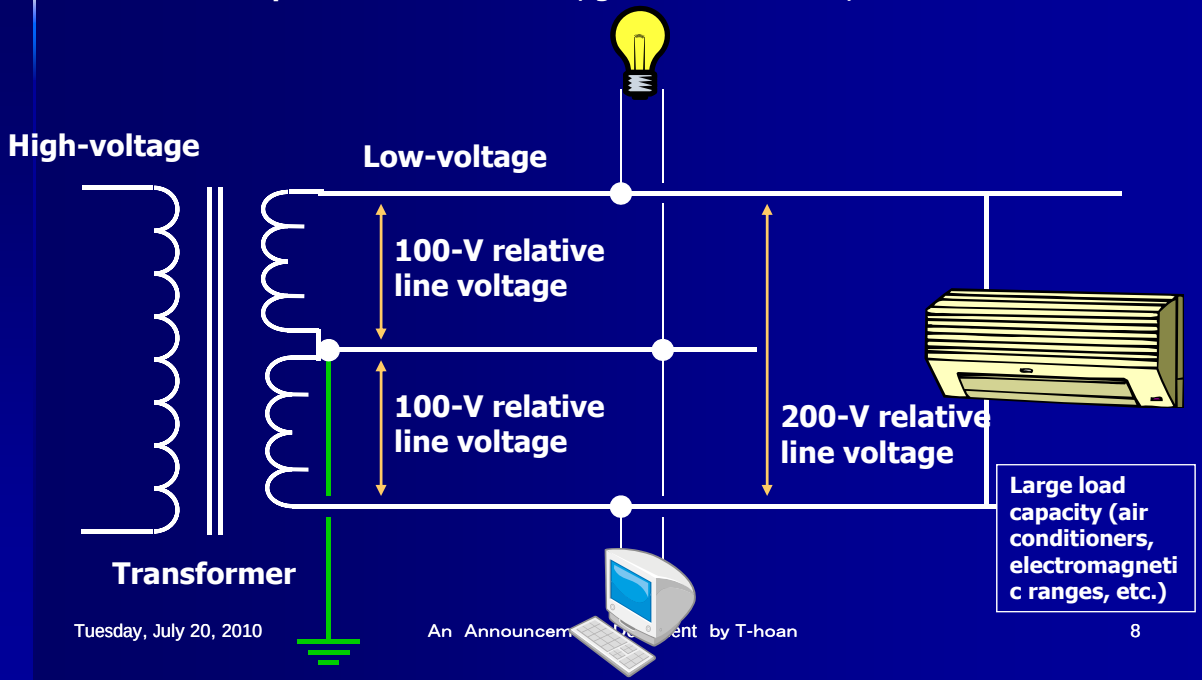
100-V wiring method of single-phase 2-wire system

This wiring method is used as a power source for small-electric-capacity lighting equipment and power outlets at general households, etc.



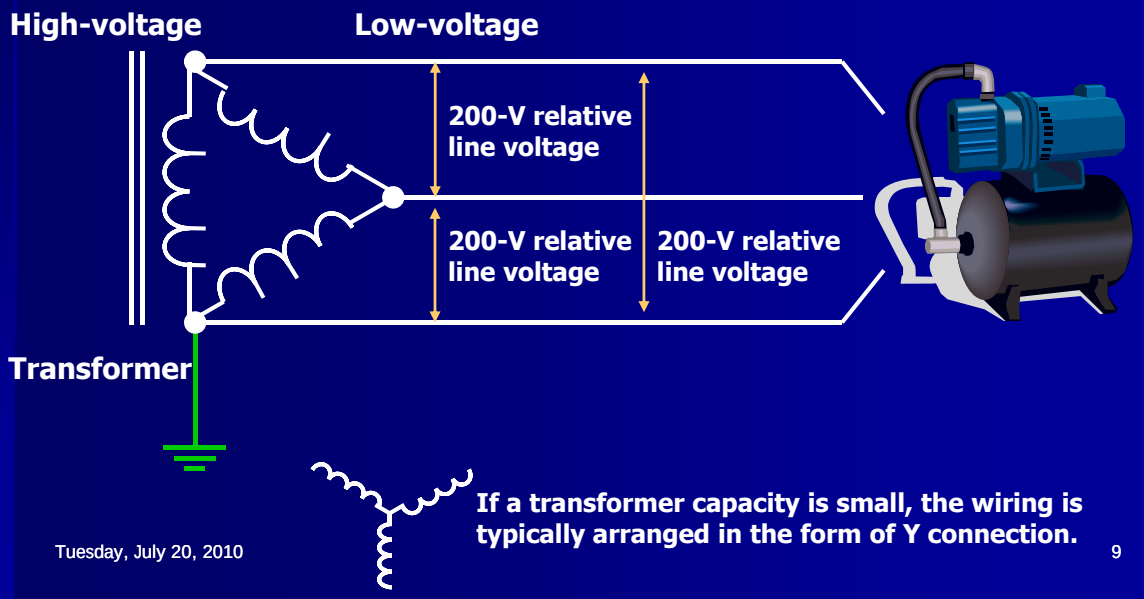
200-V/100-V wiring method of single-phase 3-wire system

This wiring method is used as a power source for lighting equipment and power outlets at offices, general households, etc.



