

Engineering and Mathematics

Practical Applications

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imagination at work

WHAT DOES GE AVIATION DO?

Designs, Builds, and Tests Aircraft Engines

WHAT DOES FACILITIES ENGINEERING DO?

Ensure the plant has the required utilities to function (i.e. lights, power, HVAC, tel/data etc.)

WHAT DO I DO?

Ensure the power, lighting, fire alarm and security systems are safe and reliable

GE Aviation, River Works Plant, Lynn, MA



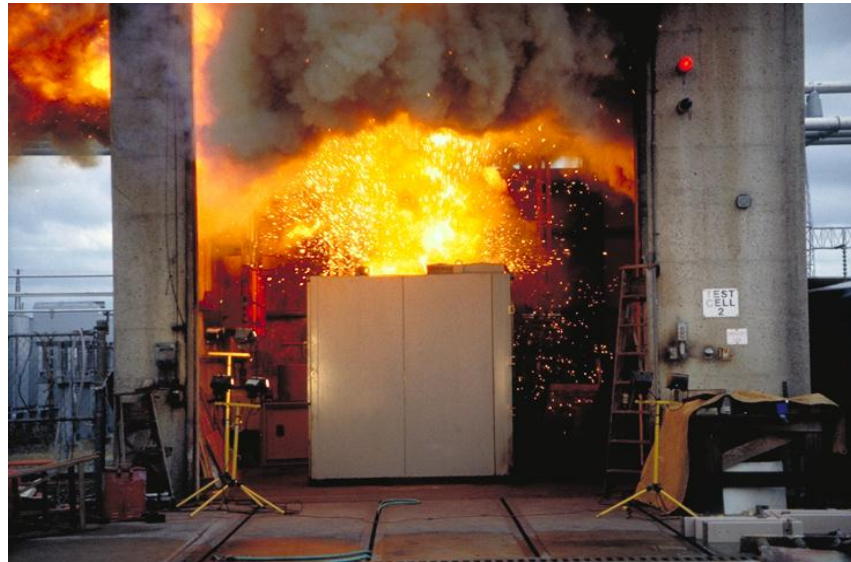
What is a typical day like?

Design power systems that are **safe**

Design power systems that are **reliable**

Design lighting systems that are **comfortable**

Design power systems that are **safe**



Finding the Bolted Fault Current

Re-derive equation to convert AFC to BFC

$$I_{bf} = \left(\frac{I_{at}}{A_4'} \right)^{\frac{1}{A_3}}$$

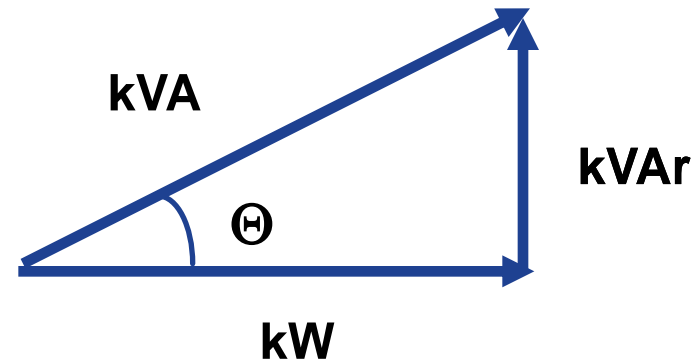
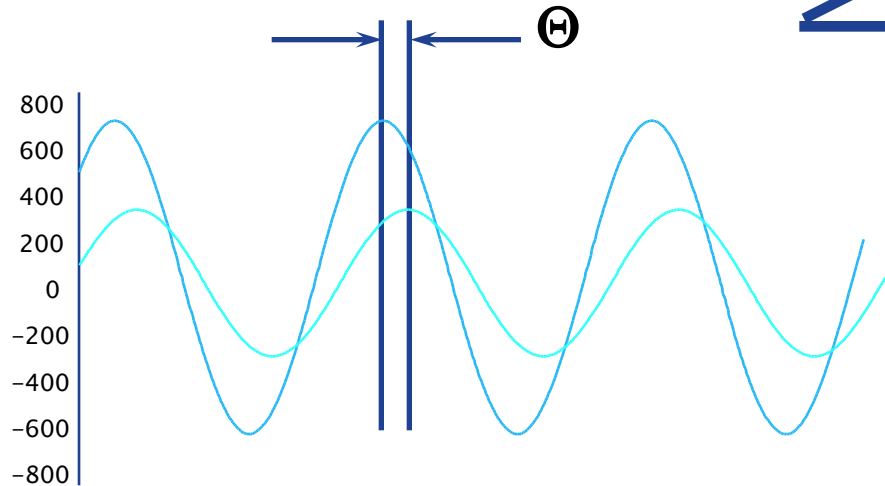
$$A_3 = 0.662 + 0.5588V - 0.00304G$$

$$A_4 = K + 0.0966V + 0.000526G$$

$$A_4' = 10^{A_4}$$

Design power systems that are **reliable**

Harmonics & Power Factor



$$PF = \text{PowerFactor}$$

$$PF = kW / kVA = \cos \phi$$

Quick Resonance Frequency Calculation

- General formula for resonant frequency

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

- Quick power engineering version

$$h = \sqrt{\frac{SSkVA}{kVAR}}$$



Total Harmonic Distortion - THD

A measure of the amount of distortion associated with a voltage or current waveform

$$V_{\text{THD}} = \sqrt{\frac{\sum V_h^2}{V_1^2}} \Rightarrow \frac{V_{\text{RMS-H}}}{V_{\text{Fundamental}}}$$

$$I_{\text{THD}} = \sqrt{\frac{\sum I_h^2}{I_1^2}} \Rightarrow \frac{I_{\text{RMS-H}}}{I_{\text{Fundamental}}}$$

