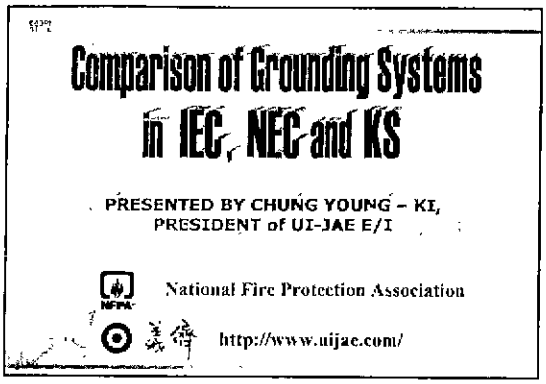
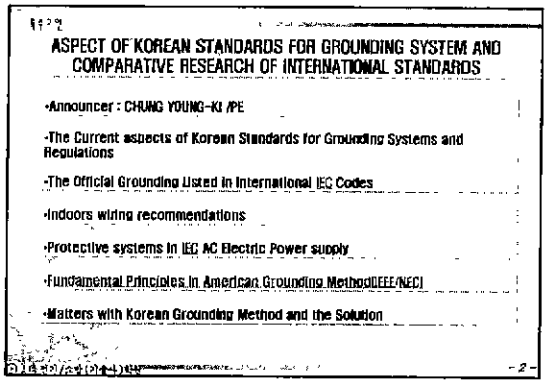
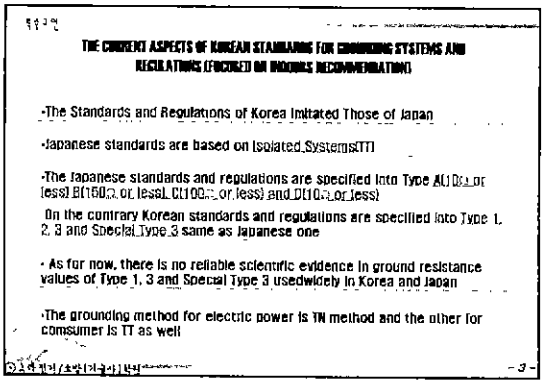
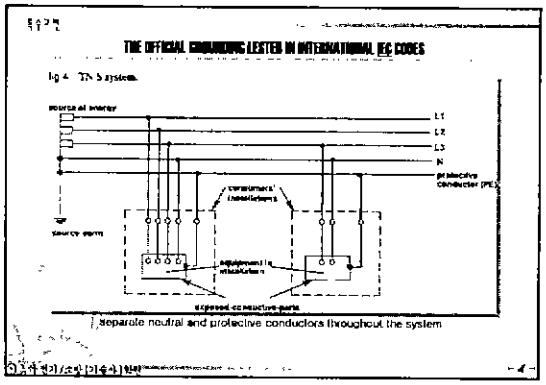
국제IEC 접지계통과 미국NEC 접지계통의 비교 검토를 통한 한국접지시스템에 대한 문제점 연구

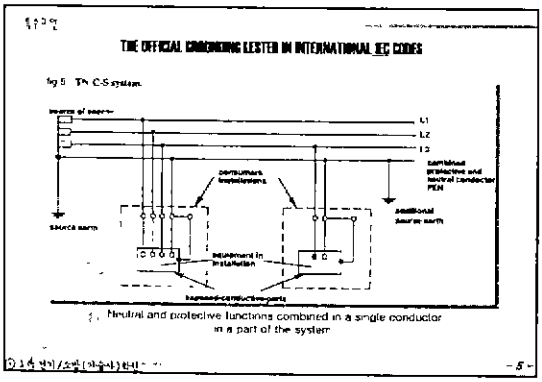
정용기°, 고동희(의제), 곽희로(숭실대)