200-V wiring method of three-phase 3-wire system

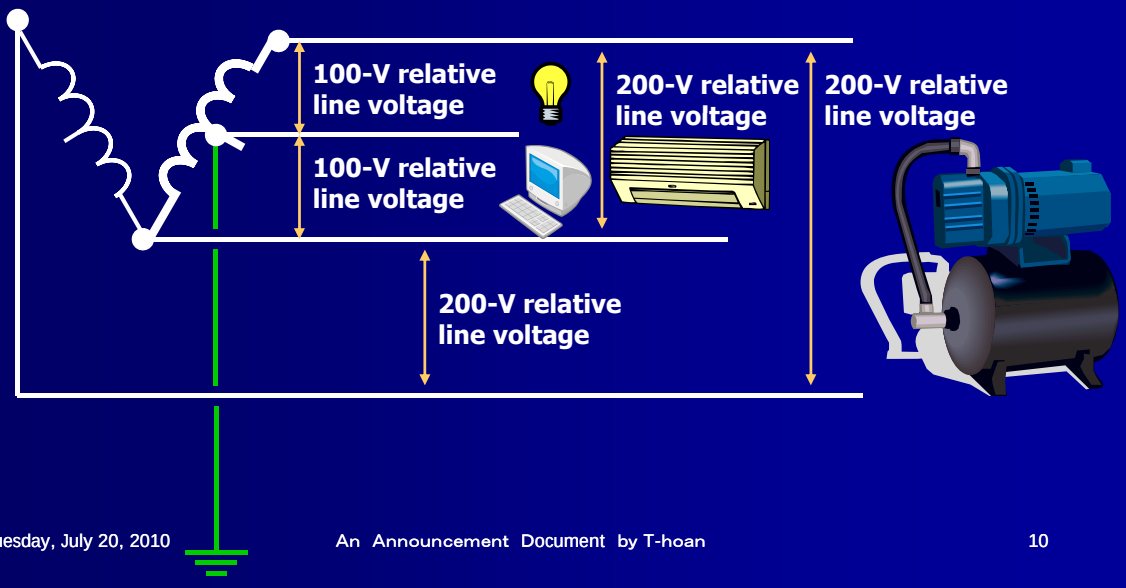
This wiring method is used as the equipment power source for motors, etc. in factories.



If a transformer capacity is small, the wiring is typically arranged in the form of Y connection.

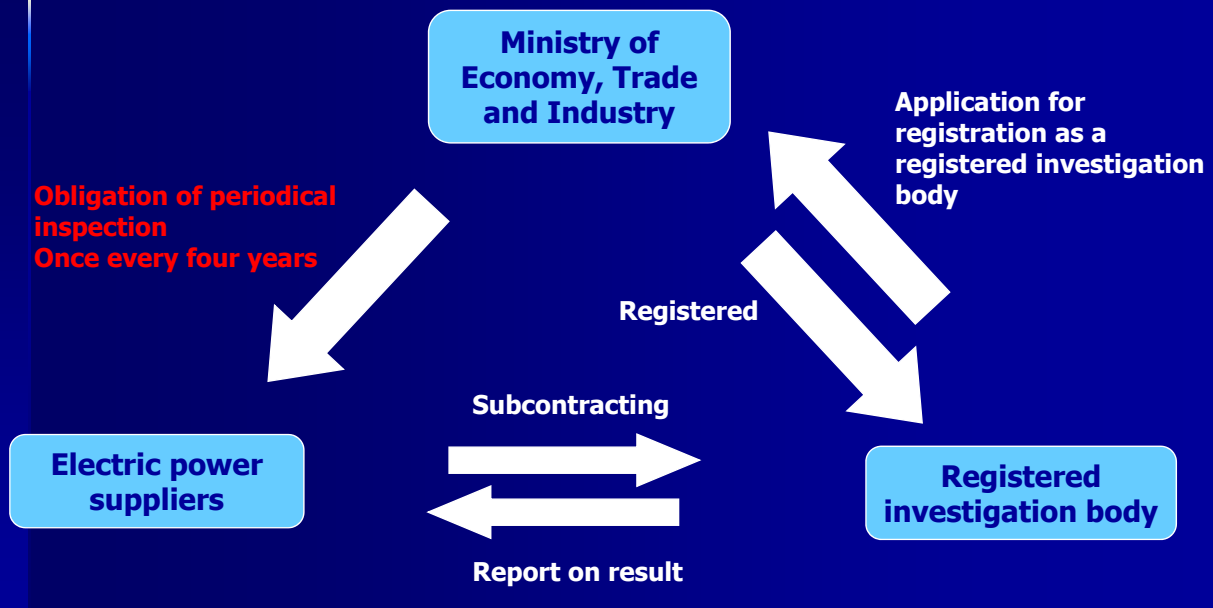
Other wiring methods

The wiring method in which two single-phase transformers whose capacity is different from each other are used
This kind of wiring method is often found in distribution transformers of electric power suppliers.

