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SUBJECT: Reflection of Metallized Spheres

The information you requested is given with some additional data that might be useful.

I. REFLECTIVITY OF METALLIZED SPHERES

The properties of a four-foot diameter metallized sphere to be used in the S band are listed below:

1. Directivity or gain (radiation in the maximum direction divided by the average radiation intensity).

2. G_L = 1.30 or 1.1 db for 3Kmc and a 4-foot diameter sphere (a/λ = 6.1) For Linear polarization

   For Circular polarization:
   G_c = 1.43 or 1.3 db max or-1.3 db min

3. Reflection coefficient (ρ)

   The reflection coefficient for one-ohm-per-square (275A°) Aluminum film is greater than 99%.

   If more information is desired these properties consult Items 5 and 6 of the List of References.

II. FREQUENCY BANDS

These classifications are commonly used but are not standard. *1

Abbreviation	Meaning	Frequency Range	Band No.	Metric des ignition by wave length
v-l-f	very-low-frequency	3-30Kc	4	Myriametric
L-f	Low-frequency	30-300Kc	5	Kilometric
m-f	Medium-frequency	300-3,000Kc	6	Hectometric
n-f	High-frequency	3-30Mc	7	Decametric
v-h-f	very-high-frequency	30-300Mc	8	Metric
o-h-f	Ultra-high-frequency	300-3,000Mc	9	Decimetric
s-h-f	Super-high-frequency	3,000-30,000Mc	10	Contimetric
e-h-f	Extremely-high-frequency	30,000-300,000Mc	11	Millimetric

K band	30 kmc or 1 cm
X band	10 Kmc or 3 cm
S band	3 Kmc or 10 cm
L band	1 Kmc or 30 cm
P band	1/3 Kmc or 10 meters

The C band is also used which ranges from 5.2 to 8.5 Kmc.

III. RADAR SCATTERING CROSS SECTION (σ) *2

The ratio of the power per unit solid angle scattered back toward the transmitter to the power per unit area striking the target multiplied by 4 is defined as the radar scattering cross section (σ)

For a sphere

		σ
Small sphere	radius = a $a/\lambda < .15$	$9\pi a^2\left(\frac{2\pi a}{\lambda}\right)^4$
Large sphere	radius = a $a/\lambda > 1$	πa^2

For a small airplace (AT-11)	200 ft^2
For a large airplace (B-17)	800 ft^2

IV. EFFECTIVE AREA (A_T) *3

It is defined on the area of an equivalent flat plate oriented so as to be perpendicular to the direction of the incident radiation. For a sphere $A_T = \frac{a\lambda}{2}$

V. DIRECTIVITY

Directivity is usually expressed as a directive gain, which is the radiation intensity in the maximum direction divided by the average radiation intensity.

The directivity or equivalent gain of a sphere $a/\lambda \geq 5.1$ over and isotropic scatterer is: *5

For linear polarization

G_L = 1.30 or 1.1 db

For Circular polarization

G_c = 1.43 or 1.3 db maximum or -1.3 minimum

VI. REFLECTION COEFFICIENT (P) *

The voltage reflection coefficient for a thin homogeneous conductive film suspended in free space is considered to be:

$$P = \frac{Z_{in} - Z_0}{Z_{in} + Z_0}$$

The article gives the following information on aluminum films. (conductiviity = 1.1×10^7 mhos/ m)

Thickness	
20Å	P > 80 % at 900 mc
350Å	P ≥ 98.8% at 900 mc or at 2,000 are instead of 900 mc the film exhibits excellent conductive properties.

List of References

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*1 Page 19-1 "Radio Engineering Handbook"
Fifth Edition, By Keith Henney McGraw-Hill Book Co. 1959

*2 Page 804 "Reference Data for Radio Engineers"
Published by I.T.S.T. Corp.

*3 Page 13-10 "Antenna Engineering Handbook"
First Edition, by Henry Jasik

*4 Page 20-4 "Radio Engineering Handbook"
Fifth Edition, by Keith Henney McGraw-Hill Book Co. 1959

*5 Page 620-24 "The use of a passive spherical satellite for Communication and Propagation Experiments" by T.H. Vea, J.D. Day and R. T. Smith Vol. 48, April 1960, issue of proceedings of the I.R.E.

*6 Page 1654 "Depth of Penetration as a Measure of ~~Feflectivity~~ Reflectivity of ~~This~~ thin Conductive Film" by F.T. Koide, Vol. 48, September 1960 Procedings of the I.R.E.