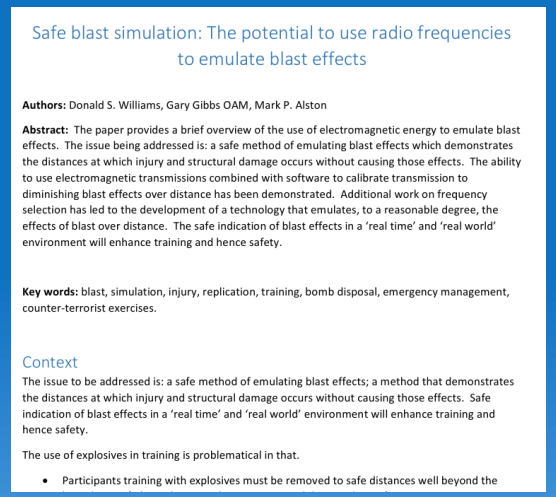
Using RF to Emulate Explosive Effects!



Don Williams
Managing Director

Layer3Services.net.au

Proven – Parari, IExpE, IABTI, others



Safe blast simulation: The potential to use radio frequencies to emulate blast effects

Authors: Donald S. Williams, Gary Gibbs OAM, Mark P. Alston

Abstract: The paper provides a brief overview of the use of electromagnetic energy to emulate blast effects. The issue being addressed is: a safe method of emulating blast effects which demonstrates the distances at which injury and structural damage occurs without causing those effects. The ability to use electromagnetic transmissions combined with software to calibrate transmission to diminishing blast effects over distance has been demonstrated. Additional work on frequency selection has led to the development of a technology that emulates, to a reasonable degree, the effects of blast over distance. The safe indication of blast effects in a 'real time' and 'real world' environment will enhance training and hence safety.

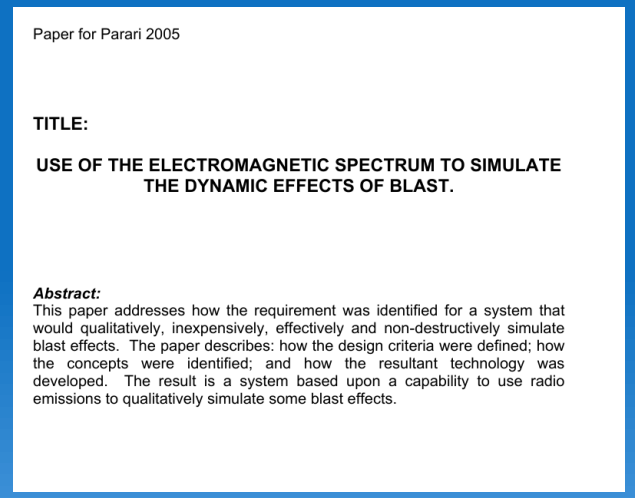
Key words: blast, simulation, injury, replication, training, bomb disposal, emergency management, counter-terrorist exercises.

Context

The issue to be addressed is: a safe method of emulating blast effects; a method that demonstrates the distances at which injury and structural damage occurs without causing those effects. Safe indication of blast effects in a 'real time' and 'real world' environment will enhance training and hence safety.

The use of explosives in training is problematical in that.

- Participants training with explosives must be removed to safe distances well beyond the

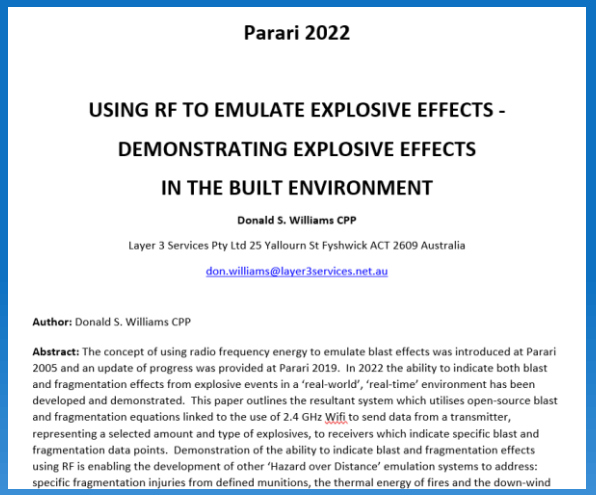


Paper for Parari 2005

TITLE:

USE OF THE ELECTROMAGNETIC SPECTRUM TO SIMULATE THE DYNAMIC EFFECTS OF BLAST.

Abstract:
This paper addresses how the requirement was identified for a system that would qualitatively, inexpensively, effectively and non-destructively simulate blast effects. The paper describes: how the design criteria were defined; how the concepts were identified; and how the resultant technology was developed. The result is a system based upon a capability to use radio emissions to qualitatively simulate some blast effects.



