

**Satellite Receiving Problems in Snowing Climates and  
Its Resolution Methods**

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## 1. INTRODUCTION

High quality television services are offered by broadcasting satellites (BS) in Japan from 1987. However, signal attenuation values of 5-10 dB due to snow on antenna are frequently occurred in snowing climates. Such snow on antenna remains half a day or a day, then unavailable time becomes large. In this paper, two methods, i.e., (1) the snow melting antenna system, and (2) the negative gradient slanted polymer-shielded antenna system are examined and experimented for resolving the problems of snowing on antenna. [1,2]

## 2. EXAMPLES OF SNOWING ON ANTENNA AND ITS SIGNAL ATTENUATION

By improved BS low noise receiving amplifier, diameter of 45-50 cm antennas can be used for BS reception in Japan. When such antennas are used in Sapporo area, rain margins are about 1-2 dB. However, in the case of wet snowfall in January 1991, offset parabolic antenna was covered by snow on lower part of main reflector and feed horn by snowfall, and about 10 dB signal attenuation was observed.

Availability performance for system which access to communication satellite are required very small values, e.g., 99.9% per year. Then unavailability times due to snow must be decreased.

## 3. SNOW MELTING ANTENNA SYSTEM

### 3.1 MELTING METHOD OF MAIN REFLECTOR

Proposed snow melting antenna system is shown in Fig. 1. As shown in this figure, first layer is covered in front of antenna surface, and its layer's material has high heat conductivity and high electrical insulation, for example, poly-carbonite. On the first layer, about 0.1-0.3 mm diameter heating wires are attached with zigzag configuration. Top layer's material has low coefficient of friction and high electrical insulation, for example Teflon. Lines arrangement are horizontal direction, which are considered freedom of changing heat capacity, temperature gradient changing feasibility and snow sliding easiness and so on. Space of heating lines of lower part (1 cm) of antenna is smaller than upper part (2 cm). Electrical power can be feed every lines or alternate lines. Two kinds of line calorific materials, i. e., Cu-Ni line heater (Cu-Ni heater ) and carbone-fiber line heater (CF-heater ) are used for this system. Then attenuation of satellite signal due to resistance of antenna surface will become smaller than surface calorific materials. Moreover, decreasing of electrical power consumption will be expected by wider spacing of calorific lines. The CF-heater is made by mixing powder of carbone-black in polymer material (e. g., polyestel) line. As a result, reliability for frequent bending can be increased.

### 3.2 SNOW DETECTOR

Calorific line on the antenna must be switched on as soon as snowing. Conven-

tional snow detectors were expansive and sometimes error responses for snowing were occurred.

Newly developed snow detector blockdiagram is shown in Fig. 2. As shown in this figures, the snow detector is constructed by water detector and temperature detector. Temperature detector detects two kinds of temperature. First one detects about 7-10°C for switching the water detector heater, which melts snow on meander line type water detector. Second one detects about 2-5°C for ambient snowing temperature. When snow falls on the water detector and temperature decreased below snowing temperature, the AND circuit is activated and switch for calorific line on antenna surface turns ON.

The arrangement of water detector is shown in Fig. 3, where the surface of the water detector has gradient angle about 30-45 degrees for preventing unnecessary snow or ice on the surface.

### 3.3 EXPERIMENTAL CONSTITUTION

Three antennas, i. e., 1 m diameter reference offset parabolic antenna, Cu-Ni heater antenna and CF-heater antenna, are examined. Measuring system block diagram is shown in Fig. 4. The reference antenna received signal levels from satellite are displayed on spectrum analyzer. And whole views of three antennas are took a video camera. Those two signals are combined by computer and recorded on video tape with intermittence recording.

### 3.4 EXPERIMENTAL RESULTS

Experiments were performed for three seasons, i. e., from 1988 to 1991, with different experimental parameters. Table 1 shows summary of main experimental results of the snow melting antenna.

Table 1 Summary of experimental results of snow melting antenna.

