

Blast Injury Prevention Standards Recommendation (BIPSR) Process: Dermal Burns Blast Injury Type

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Introduction

The Military Health System (MHS) Blast Injury Prevention Standard Recommendation (BIPSR) Process is the DoW's first unbiased, inclusive, stakeholder-driven process designed to identify and assess the suitability of existing candidate standards and to recommend standards that meet DoW Stakeholder needs (Figure 1). The MHS BIPSR Process has two major objectives:

1. identify existing biomedically-valid candidate standards for immediate use by the DoW
2. inform the research community of knowledge gaps where no suitable candidate standards exist

There are four core elements to the BIPSR process:

- **BIPSR Process Stakeholders Committee:** Members of the medical, T&E, operational, and MATDEV communities
- **Focused Stakeholder Committee:** a subset of the BIPSR Process Stakeholders Committee with expertise on a particular Blast Injury Type
- **Subject Matter Expert (SME) Panel:** Broad-based, non-advocacy panel from industry, academia, and government
- **Stakeholder-Driven Consensus-Building Meeting:** Forum for stakeholders, SME Panel, users, analysts, and Candidate Standard developers and owners to discuss evaluation of the Candidate Standards

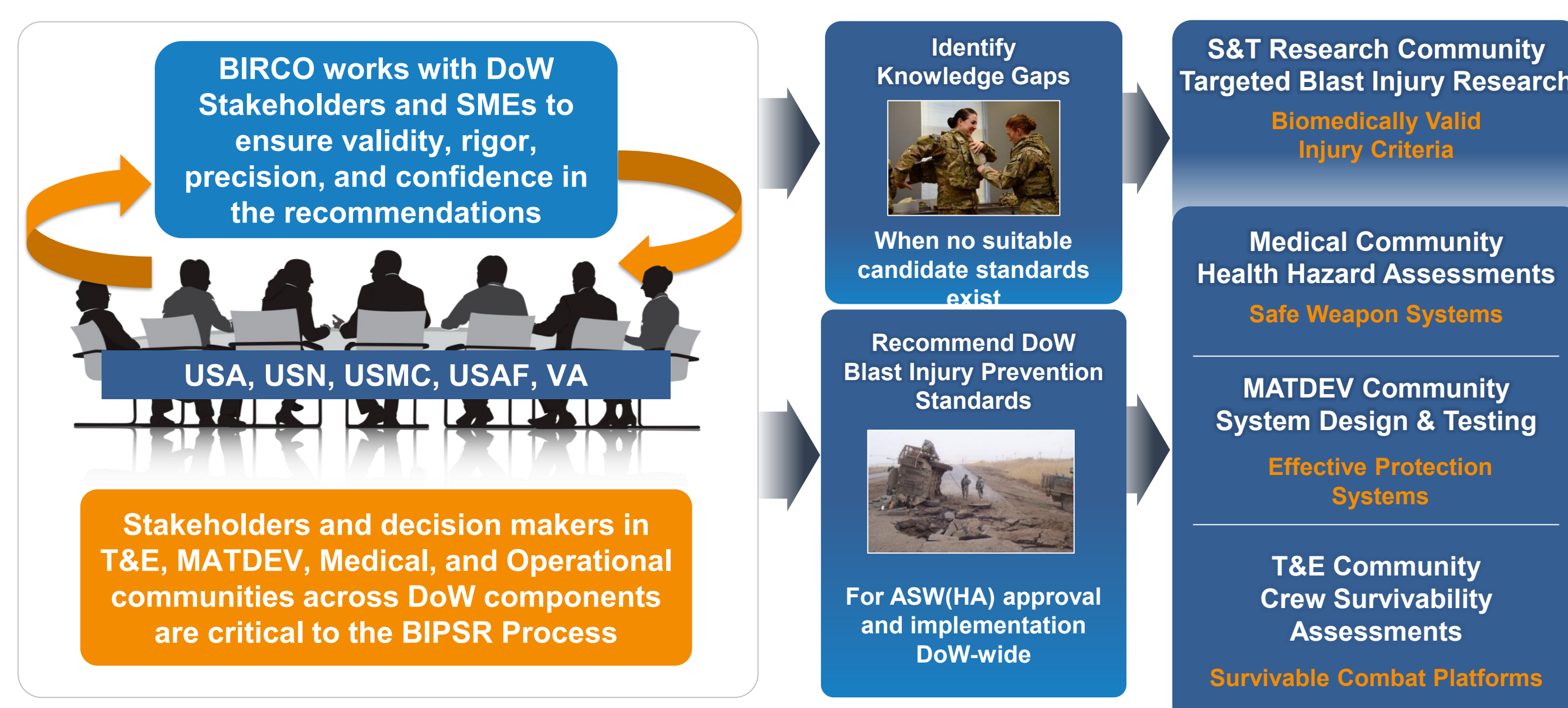


Figure 1: The BIPSR Process & Outcomes

A MHS Blast Injury Prevention Standard is a “biomedically-valid description of the physiologically- or biomechanically-based injury and performance response of a human to blast insults.” Standards range from simple dose-response curves and injury thresholds to complex algorithms and computational models (Figure 2).

