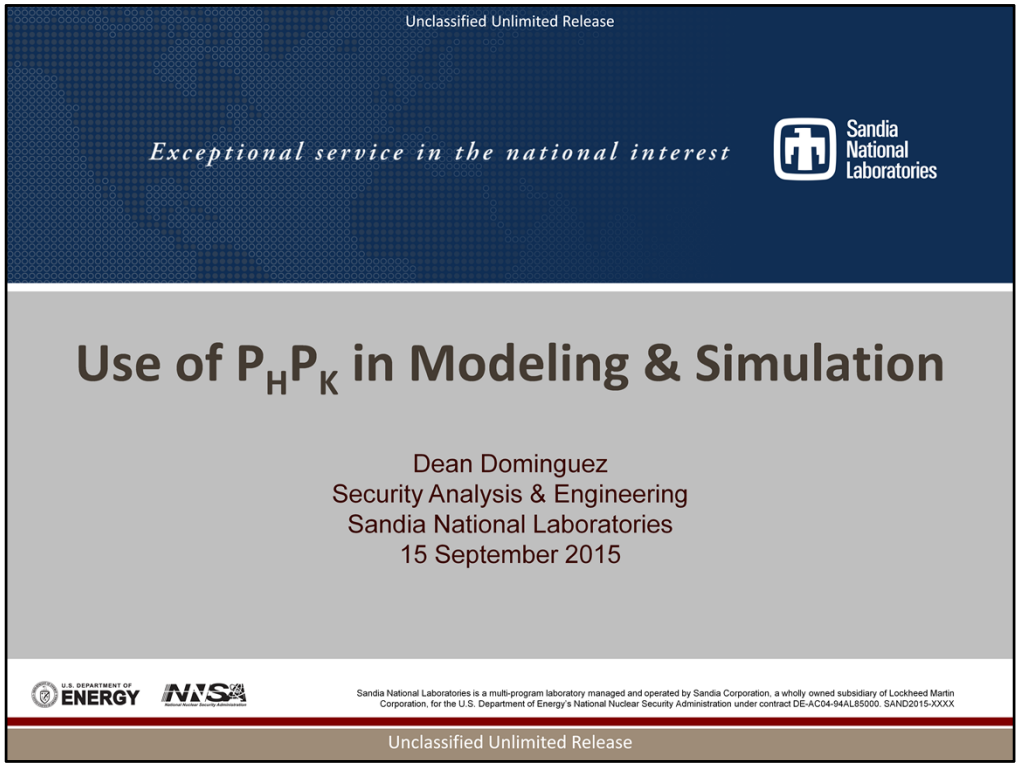
SAND2015-7632C

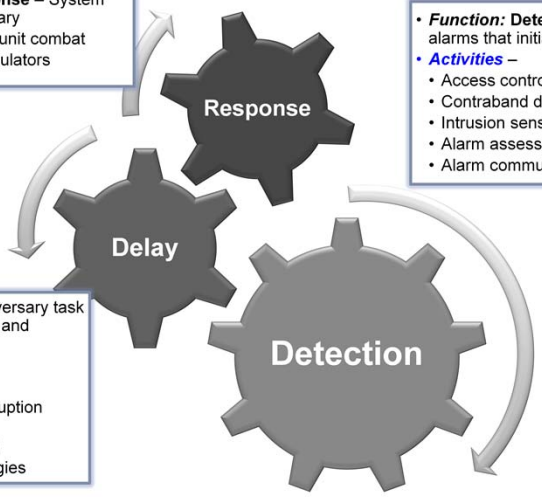


Unclassified Unlimited Release

Sandia National Laboratories

Physical Protection Functions & Activities

- ***Function*** **: Response** – System defeats the adversary
- ***Activities*** – Small unit combat
- ***Toolset*** – FoF Simulators



- ***Function:*** **Detection** – Assessed alarms that initiate response
- ***Activities*** –
  - Access control
  - Contraband detection
  - Intrusion sensing
  - Alarm assessment
  - Alarm communication

- ***Function:*** **Delay** – Adversary task time between detection and completion of objective
- ***Activities*** –
  - Barriers
  - Response force interruption (active delay)
  - Terrain (natural delay)
  - Active delay technologies

Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

History

- Models use $P_H P_K$ data for training, analysis, planning & mission rehearsal
- Database contains weapons that were most commonly used in scenarios
- Historically, data largely came from
  - State-sponsored test data
  - State R&D initiatives

