Devices & Services Co.

D & S TECHNICAL NOTE 81-1

USE OF EMISSOMETER FOR SEMI-TRANSPARENT MATERIALS MEASUREMENTS

The use of the Emissometer for measurements on flat opaque solids is described in the operating instructions and Technical Notes 79-17 and 78-2. For these materials the sample is placed in thermal contact with a heat sink, to maintain a constant temperature, and the emissometer output is compared to the output on a standard sample.

For semitransparent film materials this method is not applicable since the emissivity reading will be changed by the nature of the material behind the sample. Since both the emissivity and transmissivity are unknown, a special measurement is required to determine the thermal properties of the material. This consists of making two measurements of the film, using two different materials, one high emissivity and one low, backing the sample. The emissivity is measured in the usual manner but the reading produced is an apparent emissivity for the two materials combined. It is required that the two materials be at the same temperature, the backing and the film need to be in good thermal contact, however no heat transfer compound can be used since this would change the properties of the backing sample. In most cases if the film is thin and lays flat on the sample, conduction through the small air gap will be sufficient to keep the film from being heated by the emissometer. Better thermal contact can be achieved by pulling a partial vacuum between the backing sample and the film sample.

The apparent emissivity of the film backing combination is as follows:

$$Ea = Es + Ts*[\ 1 - Ts*(1-Eb)/(1-(1-Es-Ts)*(1-Eb))\ ]$$

where,

E = emissivity
T = transmissivity
Ea = apparent emissivity
s - denotes a sample property
b - denotes a backing property

The derivation of the relationship given above is similar to that found in Technical Note 78-3 for a solar collector cover-absorber combination. If the apparent emissivity of the film is measured with two different backing emissivities, two independent equations result. From these equations you can solve for the sample transmissivity and emissivity. If you use the standard samples provided with the Emissometer, for the backing materials, the equation can be approximated as follows:

For a high emissivity backing material, E>0.9,

$$Ea = Es + Ts*(1 - Ts*(1-Eb)),$$

For Eb = 0.93,

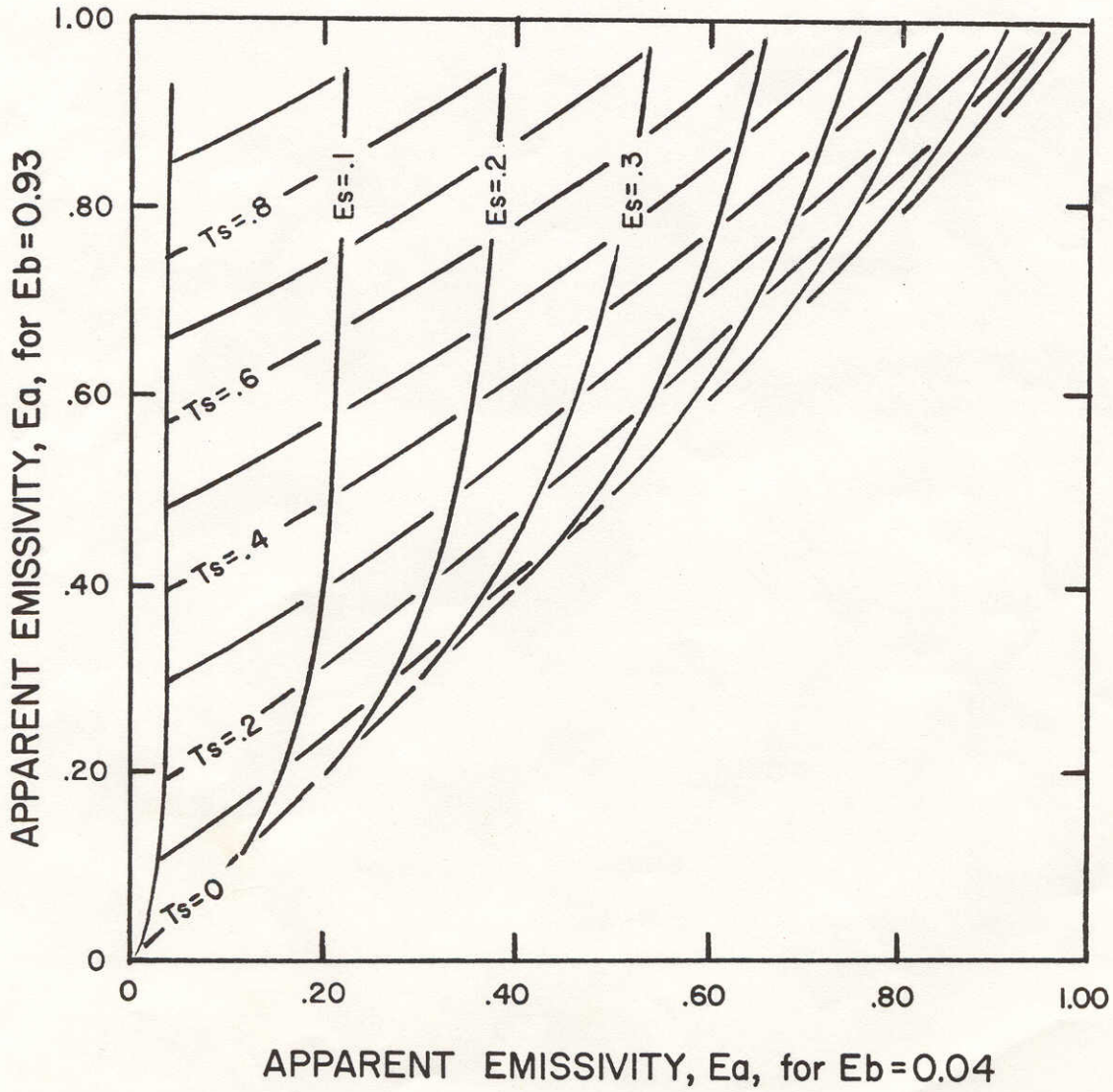
Ea = Es + Ts - 0.07*Ts**2

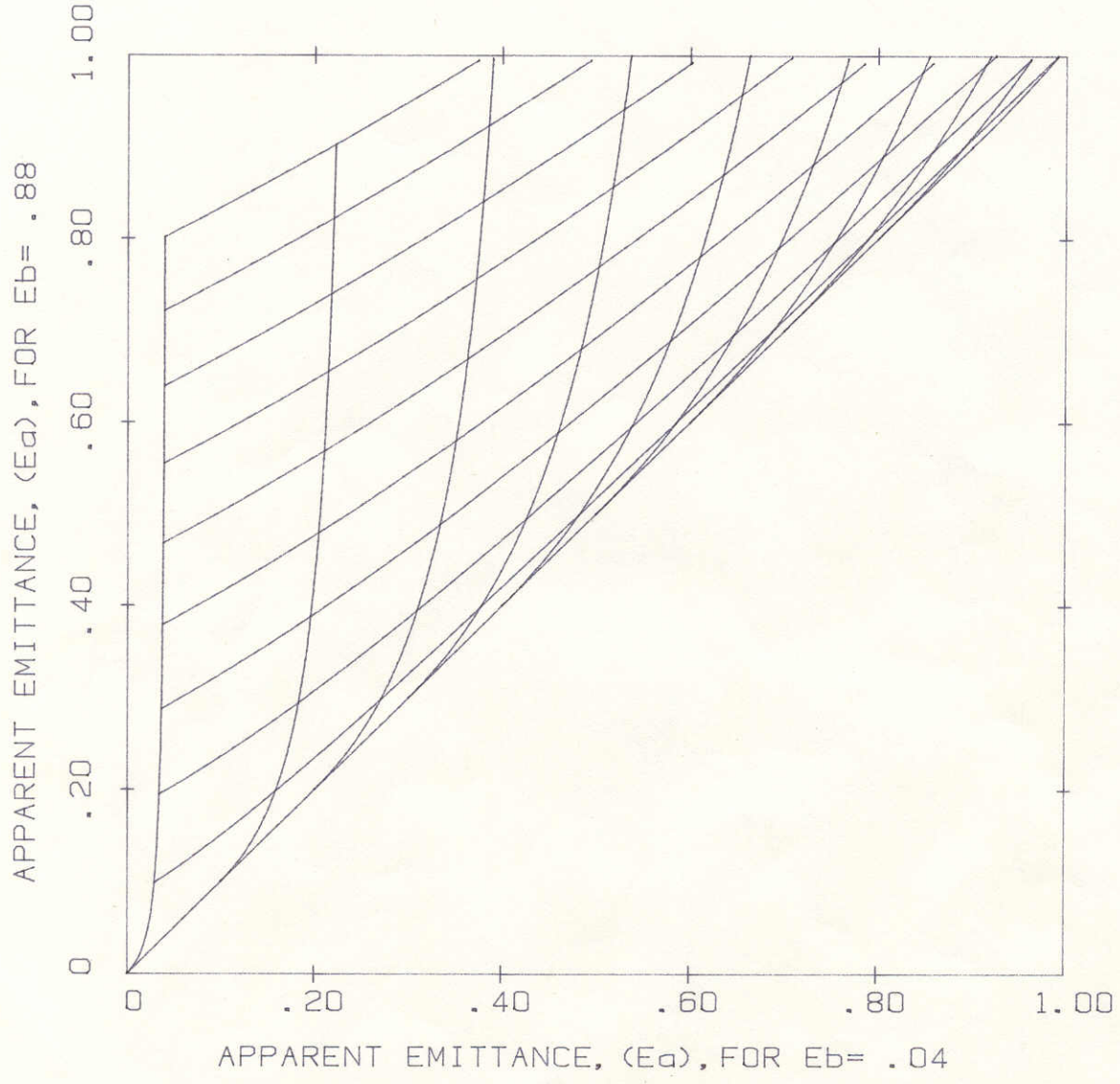