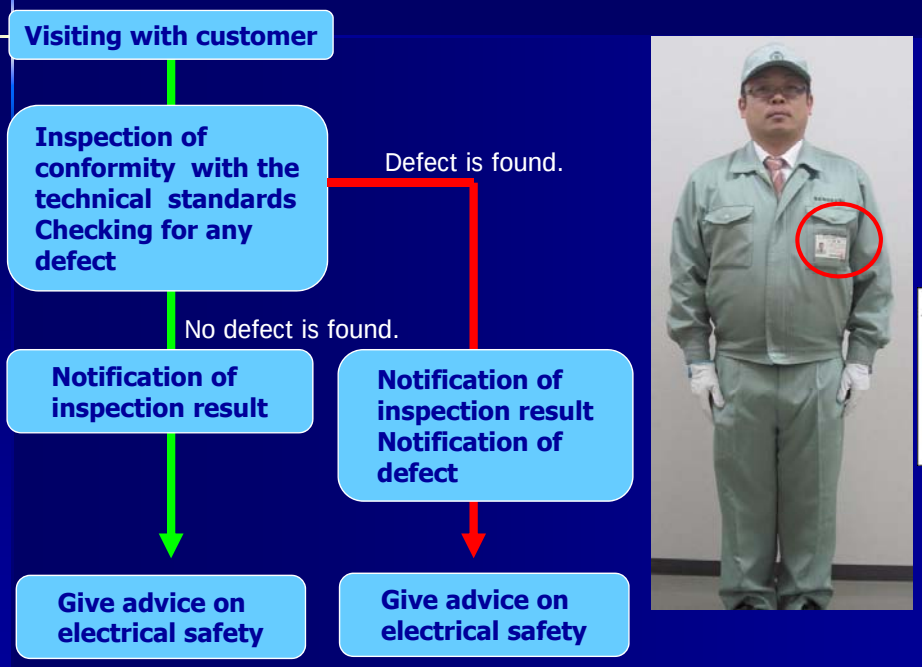


3. Insulation management for low-voltage electric power circuit
(1) Regulations concerning insulation management

Obligations of periodical inspection



Workflow of periodical inspection



ID card

3. Insulation management for low-voltage electric power circuit

(2) Insulation management by means of an insulation resistance tester

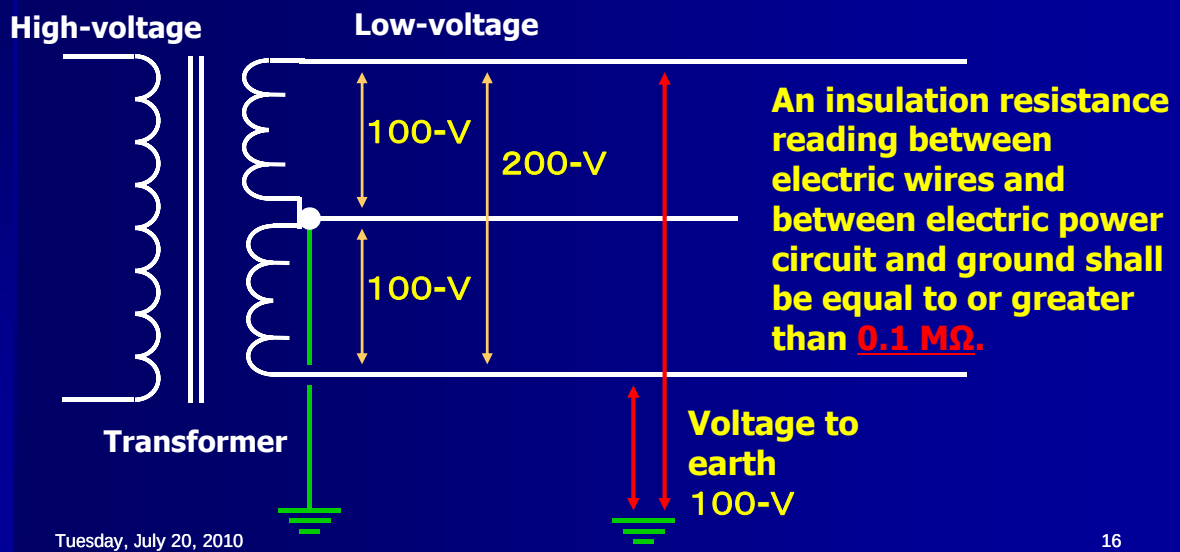
Regulations concerning insulation resistance reading

- Requirements of the technical standards of electrical facilities

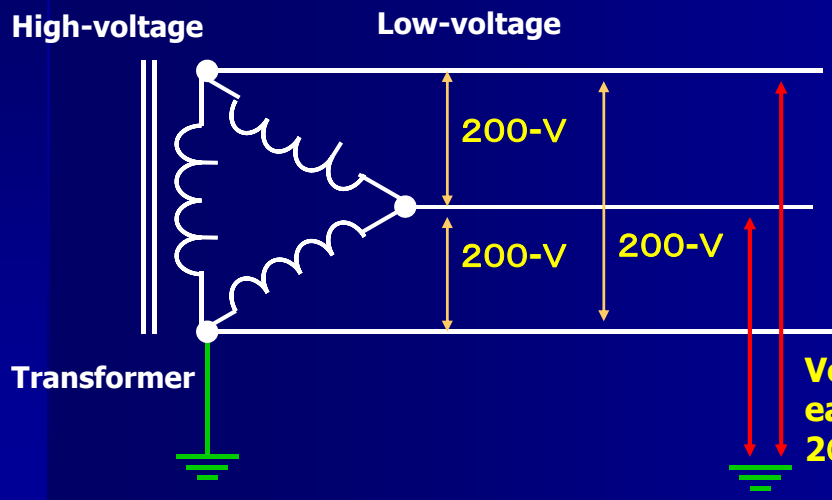
  Electrical circuits must be insulated from the ground. (The rest is omitted.)
- Requirements of the technical standards of electrical facilities

An insulation resistance reading must be equal to or greater than the following reading:

An insulation resistance reading shall be equal to or greater than 0.1 MΩ in the event that the line voltage is 300 V or lower and the voltage to ground is 150 V or lower.



