Introduction.

A wireless micro-radio steel tower station damaged by lightning was investigated and the causes of damage were examined from the experiments and the EMTP analysis. The lightning protection measures were discussed with voltage rise and current flow based on the EMTP analysis applying the direct lightning waveforms (10/350μs, 100kA).

Contents

1. Investigation

Investigation result on wireless microwave relay station.

Outdoor.

Lightning damage were found in the ITV cameras.

ITV cameras located in the garage and 30m steel tower.

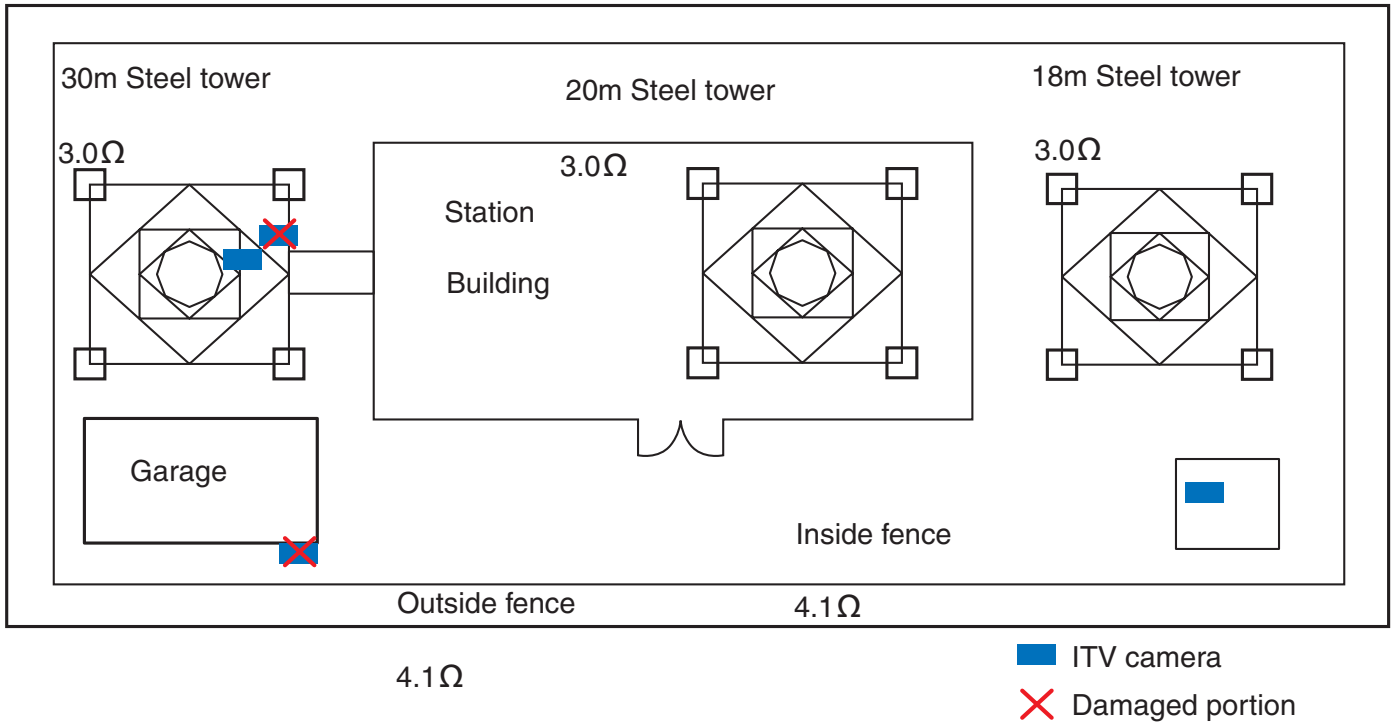

Figure1 Composition of micro-radio steel tower station.

Building.

Lightning damage were found in the wireless telegraphic apparatus and control device of an ITV camera.

