SHOWING EXPLOSIVE EFFECTS WITHOUT DESTROYING BUILDINGS AND KILLING PEOPLE

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Previous Paper

Journal June 2020 - Possibility of Using Radio frequency to Emulate Blast Effects?

It is possible and has been done.

Why? Problem

Need real-world, real-time indication of the effects of an explosion.

Blast not well understood, difficult to demonstrate in a safe manner.

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CURRENT METHODS

Modelling

Blast Safety tables

Rule of thumb

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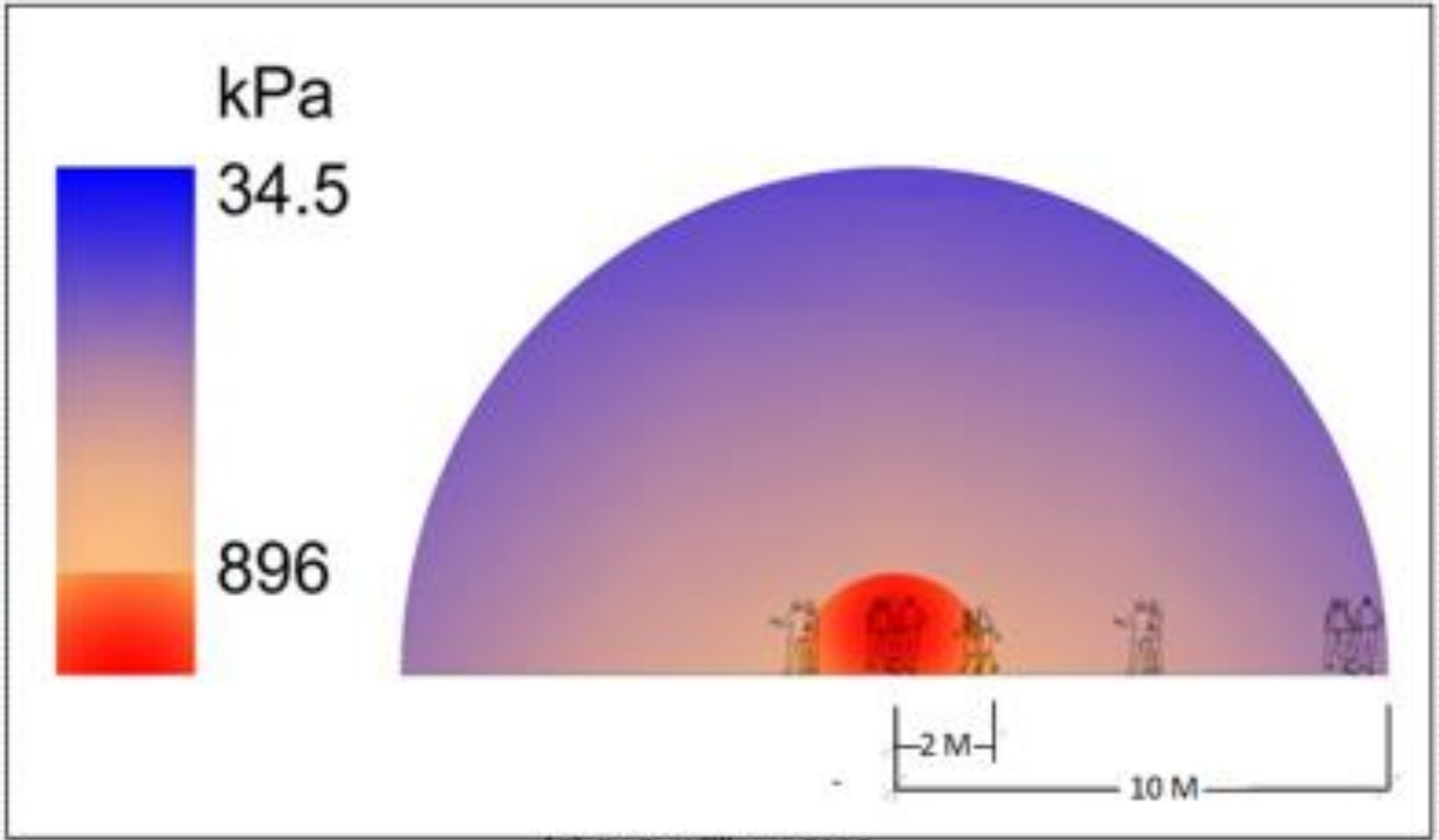