An insulation resistance reading shall be equal to or greater than 0.2 MΩ in the event that the line voltage is 300 V or lower and the voltage to ground is more than 150 V.

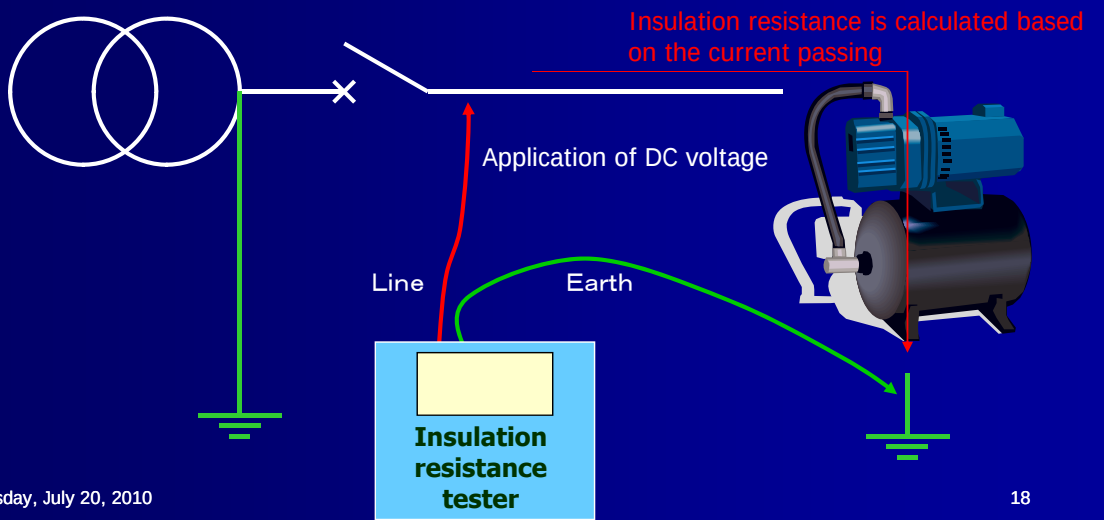


An insulation resistance reading between electric wires and between electric power circuit and ground shall be equal to or greater than 0.2 MΩ.

Measurement of insulation resistance between electric power circuit and earth

Advantage : Only pure resistance component can be measured without being affected by static capacity, etc.

Disadvantage: The power supply to an electrical circuit to be measured has to be cut off.



Measurement by means of insulation resistance tester

Tuesda

Insulation resistance tester

3. Insulation management for low-voltage electric power circuit

(3) Insulation management by means of leakage current tester

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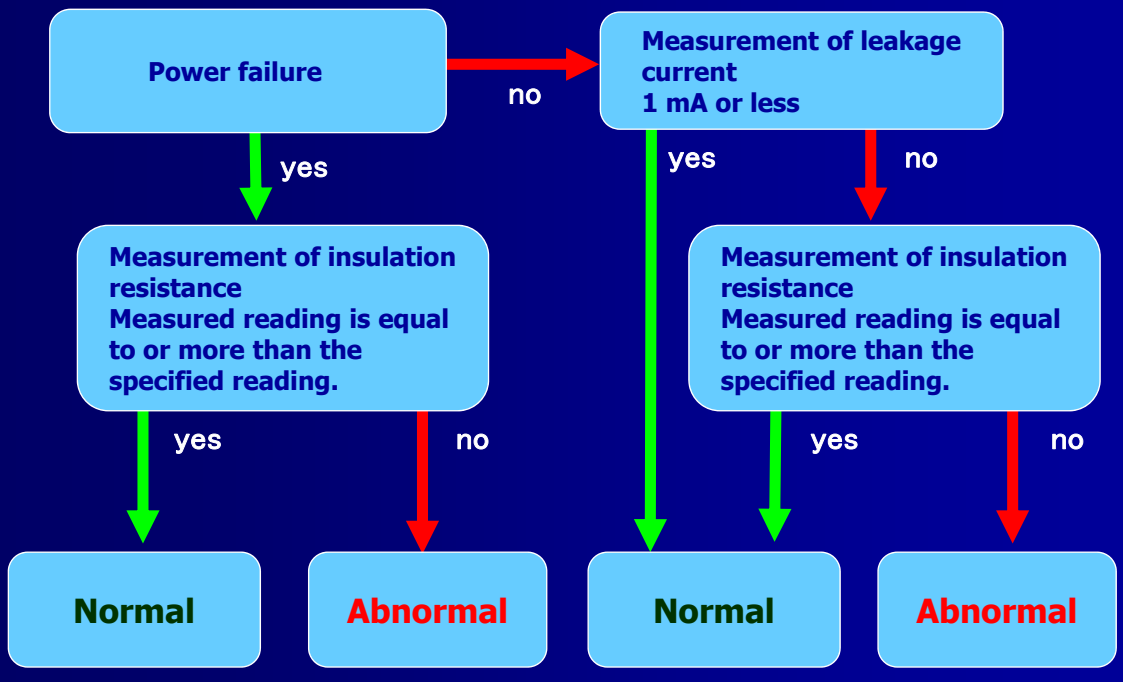
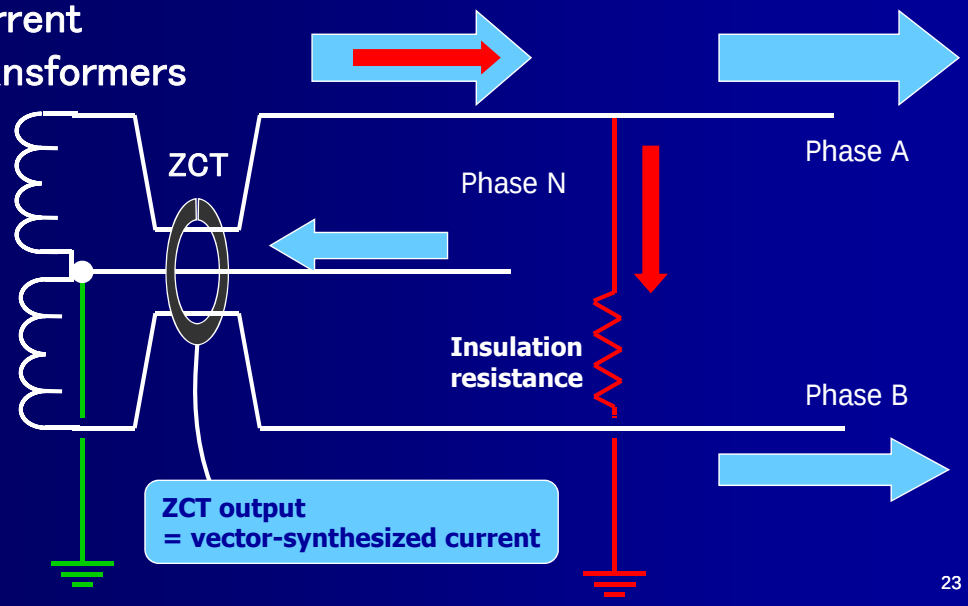
Selective utilization of either insulation resistance measurement or leakage current measurement