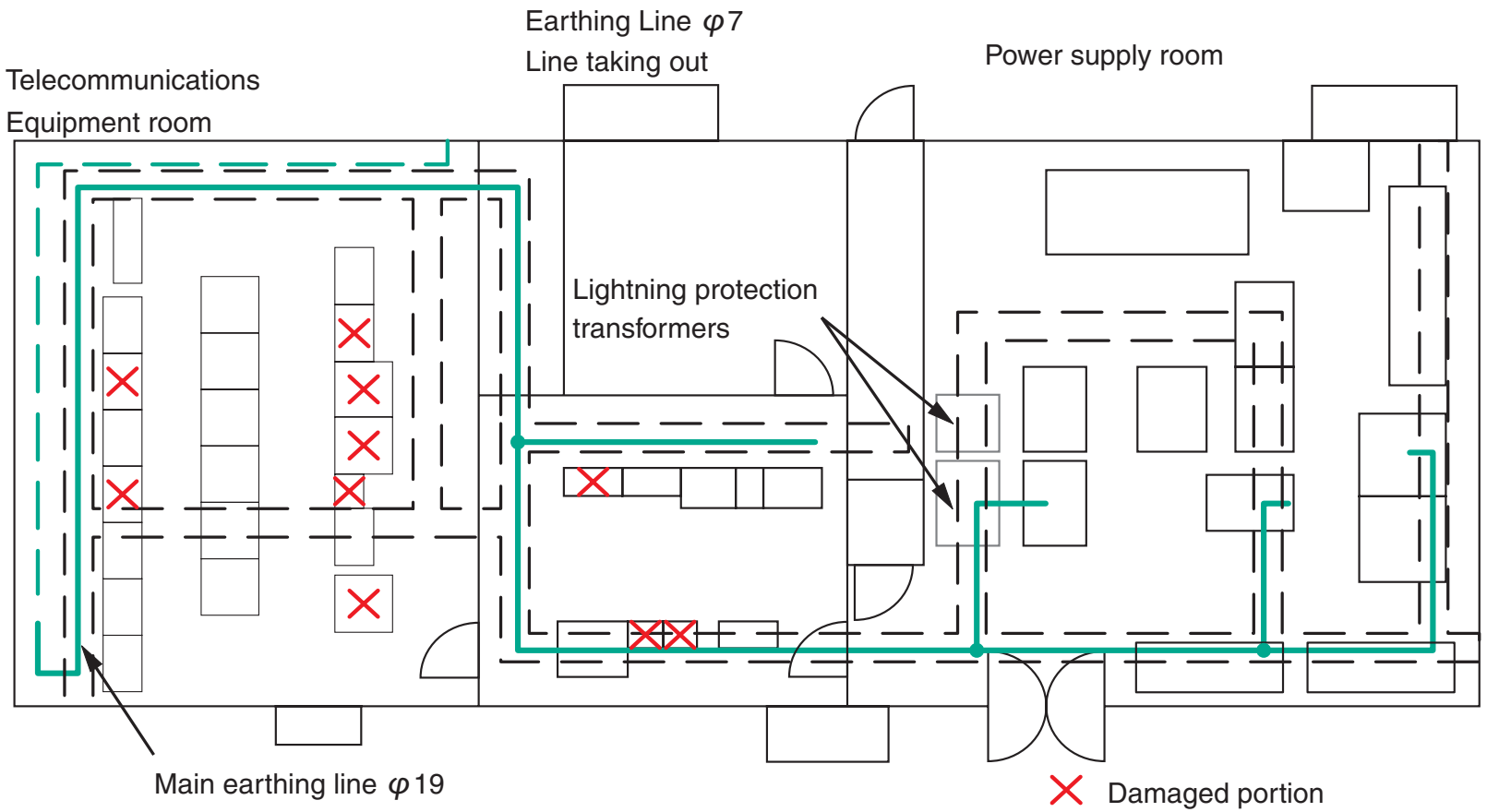

Figure2 Indoor earthing line wiring and situation of damage.

2.Cause of apparatus destruction.

2-1.ITV cameras

2-1-1. The voltage rise by earthing resistance.

The earthing of ITV cameras were not equipotentialized with the earthing system of station building. The ITV camera destructed by lightning. when the voltage of the ground of the station building rises with direct lightning, potential difference occurs in the station building and the ITV camera.

