DoD Non-Lethal Weapons Program

Non-Lethal Weapons Human Effects

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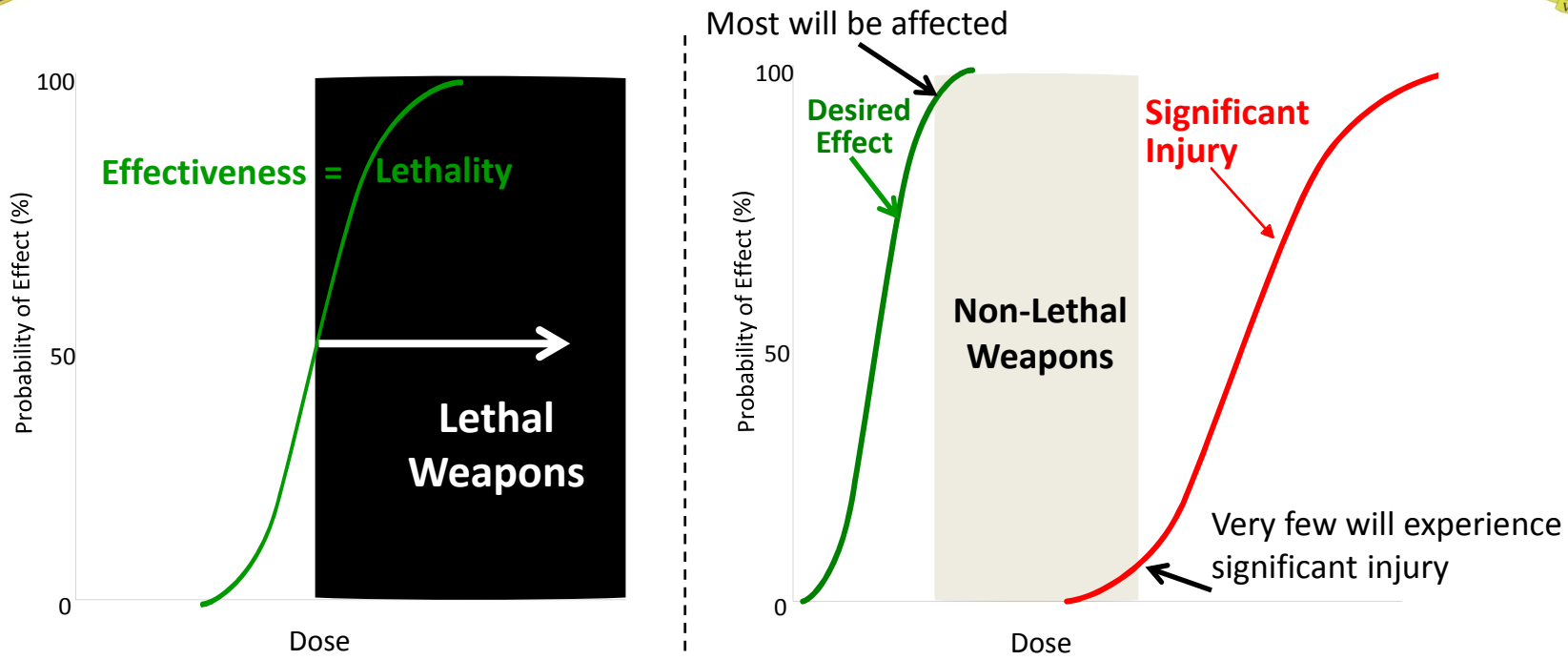
http://jnlwp.defense.gov

DoD Instruction 3200.19
NLW Human Effects Characterization

- Established:
  - Policy, responsibilities, and procedures for HE characterization
  - Human Effects Review Board (HERB)
    - Independent DoD review board
  - Human Effects Readiness Level (HERL)
    - Measure of the availability, sufficiency, and maturity of data and information
  - Health care capability (HCC) indexes as a basis to determine Risk of Significant Injury (RSI)
  - Human Effects Officer responsible for NLW HE…processes…guidance…research…risk assessment
- Requires combat developers to establish acceptable RSI as KPP or KSA
- Focus on the human effect on NLW **targets**
- Signed May 17, 2012

NLW Human Effects Characterization



- **Human Effects:** recognized as a critical issue in NLW development
- Department of Defense Instruction (DoDI) 3200.19 - signed May 17, 2012
  - **Effectiveness:** The extent to which intended effect is achieved
  - **RSI:** The likelihood that a NLW system will cause a significant injury given the intended use

What is Non-Lethality?

