Probabilistic Asteroid Impact Risk Assessment for the Hypothetical PDC17 Impact Exercise

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Planetary Defense Conference
May 15-19, 2017 – Tokyo, Japan
Impact Risk Assessment Summary

  • Impact scenarios and trajectories are developed and provided by NASA’s Near Earth Objects Office at JPL (Paul Chodas).
  • These results represent purely *hypothetical* impact scenarios, and do *not* reflect any known asteroid threat.

• Risk assessment was performed using the Probabilistic Asteroid Impact Risk (PAIR) model developed by the Asteroid Threat Assessment Project (ATAP) at NASA Ames Research Center.

• This presentation includes sample results that may be presented or used in discussions during the various stages of the impact exercise
  • Some cases represent alternate scenario options that may not be used during the actual impact exercise at the PDC17 conference.
  • Updates to these initial assessments and/or additional scenario assessments may be performed throughout the impact exercise as different scenario options unfold.
INJECT 1 (S05): MAY 15, 2017
Swath Trajectory Parameters
Asteroid Parameter Distributions

Class & Structure Distribution

- **Cc** (2%)
- **Cf** (6%)
- **Cr** (31%)
- **Sc** (13%)
- **Sf** (10%)
- **Sr** (39%)
Blast Damage Zones

- 1-2 psi
- 2-4 psi
- 4-10 psi
- 10+ psi
Mean Affected Population
Mean Affected Population
Damage Ranges (min/mean/max)

Damage Ranges Along Swath
PDC17 5/15/2017

Affected Population vs Mean Burst Longitude
Damage Level Probabilities

Total Impact Damage Risk
PDC17 5/15/2017, 1% Impact Probability

- Probability
- Affected Population

- $10^0$
- $10^{-2}$
- $10^{-4}$
- $10^{-6}$
- $10^0$ to $10^8$
Damage Exceedance Risk

- Probability of an impact causing at least a given damage level or greater.
- Complementary cumulative distribution function (CCDF)

Damage Exceedance Probabilities
PDC17 5/15/2017

Conditional Damage Exceedance Probabilities
PDC17 5/15/2017

Damage Exceedance Probabilities
PDC17 5/15/2017, 1% Impact Probability
INJECT 2 S20: NOV 30, 2018
Swath Trajectory Parameters
Asteroid Parameter Distributions (1k realizations)
Blast Damage Zones
Mean Affected Population
Damage Ranges (min/mean/max)
Damage Level Probabilities

Total Impact Damage Risk
PDC17 11/30/2018, 96% Impact Probability

Damage Exceedance Probabilities
PDC17 11/30/2018

- Conditional
- Total (96% impact prob.)
INJECT 3 S08: MAY 20, 2020
Blast Damage Zones

- 1-2 psi
- 2-4 psi
- 4-10 psi
- 10+ psi
Mean Affected Population

Sources: Esri, HERE, DeLorme, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, TomTom, © OpenStreetMap, GiS User Comm.
Tiles Courtesy of Esri ArcGIS Online
Map: World Street Map
Damage Ranges (min/mean/max)

Damage Ranges Along Swath
PDC17 5/20/2020

Mean Burst Longitude

Affected Population

Damage Ranges (min/mean/max)
Damage Level Probabilities

Total Impact Damage Risk
PDC17 5/20/2020, 100% Impact Probability

Damage Exceedance Probabilities
PDC17 5/20/2020
Swath Trajectory Parameters

![Swath Trajectory Parameters](image)

**Velocity Distribution, Inject 3 (s10)**

- Probability
  - 0.1 to 0.7
  - Velocity (km/s)
  - 16.94 to 16.9435

**Entry Angle Distribution, Inject 3 (s10)**

- Probability
  - 0.05 to 0.45
  - Angle (deg)
  - 30.2 to 30.7
Asteroid Parameter Distributions

- Diameter Distribution, Inject 3 (s10)
- Density Distribution, Inject 3 (s10)
- Impact Energy Distribution, Inject 3 (s10)
Blast Damage Zones

1-2 psi
2-4 psi
4-10 psi
10+ psi
Mean Affected Population
Mean Affected Population

Mean Damage Along Swath
PDC17 5/20/2020

Mean Burst Latitude

Mean Burst Longitude

×10^7

1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
Damage Ranges (min/mean/max)

Damage Ranges Along Swath
PDC17 5/20/2020

[Graph showing affected population against mean burst longitude]
Damage Level Probabilities

Total Impact Damage Risk
PDC17 5/20/2020, 100% Impact Probability

Damage Exceedance Probabilities
PDC17 5/20/2020
Swath Trajectory Parameters
Asteroid Parameter Distributions

Diameter Distribution, Inject 4 (s16w)

Density Distribution, Inject 4 (s16w)

Impact Energy Distribution, Inject 4 (s16w)
Blast Damage Zones

- 1-2 psi
- 2-4 psi
- 4-10 psi
- 10+ psi
Damage Ranges (min/mean/max)
Damage Level Probabilities

Total Impact Damage Risk
PDC17 2/25/2024, 100% Impact Probability

[Histogram showing probability distribution for affected population range from $10^0$ to $10^6$]

Damage Exceedance Probabilities
PDC17 2/25/2024, 100% Impact Probability

[Graph showing exceedance probability range from 1 to 0, plotted against affected population threshold from $10^0$ to $10^7$]
INJECT 4 S16E: FEB 25, 2024
Asteroid Parameter Distributions

Diameter Distribution, Inject 4 (s16e)

Density Distribution, Inject 4 (s16e)

Impact Energy Distribution, Inject 4 (s16e)
Blast Damage Zones

- 1-2 psi
- 2-4 psi
- 4-10 psi
- 10+ psi

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Mean Affected Population
Damage Ranges (min/mean/max)

Damage Ranges Along Swath
PDC17 2/25/2024

Affected Population

Mean Burst Longitude
Damage Level Probabilities

Total Impact Damage Risk
PDC17 2/25/2024, 100% Impact Probability

Damage Exceedance Probabilities
PDC17 2/25/2024
INJECT 4 S16LD: FEB 25, 2024
Swath Trajectory Parameters
Asteroid Parameter Distributions

Diameter Distribution, Inject 4 (s16ld)

Density Distribution, Inject 4 (s16ld)

Impact Energy Distribution, Inject 4 (s16ld)
Blast Damage Zones

1-2 psi
2-4 psi
4-10 psi
10+ psi
Damage Ranges (min/mean/max)
Damage Level Probabilities

Total Impact Damage Risk
PDC17 2/25/2024, 100% Impact Probability

Damage Exceedance Probabilities
PDC17 2/25/2024