Unclassified Unlimited Release

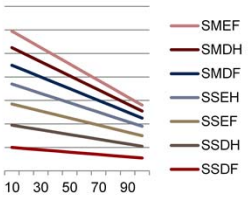
Unclassified Unlimited Release

Sandia National Laboratories

$P_H P_K$ Definitions

- Effectiveness = P_H & the probability that a hit will kill a target at specified range
- P_H/P_K data populates curve sets
- A curve defines the P_H/P_K data for a munition-target pairing at discrete ranges for shooter / target state
- Combining the shooter-target states of moving/stationary, defilade/exposed, and flank/head shot creates the curves
- Simulator linearly interpolates between range/probability values

Range (m)	SSDF	SSDH	SSEF	SSEH	SMDF	SMDH	SMEF	SMEH	MSDF	MSDH	MSEF	MSEH	MMDF	MMDH	MMEF	MMEH
10	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25
20	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20
30	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15
40	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
50	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5
60	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
70	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0	0
80	65	60	55	50	45	40	35	30	25	20	15	10	5	0	0	0
90	60	55	50	45	40	35	30	25	20	15	10	5	0	0	0	0
100	55	50	45	40	35	30	25	20	15	10	5	0	0	0	0	0



Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

Problems

- Difficult to obtain usable data for ALL targets available
- Data not representative of all weaponry /skill levels (Insurgents vs. Special Forces)
  - Caution: Major issues exist with linearly degrading values
- Difficult to obtain usable data for ALL condition sets (stationary shooter, stationary target, etc.)
  - Alternate conditions are extrapolated
- Difficult to obtain data for all combat situations

Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

Lessons Learned (Solutions)

- Values must be relative to each other and remain internally consistent
- Kill types must be clearly defined
  - F, K, and M values for various vehicles
  - Appropriate K values for people, dependent on State's definition of combat ineffective.
- Data must be based on performance metrics (vetted by SME judgement)

Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

Lessons Learned

- Differentiation needed for moving shooters / moving targets
- Weapon training and tactical deployment must be factored in
  - Operators not trained to "spray and pray"
  - CQB (interior or exterior) must be heavily factored in
  - Data should represent well-qualified shooters, but not necessarily the elite (data evens out)
- Small arms effects against vehicles should be incorporated (do not assume vehicle invulnerable)
- Differentiation is needed between ammunition type
- Needs to be "fitted" for use in simulators, but remain flexible for other applications.
  - Probabilistic (as opposed to cumulative – single shot data)
  - Separation of P_H and P_k (Conditional probability of kill)
  - Mutually exclusive kill probabilities (only one possible outcome per hit)
- Rates of Fire must be incorporated; these have as large an impact on P_N results as the $P_H P_K$ values themselves

Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

Rates of Fire

Weapon	Rounds per Minute	Seconds per Round
Pistol	120	0.5
Shotgun	60	1
5.56mm Assault Rifle	86	0.7
5.56mm Machine Gun	725	0.08
7.62mm Assault Rifle	60	1
7.62mm Sniper Rifle	30	2
7.62mm Machine Gun	613	0.10
7.62mm Minigun	3000	0.02
8.6mm Sniper Rifle	20	3
10.4mm Sniper Rifle	12	5
12.7mm Anti-Materiel Rifle	8.6	7
12.7mm Machine Gun	500	0.12
25mm Machine Gun	150	0.40
RPG	6	10

Ultimately, the Probability of Kill given an engagement = $[1-(1-(PH * PK))^x]$, where x = the total number of rounds fired

8

Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

Current $P_H P_K$ Precautions

- Data often represents standard shooter in standard conditions, degradation for weather, visibility, etc difficult to determine
- Values do not incorporate the probability of acquiring a target
- DB do not grant the shooter the option of aiming at a particular part of a target
  - Example: you cannot increase P_K for a "head-shot" on a person, or choose to aim at the engine block of a vehicle in hopes of increasing the M value at the expense of the K and F values
- The values should not be considered independently accurate
  - The values are meant to be relative to each other, not predictive of a single event
  - Cannot expect that weapon X will stop a vehicle with a 23% probability
    - Development of DB intended to have relative values

Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

Data Is Probabilistic – Not Cumulative

- A small, non-zero chance that any munition can kill any target, even though it is nearly impossible for a single round to do so
- Sometimes results in an "unrealistic" attrition, but accounts for volume of fire
  - Not accounting for volume of fire will sometimes result in "unrealistic" survival

Unclassified Unlimited Release

Unclassified Unlimited Release

Sandia National Laboratories

QUESTIONS?