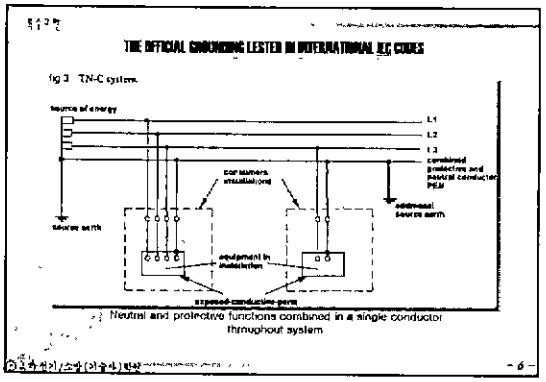




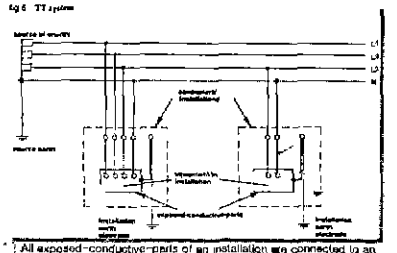






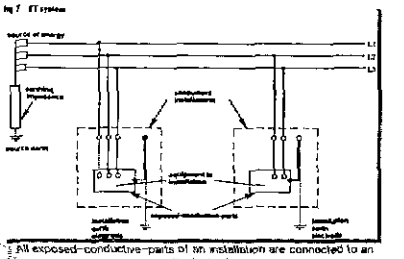


THE OFFICIAL GROUNDING LESTED IN INTERNATIONAL IEC CODES



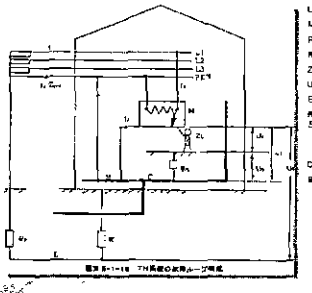
All exposed-conductive-parts of an installation are connected to an earth electrode which is electrically independent of the source earth

THE OFFICIAL GROUNDING LESTED IN INTERNATIONAL IEC CODES



All exposed-conductive-parts of an installation are connected to an earth electrode

THE OFFICIAL GROUNDING LESTED IN INTERNATIONAL IEC CODES



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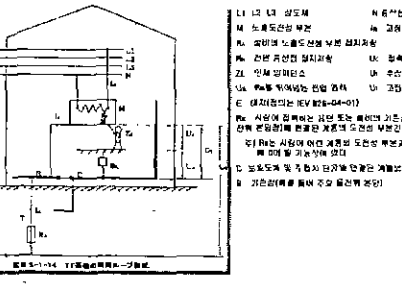

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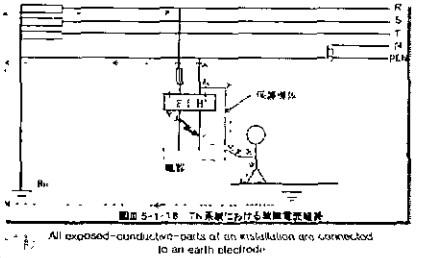
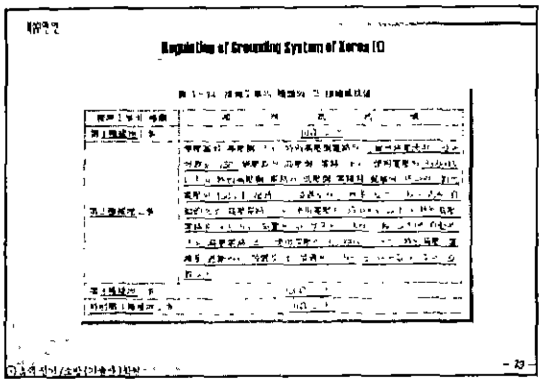
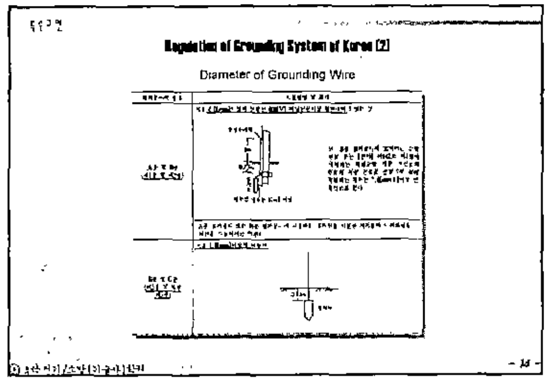
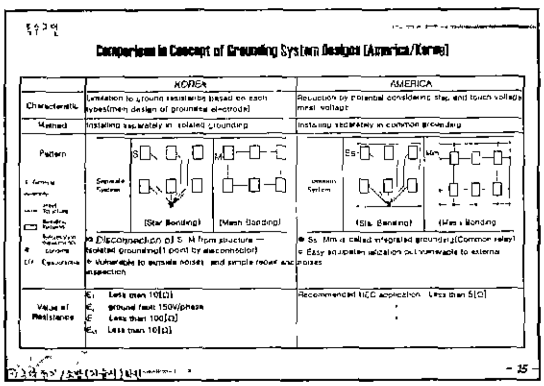