Mechanism of leakage current tester

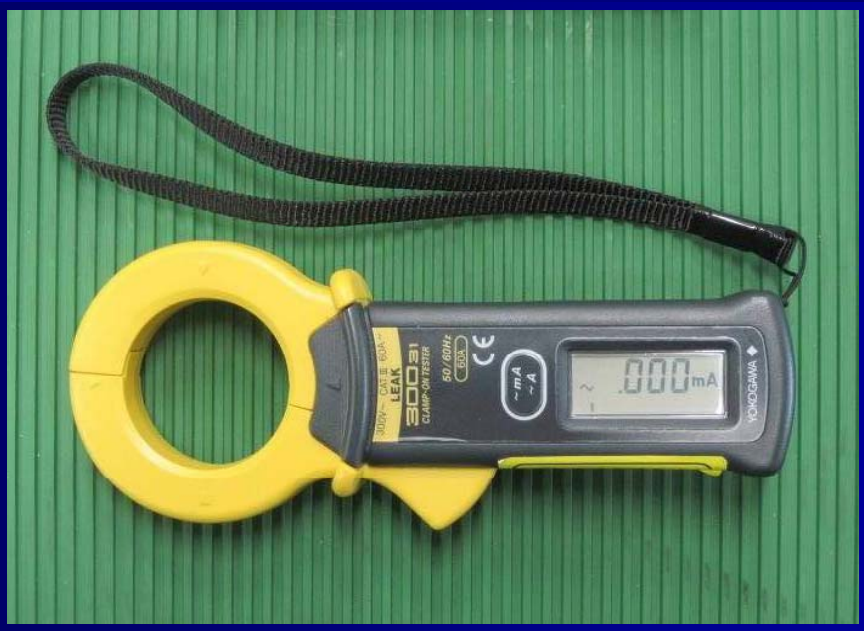
Zero phase-seaquence
Current
Transformers

Advantage: Power failure needs not be cut off for measurement.