For the low emissivity backing, E<0.10,

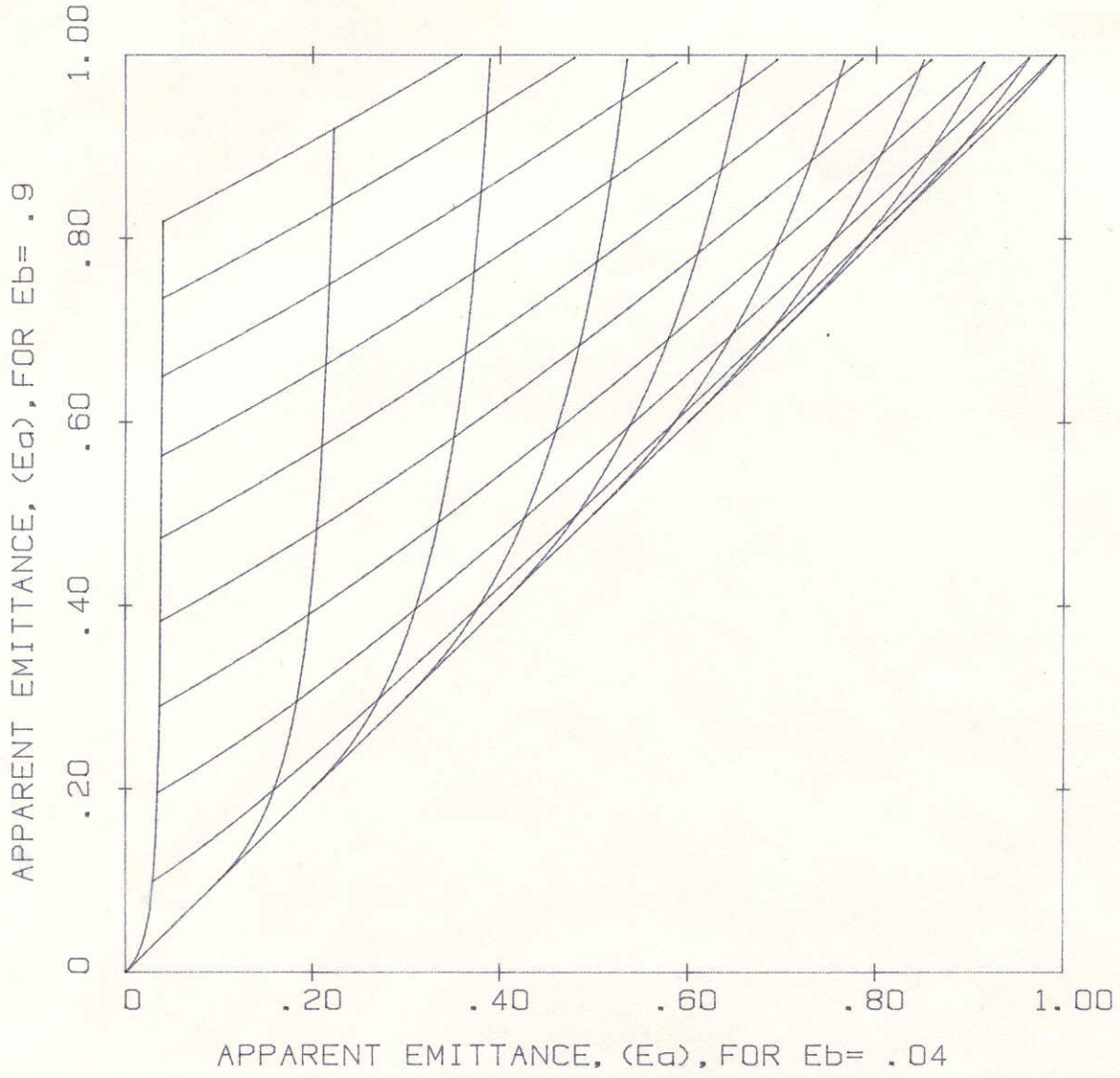
Ea = Es + Ts*Es/(Es+Ts)

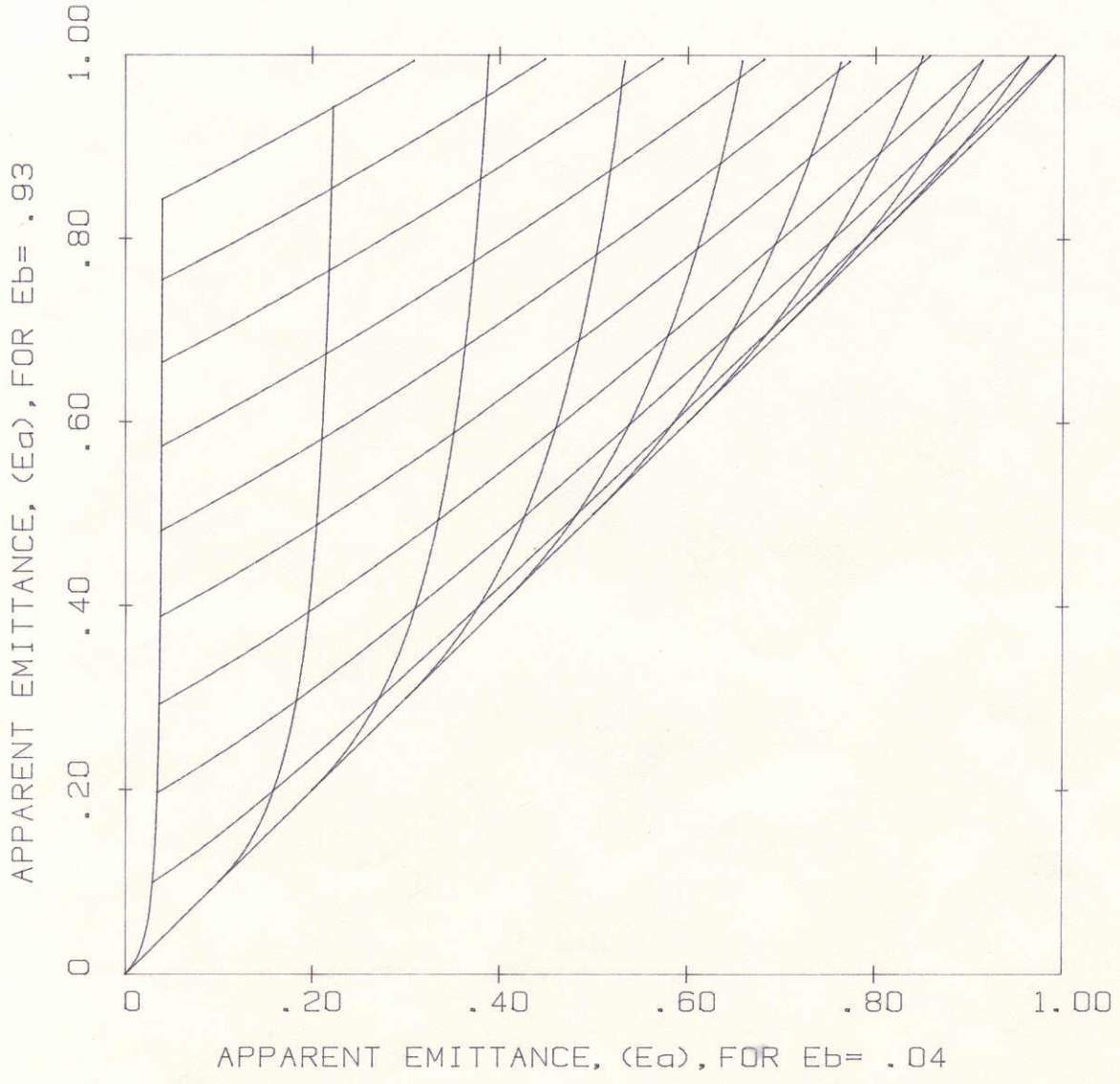
Using either the simplified or the original equation the solution is best found by trial and error. For the special case where the two backing emissivities are E = 0.04, and E = 0.93, the figure shown below can be used to determine the film properties.