Parari 2022

USING RF TO EMULATE EXPLOSIVE EFFECTS - DEMONSTRATING EXPLOSIVE EFFECTS IN THE BUILT ENVIRONMENT

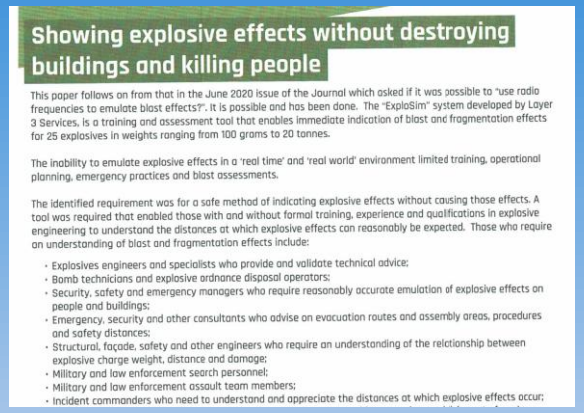
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Author: Donald S. Williams CPP

Abstract: The concept of using radio frequency energy to emulate blast effects was introduced at Parari 2005 and an update of progress was provided at Parari 2019. In 2022 the ability to indicate both blast and fragmentation effects from explosive events in a 'real-world', 'real-time' environment has been developed and demonstrated. This paper outlines the resultant system which utilises open-source blast and fragmentation equations linked to the use of 2.4 GHz Wifi to send data from a transmitter, representing a selected amount and type of explosives, to receivers which indicate specific blast and fragmentation data points. Demonstration of the ability to indicate blast and fragmentation effects using RF is enabling the development of other 'Hazard over Distance' emulation systems to address: specific fragmentation injuries from defined munitions, the thermal energy of fires and the down-wind



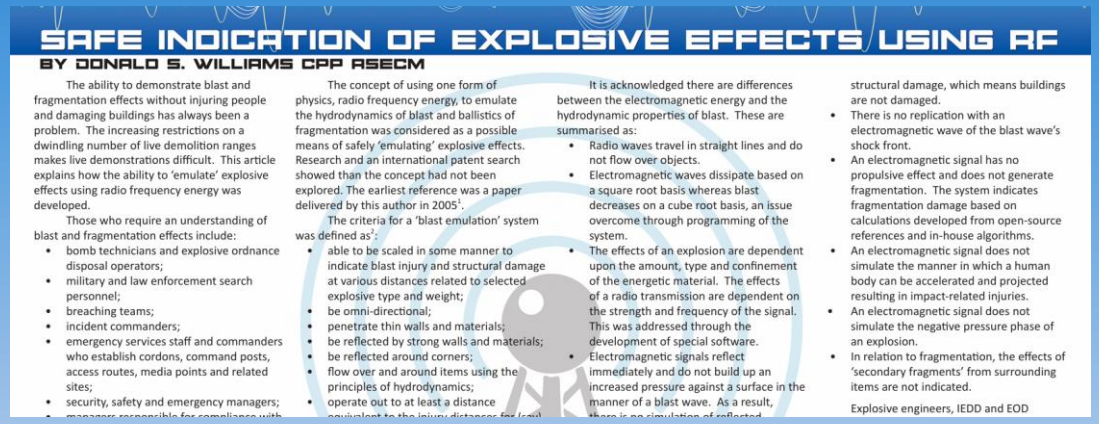
Showing explosive effects without destroying buildings and killing people

This paper follows on from that in the June 2020 issue of the Journal which asked if it was possible to "use radio frequencies to emulate blast effects?". It is possible and has been done. The "ExploSim" system developed by Layer 3 Services, is a training and assessment tool that enables immediate indication of blast and fragmentation effects for 25 explosives in weights ranging from 100 grams to 20 tonnes.

The inability to emulate explosive effects in a 'real time' and 'real world' environment limited training, operational planning, emergency practices and blast assessments.

The identified requirement was for a safe method of indicating explosive effects without causing those effects. A tool was required that enabled those with and without formal training, experience and qualifications in explosive engineering to understand the distances at which explosive effects can reasonably be expected. Those who require an understanding of blast and fragmentation effects include:

- Explosives engineers and specialists who provide and validate technical advice;
- Bomb technicians and explosive ordnance disposal operators;
- Security, safety and emergency managers who require reasonably accurate emulation of explosive effects on people and buildings;
- Emergency, security and other consultants who advise on evacuation routes and assembly areas, procedures and safety distances;
- Structural, façade, safety and other engineers who require an understanding of the relationship between explosive charge weight, distance and damage;
- Military and law enforcement search personnel;
- Military and law enforcement assault team members;
- Incident commanders who need to understand and appreciate the distances at which explosive effects occur;



SAFE INDICATION OF EXPLOSIVE EFFECTS USING RF

BY DONALD S. WILLIAMS CPP RSECM

The ability to demonstrate blast and fragmentation effects without injuring people and damaging buildings has always been a problem. The increasing restrictions on a dwindling number of live demolition ranges makes live demonstrations difficult. This article explains how the ability to 'emulate' explosive effects using radio frequency energy was developed.