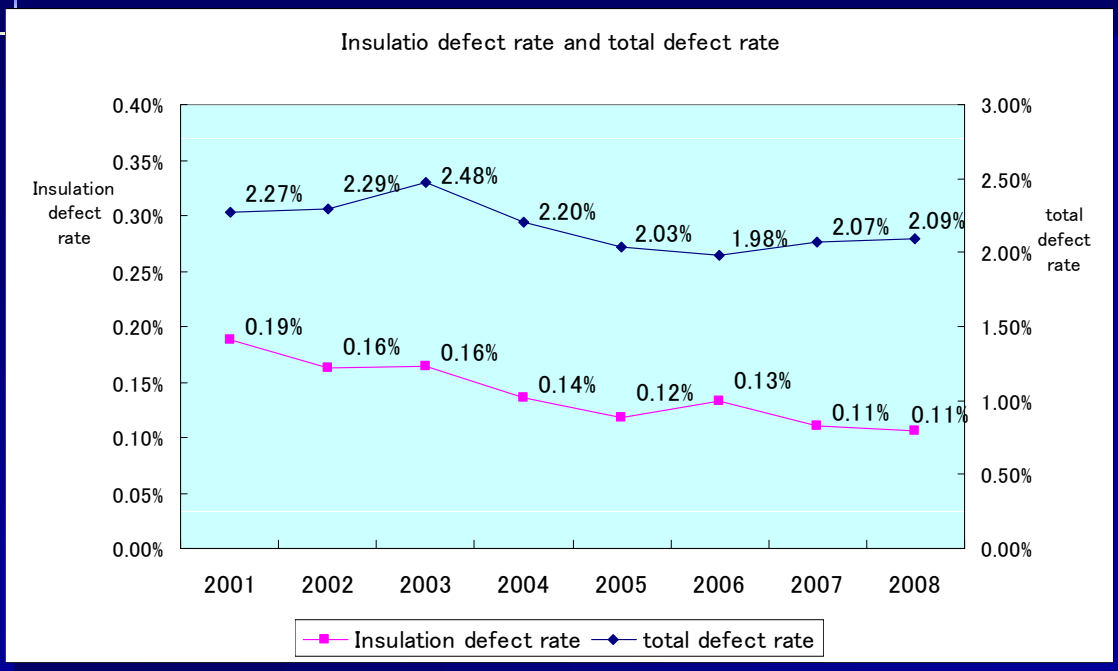
Measurement by means of a leakage current tester

Leakage current tester



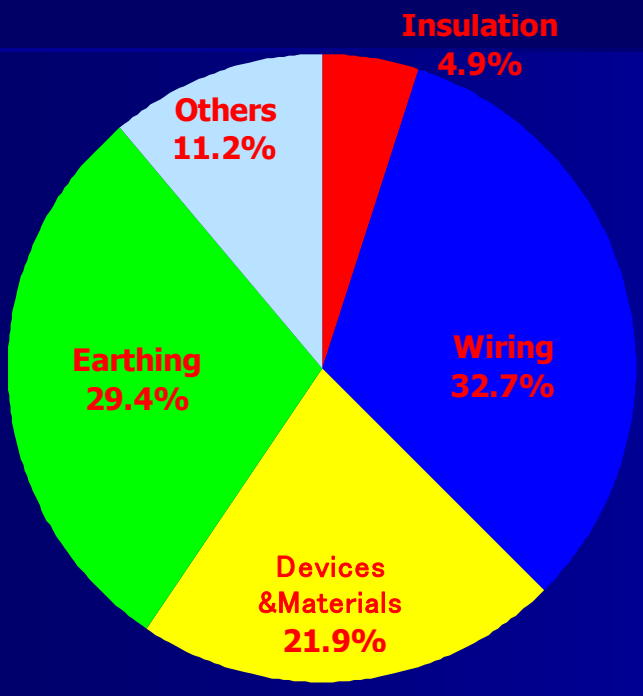
3. Insulation management for low-voltage electric power circuit
(4) Insulation defect rate and defect rate

Insulation defect rate and total defect rate



This data covers the total number of rates surveyed by the ESIA across the country.

Detail of defects



According to the date of ESIA across the county in fiscal 2008

4. Earth fault protection for low-voltage electric power circuit

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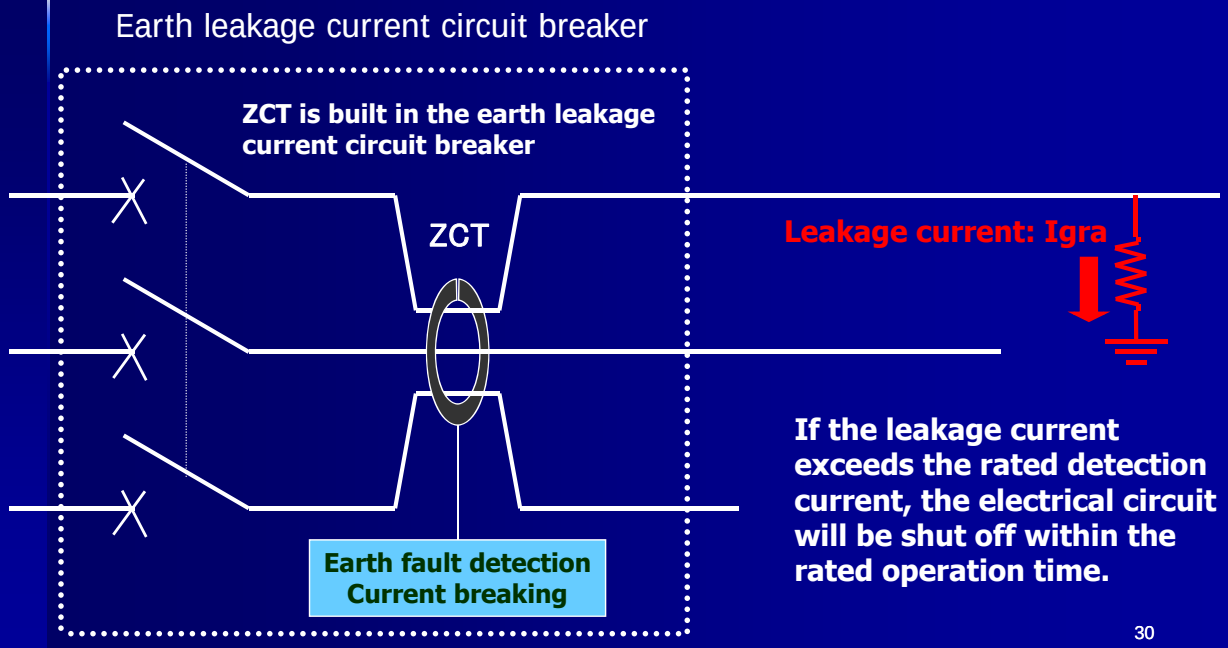
Mechanism of earth leakage current circuit breaker



If the leakage current exceeds the rated detection current, the electrical circuit will be shut off within the rated operation time.