Non-Lethal Weapons:

- Intended to **"minimize the probability of producing fatalities, significant or permanent injuries"**

- But… are NOT intended to **"eliminate risk of those actions entirely"** - DoD Directive 3000.03E

So the risk of producing **"fatalities, significant or permanent injuries"** does not have be zero. But what risk level is acceptable?

What Risk is Acceptable?

… it depends

- Combat developers determine the level of acceptable risk of fatalities, significant or permanent injuries for NLWs

- The risk has to be included as a **performance attribute** of a NLW in capabilities documents (e.g., CDDs, CPDs)

- DoD Instruction 3200.19

Is the acceptable risk value fixed for all NLWs? … No

Like any other performance attribute it should depend on the mission, the intended use, etc.

What is Risk of Significant Injury?

- Probability a NLW system will cause a significant injury
  - Given intended use

- RSI values are usually given as a percentage
  - Frequency of the occurrence of a significant injury

- "Significant" injuries include:
  a) Death
  b) Permanent injuries
  c) Injury requiring Health Care Capability indices 1 or 2

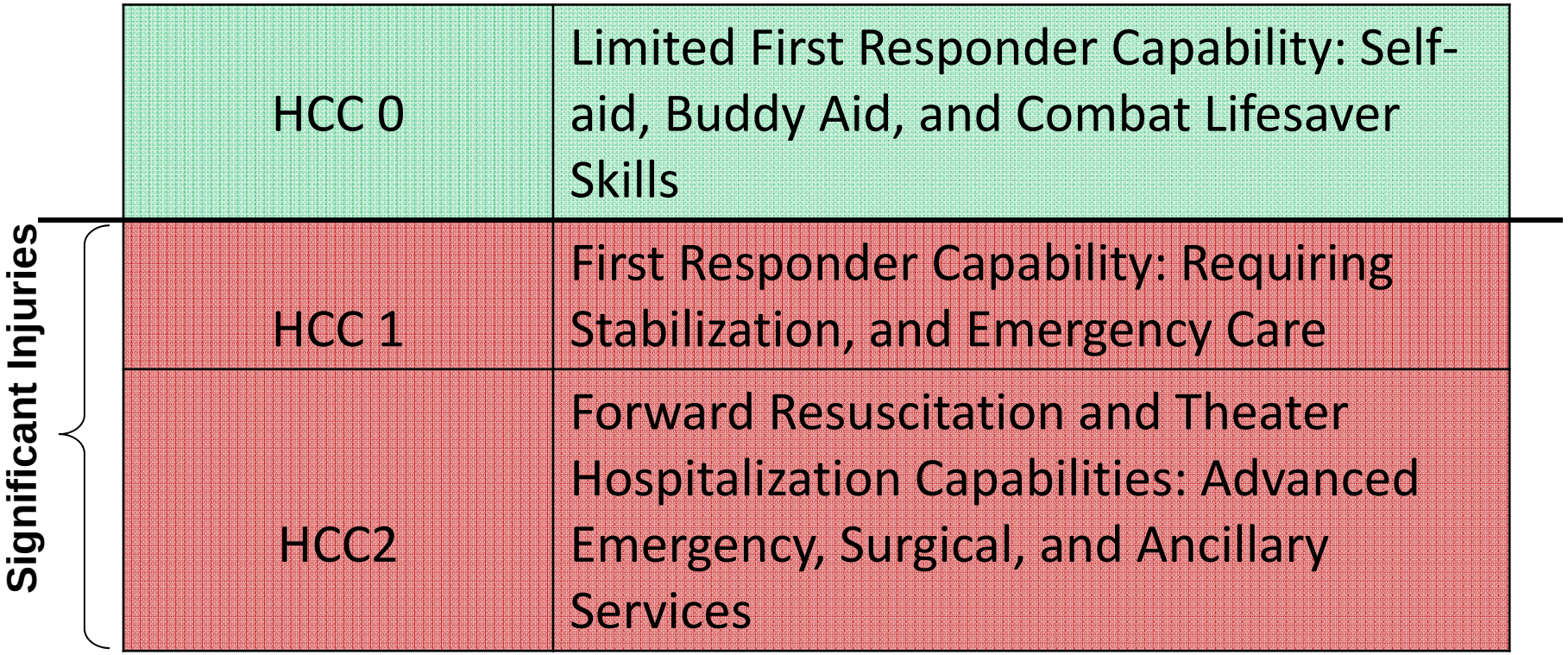
Permanent Injury

From DoDI 3200.19:

Permanent Injury:

Physical damage to a person that permanently impairs physiological function and restricts the employment or other activities of that person for the rest of his or her life

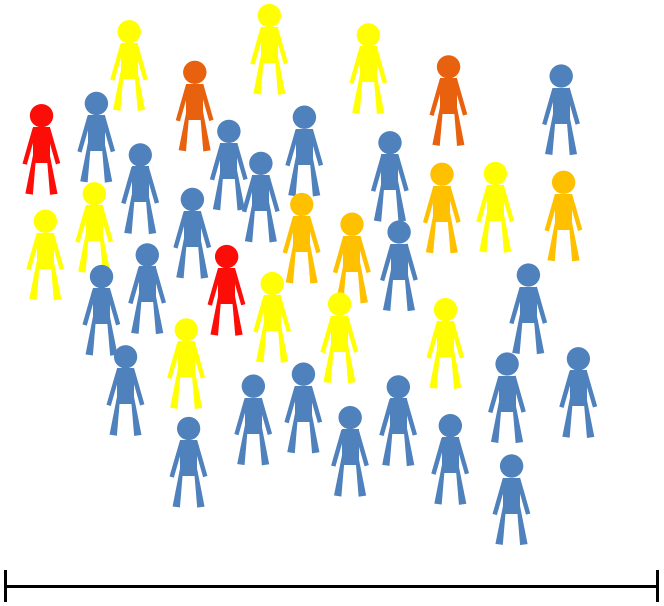
Health Care Capability Indices



- Derived from Joint Publication 04-02, Health Services Support, 31 Oct 2006

Attributes, Metrics & Methodology

- System Attribute: an inherent characteristic of the system
- Metric: a standard of measurement of the attribute
- Methodology: a set of methods, and rules used to measure the metric



A sample of injury outcomes from a NLW. This is an attribute of the system. What is the metric and methodology for describing this attribute?

Risk of Significant Injury

- RSI is the **metric** for the performance attribute associated with the risk of fatalities, significant or permanent injuries

- RSI is the **likelihood** of causing a significant injury which includes permanent injuries and fatalities.