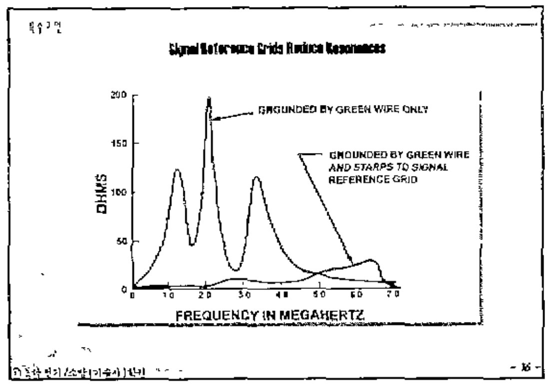
All exposed-conductive-parts of an installation are connected to an earth electrode

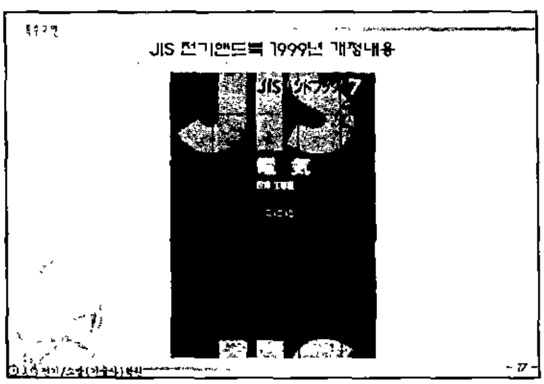
Distribution Chart of International Grounding systems

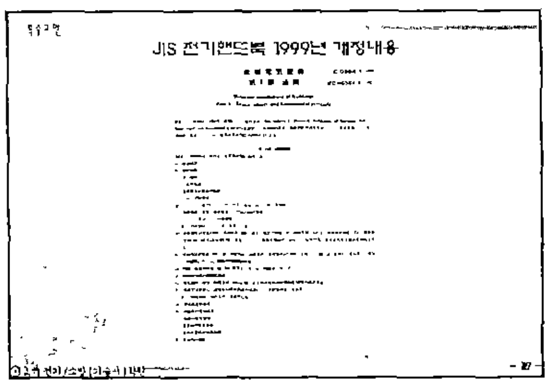

Regulation of Grounding System of Korea (1)
- 13 -


Regulation of Grounding System of Korea (2)
Diameter of Grounding Wire
- 14 -

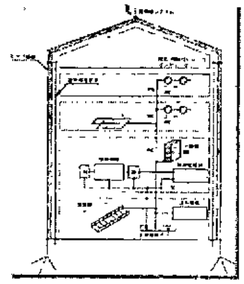

Comparison in Concept of Grounding System Designs (America/Korea)
KOREA
AMERICA
Characteristic
Method
Pattern
[Star Bonding]
[Mesh Bonding]
Value of Resistance
Less than 10[Ω]
ground fault 150V/phase
Less than 100[Ω]
Less than 10[Ω]
- 15 -


Signal Reference Grids Reduce Resonances
GROUNDED BY GREEN WIRE ONLY
GROUNDED BY GREEN WIRE
AND STARPS TO SIGNAL
REFERENCE GRID
OHMS
200
150
100
50
0
0
10
20
30
40
50
60
70
FREQUENCY IN MEGAHERTZ
- 16 -


JIS 전기핸드북 1999년 개정내용
JIS
電気
- 17 -


JIS 전기핸드북 1999년 개정내용

PROTECTIVE SYSTEM IN AC ELECTRIC POWER SUPPLY



Grounding System of Buildings based on IEC 60364-5-54, IEC 61000-2-5 and IEC 61024

1) Telephone
2) Electrical System of house and Building
3) Horizontal equipotential of Bonding System in Local area

AC Power Supply System

PE - Protective Conductor of AC Power Supply System

An American National Standard

IEEE Guide for Safety in AC Substation Grounding

2. Safety in Grounding

2.1 Basic Problem. In principle, a safe grounding design has two objectives:

(1) To provide means to carry electric currents into the earth under normal and fault conditions without exceeding any operating and equipment limits or adversely affecting continuity of service.

(2) To assure that a person in the vicinity of grounded facilities is not exposed to the danger of critical electric shock.

A practical approach to safe grounding thus concerns and strives for controlling the interaction of two grounding systems:

(1) The intentional ground, consisting of ground electrodes buried at some depth below the earth surface.

(2) The accidental ground, temporarily established by a person exposed to a potential gradient in the vicinity of a grounded facility.

