Point defense modeling

This is incredibly important, as nearly every ship is going to have some sort of point defense.

Point defense works against kinetic weapons. To understand how point defense works, we need to view it as a "ship" of its own.
For overall k value, point defense counts as an increase to the opposing ship's kill threshold.
Point defense has qualities such as:

a) Hit probability:

For point defense, hit probability is calculated similarly to ship's hit probability. In this case, the target is the kinetic impactor, be it a slug or a guided warhead.

The volume in which point defense can operate is:

$$V_{PD} = \frac{1}{3} \times \pi (R \times \tan \alpha)^2 \times R$$

Against a kinetic slug, the formula for hit probability is the same as for kinetic or energy weapons, as in:

$$P_{kPD} = \min(1, \frac{4cv^4}{\pi a^2 D^4})$$

For kinetic point defense, and:

$$P_{ePD} = \min(1, \frac{Cc^4}{4\pi a^2 D^4})$$

For energy point defense (lasers, particle beams).

Against missiles, we again incorporate the volume overlap, where the hit probability for kinetic point defense is:

$$P_{hitPD} = \min(1, \frac{V_{PDoverlap}}{V_{MRelative\_maneuver}} \times \frac{4cv^4}{\pi a^2 D^4})$$

And for energy point defense:

$$P_{hitPD} = \min\left(1, \frac{V_{PDoverlap}}{V_{MRelative\_maneuver}} \times \frac{Cc^4}{4\pi a^2 D^4}\right)$$

We may incorporate team dynamics. The total volume of multiple point defense modules on a ship/ships is equal to:

$$V_{teamPD} = \bigcup_{i=1}^{n} V_{PD}$$

This will come again in damage per shot calculations. Against missiles, we can surmise that:

$$V_{PDcoverage} = V_{teamPD} \cap V_{Mmaneuver}$$

The probability of the missile being hit is:

$$P_{geometric,teamPD} = \frac{V_{PDcoverage}}{V_{Mmaneuver}}$$

Point defense penetration percentage chance is calculated by:

$$P_{penetrate} = 100(1 - P_{geometric,teamPD})$$

b) Fire rate

This just depends on the weapon design itself.

c) Damage per shot:

This is similar to cycle based attrition against ships. You can concentrate point defense on target similarly to how you would do with ships. If the point defense module isn't fired at, then we simply need $N = \frac{E_{kt}}{d_{PD}}$ modules (divide enemy projectile kill threshold by the damage caused by point defense).

But, we have to take into consideration the worst case scenarios. First, we need to know the worst case scenario, where the enemy tries to saturate out point defense. Based on the fire rate of the enemy fleet and the kill threshold of the projectiles, we can build the minimum amount of point defense modules that will be required to survive.

$$N_{PD} = \frac{d_{PD}}{A_p \times E_{pkt}}$$

Where:

N_{PD}: number of PD modules
$d_{PD:}$ damage per PD module
A_p: amount of projectiles
E_{pkt}: projectile kill threshold (take the maximum value)

d) Kill threshold

Similar to ship's kill threshold. Simply think of it as "If the point defense module gets hit, it will fail". However, for point defense, we also need to incorporate jamming.

The energy required to "kill" a point defense module is:

$$E_{PD} = t_{PD} a_{PD}$$

Which is basically the amount of damage that the point defense module can sustain until it fails.

However, if the PD module is kinetic based, it has the possibility of jamming, especially at higher fire rates.