Adoption of earth leakage current circuit breaker

Standard specifications
Threshold current: 30 mA
Operating time: 0.1 sec.

Adoption of earth leakage current circuit breaker

Regulatory requirement

Around 1969
Legal arrangements for technical standards were examined.

↓

1972
Regulations based on technical standards

↓

When voltage is more than 150 V:
An earth leakage current circuit breaker is required to be mounted in place, except for dry areas.

When voltage is equal to or less than 150 V:
An earth leakage current circuit breaker is required to be mounted in wet areas.

Adoption of earth leakage current circuit breaker

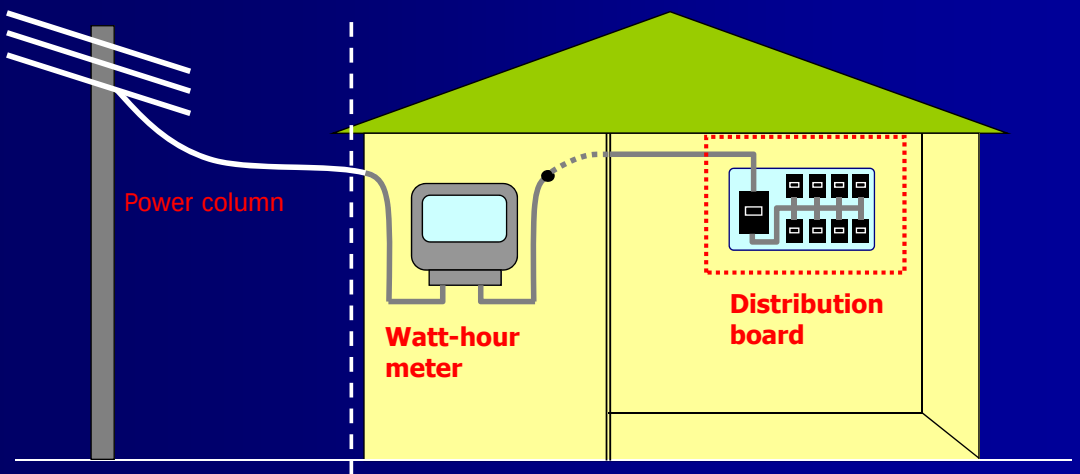
Expanded at-home use

From around 1967, Japanese manufacturers started developing and manufacturing earth leakage current circuit breakers.

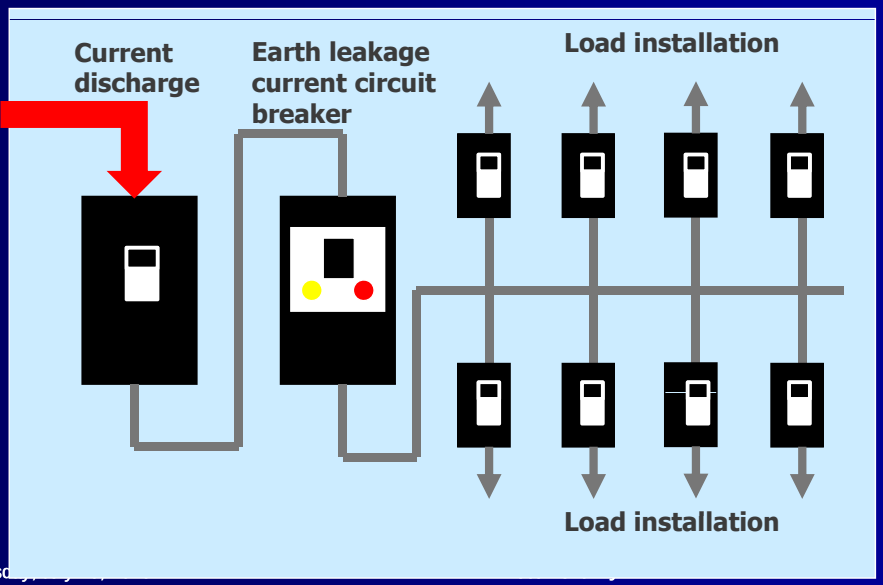
Enhanced customers' awareness towards electrical safety

