

**PDC2025**  
**Stellenbosch, Cape Town, South Africa**

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- Hypothetical Asteroid Threat Exercise
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**Using the NEO Size-Frequency Distribution in Probabilistic Assessments**

**Andrew S. Rivkin<sup>(1)</sup> and Nancy L. Chabot<sup>(1)</sup>**

<sup>(1)</sup>*Johns Hopkins Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD, 20723, USA*

The destructive power of an NEO impact is closely tied to its mass. Especially in the period prior to or in the absence of a reconnaissance mission, an impactor mass must be determined using an estimated size, and it is this estimated size that is reported in official IAWN notifications and used by the international community to plan subsequent actions.

Currently, asteroid size estimates reported in IAWN notifications do not include consideration of the size-frequency distribution of the NEO population. However, it is well established that the number of NEOs exponentially increases with decreasing size, and accordingly that smaller impactors are more frequent than larger ones.

The PDC 2025 Hypothetical Asteroid Impact Scenario provides a useful case to illustrate the importance of including the NEO population size frequency distribution when considering the risk from a possible impact. The IAWN notification and Impact Risk Assessment Dashboard for the PDC 2025 hypothetical exercise gives:

- most likely 90-160 m diameter
- median of 126 m
- 5% of 75 m; 95% of 194 m

The reported probability distribution of diameters is consistent with a diameter measurement of roughly  $126 \pm 35$  m (1 sigma), which would predict that a potential impactor with a diameter of  $\sim 90$  m is about as likely as one of  $\sim 160$  m diameter. Similarly, the estimate predicts that a potential impactor of 75 m is as likely as one of 194 m.

However, NEO size-frequency distribution models (Nesvorny et al. 2024, Harris and Chodas 2021) show that there are roughly 4 times as many NEOs between 90-100 m as between 160-170 m, and 12 times more NEOs of 75-m diameter as at 194 m. A simple convolution of the NEO size-frequency distribution and a Gaussian probability distribution for a diameter measurement of  $126 \pm 35$  m (1 sigma) yields the following size estimate:

- most likely roughly 60-125 m diameter
- median diameter of  $\sim 90$  m
- 5% of  $\sim 50$  m; 95% of  $\sim 155$  m

We note that the difference in volume between a 90-m and a 126-m object would lead to a roughly factor of 2 difference in mass, and that considering size-frequency-weighted probability distributions would likely lead to a lowered risk estimate. An analogous exercise can be done using H-magnitude size-frequency distribution, which would show similar results. We advocate for including the size-frequency distribution convolution in future size estimations provided in IAWN notifications, at least as an augmentation to the current size estimate information provided, to provide a fuller context for risk assessment.

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**Comments:**

*This could also potentially go into a different category. But we're planning to use the current exercise as the example.*