Design lighting systems that are comfortable

TYPE C

Mechanical Room (elev 605', west end, dwg E-23)

Notes: Type C, 2 x 4
Hemphill, Grand
Spill = 1.9 Type E
8' Mounting \approx 15' option

Section A-A
8' x 5' 0"

Section B-B
8' x 11' 0"

$$RCR = \frac{5 \text{ hrc} \times (L + W)}{L \times W} = \frac{5 \times 5 \times (17 + 29)}{17 \times 29} = 2.33$$

$$p_{cc} = 80\% \text{ (White Concrete)} \quad C_{11} = .70$$

$$p_{fc} = 20\% \text{ (Grey Concrete)}$$

$$p_w = 50\% \text{ (medium color)}$$

$$\text{Rated Lumens} = 2900/\text{lamp} \times 8, 4'$$

$$\text{Area} = 17' \times 29' = 493 \text{ Ft}^2$$

I. Illuminance - "Distributed" (Average)

$$\text{Illuminance} = \frac{2900 \text{ lumens/lamp} \times 2 \text{ lamps/foot} \times 5 \text{ Feet} \times \frac{MC}{FC} \times C_u}{493 \text{ Ft}^2}$$

$$= 28.8 \text{ FC}$$

II Illuminance - "Point" 5'

$$FC = \frac{\text{Candlepower}}{D^2} \times \cos^3 \theta$$

$$D^2 = 5^2 + 5^2 = 50$$

$$D = \sqrt{50} = 7.1$$

$$\cos \theta = \frac{H}{D} = \frac{5}{7.1} = .71$$

$$\theta = 45^\circ$$

$$FC = \frac{1375 \times .71}{7.1^2} = 17.5$$

9' Mounting
 $d^2 = 85, d = 9.2$
 $\cos \theta = .65$
 $\theta = 49^\circ$
 $CP = 1300$
 $\text{Point} = 7.9 \text{ fc}$

8' Mounting, 8' Horizontal
 (16" spacing)
 $d^2 = 89, d = 9.4$
 $\cos \theta = .53$
 $\theta = 57.9^\circ$
 $CP = 875$
 $FC = 5$

8' Mounting, 10' Horizontal
 (20" spacing)
 $d^2 = 125, d = 11.2$
 $\cos \theta = .415, \theta = 63.5^\circ$

Design lighting systems that are **comfortable**

I. Method #1 (Cavity Ratio) CONT'D [Average, distributed]

$$\text{Illuminance} = \frac{\text{"rated" lumens} \times \text{C.U.} \times \text{MF}}{\text{Area}}$$

$$= \frac{27,500 \text{ lumens/fix} \times 0.8 \text{ Fix} \times 0.82 \times 0.70}{9310 \text{ ft}^2}$$

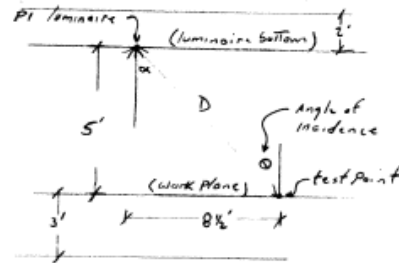
$$= \boxed{47.5} \text{ FC}$$

[30 FC - CWD Emrg Std]

lumens = 27,500
Maint fact = .70
Based on "Poor" CR

opt
Fixt Spacing = 19' } 1:1
(Along width)
Fixt Spacing = 18' } 1:1
(Along length)

II. Method #2 (Candlepower Graph) * Illuminance at Point



$$\text{FC} = \frac{\text{Candlepower} \times \cos \theta}{D^2}$$

$$D^2 = 5^2 + 8.5^2 = 97.25 \text{ ft}^2 \quad D = 9.86'$$

$$\cos \theta = \frac{5}{D} = \frac{5.0}{9.86} = .51$$

$$\theta = \cos^{-1} .51 = \cos^{-1} (.51) = 59^\circ$$

$$\text{CP} (59^\circ) = 4167$$

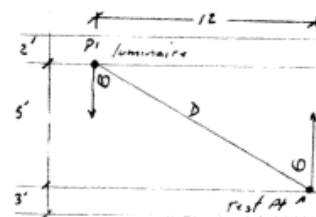
$$\text{FC} = \frac{4167 \times .51}{97.25 \text{ ft}^2} = \boxed{21.9} \text{ Foot-Candle}$$

alpha = Angle used in data Graph

theta = Angle that light hits test point

Note: FC @ test point will be higher than 21.9 due to adj. fixt contributions

Note: alpha = theta



$$D^2 = 5^2 + 12^2 = 169 \quad D = 13$$

$$\cos \theta = \frac{5}{13} = .38 \quad \theta = 67.4^\circ$$

$$\text{CP} = 2500 \quad \text{FC} = \frac{2500 \times .38}{169} = \boxed{5.6}$$