SAND2019-9532C

Exceptional service in the national interest

CUAS Security Performance Metrics and Requirements

Presented by: JR Russell
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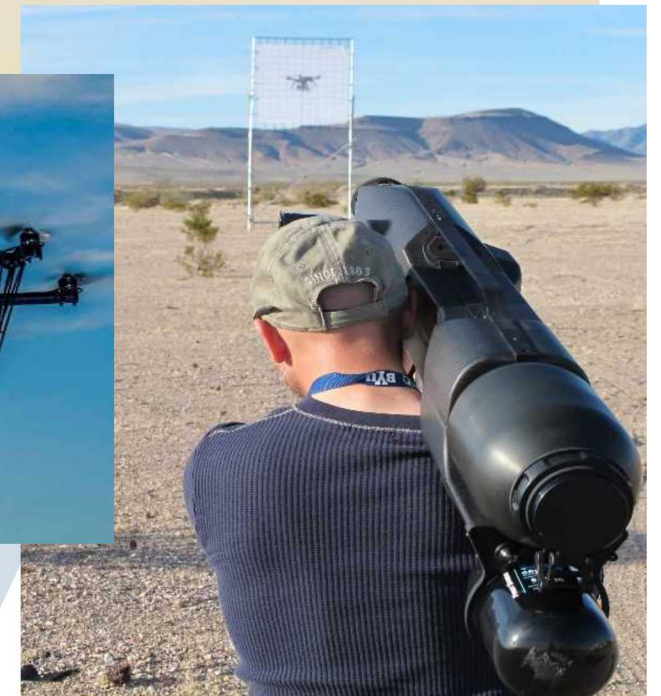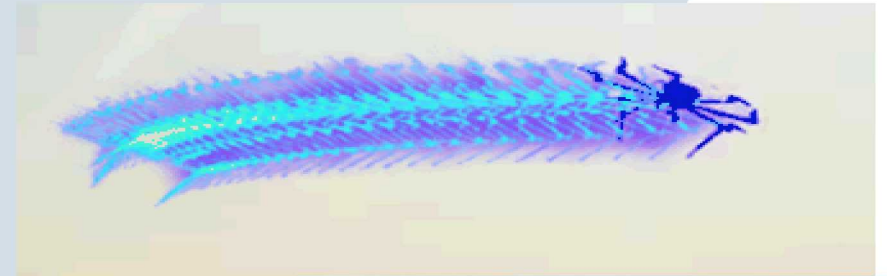Sandia National Laboratories

EXAMPLE OF FUNDAMENTAL SECURITY SYSTEM

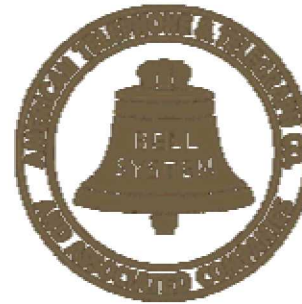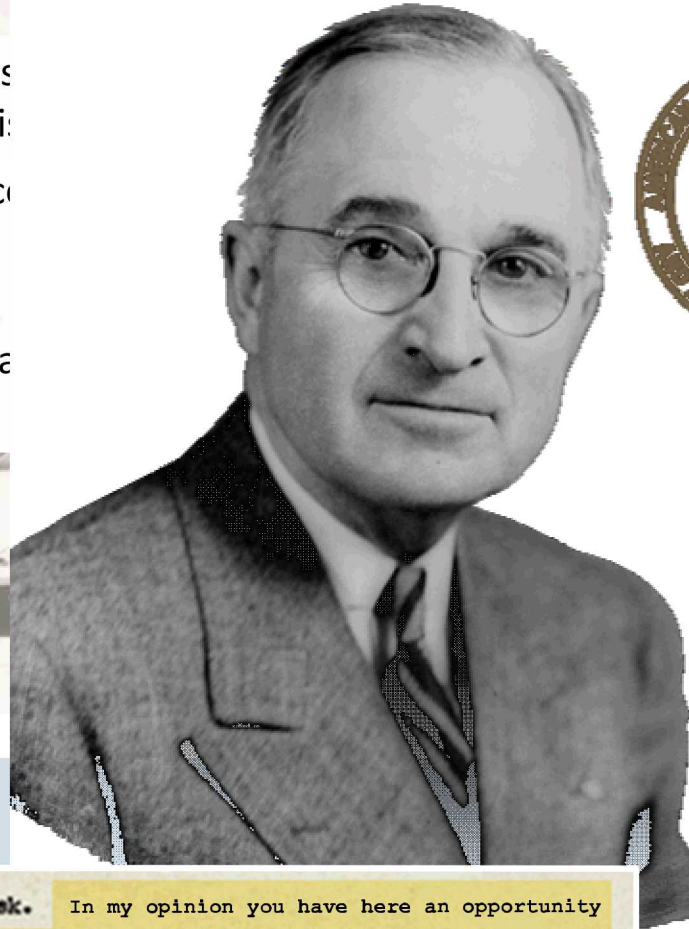*Courtesy of: Suburban Auto Group*