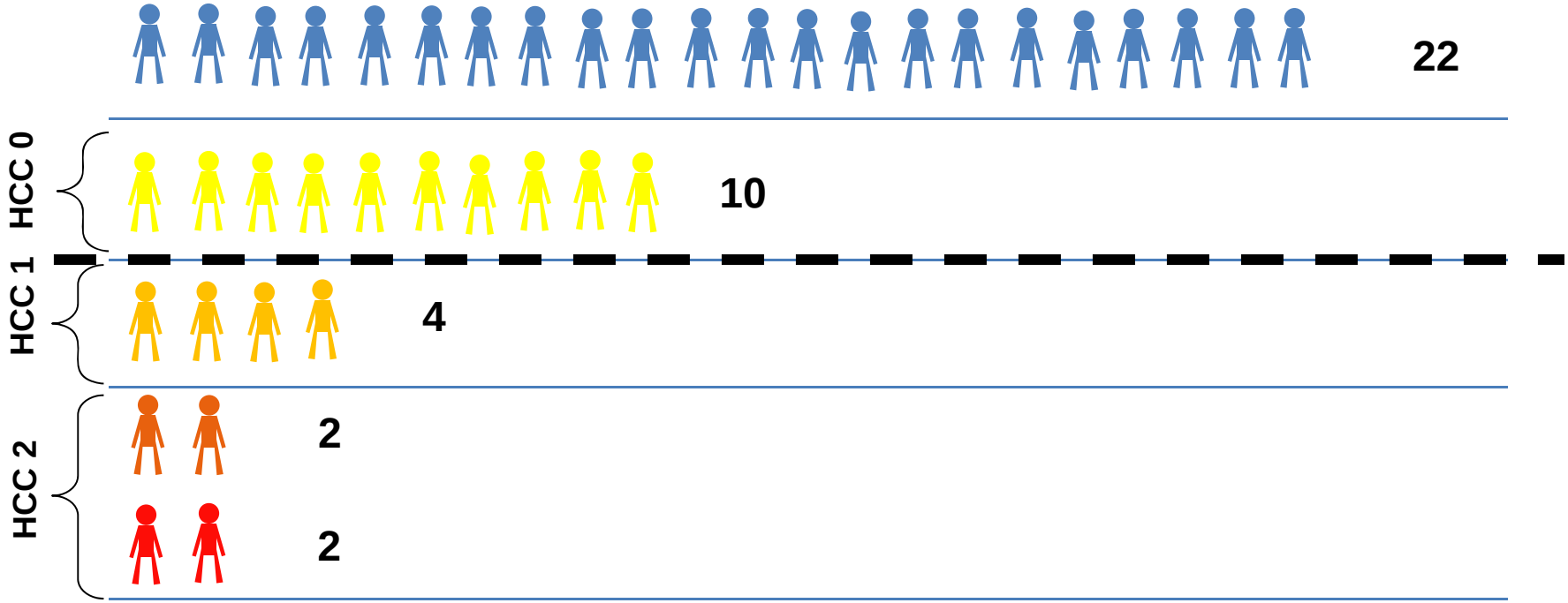
- DoD Instruction 3200.19

What about injuries that aren't permanent or don't cause death?

Health Care Capability Indices are used to draw the line for "significance"

RSI Measurement Example

Same injuries as before, now binned by HCC…



RSI = 8/40 = 20%

RSI as a System Attribute

• RSI value in a capabilities document may be one of the most constraining system attributes

• Determination of the acceptable RSI attribute should be a deliberative process

As a System Attribute, RSI should:

• Be assessed at the system level rather than the stimulus level
  - E.g., safety features built into the system can reduce risk

• Account for intended use of the specific NLW system
  -E.g., point of aim, expected target population, concept of employment, etc

RSI Technical Working Group

Purpose:

- Provide a forum to establish consistent, systematic, and scientifically rigorous processes to evolve RSI calculation methodologies for non-lethal weapons.

Objectives:

- Develop methods to better characterize RSI
  - Improve RSI Accuracy
  - Provide guidance for RSI calculation standards
  - Develop **Implementation Guidance**
- Better communicate RSI to stakeholders
  - Assess methods for communicating certainty levels
  - Develop lay-person RSI educational material

Human Effects Modeling and Analysis Program (HEMAP)

Human Effects S&T Transition

Human Effects Applied Research (BA-2)

- Systematic studies to understand injury potential and effectiveness of non-lethal weapons stimuli

HEMAP (BA-3)

- Build human effects models and surrogates that have direct relevance to identified military needs.

Simulations

- Used by HEMAP Customers

HEMAP is the primary way human effects knowledge is transitioned to the NLW community

HEMAP
Vision, Mission, & Scope

VISION:
NLE technology developers and the DoD T&E community are able to use human effects knowledge to improve technology design, establish trade spaces, and verify HE-related system attributes and mission effectiveness.

MISSION:
Utilize NL human effects research to develop a suite of human effects models that can be used to predict effects, effectiveness, and risk of significant injury.

SCOPE:
- Model development to include:
  - Empirical models (models of data)
  - Computational models
  - Instrumented test targets
- Model calibration
- Model V&V

OUT OF SCOPE:
- Model accreditation
- Conducting simulations
- Test target procurement

HEMAP Customers

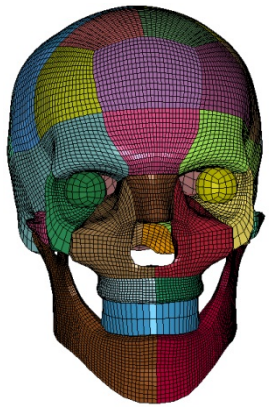
- Technology/Material Developers
  - Evaluate trade offs of RSI and effectiveness with other system specifications.)
  - Assess RSI
  - Assess effectiveness of technology development and commercial products (can inform AoAs)