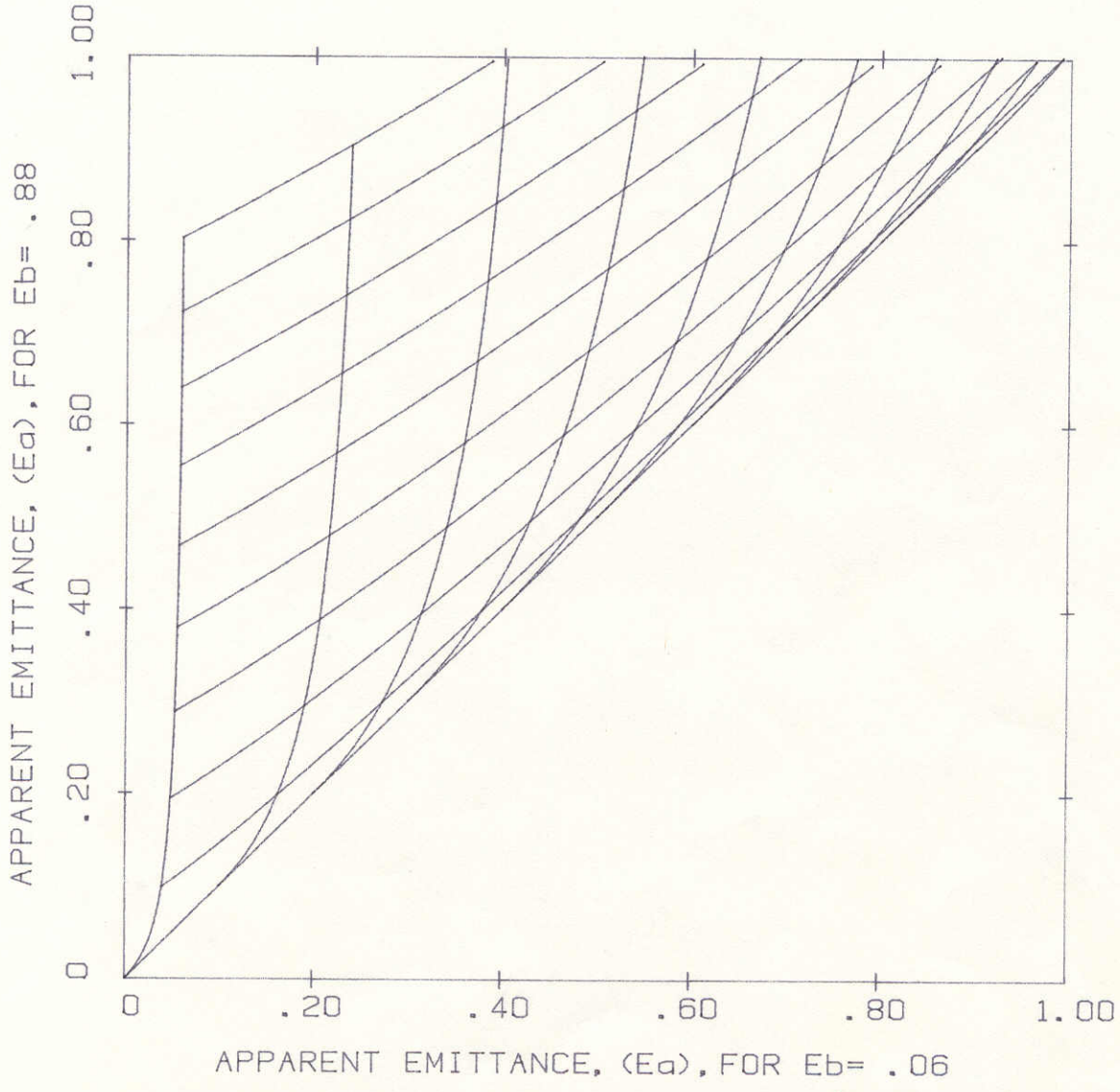
*NOTE: Plots for several combinations of background emissivities have been added at the end of this Tech Note. (1-31-85)