OUTLINE

- Sandia's Mission and Background in Physical Security

- Design Evaluation Process Outline (DEPO)

- CUAS Requirements

- Security Performance Metrics – Performance Based

- CUAS Requirements – Based On Performance Metrics

- Analysis of Ability to Meet Requirements

- CUAS Security Requirements- A balance of security risks vs legal/policy risks

SANDIA'S HISTORY

- July 1945: Los [Alamos] creates Z Divi[sion]
- Nonnuclear c[omponent] engineering
- November 1, [1949:] Sandia Labora[tory] established

Exceptional service in the national interest

to undertake this task. In my opinion you have here an opportunity
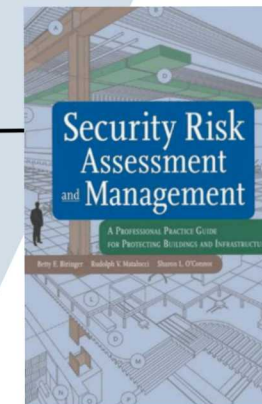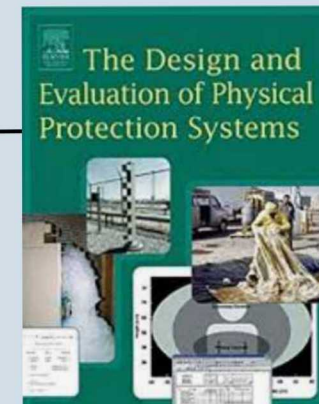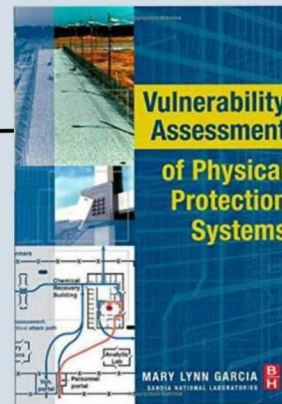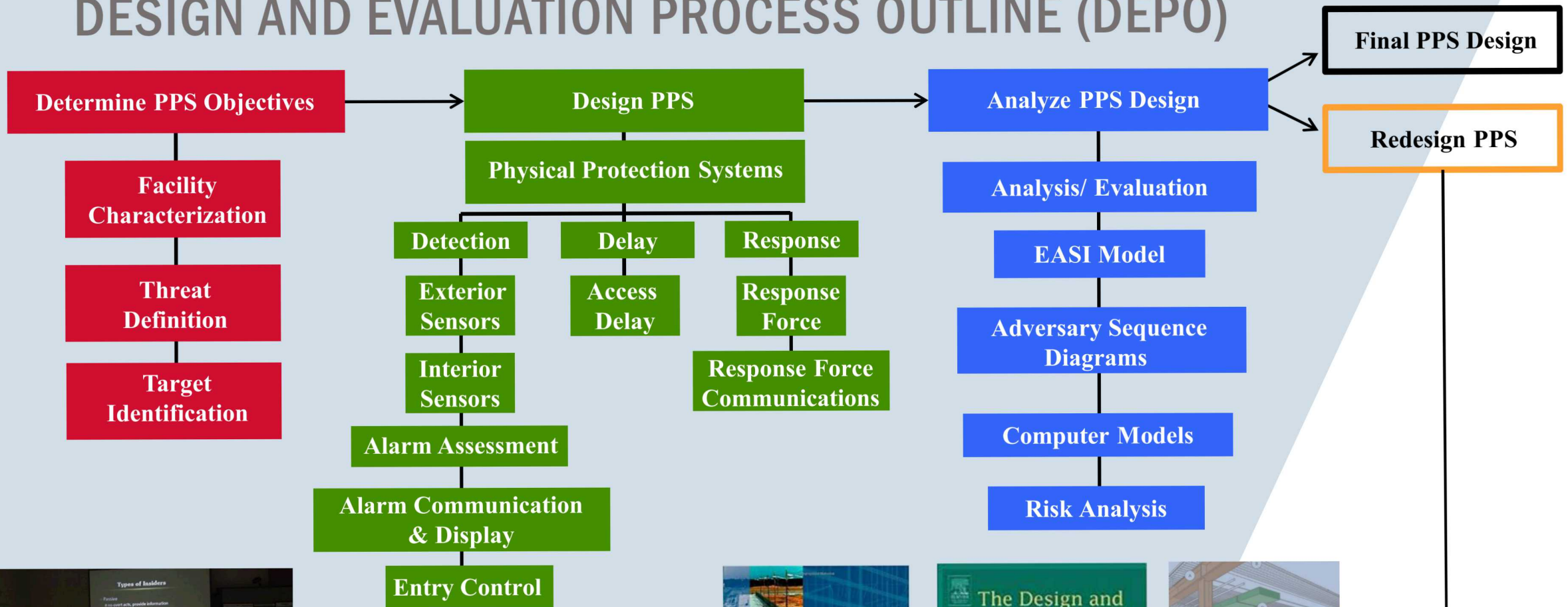to render an exceptional service in the national interest.