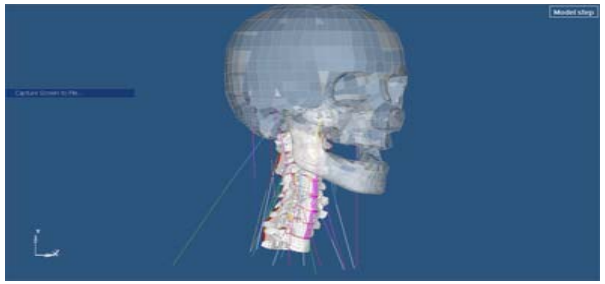
- Developmental Testers
  - Conduct developmental testing
    - "Did the technology do what it was designed to do?"

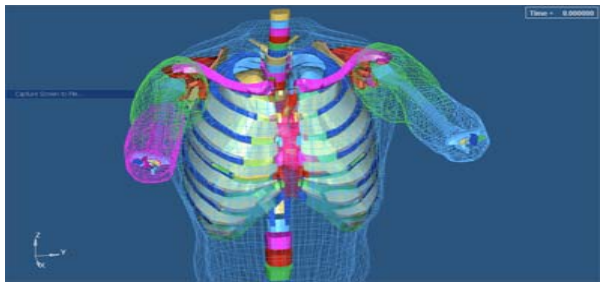
- Operational Testers
  - Conduct operational testing
    - "Did the material developer design the right thing?"

Stakeholders:
- Customers
- JNLWD
- AFRL
- HECOE

Advanced Total Body Model (ATBM)







OBJECTIVE:

- Assess human effects from kinetic energy non-lethal weapons.

DESCRIPTION:

- Models that analyze the delivery of KE NLW onto a target and the subsequent human effects.
- Characterize non-lethal stimuli
- Simulate Human Responses and Effects following delivery of stimuli and complex operational scenes
- Integrates research outcomes of models and data into application software and dose response tables

MODELS:

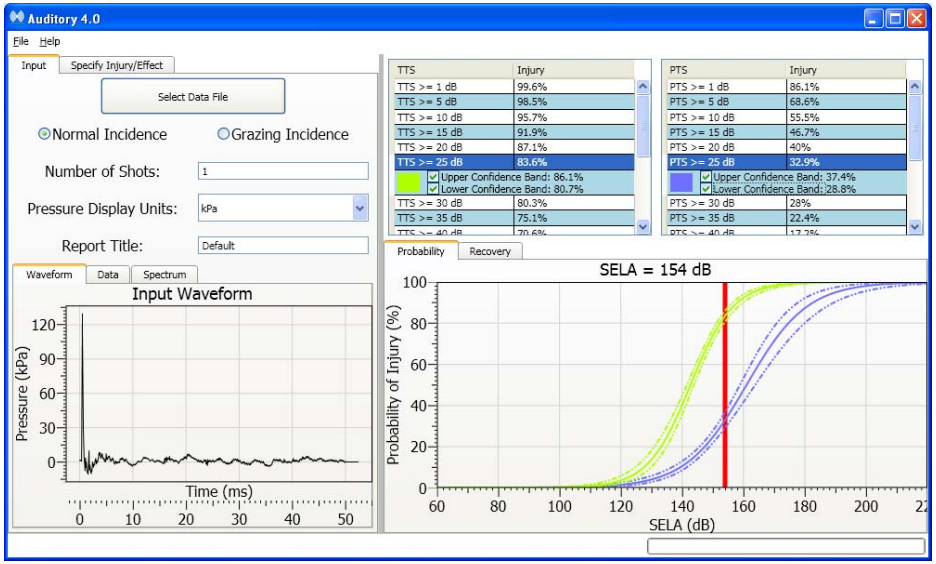
- Support for thorax, Abdomen, Head, Eye, Deterrence, Penetration, Projectile Impact Characterization, Projectile Delivery, Projectile Flight Parameters
- Propagation or dosage delivery models developed and included in software to determine intensity at target

UPCOMING ROADMAP:

- Lower Abdomen
- Pelvic/Reproductive
- Upper Spine
- Facial Bones
- Test Target Development

SERVICE LEAD: USAF AFRL HECOE
SUPPORTED BY: JNLWD

Auditory



OBJECTIVE:

- Predict effects of impulse noise stimuli to include the full range of temporary threshold shift (TTS) and permanent threshold shifts (PTS).