Figure 1 Injury distances for 5 kg PBIED

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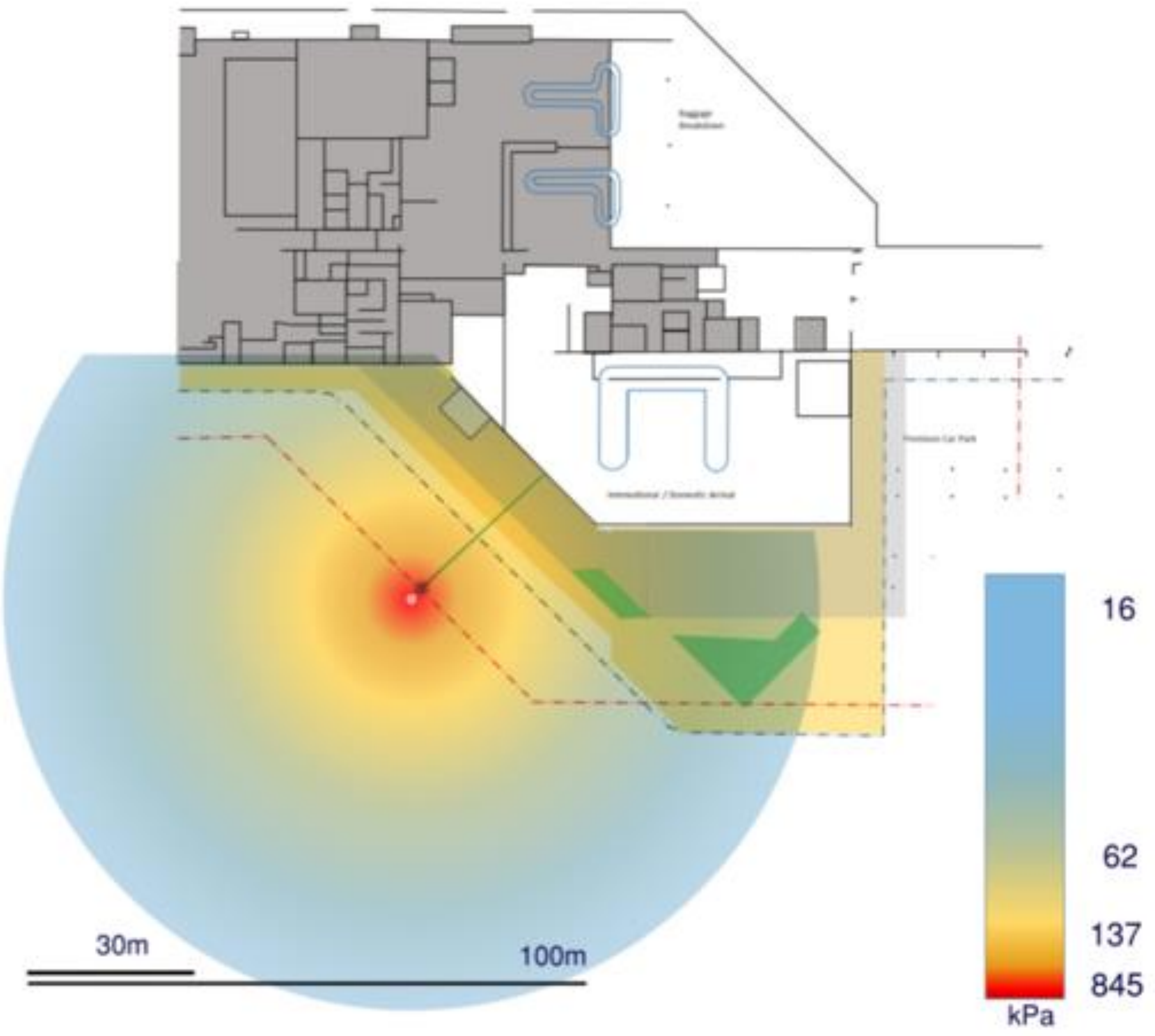

Figure 2 Indicative Blast Contour Drawing 100 kg at 30 m

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WHAT IS THE REQUIREMENT?

- **Able to be scaled in some manner to indicate damage at distances related to selected explosive charge weights.**
- **Be omni-directional.**
- **Penetrate thin walls and materials.**
- **Be reflected by strong walls and materials.**
- **Preferably be reflected around corners.**
- **Ideally flow over and around items using the principles of hydrodynamics.**
- **Operate out to distances equivalent to the injury distances for (say) 100 kilograms of TNT (trinitrotoluene).**
- **Be simple to operate.**
- **Be non-hazardous to store, transport and operate.**
- **Be deployable in a wide range of physical environments.**
- **Be easily transportable across jurisdictions.**
- **Have a low cost of procurement and maintenance.**