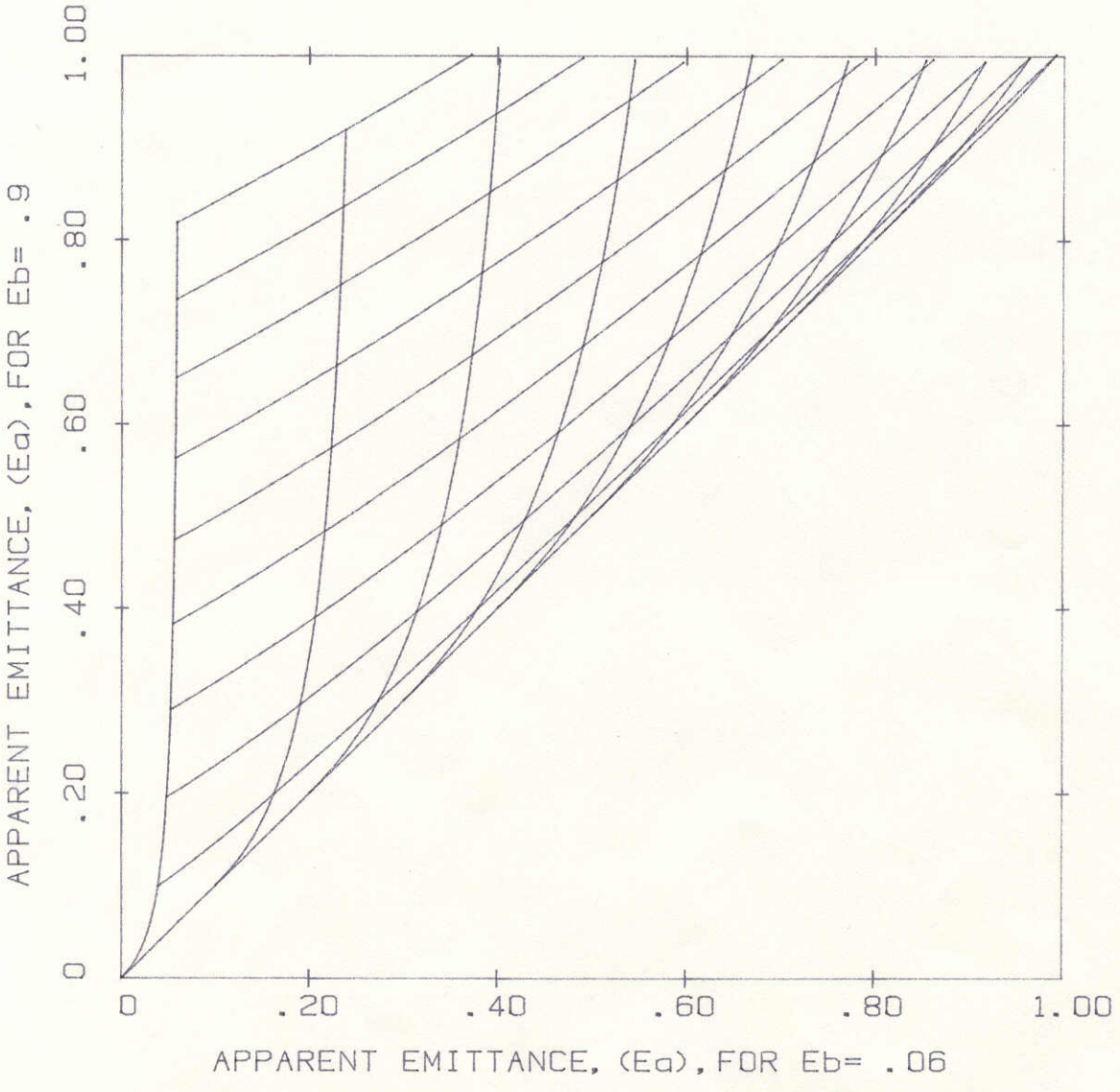


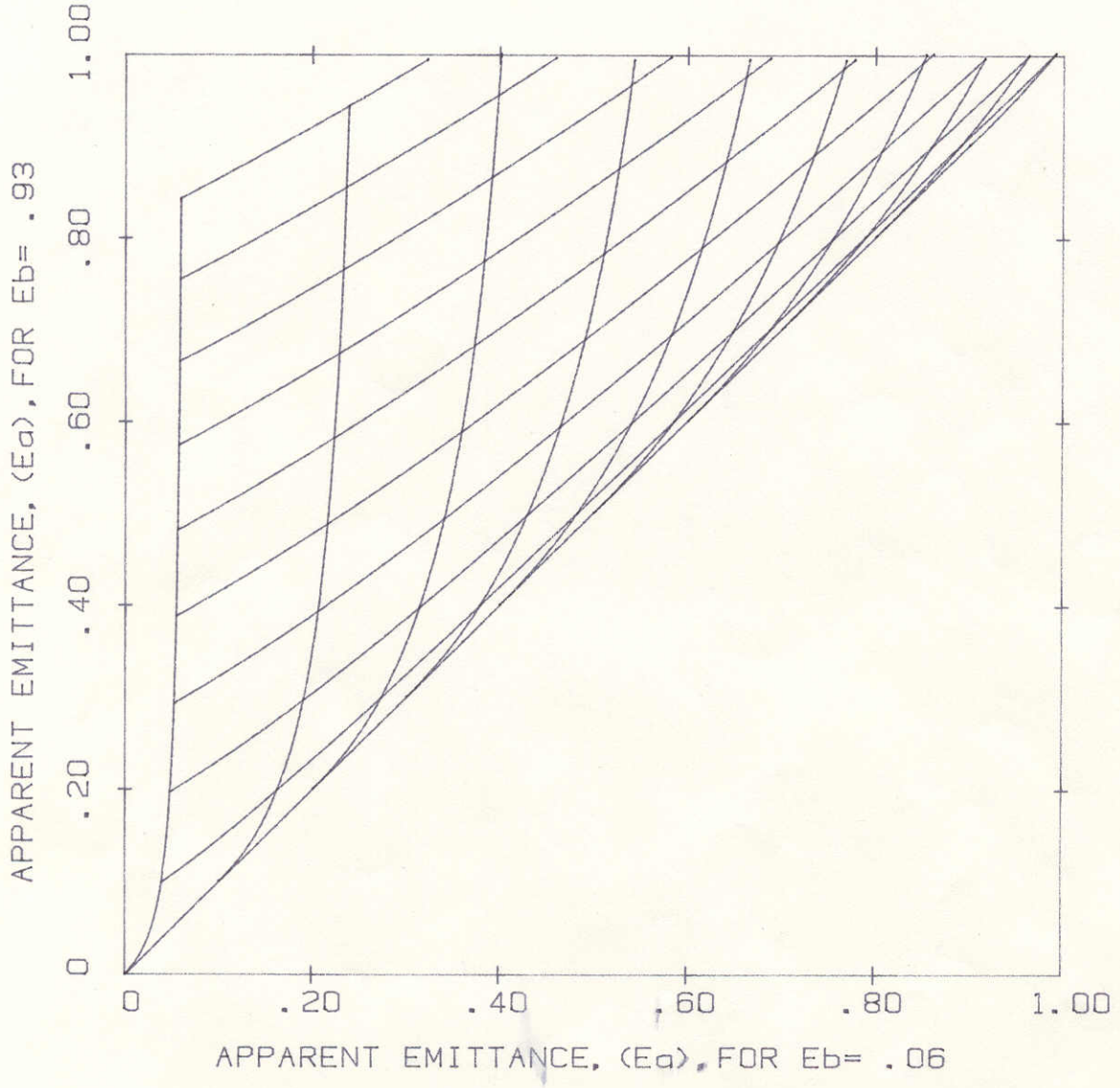

APPARENT EMITTANCE, (Ea), FOR Eb= .88
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .04

