Analysis of Pressurized Radome Enclosures

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***Abstract*—Enclosures are discussed for the protection of antenna equipment in extreme environments.**

***Index Terms*—Radome, Antenna Arrays**

I. Introduction

Pressurized radome enclosures eliminate the effects of the environment on the internal components of the antenna. This reduces the maintenance involved on a pressurized antenna to external damage to the radome, such as a lightning strike -- a very unlikely occurrence. In contrast, the likelihood of damage to the internal components of a non-pressurized antenna is great, as well as the probability that it will go unnoticed until catastrophic failure occurs.

II. Creating Enclosures

Waveguide and coaxial transmission lines contain many joints sealed with o-rings around the flanges. Terrestrial and satellite microwave transmission lines are similarly sealed and pressurized [1]. All such transmission lines contain critical junctions that would corrode or otherwise degrade in the presence of contaminants, and for this reason that almost all high-power broadcast transmission facilities have pressurization equipment supplying dry gas to transmission lines.

These systems contain o-rings and high-pressure flanges providing a seal, and they are pressurized as well. With a sealed volume of air, or any other gas, a pressure vessel exists. Such volumes are created in an effort to eliminate ingress of water or other contaminants. A small amount of gas is leaked in every seal, and over time a pressure differential will not exist between the sealed volume of gas and the environment surrounding it (Figure 1).

Efforts to create volumes sealed from environments that include the passage of weather systems are often thwarted by the pressure changes. A situation where the outside pressure rises above the pressure of the sealed environment is inevitable and accompanied by moisture (Figure 2). The moisture and other contaminants are ultimately pumped into the sealed volume. Without equipment to constantly provide greater pressure in the enclosure, water and other contaminants would be pumped into the sealed line every time a front passes.

III. Ingress Protection Ratings

The IEC Test Standard EN 60529 [2] outlines an international classification system for the sealing effectiveness of enclosures of electrical equipment against the intrusion into the equipment of foreign objects (i.e. tools, dust, fingers) and moisture. This classification system uses the letters "IP" ("Ingress Protection") followed by two digits.

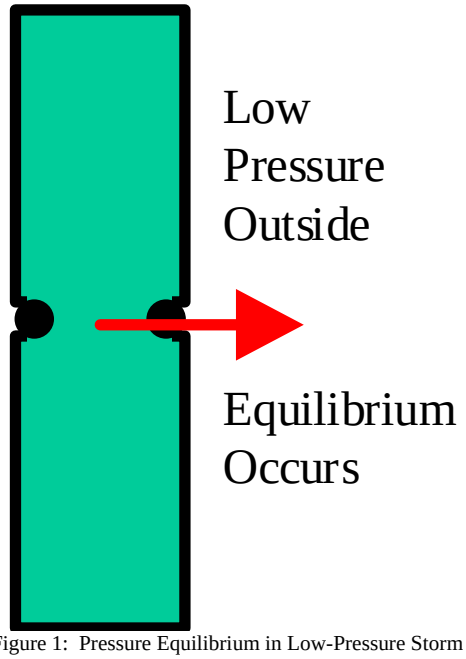

Figure 1: Pressure Equilibrium in Low-Pressure Storm

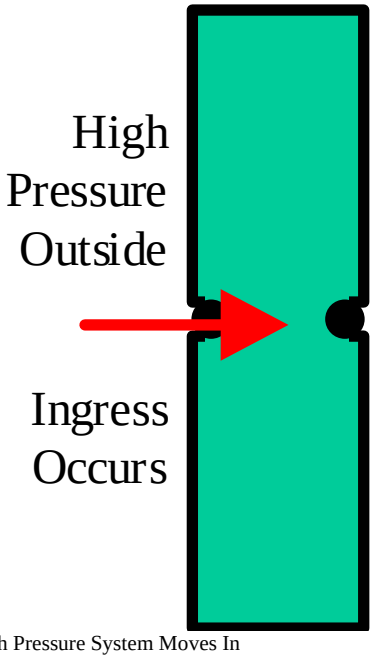

Figure 2: High Pressure System Moves In

The first digit of the IP code indicates the degree that persons are protected against contact with moving parts (other than smooth rotating shafts, etc.) and the degree that equipment

is protected against solid foreign bodies intruding into an enclosure. The second digit indicates the degree of protection of the equipment inside the enclosure against the harmful entry of various forms of moisture (e.g. dripping, spraying, submersion, etc.)

IV. Pressurized Antennas

Broadcast television antennas have critical components that would be impaired greatly in the presence of water or other contaminants. Many antennas have flange junctions nearly identical to those critical junctions found in the transmission lines mentioned above. In addition, the performance of radiating elements, coupling devices, and power dividing components suffers if subjected to corrosive or contaminated environments. Without the use of pressurization equipment to eliminate the ingress of contaminants, periodic maintenance is required to clean and repair the damaged surfaces.

Levels of Protection	1st Digit	2nd Digit
0	No special protection	
1	Objects greater than 50mm in diameter.	Protection from dripping water.
2	Object not greater than 80mm in length and 12mm in diameter.	Protection from vertically dripping water.
3	Tools, wire, etc., of thickness greater than 1.0mm.	Protection from sprayed water.
4	Any object with a diameter or thickness greater than 1.0mm	Protection from splashed water.
5	Volume of dust that would interfere with operation	Protection from water projected from a nozzle
6	Dust tight.	Protection against heavy seas, or powerful jets of water.
7	NA	Protection against immersion.
8	NA	Protection against complete, continuous submersion in water.

Figure 3: Ingress Protection (IP) Ratings

Ingress protected antenna equipment, with IP67 or better ratings, requires no periodic maintenance. No dust or debris from the harsh external environment will contaminate critical conducting surfaces and points of conductor contact. No water will be pumped into the antenna by passing storms and pressure changes. After 30 years of service, critical components (Figure 4) will still be shiny and undamaged.

Figure 4: Pressure Protected Antenna After 30 Years of Service in Chicago

References

[1] Wittaker, Jerry, ed., *NAB Engineering Handbook, 9th Edition*, Washingtion, DC, 1999

[2] IEC 60529, Edition 2.1, *Degrees of protection provided by enclosures (IP Code)*, Geneva, Switzerland, 2001.

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