



# Project Nu Sun: Nuclear Survivability of Naval Vessels



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## Problem And Goal

There are limited means to analyze the combat power of naval ships in a battlefield where nuclear weapons are used. The goal is to develop a program that can accurately determine the Combat Effectiveness after a nuclear detonation.

### Inputs

- Yield (kT)
- Source type
- Range over ground (m)
- Height of airburst (m)
- Ship type (Carrier or destroyer)
- Average hull armor thickness (cm)
- Average inner wall thickness (cm)
- Time after det. (min)

### Outputs

- Ship overpressure (psi)
- Ship thermal flux (cal/cm<sup>2</sup>)
- Total dosage (rem)
- Personnel combat effective, performance degraded, combat ineffective, and deceased from radiation (%)
- Mortality and combat ineffectiveness for personnel from overpressure (%)

## Background

Operations Crossroads detonated a 22.5 KT weapon among ships in 1946. No prediction tool currently exists that can accurately create a measure of survivability or combat effectiveness of a warship.



## Prototyping, Testing & Evaluation

The team made use of existing equations, figures, and tables to create the intermediary section of the program that calculates the effects formed by a nuclear detonation. The primary effects look at were peak overpressure, radiation, and thermal fluence.

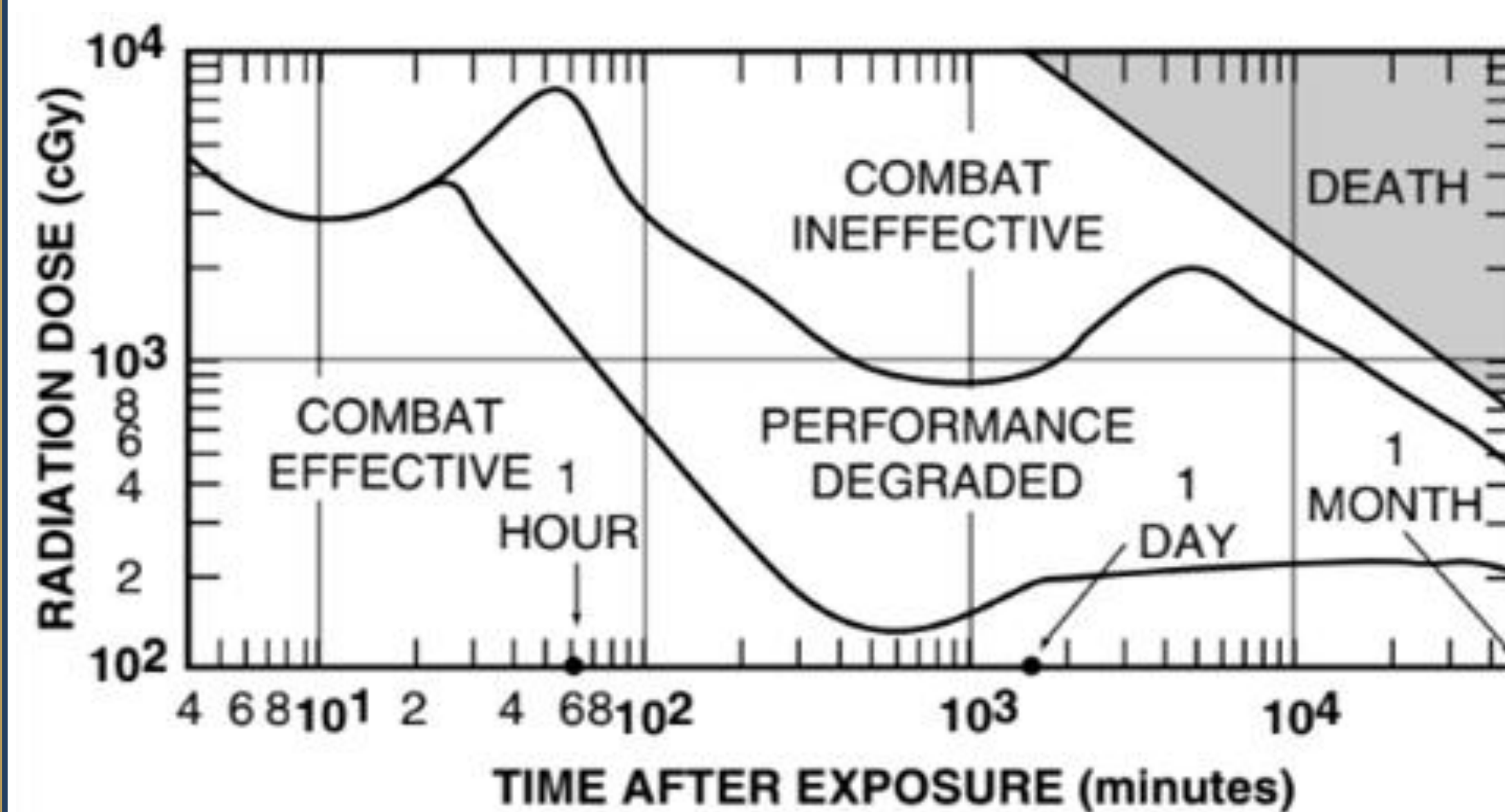


Figure 14.17. Expected Response to Radiation for Physically Demanding Tasks.

The user can input a variety of variables that simulate a unique type of detonation, and receive corresponding qualitative and quantitative data that explains the survivability of a ship and its crew.

MATLAB was used as the primary modeling tool.

## Results

### Comparison of Operation Crossroads Pressure & Damage Data to Code Developed

| Ship:                                     | Code Output:   | Measured Damage from Operation Crossroads:   |
|---|--|--|
| USS GILLIAM (Transport)                   | 804 psi, Structural failure and flooding. Ship sunk.   | “Ship sank immediately enveloped in flames.”   |
| USS INDEPENDENCE (Light Aircraft Carrier) | 20 psi, Carrier combat ineffective and requires significant repairs in port. Flight operations halted due to heavy damage to flight deck, superstructure, and loss of most radar systems. Aircraft topside blown away. | “Island superstructure destroyed and carried away. 25 aircraft carried off the flight deck. Flight deck seriously warped.” |

### Comparison of Operation Crossroads Dose Data to Code Developed

|   | 5 minutes             | 1 week                         | 3 weeks                   | 4+ weeks                  |
|---|-----------------------|--------------------------------|---------------------------|---------------------------|
| Code                                    | 100% combat effective | 100% with performance degraded | 100% combat ineffective   | 100% ship dead            |
| Operation Crossroads (USS Pennsylvania) | 0/202 animals dead    | 11/202 total animals dead      | 16/202 total animals dead | 49/202 total animals dead |

## References

- Glasstone, Samuel and Dolan, Phillip J. *The Effects of Nuclear Weapons*. Atomic Energy Commission, Washington, U.S. 1962.
- Northrop, John and Sachs, Donald C. *Effects Manual One (EM-1): Capabilities of Nuclear Weapons*. Defense Nuclear Agency, Alexandria, VA. 1994.

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