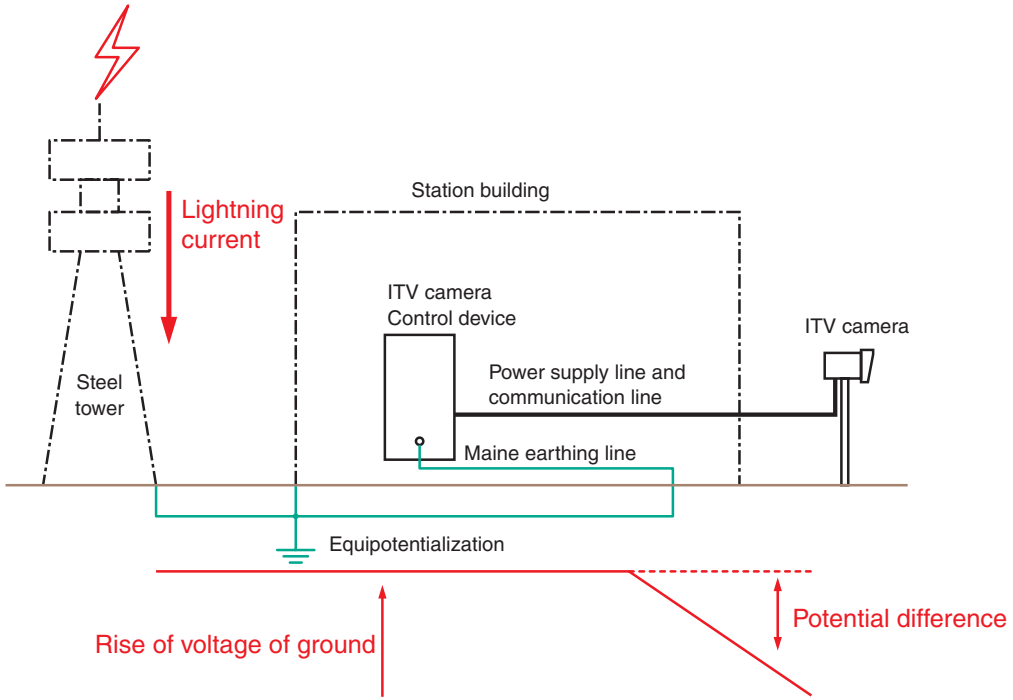

Figure3 Composition of ITV camera earthing system.

2-1-2. Voltage generated by earthing line inductance.

The ITV cameras can be destroyed by earthing line inductance even when the earthing is equipotentialied ITV camera and ITV camera Control device.
This matter was proved with an experiment and EMTP analysis numerically.

When the surge current of 110A is Applied experiment circuit , the potential difference raises 100V between the A point and the B point.

Part	Experiment	EMTP
Experimental current	110A	110A
ITV camera control device	1800V	1800V
ITV camera	1800V	1800V
Potential difference	100V	100V

Table. 1 Potential difference of earthing line both-ends.
-Comparison of experimental result and EMTP analysis-

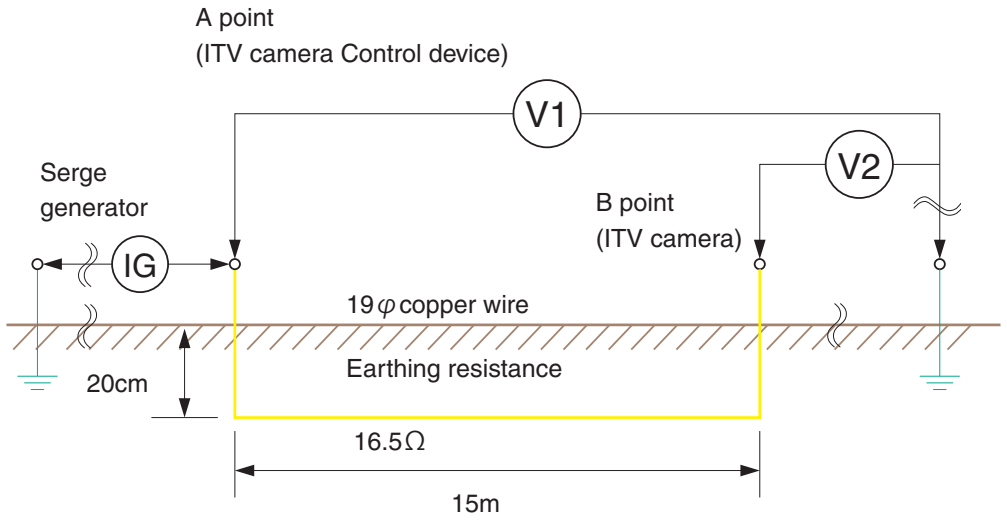

Figure4 Evaluation of potential deference based on earthing line inductance. -Experimental circuit-

2-2. Wireless telegraphic apparatus.

2-2-1. The potential difference by the invasion of the surge current into a main earthing line.

When larger surge current flowing into the station building main earthing line, larger potential difference arises between apparatus by the inductance of main earthing line.
This matter was proved with an experiment and EMTP analysis numerically.

When the experimental current of 250A is applied steel tower,the potential difference raise 10V between the apparatus.