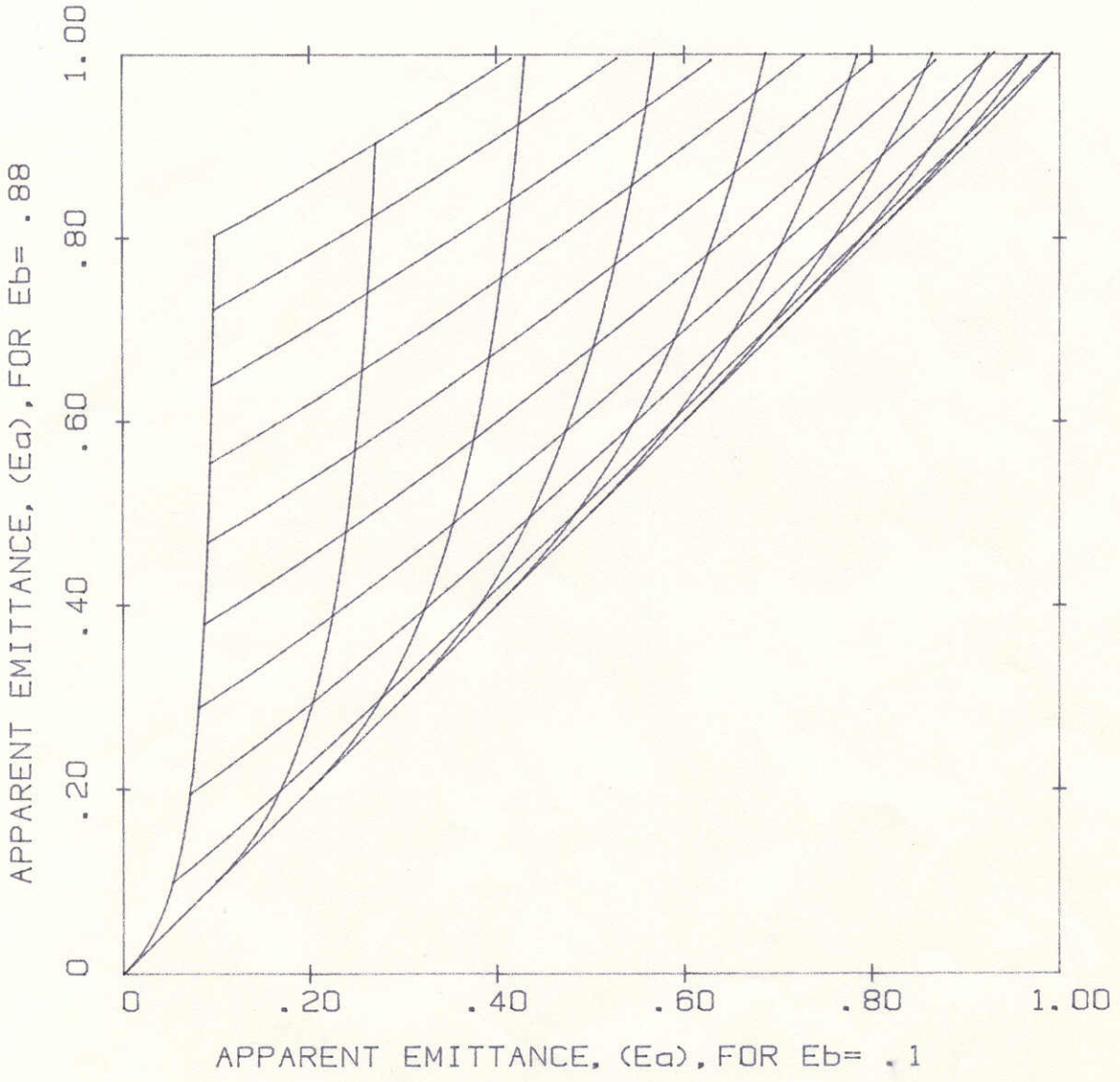

APPARENT EMITTANCE, (Ea), FOR Eb= .9
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .04

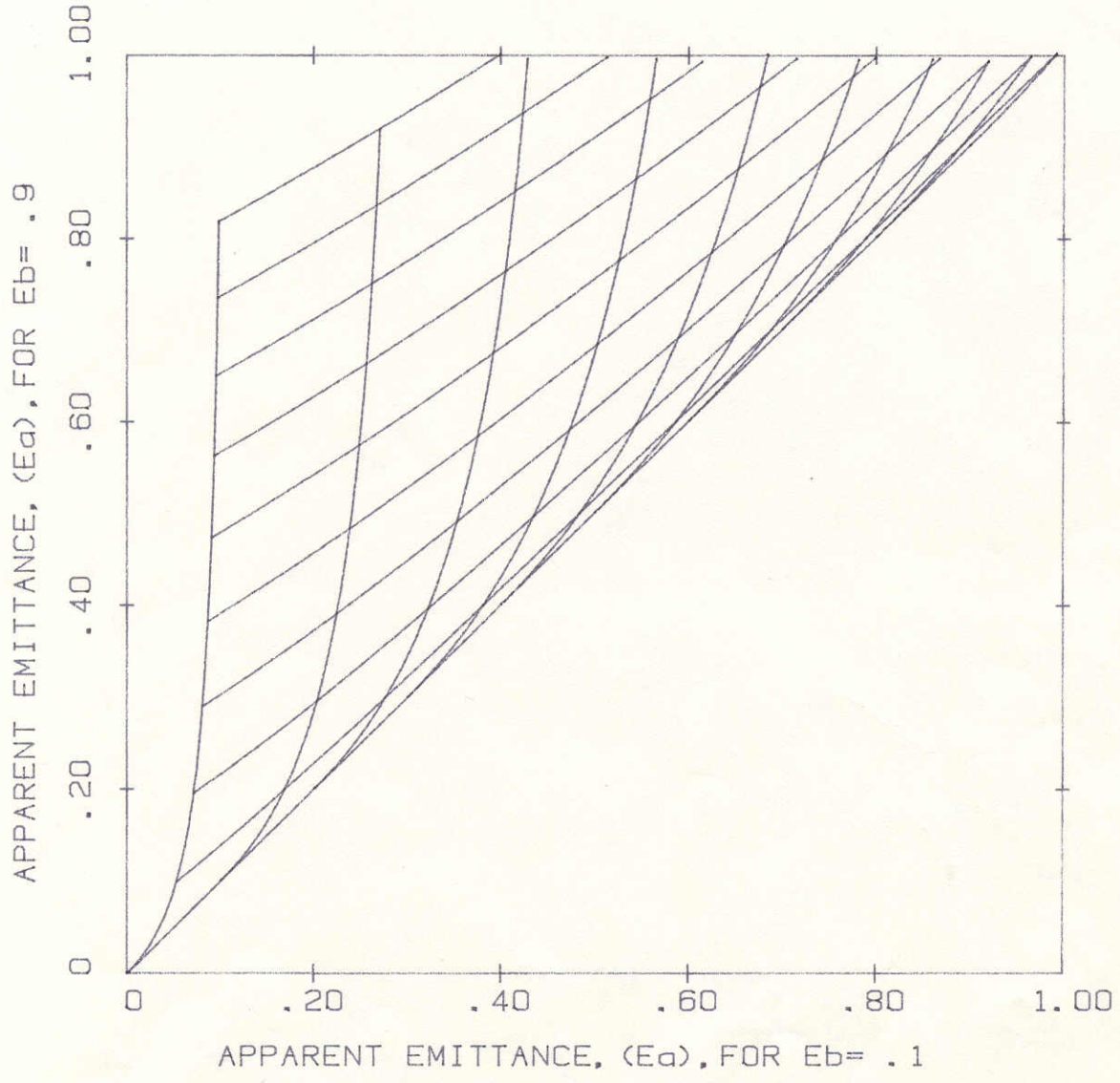

APPARENT EMITTANCE, (Ea), FOR Eb= .93
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .04

