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VOLTAGE RIPPLE ON SLOW BEAM EXTRACTION EQUIPMENT

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The present slow external beam from the AGS is modulated due to ripple voltage in the power system that drives the extraction magnet elements as well as ripple in the main magnet system. In order to reduce this ripple structure, filtering must be added to certain power systems. The limits on voltage ripple may be estimated as follows.

If we assume the beam is uniformly populated in ν and occupies a region 0.2 ν units wide, then the rate of beam spill will be proportional to $\frac{d\nu}{dt}$. This assumption of uniform population is a gross simplification, but the results will still serve as a useful guide in equipment design.

Each magnet element is assumed to be a simple L and R in series. The driving generator consists of a dc battery (E_o) and a ripple generator (Δe) in series.

$$\Delta i = \frac{\Delta e}{z} \simeq \frac{\Delta e}{\omega L}$$

Note $E_o = I_o R$

$$\therefore \frac{\Delta i}{I_o} = \frac{\Delta e}{\omega L} \cdot \frac{R}{E_o} = \frac{\Delta e}{E_o} \cdot \frac{1}{\omega\lambda} \text{ or } \frac{\Delta e}{E} = \frac{\Delta i}{I_o}\ \omega\lambda$$

where λ is the time constant $\frac{L}{R}$

if $\nu = \alpha t + \beta \sin \omega t$ where $\alpha = \frac{0.2}{\text{flat top time}}$

$$\frac{d\nu}{dt} = \alpha + \beta\omega \cos \omega t.$$

Since the spill is proportional to $\frac{d\upsilon}{dt}$, the fractional spill ripple $f = \frac{2\beta\omega}{\alpha}$ measured as a ratio of peak to peak spill ripple to the average spill.

β is measured in υ units to obtain Δi we need only divide by the appropriate co-efficient γ (υ units per amp)

$$\therefore \quad \Delta i = \frac{\beta}{\gamma} = \frac{f\alpha}{2\omega\gamma}$$

and $$\frac{\Delta e}{E} = \frac{f\alpha\omega\lambda}{2\omega\gamma I_o} = \frac{f\alpha\lambda}{2\gamma I_o} \quad .$$

The following table evaluates this expression for the magnet elements indicated.

Element	Time Constant	Allowed Spill Ripple (f)	$\frac{\Delta e}{E}$ 400 msec Flat Top	$\frac{\Delta e}{E}$ 1 sec Flat Top
Backleg Windings	.083	10%	10.4%	4.2%
Quadrupole Horizontal	.150	20%	7.5%	3.0%
Quadrupole Vertical	.150	10%	7.5%	3.0%
Magnet Voltage*		20%	0.7%	0.3%

*Extracted from AGSCD Technical Note #1, June 28, 1965.

The spill ripple due to ripple in the sextupole magnets are being studied by others and will be reported later.

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