SANDIA'S PHYSICAL SECURITY CENTER OF EXCELLENCE (PSCOE) MISSION

Provide physical security system designs and technologies for the protection of nuclear weapons, material, and other high consequence assets.

- 50+ years of Department of Defense and Department of Energy support

- Over 1 Billion executed for DOE and DoD over the last decade

DESIGN AND EVALUATION PROCESS OUTLINE (DEPO)

Determine PPS Objectives → **Design PPS** → **Analyze PPS Design**

Final PPS Design

Redesign PPS

Determine PPS Objectives
- **Facility Characterization**
- **Threat Definition**
- **Target Identification**

Design PPS
Physical Protection Systems

- **Detection**
  - **Exterior Sensors**
  - **Interior Sensors**
  - **Alarm Assessment**
  - **Alarm Communication & Display**
  - **Entry Control**
- **Delay**
  - **Access Delay**
- **Response**
  - **Response Force**
  - **Response Force Communications**

Analyze PPS Design
- **Analysis/ Evaluation**
- **EASI Model**
- **Adversary Sequence Diagrams**
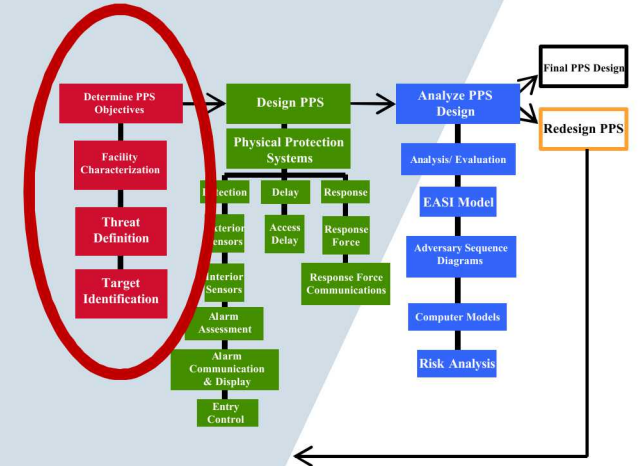- **Computer Models**
- **Risk Analysis**

ESTABLISH SECURITY REQUIREMENTS
QUESTIONS, QUESTIONS, QUESTIONS

What are you trying to protect?

