ID 143

High-Altitude Electromagnetic Pulse – The Threat to the Electric Power Grid Updated

William A. Radasky

Metatech Corporation
Goleta, California USA
wradasky@aol.com

***Abstract*— A nuclear burst detonated in space over any of the continents in the world would create a high-altitude electromagnetic pulse (HEMP) that could cause the functional collapse of the exposed electrical power grids. As a result, major infrastructures that depend on the power grid such as communications, transportation, financial services, emergency services, energy distribution, food and water could also be disrupted or extremely impaired.**

Keywords-HEMP, Power Grid, Standards, Critical Infrastructures

I. Introduction

The United States Congress formed a Commission in 2002 to examine the impact of nuclear weapon generated electromagnetic pulse (EMP) on the United States. The work performed by the EMP Commission from 2002-2008 was groundbreaking in terms of studying the impact of HEMP on the critical civil infrastructures of the United States and is applicable to critical infrastructures in modern societies.

This paper updates the public information available concerning HEMP and its likely effects on the electronics operating the power grid since 2008 including work performed for the Federal Energy Regulatory Commission (FERC) and the Special Issue on HEMP in the IEEE EMC Transactions. Discussion and references will be provided in the presentation.

II. The HEMP Time Waveform

The high-altitude electromagnetic pulse (HEMP) is defined as a series of electromagnetic waveforms that are generated from a nuclear detonation at altitudes above 30 km and propagate to the Earth's surface.

It is important to understand that HEMP is not described as a single pulse, but rather as a series of waveforms covering times from nanoseconds to hundreds of seconds. After years of research it has been determined that three main waveforms are generated due to different nuclear and atmospheric mechanisms, as defined by the IEC and are shown in Figure 1.

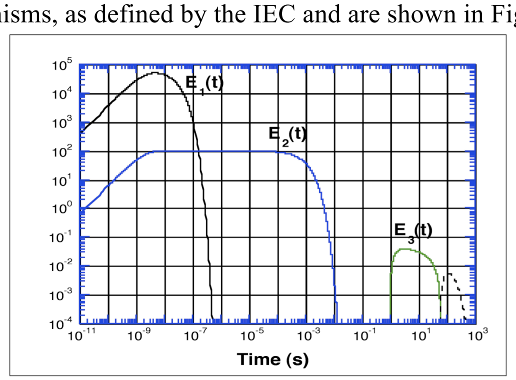

Figure 1. Three portions of the HEMP electric field waveform in volts/meter from IEC 61000-2-9.

The early-time waveform is referred to in Fig. 1 as E1, the intermediate-time waveform is referred to as E2 and the late-time waveform is known as E3.

III. The EMP Commission and the Power Grid

While the EMP Commission examined the impacts of HEMP on all portions of the critical infrastructures, they determined that the power system was the most critical due to its direct support of the other major infrastructures such as communications, transportation, financial services, emergency services, energy distribution, water/food, etc. Their conclusions regarding the power system were:

1) HEMP-induced functional collapse of the electrical power grid risks the continued existence of U.S. civil society.

2) Early-time HEMP (E1) transients are likely to exceed the capabilities of protective safety relays.

3) Late-time HEMP (E3) could induce currents that create significant damage throughout the grid.

4) The national electrical grid is not designed to withstand near simultaneous functional collapse.

5) Procedures do not exist to perform a "black start" after an EMP attack, as restart would depend on telecom and energy transport, which depend on power.

6) Restoration of the national power grid could take months to years.

7) HEMP-induced destruction of power grid components could substantially delay recovery.

The EMP Commission's overall power system conclusion was: "Widespread functional collapse of the electric power system in the area affected by EMP is likely."

While the Commission felt that there were approaches available to deal with many of the problems raised above, it was not clear who should lead the effort to mitigate the threat of HEMP on the power grid.

One option in the opinion of this author is to develop protective methods, operational responses, and restoration approaches for the power system. The best approach to deliver this information to manufacturers and operators would be to develop openly available standards that deal with the problem. Fortunately much of this work has been underway in the IEC for more than 20 years. Details of the existing standards will be discussed in the presentation. In addition a substantial list of references will be provided for those interested in pursuing this subject in more detail.