SPACE RAD. LAB. INTERNAL REPORT # 1

NOTES FROM READING

HANDBOOK ON RFI VOL 3 FREDRICK RES. CORP 1962

MARTIN ISRAEL

GENERAL.

SOLID COVER MUCH BETTER THAN MESH

FOR HIGH FREQ SHIELD MUST BE ALMOST WATERTIGHT

USE MULTIPLE SHIELDING & FILTERS FOR ALL LEADS !

BELOW SEVERAL Mc COPPER MUST BE VERY THICK FOR MAGNETIC SHIELDING. BETTER TO USE HIGH μ MATERIAL

ELECTROSTATIC SHIELDING IMPORTANT FOR HIGH VOLTAGES

REFLECTION & ABSORPTION LOSSES IN SHIELDS

1) PLANE WAVE ON INFINITE PLANE SHIELD NORMAL INCIDENCE (WORST CASE)

(p 3-11) TOTAL LOSS (db) = $\underbrace{3.34\sqrt{f_m \mu_r \sigma_r}\, S}_{\text{ABSORPTION}} + \underbrace{108.2 + 10 \log \frac{\sigma_r}{f_m \mu_r}}_{\text{REFLECTION}}$

WHERE f_m = FREQ IN Mc

μ_r = REL. PERM. ($\mu_r = 1$ FOR NON-MAGNETIC)

σ_r = REL. CONDUCTIVITY ($\sigma_r = 1$ FOR COPPER)

S = SHIELD THICKNESS IN MILS

AT FREQUENCIES $\gtrsim$ 1 Mc MAGNETIC MATERIEL IS BETTER THAN COPPER *

(BUT EVEN 5 MILS OF CU GIVE 125 db)

(FOR 5 MIL Cu ABSORPTION DOMINATES FOR $f > 40$ Mc

FOR 5 MIL $\sigma = 0.1$ $\mu = 1000$ " " " $f > 0.2$ Mc

2) CYLINDRICAL SHIELDS ABOUT LINE OR LOOP SOURCE

FOR ONE POLARIZATION, REFLECTION PRODUCES LITTLE LOSS

∴ CONSIDER ONLY ABSORPTION LOSSES.

PLANE WAVE EQN GIVES GOOD APPROX.

(NOTE, AT ALL FREQ ABSORPTION LOSS FOR TYPICAL MAG SHIELD IS BETTER THAN CU, * BUT FOR 5 MIL CU. ABSORPTION IS FAIRLY LARGE ABOVE 10 Mc

5 MILS Cu:

F (Mc)	1	10	30	100	300
ABS. LOSS (Db)	20	50	80	160	300

* BUT FOR TYPICAL MATERIAL

σ_r (STEEL) = 0.03 - 0.16

σ_r (Al) = 0.61

σ_r (Cu) ≡ 1.0

f_m	≤ 10	100	1000	10,000
μ_r	1000	100	10	1

FOR ABSORP. ADVANTAGE OVER Cu / THICKNESS $(\mu_r \sigma_r)_{steel} > 1$

FOR ABSORP. ADVANTAGE OVER Al / WEIGHT $(\mu_r \sigma_r)_{steel} > \frac{\rho_{st}}{\rho_{al}} (\mu\sigma)_{al} = 1.8$

(DENSITY OF STEEL ≈ 7.8
" " Al ≈ 2.7
" " Cu ≈ 8.9)

∴ STEEL BETTER FOR f_m < 200-1000

SHIELDING MATERIALS (P3-22)

MINIMUM THICKNESS OF SOLID WALL FOR 33db (IE 100 db AT 10 Mc) ABSORPTION LOSS AT 1 Mc

MATERIAL	Al	BRASS	Cu	Ag	STEEL*	Sn
THICKNESS (MILS)	13	20	10	10	25-55	26

* ASSUMING $\mu = 1$

PRINCIPLE SHIELDING OF MESH IS DUE TO REFLECTION (ABSORPTION, MUCH LOWER THAN FOR SOLID SHIELD)

TOTAL LOSS OF SOLID WALL INCREASES WITH INCR. FREQ

BUT " " " MESH DECREASES " " "

(FOR MESH REFLECTION ≈ SOLID RELECTION
$\lesssim$ 50% OPEN $\gtrsim$ 60 STRANDS / WAVELENGTH, PERMANENT ELECTR. CONTACT AT INTERSECTIONS)

HOLES (P 3-24

FOR DIMENSIONS OF HOLE SMALL COMPARED TO WAVELENGTH, LEAKAGE SMALL, PROPORTIONAL TO HOLE AREA. — MANY SMALL HOLES BETTER THAN ONE LARGE HOLE

[NOTE 10 KMc ↔ 3 cm. WAVELENGTH ↔ ~.03 N.SEC RISE TIME]

PROTRUDING SLEEVES AROUND HOLES ACT LIKE WAVEGUIDES PROVIDED LENGTH $\gtrsim$ 3 x DIAM (OR 3X LONGEST XSECTIONAL DIMENSION)

$$f_c = \frac{5900}{b} \qquad f_c = \frac{6920}{d}$$

CUTOFF FOR RECTANG. CUTOFF FOR CIRCULAR

f_c IN Mc
b = LONGEST XSECTION DIMENSION IN INCHES
d = DIAM. IN INCHES

NOTE 1" DIAM ⇒ f_c = 6.9 KMc
.2" DIAM ⇒ f_c = 35 KMc

FOR $f \lesssim .1 f_c$ ATTEN (db/in) = $\frac{27.3}{b}$ OR $\frac{32}{d}$

SO 1" DIAM x 3" LONG ⇒

[NOTE: IF A CONDUCTOR RUNS INSIDE THE "WAVEGUIDE" THEN A TEM MODE OF PROPAGATION IS POSSIBLE. THIS MODE HAS NO LOWER FREQ CUTOFF. (IE YOU CAN TRANSMIT DC DOWN A COAX)]

P 3-27

JOINTS : KNITTED MESH IS GOOD [EG. METEX, TECHNIT)
(ALSO LISTS OTHER POSSIBILITIES & CONSIDERATIONS)

SOLDER HAS CONDUCTIVITY ≲ 0.12 OF COPPER
[COMPARE: Al 0.61] SO EVEN A GOOD SOLDER
JOINT IS NOT AS GOOD AS A WELD.

(P 3-44)

CONDUIT RIGID CONDUIT .022" Al ⟹ 57 db ABSORPTION AT 1 Mc
570 " " " 100Mc

FLEXIBLE CONDUIT NOT AS GOOD
TIGHTLY WOVEN BRAID OVER FLEXIBLE CODUIT GIVES
~ 45 db ADDITIONAL ATTEN (AT MOST FREQ)

(P. 6-8)

MISC : GROUND CABLE SHIELDS, COAXIAL FEED THROUGHS, & FILTERS
AT SHIELDS AT POINT OF EXIT OR POINT OF ENTRY

AT HIGH FREQ A GND LEAD WHICH HAS LENGTH
WHICH IS AN ODD MULTIPLE OF A 1/4 WAVELENGTH
MAY HAVE VERY HIGH IMPEDANCE TO GND

ALSO HIGH IMPEDANCE IN GND LEAD MAY BE CAUSED
BY SUDDEN CHANGES IN CONFIGURATION, AS WHEN
LEAVING A METAL DUCT OR OTHERWISE CHANGING
THE ELECTRICAL RELATIONSHIP TO METALLIC
BODIES. SUCH CHANGES PRODUCE SERIOUS REACTIVE
MISMATCHES