- Facility?
- People?
- Mission?
- Materials?
- Reputation/Image?

The same process/questi...

ESTABLISH SECURITY REQUIREMENTS
QUESTIONS, QUESTIONS, QUESTIONS
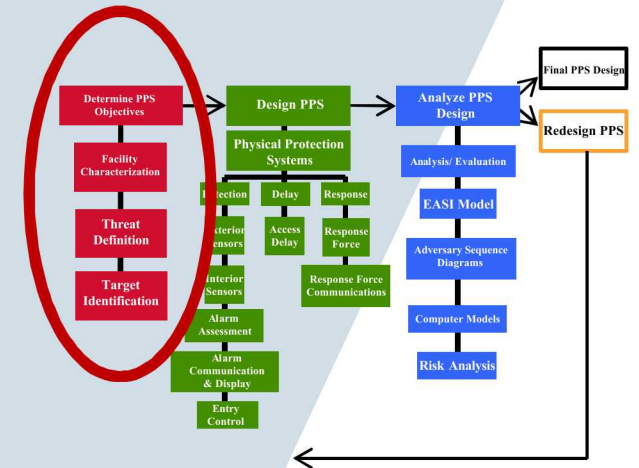
What is the threat?

Unmanned Aerial System (UAS)
- How Big?
- How Fast?
- How High/Low?
- How Many?
- Type of Navigation?

What can they carry?
- Imagers
- Explosives
- Chem/Bio
- People?
- Other?

Photo: UlrichHeither
https://creativecommons.org/licenses/by-sa/3.0/legalcode

The same process/questions used for Physical Security

ESTABLISH SECURITY REQUIREMENTS
QUESTIONS, QUESTIONS, QUESTIONS

What are the physics based constraints?
- Line of Sight – Terrain/Buildings/Foliage
- Sensor Phenomenology
- Assessment Phenomenology
- Neutralization Phenomenology
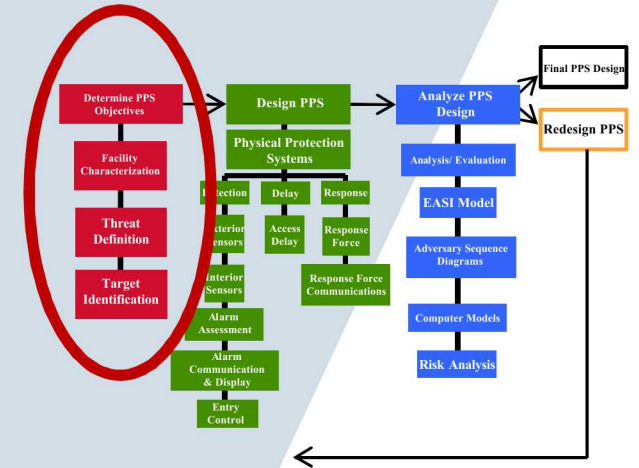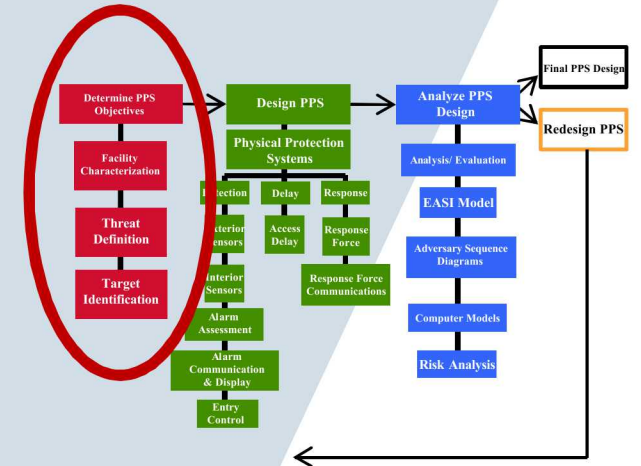- Weather – Fog, Snow, …
- Human Response Time

The same process/questions used for Physical Security

ESTABLISH SECURITY REQUIREMENTS
QUESTIONS, QUESTIONS, QUESTIONS

What are the non-physics based constraints?