DESCRIPTION:

- Provide dose response curves for full range of TTS and PTS for unprotected ears
- Dose response curves with actual sound exposure levels (dBA)
- Estimates auditory recovery starting at 2 minutes after exposure to an impulse noise

MODELS:

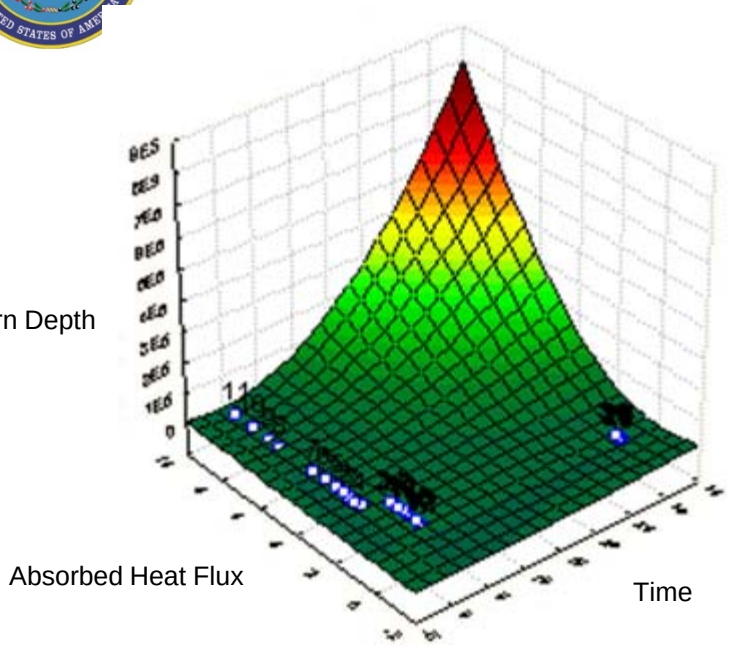
- Developed from chinchilla, Blast Overpressure data and human rifle data leveraged from MRMC
- Supports single/multiple identical shots at equal intervals
- Includes flash bang pressure trace data
- TTS and PTS recovery models for human and chinchilla data

UPCOMING ROADMAP:

- Frequency-specific
- Eardrum rupture
- Hearing Protector
- Tinnitus
- Test Target Development

SERVICE LEAD: USAF AFRL HECOE
SUPPORTED BY: JNLWD

Burn Simulation (BURNSIM)



OBJECTIVE:

- Assess injury to protected or unprotected skin from thermal hazards including radiative and convective heat.

DESCRIPTION:

- Predict burn depth and gradation of thermal pain given heat flux incident to bare skin, directly or through clothing.
- Outputs depth at which thermal damage is achieved based upon intensity and duration of thermal insult.

MODELS:

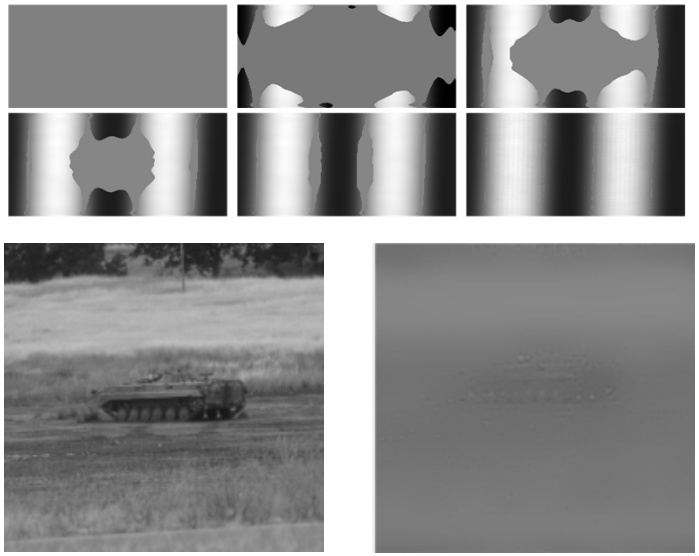
- Heat flux may be constant or varying (thermal pulse from flash bang)
- One-dimensional heat transfer model with 89 depth positions 25 microns apart
- Does not predict % area of body with certain level of thermal damage
- Does not predict probability of certain level of thermal damage