People often assume that any object grounded, however crudely, can be safely touched. This misconception probably contributed to many tragic accidents in the past. Since a low station ground resistance is not, in itself, a guarantee of safety, there is no simple relation between the resistance of the ground system as a whole and the maximum shock current to which a person might be exposed. Therefore, a station of relatively low ground resistance may be dangerous under some circumstances, while another station with very high resistance may be safe or can be made safe by careful design.

For instance, if a substation is supplied from an overhead line with no shield or neutral wire, a low grid resistance is important. A substantial part of the total ground fault current enters the earth causing an often steep rise of the local ground potential Fig 2 (a).

Fig 9 Basic Shock Situations

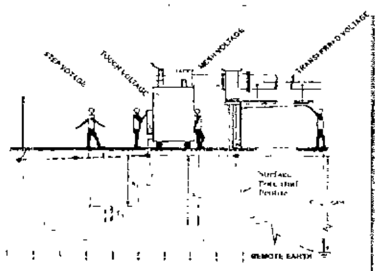


Fig 9
Basic Shock Situations

Fig 10 Typical Situation of External transferred Potential

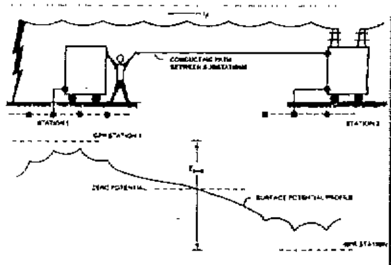


Fig 10
Typical Situation of External Transferred Potential

Fig 5. Step Voltage Circuit

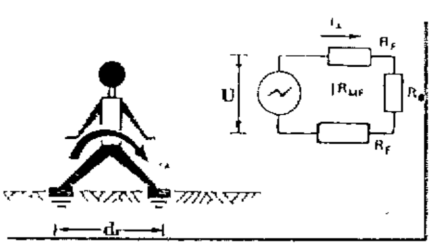
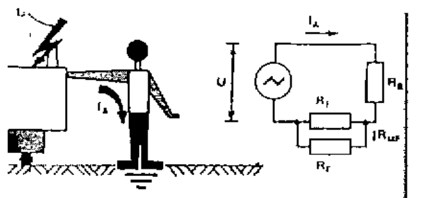


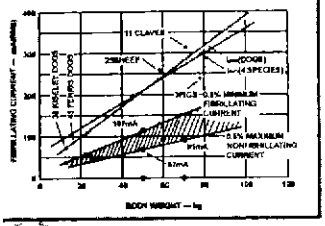
Fig 6. Touch Voltage Circuit



$R_A = R_B + \frac{1}{2}(R_F + R_{MF})$

Fig 6
Touch Voltage Circuit

The Basic Concept of American Grounding Method (IEEE)



VALUE OF CONSTANT k FOR EFFECTIVE RMS VALUES OF

$I_B(k = I_P \sqrt{t})$

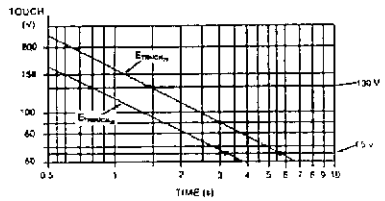
$k_{70} = 0.091 \quad \sqrt{3} = 0.157$

$k_{50} = 0.067 \quad \sqrt{3} = 0.116$

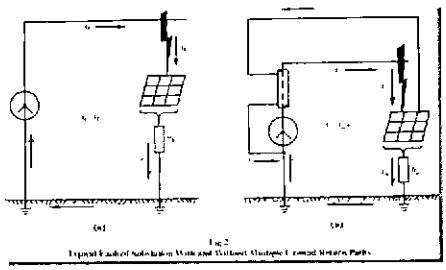
$k_{70} = 0.107 \quad \sqrt{3} = 0.185$

FIBRILLATION

The Basic Concept of American Grounding Method (IEEE)



The Basic Concept of American Grounding Method (IEEE)



Fault in Station System Grounded at Local Station and Also at Other Points

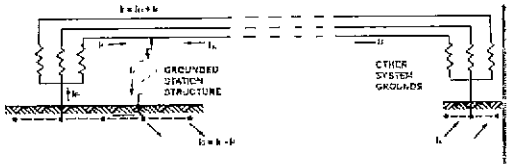
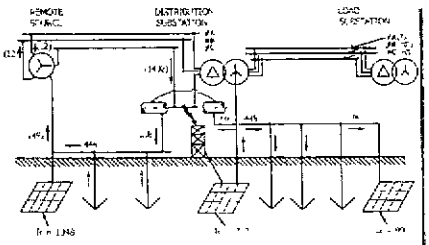