YEARS	ELEVATION ANGLE	HEATING POINTS (LINE SPACIMG)	REQUIRED POWER FOR MELTING SNOW	
			(Ni-Cr heater)	(CF-heater)
'89-'90	45 deg.	B and C (2cm) (1cm)	79-123W	53-81W
'90-'91	31 deg.	B and C (4cm) (2cm)	60-72W	36-48W

Main features of the system are summarized as follows;

- (1) Required electric power for melting snow on antenna is rather small value when melting snow quickly by snow sensor. On the contrary, when heater is switched on after covered by snow on antenna surface, required electrical power must be increased as much as twice. Then presence of high performance snow detecting sensor become significant for efficient use of electric power.
- (2) Antenna gain losses by attaching heaters on antenna surface were below 1.0 dB for Cu-Cr heater and 1.5 dB for CF-heater. This values can be reduced by painting conductive paint on the surface or increasing the pitch of heaters.
- (3) This melting snow system has large operating flexibility for climates and seasons, e. g., setting flexibility of snow detecting temperature or changing pitch of heaters. By optimum setting, power consumptions can be decreased.

## 4. NEGATIVE-GRADIENT SLANTED POLYMER-SHIELDED (NGS) ANTANNA

The main reflector of earth station antenna look up toward satellite and front surface of feed-horn look up main reflector, i.e., they have positive

gradient. Consequently, snow attaches on those surfaces. The negative gradient slanted polymer-shilded (NGS) antenna, which is shown in Fig. 5, is one of good resolution.

#### 4.1 CONSTRUCTION OF NGS ANTENNA

Materials for the NGS antenna must have small attenuation characteristics for satellite signals and weak sliding friction for snow. The plastic form material (forming polystyrol) and Teflon are selected. The former material is cheap, high mechanical strength and small attenuation for 12 GHz band, because of large content of air in the material. As surface of forming polystyrol is rather rough, then smooth surface material, i. g., Teflon, is covered on the surface of forming polystyrol. The electrical magnetic waves are focused in front part of the feed-horn. Then, as shown in Fig. 5, only negative-gradient slanted Teflon thin film is arranged in front of feed-horn. By this construction, signal attenuation becomes negligible small value. The negative-gradient slanted angles are examined with several gradient slanted surfaces. As a result, by using Teflon surface, almost vertical or minus several degrees were sufficient for non-attaching of snow.

#### 4.2 EXPERIMENTAL RESULTS

This system is applied to offset parabolic antennas with main reflector of 0.75, 1.0 and 1.8 m equivalent diameter and flat panel antenna. Example of offset parabolic NGS antenna with main reflector of 1.8 X 2.0 m diameter is shown in Fig.6. Hyperlon-sheet is newly used for surface and side covers instead of Teflon. The framework is constructed with wood and forming polystyrol. The attenuation for signal is about 0.4 dB. This value is sufficiently small for practical use. As shown in the Fig.6, there are no snow on surface of negative-gradient slanted antenna. By using this system, antenna surface and feed-horn output can be protected from attaching snow for any types of snow and wind velocities and so on.

#### 4.3 MAIN FEATURES OF NGS ANTENNA

The NGS antenna has following features;

- (1) Materials are sold widely and cheap. Then the initial cost or operating cost can be drastically decreased.
- (2) The signal attenuations are 0.4-0.5 dB. This values are enough small values compared with rain margin.
- (3) Negative-gradient slanted Teflon sheet is used in front of feed-horn, then attenuation is very small without snow attachment.
- (4) Negative-gradient slanted polymer can be removed except winter season to decrease rain margin, if necessary.

### 5. CONCLUSION

Two methods, i.e., the snow melting antenna system and the NGS antenna system, are examined for resolving signal attenuation due to snow on antenna. The snow melting antenna system can be applied every sizes of antenna, even though electric power cost is required. The NGS antenna system can be applied until from 1.8 m to 2.0 m diameter antenna without electric power cost.

