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Determination of ILS Critical and Sensitive Areas

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Discussion Points

- Effects of Multi-Path on ILS Signal-in-Space
- ILS Critical and Sensitive Areas
- ICAO Recognition of Critical and Sensitive Areas
- Mathematical Model Validation
- Simulation Results
- Conclusions
- Questions

Effects of Multi-Path on ILS

- ILS Localizer and Glide Path Signal Quality is Influenced by Multi-Path
- Multi-Path Occurs When a Radio Signal Travels by More Than One Path to Arrive At the Receiver
  - The Direct Path is From the Transmitter to the Receiver
  - Additional Paths are Created When the Transmitted Signal Reflects Off Another Object and Then Arrives at the Receiver

Effects of Multi-Path on ILS

- Multi-Path Can Be Characterized as Either Static or Dynamic
  - Static Multi-Path is Created by Fixed Objects Such as Buildings or Terrain
  - Dynamic Multi-Path is Created by Transient Objects Such as Airplanes or Vehicles
- The Amount of Degradation on an ILS Signal due to Multi-Path is a Function of Location, Size, and Orientation of the Reflecting Object

Effects of Multi-Path on ILS

- ILS Signal Degradation Due to Multi-Path is Realized by Structure Roughness and Alignment/Angle Deviation
- Effects of Multi-Path due to Static Sources Do Not Change Over Time
- Effects of Multi-Path due to Dynamic Sources Change with Location of the Reflector

ILS Critical and Sensitive Areas

- Aircraft and Vehicles Operating Near Localizer and Glide Path Facilities Can Cause Distortion to the ILS Signal-in-Space
- Protection Areas Around the Localizer and Glide Path Facilities Become Necessary to Protect the Integrity of the ILS Signal-in-Space
  - Historically Called ILS Critical and Sensitive Areas

ILS Critical and Sensitive Areas

- Dimensions and Location of ILS Critical and Sensitive Areas Are Determined by Both Direct Flight Measurement and Mathematical Modeling
- Movement of Aircraft and Vehicles in the ILS Critical and Sensitive Areas Can be Restricted or Operationally Controlled to Protect ILS Signal Quality During ILS Operations

ICAO Recognition of CSA

- The International Civil Aviation Organization (ICAO) Publishes Critical and Sensitive Area Dimensions and Location in Annex 10
- ICAO's Navigation Systems Panel Recognized Published Critical and Sensitive Areas May Not be Sufficient to Protect ILS Signal Quality Considering Today's Larger Aircraft

ICAO Recognition of CSA

- A Group was Commissioned by the Navigation Systems Panel in March 2007 to Consider Updates to ILS Critical and Sensitive Areas
- The Group Determined Updates to ICAO Critical and Sensitive Areas Considering:
  - Critical Area is a Dimension About the Localizer or Glide Path Such That Aircraft or Vehicles Within the Area Cause Out-of-Tolerance Disturbances to the ILS from the Limit of Coverage to 2 Nautical Miles from Threshold

ICAO Recognition of CSA

- Sensitive Area is a Dimension About the Localizer or Glide Path Such That Aircraft or Vehicles Within the Area Cause Out-of-Tolerance Disturbances to the ILS from 2 Nautical Miles from Threshold to the Point the ILS Signal is No Longer Used

ICAO Recognition of CSA

- Critical and Sensitive Area Dimensions are Determined by the Root Sum Square Combination of Static and Dynamic Multi-Path Contribution
  - Static Multi-Path is Considered to Consume 60% of Allowable Tolerance
  - Dynamic Multi-Path is Considered to Consume 80% of Allowable Tolerance