Those who require an understanding of blast and fragmentation effects include:

- bomb technicians and explosive ordnance disposal operators;
- military and law enforcement search personnel;
- breaching teams;
- incident commanders;
- emergency services staff and commanders who establish cordons, command posts, access routes, media points and related sites;
- security, safety and emergency managers;

The concept of using one form of physics, radio frequency energy, to emulate the hydrodynamics of blast and ballistics of fragmentation was considered as a possible means of safely 'emulating' explosive effects. Research and an international patent search showed than the concept had not been explored. The earliest reference was a paper delivered by this author in 2005[1].

The criteria for a 'blast emulation' system was defined as[2]:

- able to be scaled in some manner to indicate blast injury and structural damage at various distances related to selected explosive type and weight;
- be omni-directional;
- penetrate thin walls and materials;
- be reflected by strong walls and materials;
- be reflected around corners;
- flow over and around items using the principles of hydrodynamics;
- operate out to at least a distance

It is acknowledged there are differences between the electromagnetic energy and the hydrodynamic properties of blast. These are summarised as:

- Radio waves travel in straight lines and do not flow over objects.
- Electromagnetic waves dissipate based on a square root basis whereas blast decreases on a cube root basis, an issue overcome through programming of the system.
- The effects of an explosion are dependent upon the amount, type and confinement of the energetic material. The effects of a radio transmission are dependent on the strength and frequency of the signal. This was addressed through the development of special software.
- Electromagnetic signals reflect immediately and do not build up an increased pressure against a surface in the manner of a blast wave. As a result,

structural damage, which means buildings are not damaged.

- There is no replication with an electromagnetic wave of the blast wave's shock front.
- An electromagnetic signal has no propulsive effect and does not generate fragmentation. The system indicates fragmentation damage based on calculations developed from open-source references and in-house algorithms.
- An electromagnetic signal does not simulate the manner in which a human body can be accelerated and projected resulting in impact-related injuries.
- An electromagnetic signal does not simulate the negative pressure phase of an explosion.
- In relation to fragmentation, the effects of 'secondary fragments' from surrounding items are not indicated.

Explosive engineers, IEDD and EOD

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Why? How?

- Blast injury not new. 1990's "How close is too close?"
- 1999 concept of using RF?
- 2005 Proof of Concept built.
  - Blast and fragmentation calculations well established – bringing them into the real-world was the challenge.
  - Key was in the RF and computing components.
- 2018 technology caught up.
- 2022 ExploSim + 2026 ExploMeter.
- Others in development.

RF v Hydrodynamics

- Square root v Cube root.
- Reflection ‘Bounce’ off surfaces v build up.
- Wrap around flow v straight line projections.
- Speed - RF make blast look slow.

Key has been modifying the RF to provide the required outputs.

Result = Patented “Hazard over Distance” technology.

“We are not in, nor should we be in,
the modeling market – we provide the missing link
to radically improve blast modelling techniques.”

REAL WORLD BLAST DATA CAPTURE & EMULATION

ExploMeter® + ExploSim®: different applications



ExploMeter®

Measurement - instant blast pressure calculation.

Enhances what a specialist firm uses operationally on a real site.

Takes seconds to capture and calculate blast effects impact at actual sites, speeding up capture of data across multiple vectors. “What would happen if?”

Better quality calculations to feed into any blast model.

Our latest product now in full production.



ExploSim®

Training & demonstration – Emulation blast scenarios from multiple vectors.

Shows calculated blast pressure distances alongside illuminated LEDs — across multiple vectors, building a multi-dimensional picture of risk of damage, standoff and human-exposure. “How close is too close?”

Data can be fed into any existing 3D blast model.

Established product

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ExploMeter - measuring





ExploMeter - measuring

- Fills the gap between ready reckoners and full FEA modelling.
- Real world measurements without the need for an explosion.
- Takes into account reflections and intervening surfaces.
- Up to 99 waypoints, data downloadable in various formats.
- Quick surveys.
- Safety & storage, site protection, stand off distances, liability.
- Inform and validate modelling.