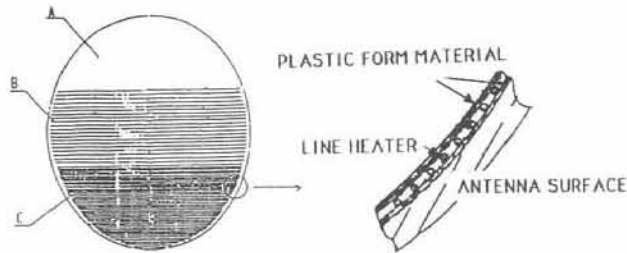
Earth station installations for VSAT systems will increase very rapidly in the future, then signal attenuation by snow will become more severe problems. The resolution methods discussed above can give good information for the problems.

#### ACKNOWLEDGMENT

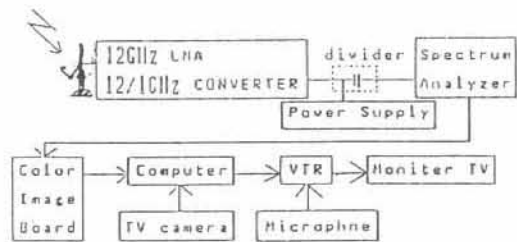
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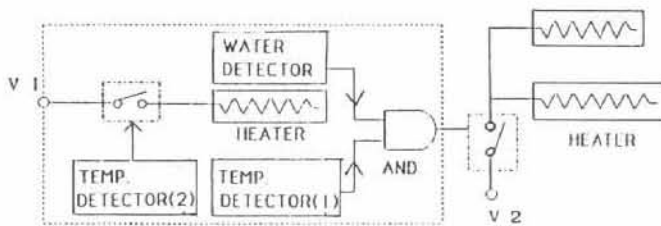
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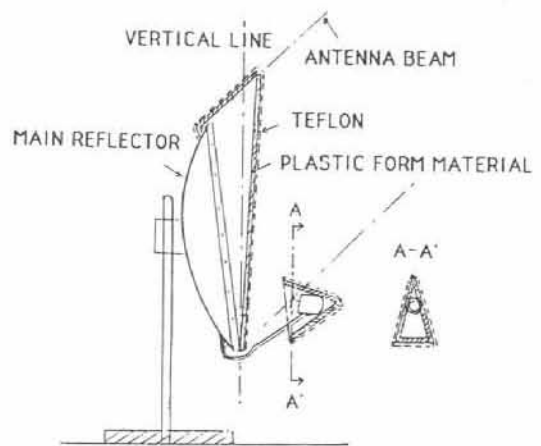
**Fig.1 Line heaters on antenna surface and its construction.**



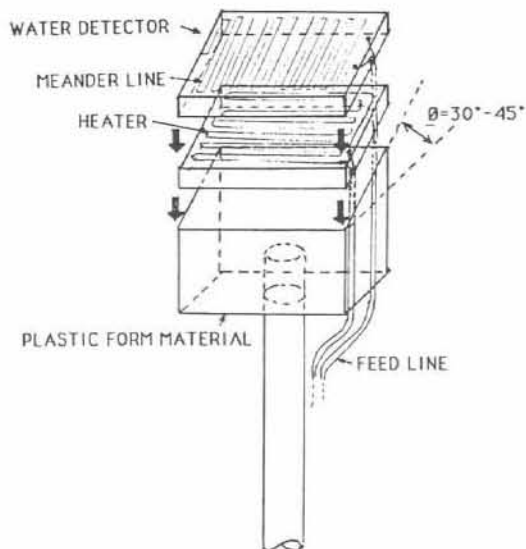
**Fig.4 Measuring system block diagram.**



**Fig.2 Snow detecting sensor construction.**



**Fig.5 Construction of NGS off-set type antenna.**



**Fig.3 Snow detecting sensor arrangement.**



**Fig.6 Example of 1.8m diameter NGS off-set type antenna.**