

# Maximizing the Klystron's life expectancy

## COOLING:

Adequate cooling is essential. Two areas require particular attention:

### i) The Collector

Sufficient cooling air must be continually supplied to the collector. Otherwise, it will overheat and cause premature failure.

To prevent this, periodic maintenance must be conducted. The filters on the air supplied to the amplifiers and the cooling fins on the collector must be kept clean. Always ensure the minimum specified air mass-flow is met or exceeded. Account must be taken of the ambient temperature of the cooling air ... the altitude of the installation ... and the pressure drop introduced by the ducting of the installation during the system design.

Overheating can cause gas to evolve inside the vacuum envelope. This causes irreversible damage to the cathode. Overheating also increases the mechanical stress on the vacuum envelope, which (in extreme cases) ultimately causes the failure of a vacuum seal – and the breakdown of your klystron.

The collector assembly is fitted with a thermal interlock switch that is intended to protect the klystron against a complete cooling system failure. It should not be relied upon to protect the klystron against either a sub-spec or a poorly maintained cooling system which causes gradual and permanent damage long before 'thermal interlock' activation.

### ii) The Body/Cathode

On some models, the body and the cathode also require cooling. And failure to supply the specified air mass-flow to these components will also result in overheating and premature failure.

The air-cooled cathode assemblies are especially sensitive. When these overheat, it results in an increased evaporation rate of Barium at the cathode surface – and this (in turn) reduces your klystron's life expectancy. Overheated cathodes can also evolve gas into the vacuum envelope which will reduce your klystron's life as well.

## OPERATION:

Proper operation can greatly enhance the longevity of your klystron. There are 3 different modes of operation

### a) 'Filament' Operation

Except under 'stand-by conditions', the filament should always be operated at the voltage shown on the nameplate. Operating at either too high or too low a voltage can cause premature klystron failure.

If the beam current drops due to aging effects ... the filament voltage can be raised up to 0.5V either for a short period (e.g. 20 minutes) or permanently if the situation persists. Running a depleted klystron continuously at high heater voltage may temporarily extend the life of the klystron. But remember, there is no certainty as to the period of extended life, if any. (It varies depending on the condition of the cathode.)

### b) 'Reduced Power' Operation

Many of today's applications do not require the klystron to run at full power. In these situations, it is recommended that the klystron be operated in a reduced beam power mode. This not only reduces your utility bill, but it also reduces the thermal loads and stresses on the klystron's components. (Most modern KPAs come equipped to run in these reduced beam power modes.)

### c) "Stand-By" Operation

This occurs when an amplifier is used in a 1:n configuration. It can also occur if an amplifier is only being used to carry very occasional traffic. In this case, an operator may want to save power during the "off air" period.

The following table shows the recommended mode of operation for klystrons used in stand-by operation. It starts with the most desirable mode of operation – and flows down to the least desirable. The most desirable will provide maximum klystron life expectancy – and the least desirable will provide the lowest life expectancy.

## Recommended stand-by operation

Tube Life	Filament Power	Beam Power	RF Power
<b>Best</b>	<b>Off</b>	<b>Off</b>	<b>Off</b>
↓	<b>On<sup>1</sup></b>	<b>Reduced<sup>2</sup></b>	<b>On</b>
	<b>On<sup>1</sup></b>	<b>Reduced<sup>2</sup></b>	<b>Off</b>
	<b>Full</b>	<b>Full</b>	<b>On<sup>2</sup></b>
<b>Worst</b>	<b>Full</b>	<b>Full</b>	<b>Off</b>
	<b>On</b>	<b>Off<sup>3</sup></b>	<b>N/A</b>

### Notes:

1. Assumes beam power reduced by at least 1 kW
2. Assumes RF output power is less than 1 kW
3. Most modern KPAs automatically reduce filament power when in this mode

## B) Maintenance during 'Storage'

If you are storing a Klystron for an extended period of time, it should be conditioned at least once every 6 months, as follows:

- Apply filament power in the usual manner.
- Allow the klystron to warm up for a minimum of five minutes.
- Do not leave it for longer than fifteen minutes before applying high voltage.
- When applying high voltage, start from the lowest value possible.

- Set body current trip level to 20mA, as a precaution, while running up.
- There may be intermittent bursts of body current as gas is cleared. This should clear fairly quickly, so that full operating voltage is reached in a few minutes.
- Once full voltage is attained, RF may be applied.
- The klystron should then be run both with and without RF input for a minimum of a half-hour after the body current has stabilized. The time to stabilize will vary with the age of the klystron, storage time, storage conditions, etc.

## Technical Assistance

CPI Canada's Engineers are available to offer technical assistance on these or any other matters regarding klystron products. Just call 1-905-877-0161 and ask for 'Klystron Engineering'.

This document is not designed to replace safety, operational and maintenance instructions in the amplifier operations manual. It should only be used to supplement information given. For a complete guide of this information, please consult your operating instructions.



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