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ExploSim –Training and Testing



- Any type and qty of explosive up to 20 tonnes = storage sites.
- Multiple ‘explosions’ multiple receivers.
- Shows fatality, injury, fragmentation strike and structural damage via LEDs.
- Not limited by range access or fire restrictions.

mTBI and other blast injuries

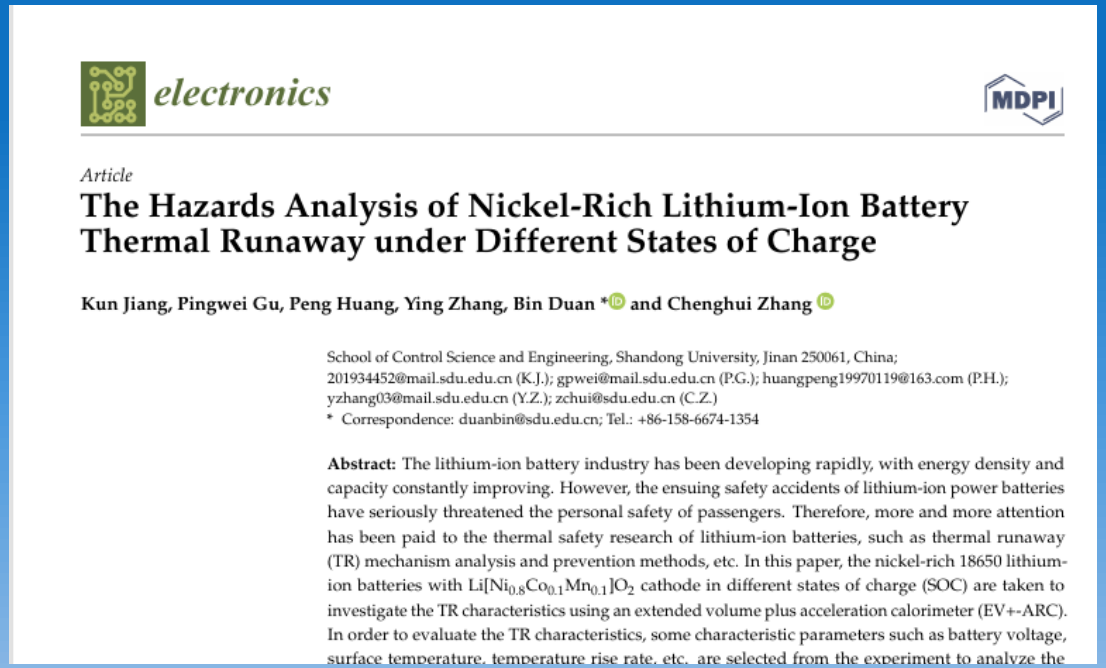
- Original concept = Breachers and EOD.
- Broader = any who use explosives can be taught ‘how close is too close’.
- Train with ExploSim (Orange LED shows > 4psi).
- Test measure with ExploMeter.
- ‘See’ the effects without causing them.
- Train, test, validate.

Uses:


Bomb Awareness
Task Specific Training
Planning
Validation
ExploSim
• Recruits
• Staff
• Contractors
• Bomb incidents
• Threats
• Unattended Items
• Bombs
• Post-Blast
• Safety
• Security
• Emergency response
• First Aid
• Bomb disposal
• EOD
• Rapid appraisal & response
• Search
• Tactical entry
• Emergency medical
• Firefighting
• Forensic
• Command & Control
• Safety
• Security
• Risk management
• Crowded places/Events
• Engineering
• Access controls & Barriers
• Screening
• Emergency management
• Business continuity
• Tactical response
• Operational capability
• Policies and Procedures
• Risk management
• Compliance
• Safety
• Security
• Insurance
• Exercises
• Recreation of incidents

Lithium Battery explosions

- ExploMeter may be able to show the effects of Lithium battery explosions.
- Further research required.



electronics

MDPI

Article

The Hazards Analysis of Nickel-Rich Lithium-Ion Battery Thermal Runaway under Different States of Charge

Kun Jiang, Pingwei Gu, Peng Huang, Ying Zhang, Bin Duan * and Chenghui Zhang

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Abstract: The lithium-ion battery industry has been developing rapidly, with energy density and capacity constantly improving. However, the ensuing safety accidents of lithium-ion power batteries have seriously threatened the personal safety of passengers. Therefore, more and more attention has been paid to the thermal safety research of lithium-ion batteries, such as thermal runaway (TR) mechanism analysis and prevention methods, etc. In this paper, the nickel-rich 18650 lithium-ion batteries with $Li[Ni_{0.8}Co_{0.1}Mn_{0.1}]O_2$ cathode in different states of charge (SOC) are taken to investigate the TR characteristics using an extended volume plus acceleration calorimeter (EV+-ARC). In order to evaluate the TR characteristics, some characteristic parameters such as battery voltage, surface temperature, temperature rise rate, etc. are selected from the experiment to analyze the

Not just blast



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RF is used to emulate explosive effects.

Early adopter options available.





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Collaboration

- Open for early adopters
- Input to R&D & new applications development
- Webinars & paper sharing new advanced methods
- Field results & Case-study development
- Early access to future products
- Investment opportunities
- Work with innovative leaders

Use of RF to Emulate Explosive Effects



Visit our stand for more information.

don.williams@layer3services.net.au