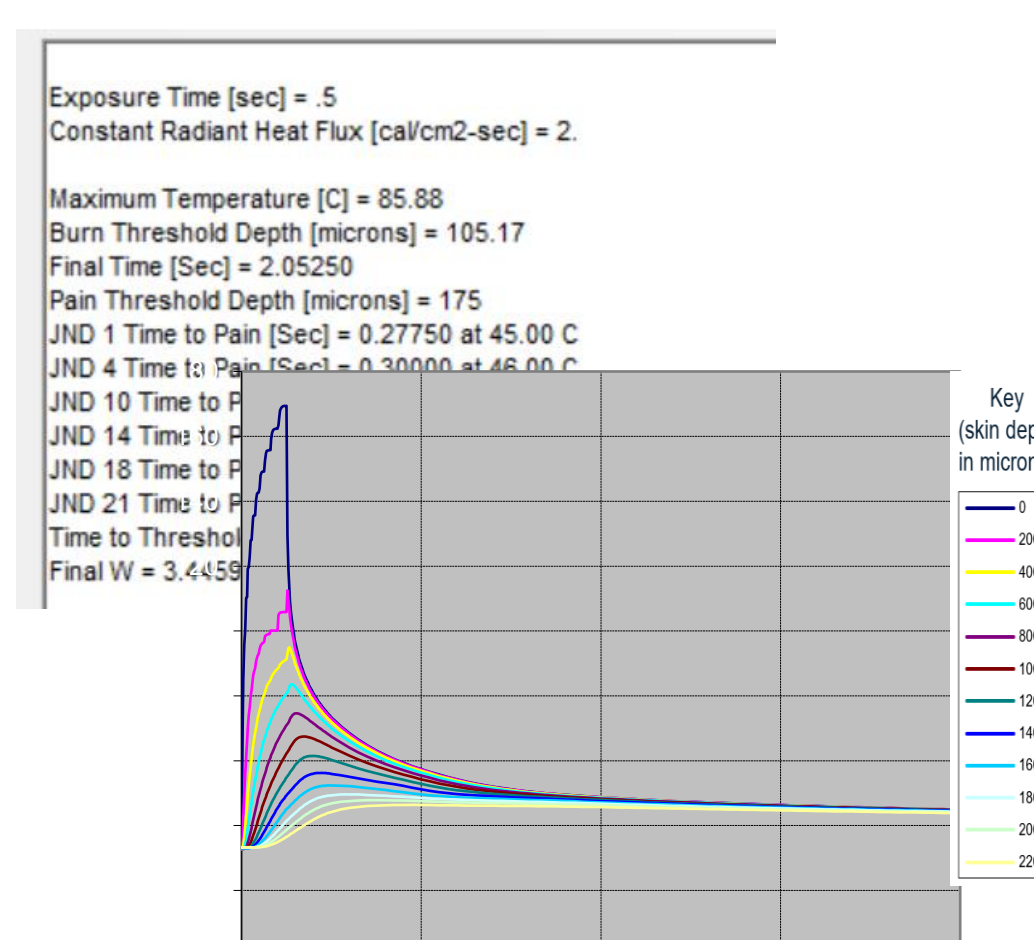


Figure 2: Example output from Dermal Burns Blast Injury Type Candidate Standards

BIPSR Process Activities for the Dermal Burns Blast Injury Type

The BIPSR Process is divided into six pillars with individual sub-processes and activities. For the Dermal Burns Blast Injury type the following check marked activities have been completed:

- ✓ **Pillar I: Review Existing Capabilities**
 - Conducted Literature Survey of over 180 journal articles and reports
 - Pulse Community for Candidate Standards through interviewing ten dermal burns SMEs and conducted a Request for Information (RFI) on SAM.gov
 - Identified eight Dermal Burns Blast Injury Candidate Standards:
 - ASTM F1959
 - ISO 13506-2
 - BURNSIM
 - Quantity Distance
 - ASTM F1930
 - Explosive Safety Standoff Distance
 - Arrhenius Reaction Rate Predictions
 - HExCAT Thermal Injury
 - Engaged with Focused Stakeholders to identify Intended Uses of Candidate Standards:
 - Individual Susceptibility
 - Combined Injury Mechanisms with chemical burns
 - Repeated Exposure
- ✓ **Pillar II: Develop Data Collection Mechanisms**
 - Assembled SME Panel of 8 members from academia, industry and government
 - Defined and used Candidate Standard Assessment Information Template to collect pertinent information from Candidate Standard owners
 - Implement Information-Sharing Repository
- ✓ **Pillar III: Develop Evaluation Criteria**
 - Defined Evaluation Methodology, Factors, and Template including:
 - Validation: Conceptual Model, Key Model Parameters, and Output
 - Verification: Design Implementation
 - Usability: Practicality, Inputs and Outputs, and User Resources
 - Developed Operational Scenarios to define Test Cases including:
 - Dismounted indoor and outdoor exposures with varying blast magnitude
 - Enclosed vehicle with exposure to high and low magnitude blast
 - Fire resistant material/uniform data collection and analysis
 - Considerations of individual and unit PPE needs for operations
 - Site risk assessment for potential unit operations
- ✓ **Pillar IV: Evaluate Candidate Standards**
 - Executed and reviewed findings from the Test Cases
 - Rated and scored Candidate Standards Against Evaluation Factors using the Multi-Attribute Utility Theory (MAUT)
 - MAUT is a structured methodology for guiding tradeoffs among multiple objectives with quantitative ranking of evaluation criteria
- ✓ **Pillar V: Host Consensus-Building Meeting**
 - Planed and conducted Consensus-Building Meeting
 - Provided Mechanisms for Community Feedback
- **Pillar VI: Develop Recommendations and Evaluate Process**
 - Finalize Candidate Standard Recommendations
 - Prepare Final Reports
 - Prepare Process Improvement Recommendations

BIPSR Process Results for the Dermal Burns Blast Injury Type

The SME Panel objectively evaluated the Dermal Burns Blast Injury Candidate Standards using MAUT and identified BURNSIM for a MHS Dermal Burns Blast Injury Prevention Standard. Table 1 shows full MAUT scores and 2nd degree injury threshold for each of the Dermal Burns Blast Injury Candidate Standards.

Candidate Standards	Injury Threshold for 2 nd Degree Burn	Evaluation Factor Scores
BURNSIM	2 nd degree burn thresholds are dependent on heat flux, skin properties, humidity, and exposure time	85.61
ASTM F1930	Average heat flux is 84 kW/m ² with exposure durations up to 20 s	78.67
ISO 13506-2	Incident heat flux is limited to a nominal level of 84 kW/m ² , exposure durations of 3 s to 12 s	77.85
ASTM F1959	Incident heat flux of 84 to 25,120 kW/m ² exposure duration up to 3 s	75.30
Explosives Safety Standoff Distance	Incident heat flux of up to 4.84 kW/m ² , exposure duration up to 20 s, and radiative temperature from explosives up to 2800K	73
Arrhenius Reaction Rate Predictions	50% probability for 2 nd degree burn if ratio of total tissue to undamaged tissue after heating is < 0.7	72.19
Quantity Distance	Incident heat flux of 84 kW/m ² exposure duration up to 5 s with a maximum allowable overpressure of 2.3 psi	73.54
HExCAT Thermal Injury Estimator	2 nd degree burn thresholds are dependent on explosive mass, heat of combustion, population density, humidity, and fraction clothed	61.76

Table 1: Dermal Burn Blast Injury Candidate Standards

Recommendations & Knowledge Gaps

Recommendations for the adoption of BURNSIM as the MHS Dermal Burns Blast Injury Prevention Standard for improved service member protection against blast derived dermal burns will be coordinated with the Office of the Assistant Secretary of War for Health Affairs.

Findings from the BIPSR Process will inform future blast injury research targeting identified knowledge gaps to fulfill stakeholder needs.

Identified knowledge gaps include:

- Majority of Candidate Standards only account for 2nd degree burns
- Candidate Standards do not account for downstream effects
- Face and hands are not modeled even though majority of burns occur on those body regions
- Candidate Standards do not account for individual susceptibility (genetic, previous injuries)
- Current blast derived dermal burns data is limited



To learn more, visit:
<http://blastinjuryresearch.health.mil>