- Policy/Legal
- What kind of Legal Risk (liability) are you willing to accept?
- What kind of Security Risks are you willing to accept?
  - Loss of life
  - Loss of mission
  - Loss of materials
- What kind of Consequences are you willing to accept?
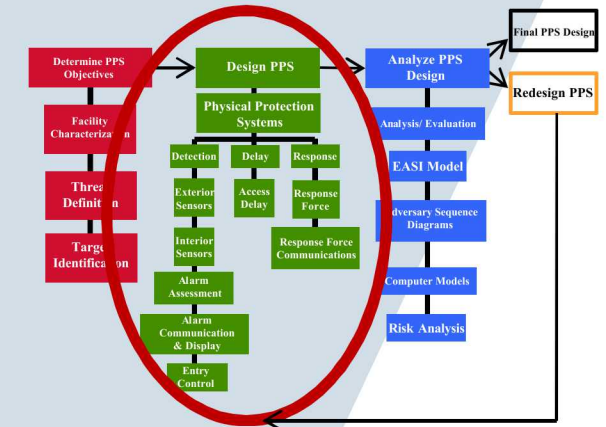- Technology Maturity
- Political/Public Perception
- Cost

The same process/questions used for Physical Security

CUAS KEY PERFORMANCE METRICS

TEST RESULTS USED TO DESIGN THE SYSTEM

- Sensing Presence of a Potential Intruder
  - Probability of Sense (P_S)
  - Sensing Range (R_S)
  - Nuisance Alarm Rate (NAR)
- Assessing Cause of Alarm
  - Probability of Assessment (P_A)
  - Assessment Range (R_A)
  - Assessment Time -- (T_A)
- Neutralizing Intruder
  - Probability of Neutralization (P_N)
  - Neutralization Range (R_N)
  - Neutralization Time (T_A)

Very similar to metrics used for Perimeter Security and Extended Detection

NOTIONAL EXAMPLE OF CUAS SCENARIO AND TEST METRICS

Is this Far Enough?

Is the CUAS fast enough?

When does policy and ConOps allow you
to respond?

Asset

| Neutralize | Assess | Sense |

Track   Track

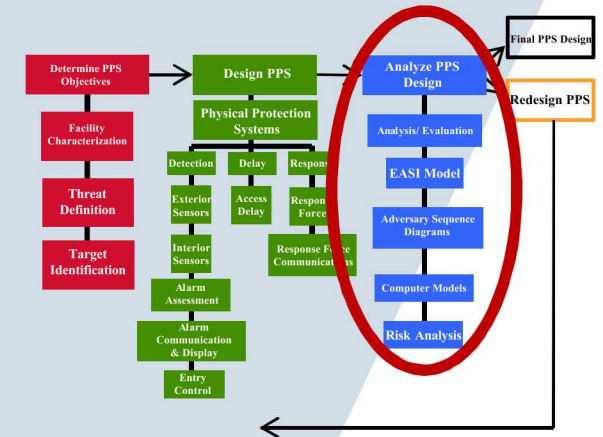P_N , R_N , T_N P_A , R_A , T_A P_S, R_S

Sensor

Side View

CUAS SECURITY EFFECTIVENESS
ESTIMATED FROM EMPIRICAL DATA

Probability of Detection (P_D)

$P_D \cong P_S * P_A$

Security Systems Effectiveness (P_e)

