Communications & Power Industries
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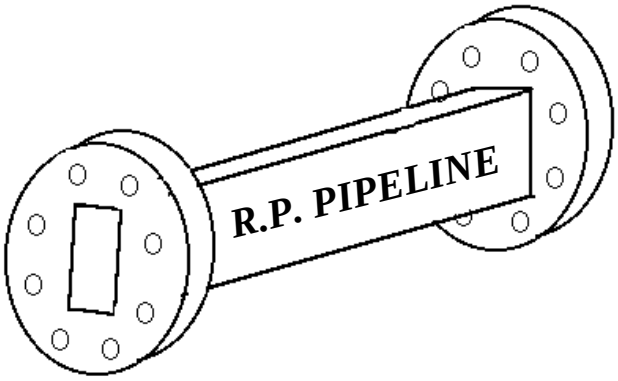

THAT'S LIFE!!

Receiver Protector Life

In this issue of the *Pipeline*, we return to our main product area - receiver protectors. One aspect of this product group that is often not well understood is the useable life of the product. In this article, we hope to give the reader a better understanding of the underlying concepts of receiver protector life and how they apply to actual performance.

To begin, not all types of receiver protectors have limited life. Only those products that contain some form of gas tube (TR tubes, TR Limiters, Pre-TR tubes, etc.) have a limited life. All solid state products (Diode limiters, switches, ferrite limiters, etc.) will last forever (theoretically) and are not part of this discussion.

Types of Life

There are two types of life: operating life and storage life. Operating life is the number of hours that the unit can be expected to function normally in the system before its performance degrades to the point where it no longer meets the specifications. The actual operating life of any tube depends on many different factors and environmental conditions. These are discussed below. Storage life refers to the period of time that a new, unused unit can be stored with no degradation in performance.

Operating Life

As a tube is operated in the system, certain internal changes take place. These changes cause the tube's performance to slowly degrade over time. The changes are as follows:

* Gas cleanup - Gas molecules become absorbed in the waveguide walls, causing a drop in pressure.
* Sputtering - Minute particles of the metal frame are chipped off as the input window fires. Some of these particles fall onto the input window, thus causing a buildup of metal on the input window glass.

Both of the above processes occur simultaneously any time the unit is subjected to high RF power conditions. The rate at which they progress depends upon a number of factors. These include operating power and duty cycle, as well as the mechanical configuration of the tube.

The processes are very complex and it is not possible to accurately predict how well any design will perform. Only an actual operating life test will give a meaningful indication of how long a particular design may be expected to last. We have established standard operating life warranties of 500 hours for soft soldered tubes with keep-alives and 1000 hours for hard brazed tubes and Pre-TRs. These are warranties only. They are not meant to be indications of expected performance.

In most cases, the gas cleanup occurs at a much faster rate than sputtering. Therefore, this factor is of most concern. One common way to offset the gas cleanup process and extend tube life is to incorporate a gas reservoir into the design. Thus, the gas that is depleted in the main tube body, is continually replaced with gas from the reservoir.

Storage Life

The two factors that control storage life are the integrity of the gas vacuum seal (i.e. braze joints, microscopic leaks, etc) and the half life of the radioactive source. The radioactive half life is well known. However, because there is no way to evaluate the integrity of the seal, there is no hard data, nor is there a model from which actual storage life can be accurately predicted. Anecdotal evidence, based on actual tests, indicates that a hard brazed tube can reasonably be expected to meet its specs after at least 15 - 20 years on the shelf, unused.

End of Life Indications

A TR tube does not fail suddenly. Instead, its performance slowly degrades over time as it is used. This is good because it gives the system operator the ability to monitor the tube's condition and replace it before it degrades to the point where other parts of the system are affected. By definition, we say that a tube has reached its "end of life" when it fails to meet one or more of its specs. Some specifications allow for a certain amount of degradation before the "end of life" is declared.

There are three typical end of life indications:
1. Long recovery time
2. High leakage power (Usually spike and breakdown power)
3. High insertion loss

Items 1 and 2 are caused by gas cleanup; item 3 is caused by sputtering on the input window.

Since gas cleanup usually proceeds at a faster rate than sputtering, long recovery time and high leakage are usually the first indications of end of life. In fact, recovery time is usually the most sensitive indicator and the one to watch.

From the radar operator's point of view, the following system characteristics may indicate that a TR tube has reached its end of life:
* Minimum detectable range increases (Long recovery time, high leakage)
* Maximum detection range decreases (High insertion loss)
* High signal to noise ratio (High loss, high leakage)
* Radar fails to detect targets (High leakage may have caused the receiver to burn out)

As stated above, the most likely initial indication is an increase in minimum detectable range. This is a clear early warning sign that the TR tube needs to be replaced.

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