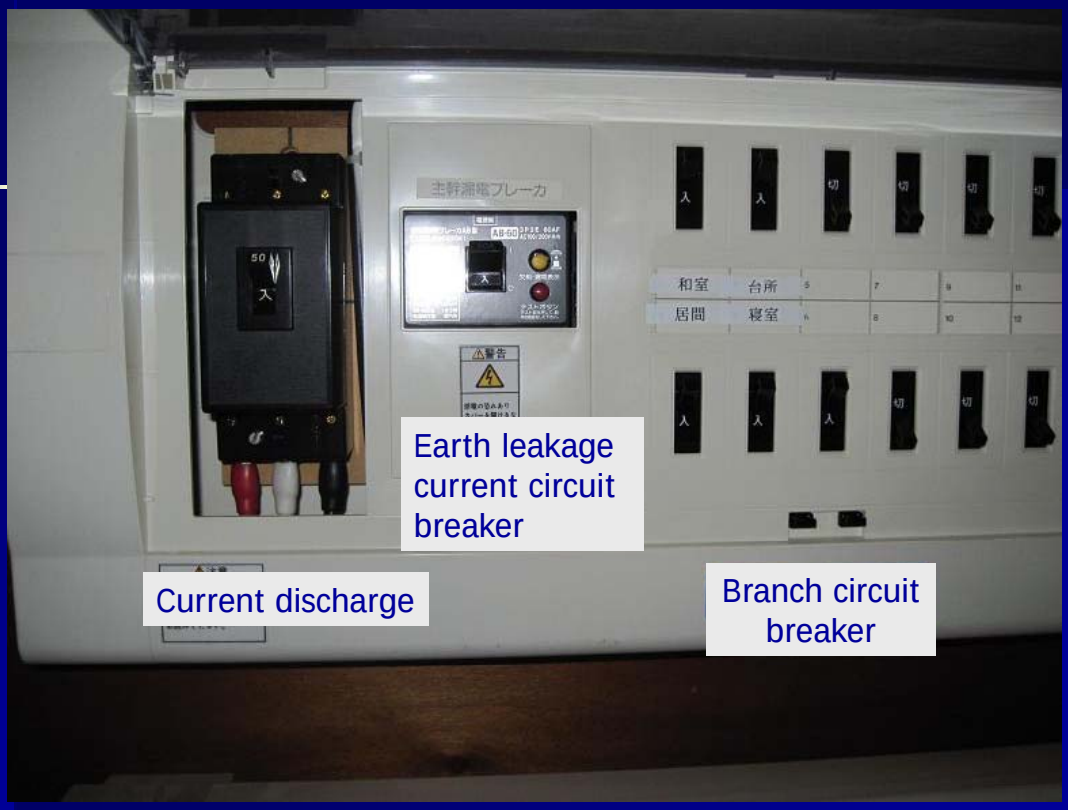
Encouragement, etc. of installation of the breaker through periodical inspection

Standard wiring diagram for general households

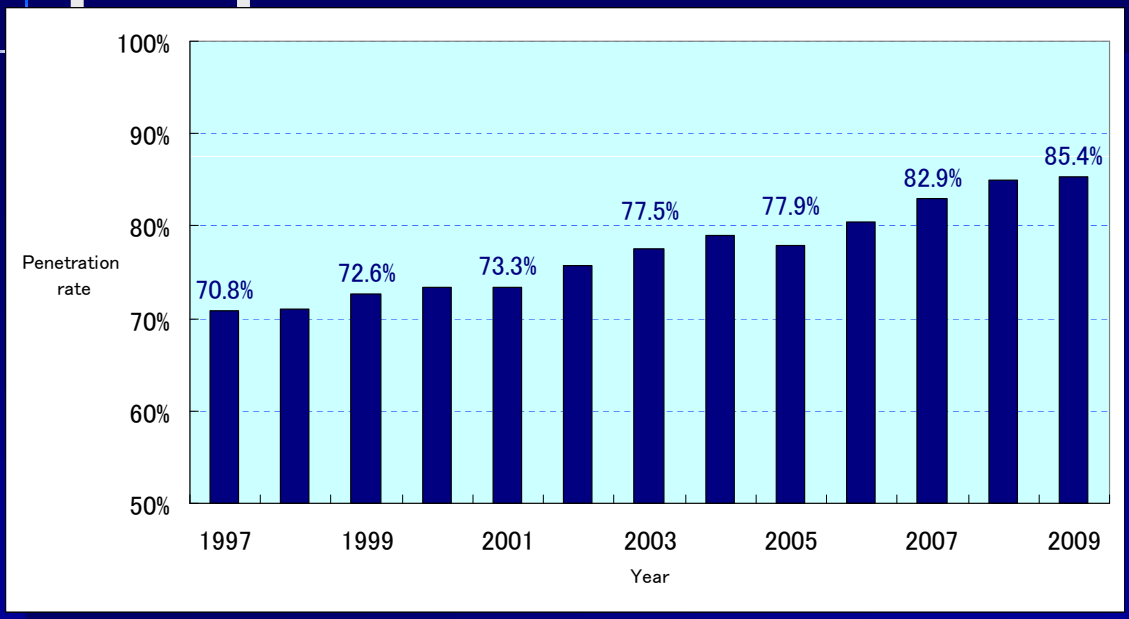


Position at which a standard earth leakage current circuit breaker for home use is mounted





Widespread use of earth leakage current circuit



The data shown above is based on about 400,000 findings resulting from the sampling survey conducted by ESIA.

Conclusions

1. Insulation management for low-voltage electric power circuit

   For the electric facilities for general use, the low-voltage electric power circuit's insulation is maintained and managed by performing a periodic inspection service.

2. Earth fault protection for low-voltage electric power circuit

   Through encouragement to install earth leakage current circuit breakers in place which is occasioned by a periodical inspection service, such breakers have become widely used throughout Japan, which is in turn contributing to prevention against electric shock and electric leakage.