UPCOMING ROADMAP:

- Interim Dose Response
- Thermal Pulse
- Multiple Exposures
- Pain and Discomfort

SERVICE LEAD: USAF AFRL HECOE
SUPPORTED BY: JNLWD

Photostress Recovery Model (PREMO)



OBJECTIVE:

- Assess recovery of the human visual system after exposure to broadband or laser optical radiation.

DESCRIPTION:

- Evaluate visual effects resulting from intense flashes of light or bright lasers
- Trace propagation of light from source to eye
- Determine probability of recognition at discrete time points following exposure.
- Assesses glare and photostress recovery effects

MODELS:

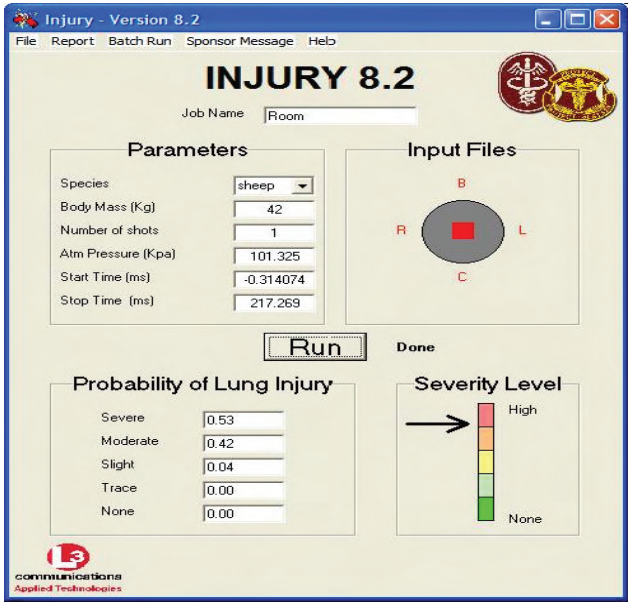
- Models a simple (single spatial frequency) and complex (multiple spatial frequency) scene
- Models equivalent background scotoma
- Uses edge detection theory to predict probability of recognition of visual task
- Analyze suppressive effects to an observer following exposure to broadband or laser optical radiation.

UPCOMING ROADMAP:

- Complex Scene
- Multiple Flashes
- Glare
- Effect of Color
- Light and Sound

SERVICE LEAD: USAF AFRL HECOE
SUPPORTED BY: JNLWD

Blast (Injury)



OBJECTIVE:

- Predict the severity and probability of lung injury from blast overpressure of an explosion.

DESCRIPTION:

- Represents thorax response under impulsive loading
- Whole thorax lung injury finite element model
- Inputs are pressure traces recorded at chest, back, and right/left sides

MODELS:

- Standard US Army blast injury model through MRMC
- Takes into account tissue properties for chest wall, heart, lung, and diaphragm
- Calibrated using human cadaver impact studies

UPCOMING ROADMAP:

- Lung and Lethality
- Trachea Injury
- Test Target with Pressure, Sound, Heat Flux, and Ocular Sensors

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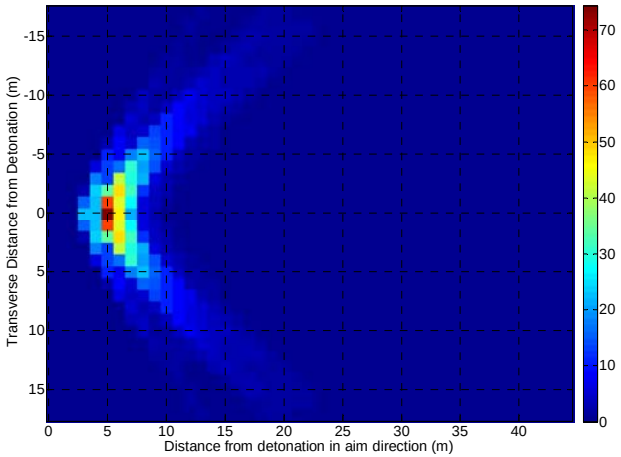
SUPPORTED BY: JNLWD

Fragment Penetration Injury Model (FPIM)



Number of fragments predicted to land in area around detonation

OBJECTIVE:

- Predicting penetration occurrence of fragments and a stochastic dispersion module for predicting fragment terminal velocity and density of fragments.