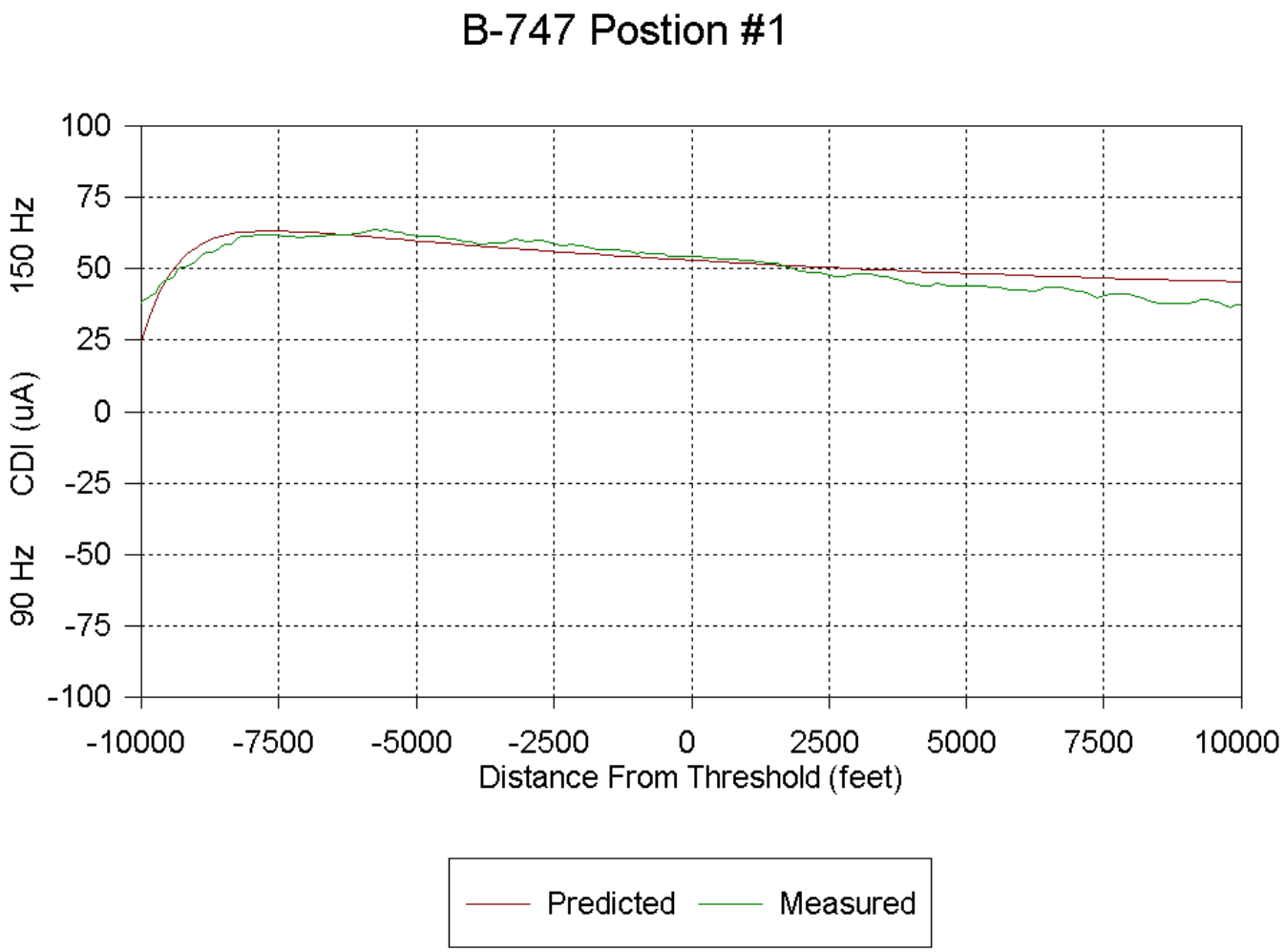
Mathematical Model Validation

- An Extensive Effort Would be Required to Completely Define ILS Critical and Sensitive Areas Only by Flight Measurement Techniques
- Mathematical Modeling and Simulation Techniques Lend Themselves to Better Define ILS Critical and Sensitive Areas
  - Simulation Must be Well Validated by Comparison with Ground and Flight Measurement for a Variety of Situations