REQUIREMENTS MET

- **Able to be scaled in some manner to indicate blast injury and structural damage at various distances related to selected explosive charge weights.**
- **Be omni-directional.**
- **Penetrate thin walls and materials.**
- **Be reflected by strong walls and materials.**
- **Preferably be reflected around corners.**
- ~~**Ideally flow over and around items using the principles of hydrodynamics.**~~
- **Operate out to distances equivalent to the injury distances for (say) ~~100~~ 20,000 kilograms of TNT (trinitrotoluene) and fragmentation.**
- **Be simple to operate.**
- **Be non-hazardous to store, transport and operate.**
- **Be deployable in a wide range of physical environments.**
- **Be easily transportable across jurisdictions.**
- **Have a low cost of procurement and maintenance.**

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WHAT? THE SYSTEM DEVELOPED

Consists of a transmitter and receivers.

Choose one of 25 common, military and home-made explosives.

Choose amount of explosive: 100 grams (0.22 lb) to 20 tonnes (22 US tons).

Issue/deploy receivers.

Trigger by built in timer or external switch.

Read results via LEDs on receivers.

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EXPLOSIVES

TNT equivalency from a range of open source references.

Note: TNT equivalency for HME is questionable but functional.

Common	Military
TNT	C4 / PE4
ANFO	SEMTEX
PETN or Penthrite	RDX
Pentolite	HMX
Blasting AN/water gel	PBX
Dynamite	Tritonal
Gelignite	Composition B
Ammonium Nitrate	Tetryl
Picric Acid	Octol
TATP	
HMTD	
Black powder	
Nitrocellulose	
Guncotton	
AMATOL	
Nitro-glycerine	

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RESULTS

Red LED (blast lethality) >207 kPA (30 psi).

Orange LED (blast injury) >34 kPa (5 psi).

Blue LED (fragmentation injury of 79 Joule).

- FEMA-426, Table 3.1 “Primary Injury Thresholds” quoting US Department of Defence 3-340-02, Structures to Resist the Effects of Accidental Explosions (2008).
- Swisdak M. Crull M. Primary Fragment Ranges for Explosives Safety Parari Conference 1999.
- 79 Joule is an accepted injury threshold for projectiles, see Henderson J (2010) Lethality Criteria for Debris Generated from Accidental Explosions UK Ministry of Defence.

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RESULTS

Building damage = Orange LED >34 kPa peak incident pressure >70 kPa reflected pressure, exceeds building strength in immediate area. Red or Orange LED = significant local structural damage.

The conversion to Pr is based on assumptions related to the 34 kPa Peak Incident pressure calculated at 10 kg TNT at 12.40 m, roughly equating to 76.91 kPa Reflected pressure.

BLAST CALCULATIONS

Kingery, C.N. and Bulmash, G. (1984), Airblast Parameters from TNT Spherical Air Burst and Hemispherical Surface Burst, Technical Report ARBRL-TR-02555, US Army Armament Research and Development Centre, Ballistic Research Laboratory, Aberdeen Proving Ground, United States.

CONWEP old but validated in numerous field trials.

Verified against third party level one software such as ExpSAFE by Gibbs software.

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FRAGMENTATION CALCULATIONS

Based on published work by M. Swisdak and M. Crull.

Additional work by G. Gibbs using Gurney equations and Mott distribution to create a <u>generic</u> scaled equation for lethal fragmentation density over range.

The equation is simply Hazard Fragment Distance = 63.5 x (NEQ) ^ 1/3. The resultant deviation worst case is 35% for 5 kg with the average deviation over the selectable explosive magnitudes of 5%. This is not a perfect curve fit but given the unknowns and variables with fragmentation provides the basis for indicating fragmentation strike based on charge weight and distance.

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PROTECTIVE DRESS

Allowing for bomb suits and protective armour, hearing and eye protection.

Accept that 34 kPa will have limited effect.

207 kPa will result in injury including projection of the body.

So ignore Orange LED and consider Red LED to equate to serious injury.

RF

Frequency = 2.4 GHz.

Power ~ 40 milliwatts. Deliberately limited to 250 m (~820 feet).

Network = Radion based.

Transmitter and Receivers work on a WiFi LAN.

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EMULATION NOT REPLICATION

Indicates effects, does not create them – hence people do not die.

Development is use of RF to indicate explosive effects.

Variations on RF signal receipt similar to 'Murphy's law' of blast and fragmentation.

For detailed structural response need engineering analysis and modelling but now based on knowledge of the areas of concern.

SUMMARY

Real-world, real-time indication of blast and fragmentation effects from an explosion is feasible.

RF can be used if the appropriate frequency is selected.

It is possible to use one form of physics to gain an impression of the effects of another.

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