DESCRIPTION:

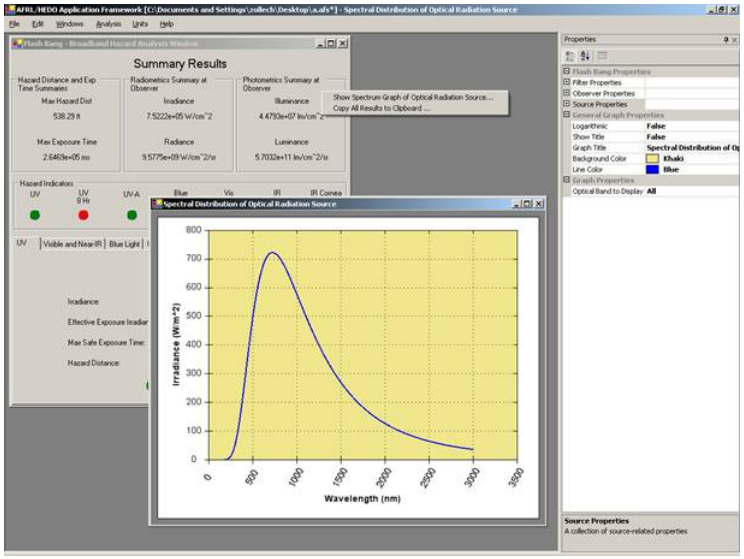
- Determines the velocity corresponding to a 50% probability of penetration
- Determine fragment trajectory and impact velocity versus range
- Trajectory module can also be used to determine blunt impactor trajectory and impact velocity

MODELS:

- Finite element models based on ballistic gelatin penetration tests
- Lack of human data
- Does not model multiple fragments in the same location
- Does not predict final penetration depth and penetration injury – only whether fragment fully penetrates skin

SERVICE LEAD: USAF AFRL HECOE
SUPPORTED BY: JNLWD

Broadband Hazard Analysis Library



OBJECTIVE:

- Assess ocular and skin hazards from broadband optical emitters

DESCRIPTION:

- Exceeding thresholds represents a risk of significant injury to exposed eyes and skin of subjects in and around target area
- Desktop analysis tool implemented to automate the process of determining whether or not broadband optical radiation exceeds occupational safety thresholds
- If threshold is exceeded, further analysis is completed in BTEC.

MODELS:

- First filter used to assess ocular hazards,
- Utilizes guidelines developed from the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) Guidelines.
- Does not consider environmental conditions, clothing, shadowing effects.
- Does not consider age, size, health of targeted individuals.

UPCOMING ROADMAP:

- Update to 2013 ACGIH TLVs Standards
- Integrate LHAZ software

SERVICE LEAD: USAF AFRL HECOE
SUPPORTED BY: JNLWD

HEMAP Focus Areas

- Directed energy (RF/Laser) thermal injury (ocular and skin) and effects prediction models
  - Laser dazzlers
  - Active Denial Technology (95GHz)
  - Thermal laser effects
  - Laser induced plasmas
- Human Electromuscular Incapacitation
- Instrumented Test Targets and Surrogates
- Incorporation of conditional probability predictions in all models

Human Effects Review Board

- Independent DoD Review
- Service SG & Safety Reps
- Advises program managers & milestone decision authorities (MDAs):
  - Quality and completeness of human effects information
  - Identifies potential human effects risks
  - Provides recommendations for further research & considerations to mitigate these risks

* THEEP: Target Human Effects Evaluation Plan

Current NLW Human Effects Partners

- Air Force Research Lab (AFRL)
- Institute for Defense Analyses (IDA/FFRDC)
- Navy Medical Research Unit (NAMRU)
- General Dynamics
- Applied Research Lab; Penn State University
- L-3 Communications
- Army Medical Research and Materiel Cmd (MRMC)
- Naval Surface Warfare Center (NSWC) Dahlgren

Questions?