$P_e \cong P_D * P_N$

Results From Test Data
- P_S = .9 at a range of 1000m: threat, daylight, good weather
- P_A = .8 at a range of 500m: threat, daylight, good weather
- P_N = .9 at a range of 300m: threat, daylight, good weather
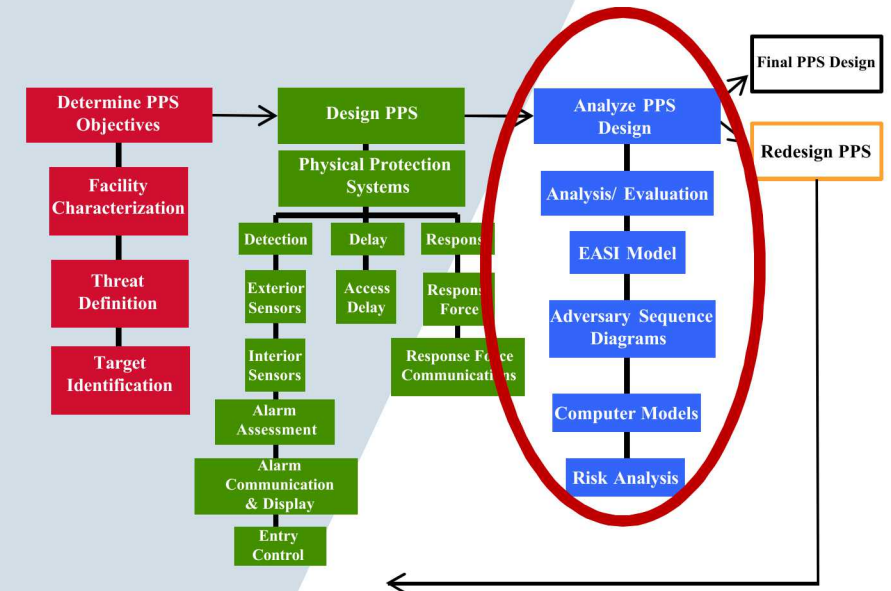 - T_N = 60 seconds

$P_D \cong (.9)(.8) \cong .7$

$P_e \cong (.7)(.9) \cong .6$

You have a probability of 60% to neutralize the threat at 300m.
The system can mitigate 1 UAS every 60 seconds.
How resilient is your design?
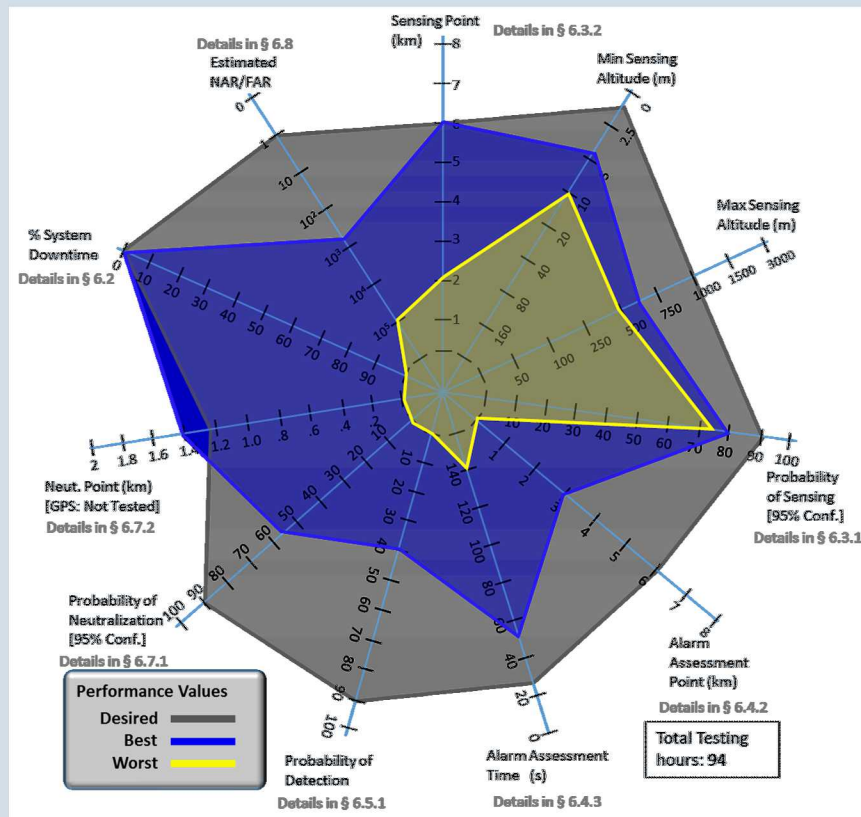
Is this good enough?