Part	Experiment	EMTP
1. Experimental current	250A	250A
2. Station building	96A	100A
3. Wireless telegraphic apparatus	96A	80A
4. Main earthing line	23A	28A
Between the apparatus	-	10V

Table. 2 Shunt Current rate of micro-radio steel tower stations.
- Comparison of experimental result and EMTP analysis -

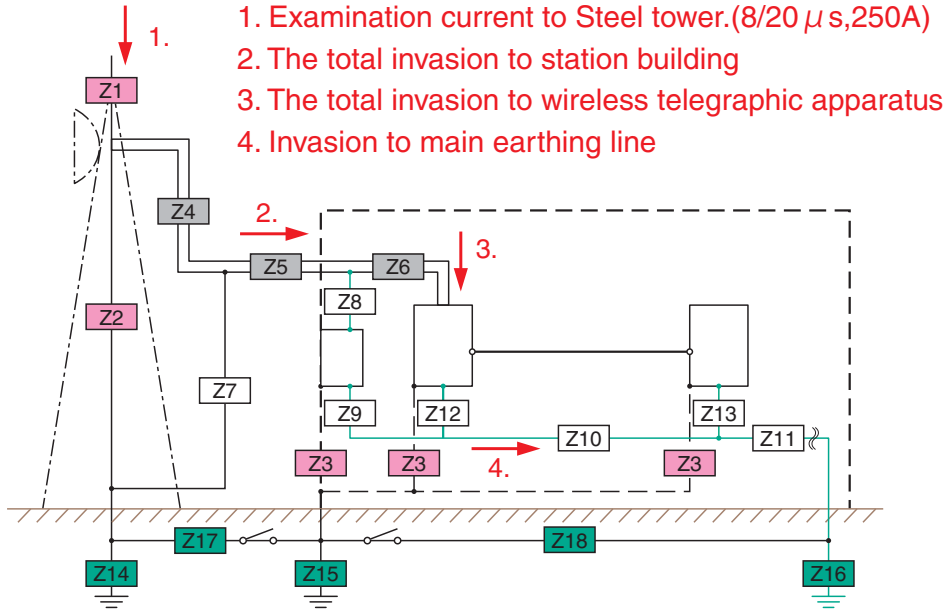

Figure5 EMTP analysis circuit for micro-radio steel tower stations.

3.Aanalysis and protection.

EMTP analysis is performed supposing the case where there is a direct lightning(10/350μs, 100kA). Furthermore, the lightning protection measures are proposed.

3-1. Protection measure proposal of ITV Camera.

The potential difference occur 270kV when the defect of equipotentialization between ITVcamera and ITV camera Control device.
The potential difference occur 30kV when the equipotentialization.
SPD's are necessary to protect an ITV camera from the lightning voltage.

When SPDs are installed, the power supply lines and the communication lines shunted current to 6.4kA and 2.8kA respectively.
The current withstand of SPD for a power supply line need 3.2kA.
The current withstand of SPD for a communication line need 2.8kA.

Part	Equipotentialization	
	Before	After
Experimental current	100kA	100kA
Potential difference	270kV	30kV
Communication line (1line)	4kA	2.8kA
Power supply line (2line)	9.2kA	6.4kA

Table. 3 EMTP analysis supposing direct lightning(100kA)
- Effect of equipotentialization on ITV cameras -

3-2. Protection measure proposal of wireless telegraphic apparatus.

The effect of the equipotentialization of the steel tower, the station and earthing terminals was evaluated.

Invasion current to station building decreased from 40kA to 20kA.

That is a potential difference with 2.6kV expected when the equipotentializaition between wireless telegraphic apparatus.

SPD's are necessary to protect wireless telegraphic apparatus from the lightning voltage.

When SPDs are installed, the variously cable between wireless telegraphic apparatus shunted current to 1.3kA.

The current withstand of SPD for cable need 1.3kA.

Part	Equipotentialization	
	Before	After
1. Experimental current	100kA	100kA
2. Station building	40kA	20kA
3. Wireless telegraphic apparatus	35kA	18kA
4. Main earthing line	10kA	3kA
Between the apparatus.	5.5kV	2.6kV
The cable between the apparatus.	4.2kA	1.3kA

Table. 4 EMTP analysis supposing direct lightning (100kA)
- Effect of equipotentialization -

4.Conclusions.

Apparatus which suffered damage from the direct lightning striking to a micro-radio steel tower station were investigated, and the causes of apparatus destruction were evaluated from the experiment and EMTP analysis. Furthermore, the suitable lightning protection measures were mentioned. The main conclusions are described below.

(1) ITV camera and wireless telegraphic apparatus were damaged by lightning.

(2) When the defect of equipotentialization on apparatus,the apparatus is damaged by the potential difference.

(3) A potential difference occurs even in case of the equipotentialization on apparatus when the space of the apparatus is away.

(4) EMTP analytic result, It described SPD was necessary to protect an apparatus from the lightning voltage.

(5) EMTP analytic result, It described that performance to lightning current required by a SPD.