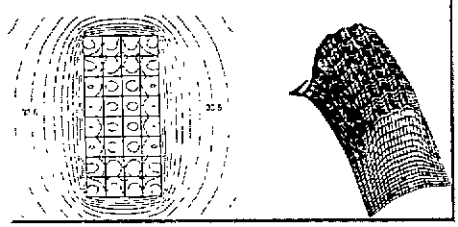
Fig 23
Fault in Station System Grounded at Local Station and Also at Other Points

Typical Current Division for a Fault on High Side of Distribution Substation

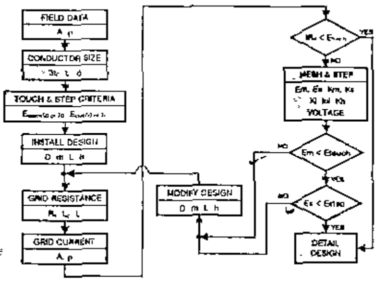


Equipotential Contours of a Typical Grounding Grid With and Without Ground Rods

Fig 3
Equipotential Contours of a Typical Grounding Grid With and Without Ground Rods



Design Procedure Block Diagram (IEEE)



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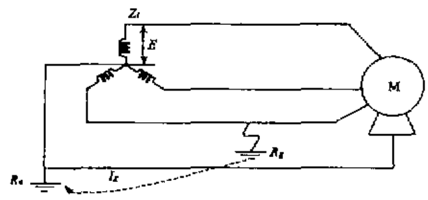
중성점 공통접지와 독립접지에서 고장전류 비교

▶ 중성점 공통접지(미국)에서 접지고장



▶ 접지고장전류

$$\frac{E}{R_n + R_g + Z}$$

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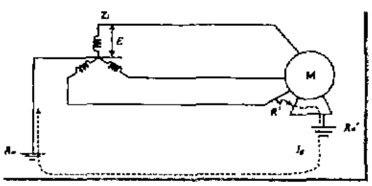
중성점 공통접지와 독립접지에서 고장전류 비교

▶ 중성점 독립접지(한국, 일본)에서 접지고장



▶ 접지고장전류

$$\frac{E}{R_n + R_o' + R + Z}$$

R 기기외함접지저항
R 접지고장점 저항

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Table 2 Minimum per Unit Conductor Sizes (cmils / A)

Fault Time(s)	100% Cu Only	97% Cu Only	40% Cu Only	30% Cu Only	97%Cu/Temperature Limits (450℃)	(250℃)
30.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4.0	[illegible]	14.2	[illegible]	[illegible]	[illegible]	[illegible]
1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 6 Typical Values of D_f

Fault Duration (s)	Cycles (60 Hz)	Decrement Factor D_f
0.008	½	1.65
0.1	6	1.25
0.25	15	1.10
0.5 or more	30 or more	1.0

$$D_f = \sqrt{1 + \frac{T_a}{t_f}(1 - e^{-2t_f/T_a})}$$

where

t_f = fault duration in s

T_a = equivalent system subtransient time constant in s ($T_a = X''/\omega R''$; for 60 Hz $T_a = X''/(120\pi R'')$)

The X''/R'' ratio to be used here is the system X/R ratio at the fault location for a given fault type. This X/R ratio is usually approximated using the X and R components of the system subtransient impedance.

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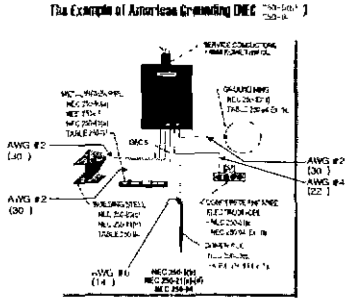
The Example of American Grounding (NEC 250-50)



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The Measures to Problems with Korean Grounding Systems and Methods

Problems

- Korean grounding systems are utilizing American and Japanese grounding system.
- Participating in WTO we should observe TBT though our domestic regulations and standards are not internalized
- The systemic and fundemental research for grounding have not been taken
- The classification of grounding are found unreasonable

Measures

- Positive consideration about NEC is required so that we should observe IEC codes
- The Grounding system for Korean Electric Power and Consumer ought to be unified.
- Unevitable the system of the regulations and standards in relation to electricity and its constructions should be modified

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