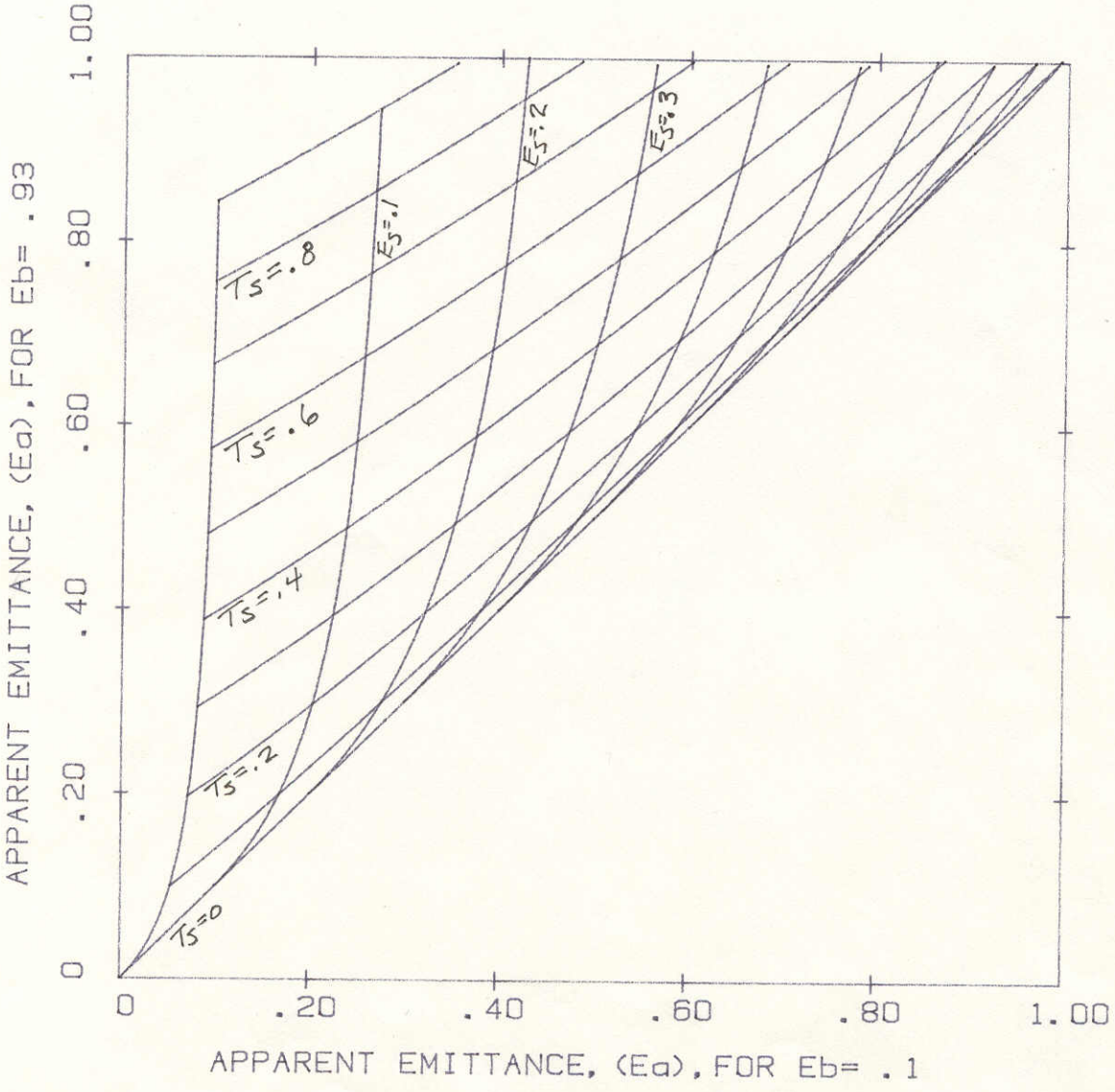

APPARENT EMITTANCE, (Ea), FOR Eb= .88
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .06


APPARENT EMITTANCE, (Ea), FOR Eb= .9
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .06


APPARENT EMITTANCE, (Ea), FOR Eb= .93
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .06


APPARENT EMITTANCE, (Ea), FOR Eb= .88
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .1


APPARENT EMITTANCE, (Ea), FOR Eb= .9
0
.20
.40
.60
.80
1.00
0
.20
.40
.60
.80
1.00
APPARENT EMITTANCE, (Ea), FOR Eb= .1


APPARENT EMITTANCE, (Ea), FOR Eb= .93
APPARENT EMITTANCE, (Ea), FOR Eb= .1
0
.20
.40
.60
.80
1.00
Ts=.8
Ts=.6
Ts=.4
Ts=.2
Ts=0
Es=.1
Es=.2
Es=.3