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Thermal Modeling of Underground Radio Wave Guides

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5 Minutes / 5 Slides
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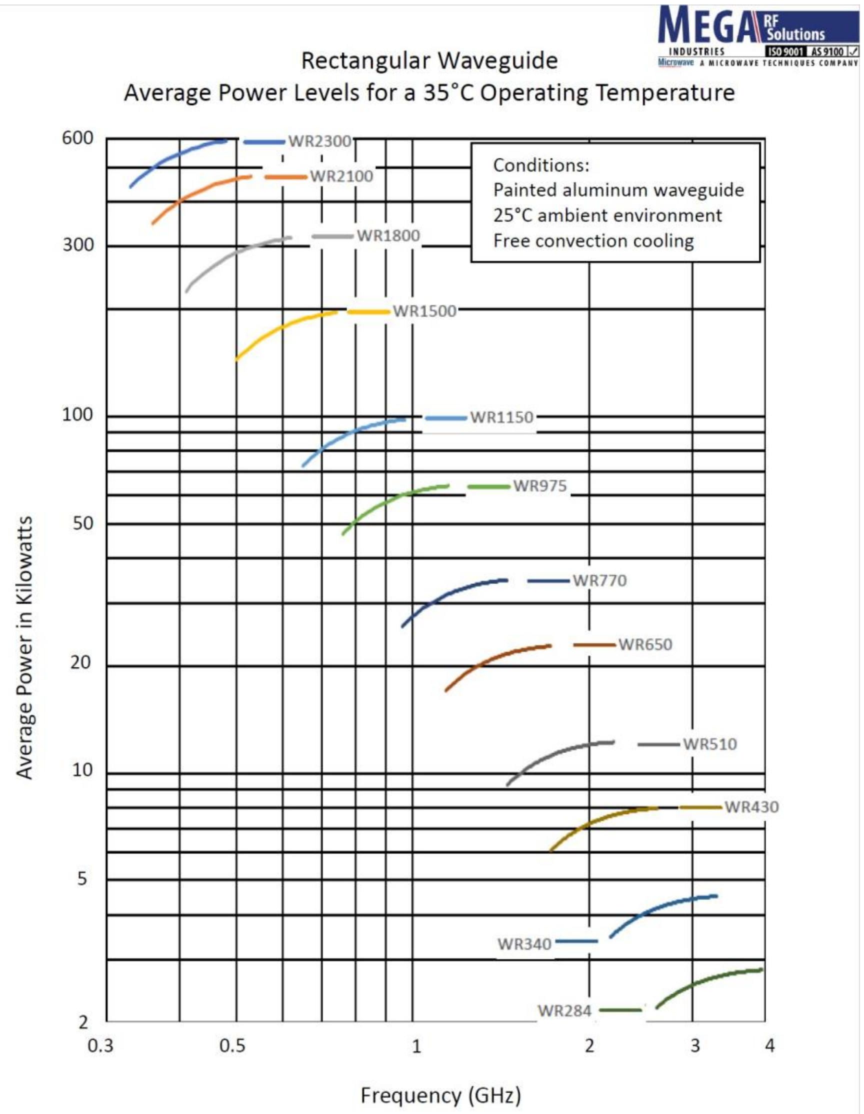
The Problem

- PIP-II will utilize resonators controlled by radio signals.
- These signals must be guided from power amplifiers to the resonators, including some travel underground.
- The wave guides to be used are not designed for this operating condition.



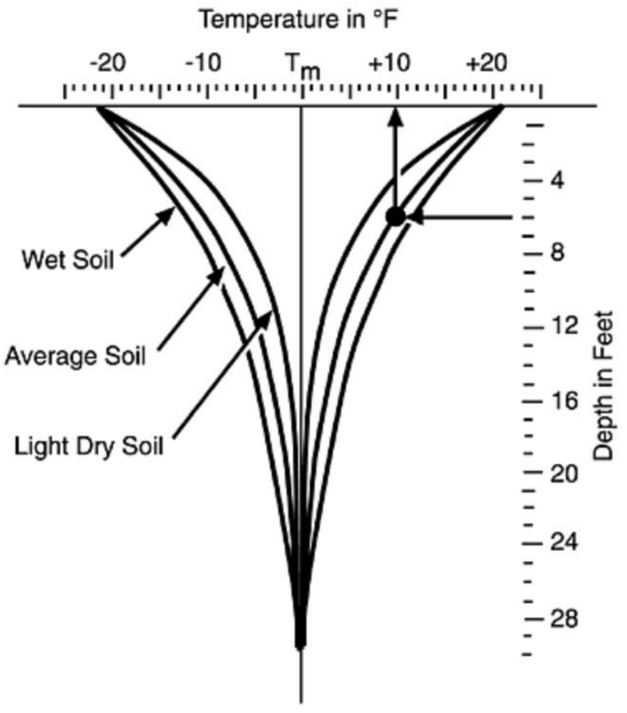
Background and Equations

- Conduction will be the primary mechanism for the dissipation of thermal energy, which can be described thusly:

$$\dot{q} = -k\frac{dT}{dx}$$

  where $\dot{q}$ is heat flux, k is thermal conductivity, and $\frac{dT}{dx}$ is the temperature gradient.

- For the first approximation, we will assume the surrounding soil starts at a constant temperature (valid at depths >30 ft).