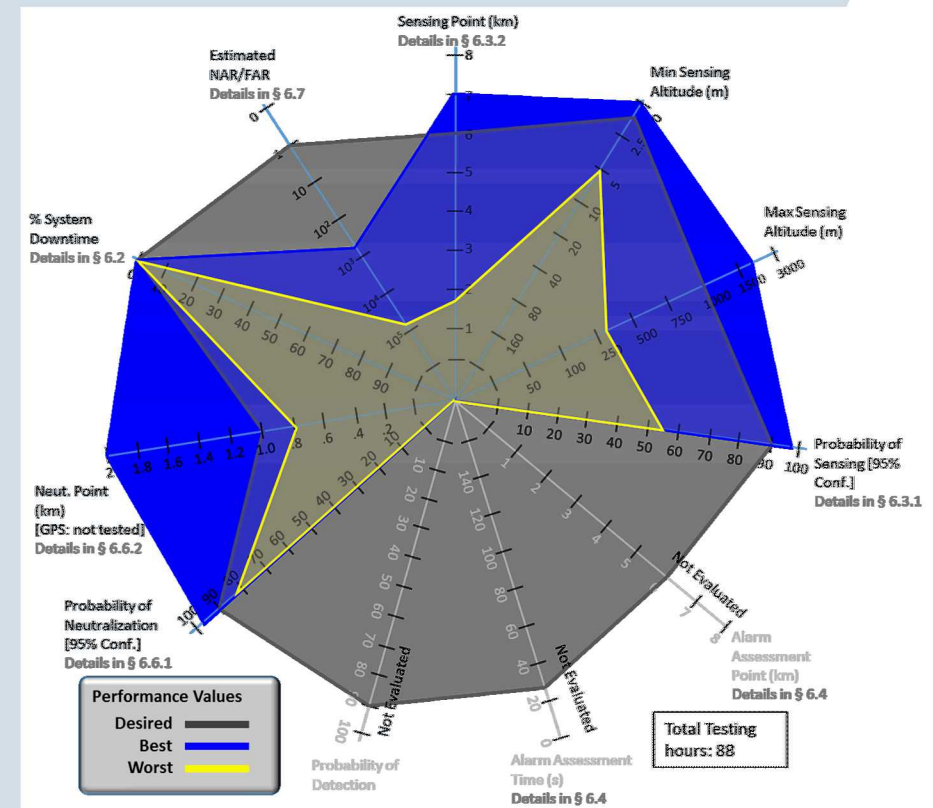# ANALYZE THE DESIGN
IS IT GOOD ENOUGH?
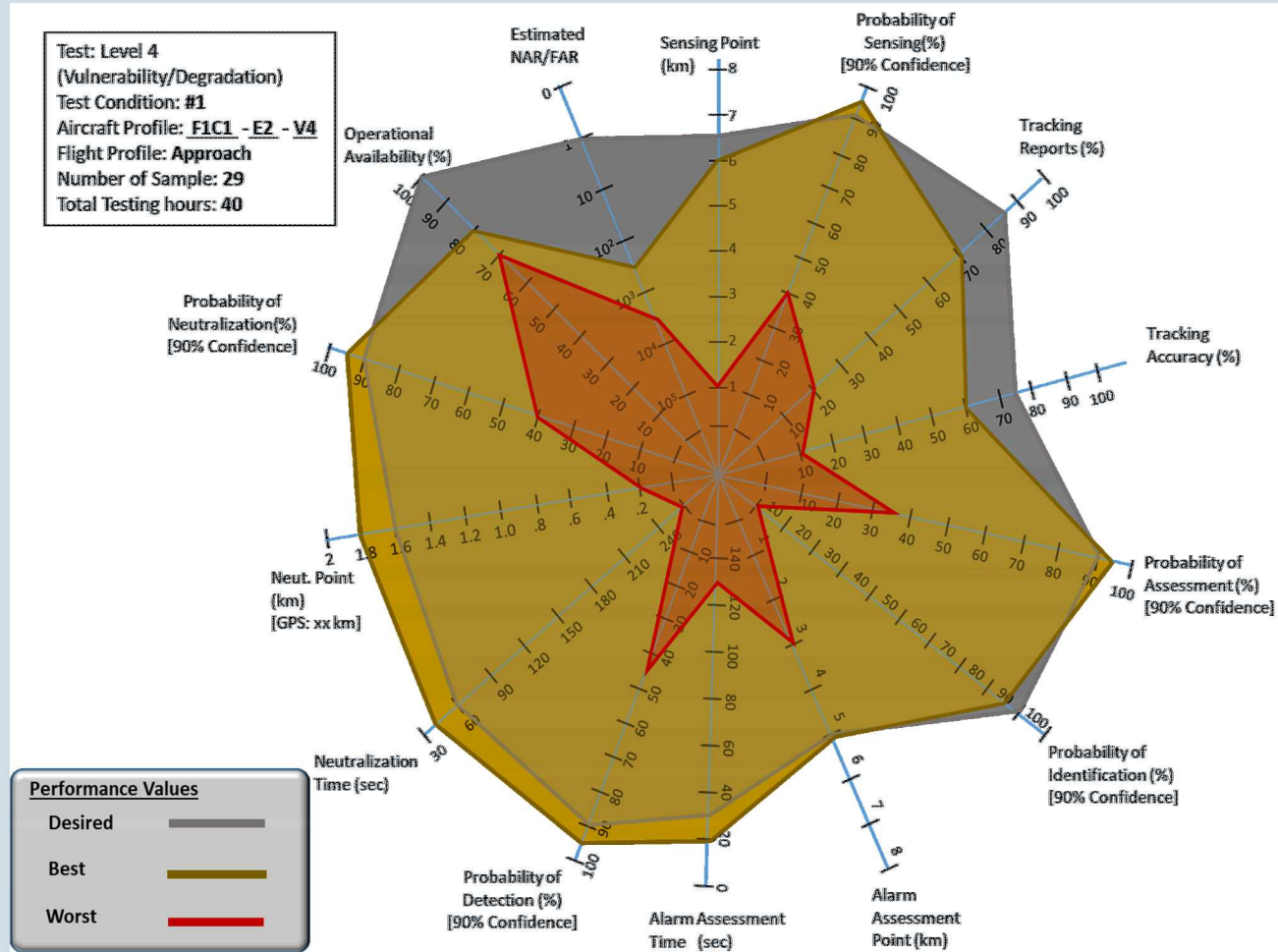
RESULTS – COMPARISON ACROSS TECHNOLOGIES

Radar/Camera Based Detection/Assessment Systems with RF Jamming (Example = CUAS 1)

RF Sensing/Detection Systems with RF Jamming (Example = CUAS 2)

VULNERABILITY/DEGRADATION TESTING

KEY CUAS SECURITY
PERFORMANCE SPECIFICATIONS

- Sensing Presence of a Potential Intruder
  - Probability of Sense (P_S)
  - Sensing Range (R_S)
  - Nuisance Alarm Rate (NAR)
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  - Probability of Assessment (P_A)
  - Assessment Range (R_A)
  - Assessment Time -- (T_A)
- Probability of Detection (P_D)
- Neutralizing Intruder
  - Probability of Neutralization (P_N)
  - Neutralization Range (R_N)
  - Neutralization Time (T_N)

Security Systems Effectiveness (P_e)

HOW MUCH IS ENOUGH?