Pulse-rated tubes as used in linear amplifier service.

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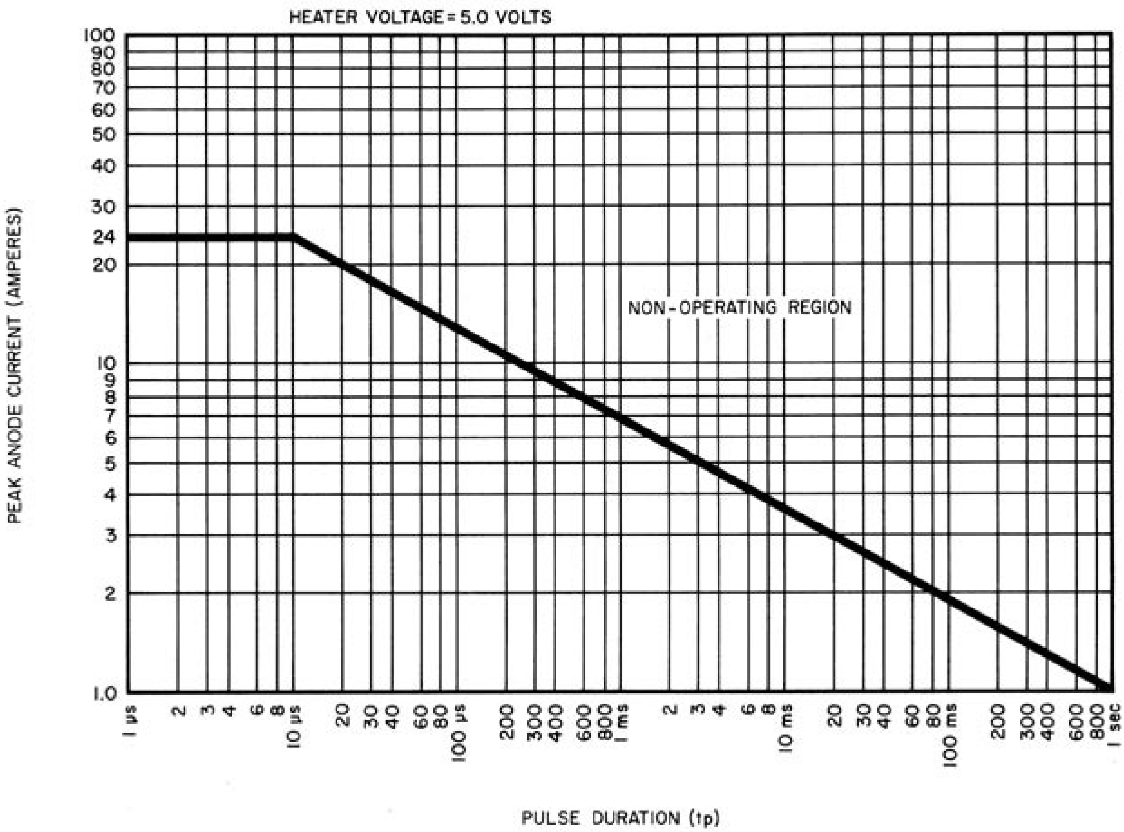
There has been a misconception about "pulse-rated" tubes when it comes to use in typical linear amplifier service, ever since these tubes became available to amateurs. First, these tubes are typically not used in linear amplifiers; pulse service by definition is decidedly "non-linear", operating deep within the class-C region of amplifier service (conduction angle < 180°). Secondly, these tubes must be "de-rated" when used in linear amplifier service.

The definition of pulse service is as follows: High RF and DC anode currents of very short duration, with equal periods of no anode current between pulses, much like a short-duration square-wave "on-off" cycle. Typically, the tube begins to come out of pulse service when the pulse durations exceed 10 μS, as seen in the graph below.



PULSE DERATING DATA, TYPE 3CPX1500A7 - PULSE MODULATOR OR REGULATOR SERVICE

Peak (pulse) anode current capability is dependent on pulse duration (tp) and duty factor (Du). Maximum peak anode current for a given value of tp is shown. Maximum Du may then be derived from the relationship: $1.0 = i_b \sqrt{D_u}$

The region from 10 μS to 100 mS is an area in which no linear amplifier could ever operate. The typical linear amplifier will begin to operate with RF pulses in the 100 mS area (conduction angle 180° or greater), but very few pulses of this duration are found in the typical SSB or CW driving signal. The typical linear amplifier will begin to be driven by signals with pulses in the region of 300 mS and longer. Essentially, the tube in linear service is typically operating in the standard-rated tube region most (at least 95%) of the time. Thus, a pulse-rated tube will also be operating in the same condition. The tube specifications for a standard tube of the same type will be the rating to use, and not the pulse ratings.

It is true that the pulse-rated tube can withstand a higher plate voltage than the same standard-rated tube; this is due to the larger spacing internally and the larger insulators used for these tubes. However, this larger spacing also reduces the overall gain of the tube in comparison to a standard tube operating at standard maximum plate voltage. It does not have higher gain, but the higher plate voltage at which pulse-rated tubes can operate brings the gain back up to equal that of a standard tube, which cannot operate at such high plate voltage levels. Gain in a vacuum tube is a function of internal element spacing and free electron flux from the cathode. Since the cathodes of pulse-rated tubes are exactly the same as those of standard-rated tube, the net effect is a reduction in gain with the increase in element spacing. Bringing the plate voltage up above that of a standard-rated tube restores the gain to that of the standard tube.

An equal amount of RF output power can be had with lower plate current than the standard-rated tube. Many misconceive this as greater gain, when in-fact it is the same as a standard rated tube.

Pulse-rated tubes are typically used in "non-linear" services such as MRI, CT scan, and radar equipment where the high output pulses are used to great effect. When used in typical amateur radio "linear" service, the pulse-ratings must be "de-rated" back to standard service tube ratings, with the only exception being the plate voltage maximum rating.

In a single sentence, the only benefit of using a pulse-rated tube in typical linear service is that the tube can handle higher plate voltages. Aside from this there are no other benefits.