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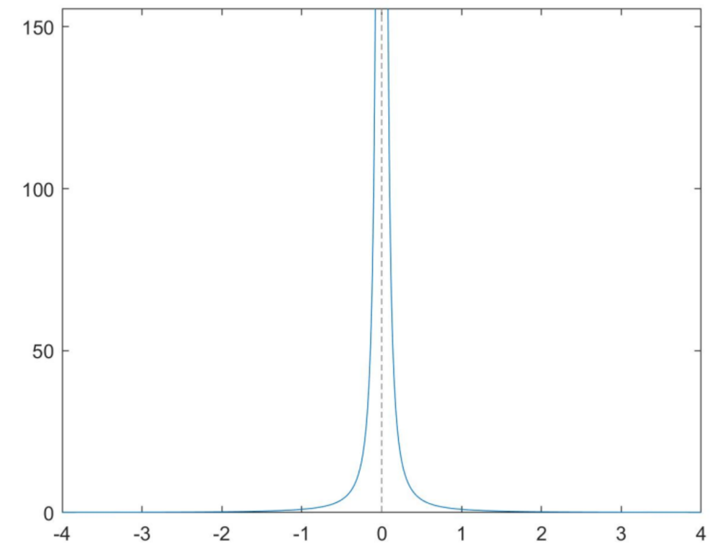
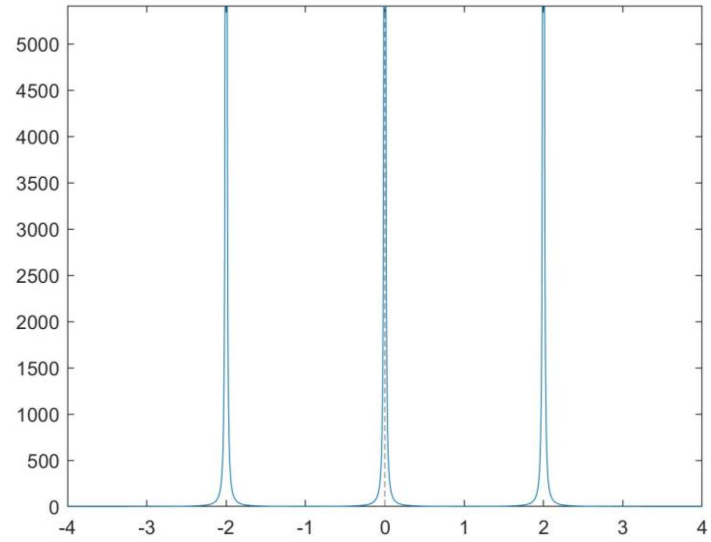
Modeling Procedure

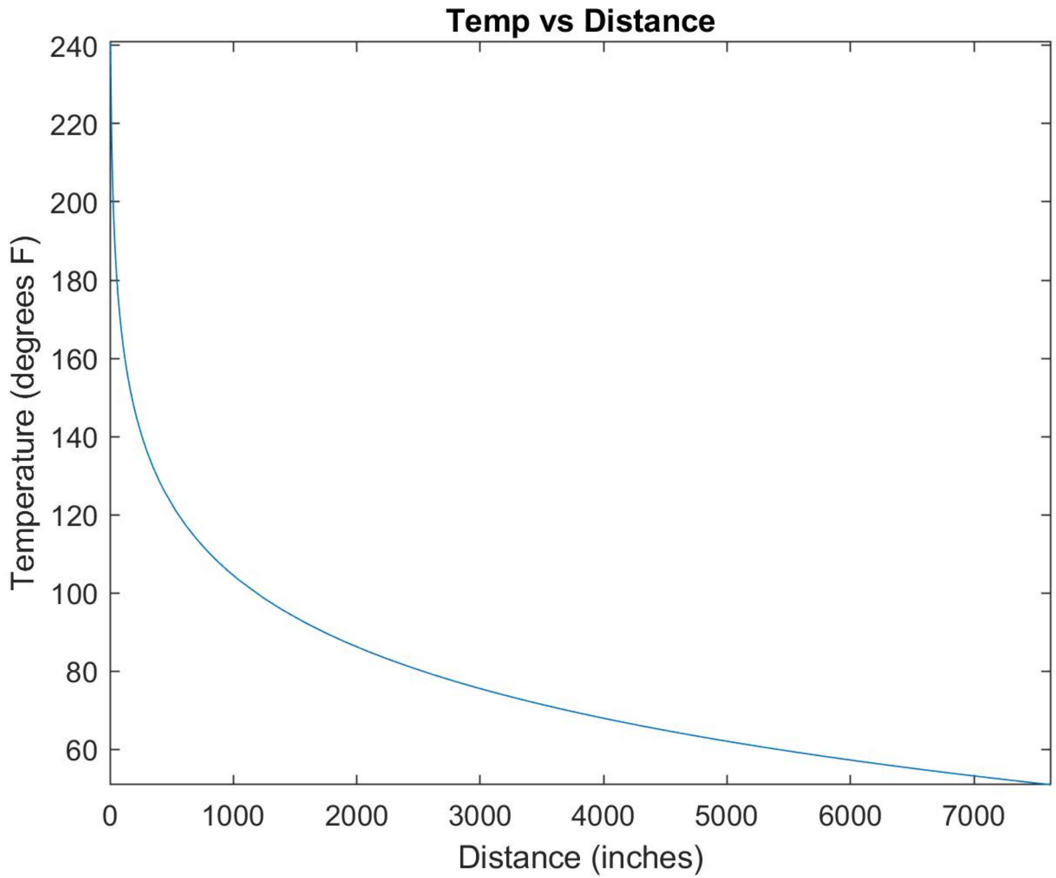
- Develop a linear conduction model of the soil around one wave guide.
- Superimpose multiple models to determine how the overall system will behave.
- Take the maximum soil temperature and work backwards to find the max inside temperature of a wave guide.





How It Started

- Max soil temp: 241 F



How It's Going

- Max soil temp: 2,500 F