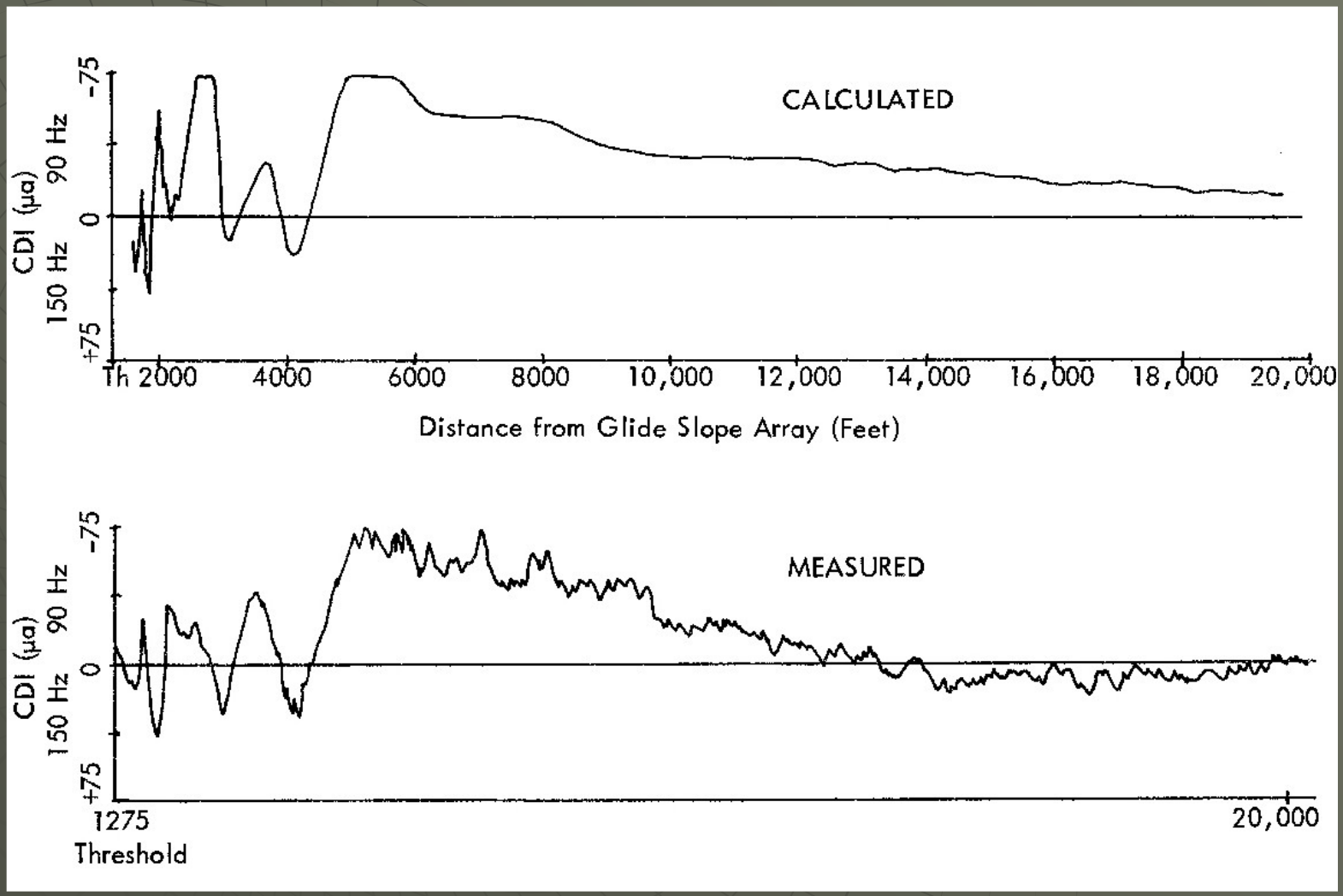
Mathematical Model Validation

- Efforts Conducted in Europe and the United States to Validate Simulation Techniques
  - Locations of Interest Were Determined by Simulation
  - Ground and Flight Measurements of an Actual Aircraft in the Determined Position were Collected
  - Results were Compared to Validate Simulation Techniques

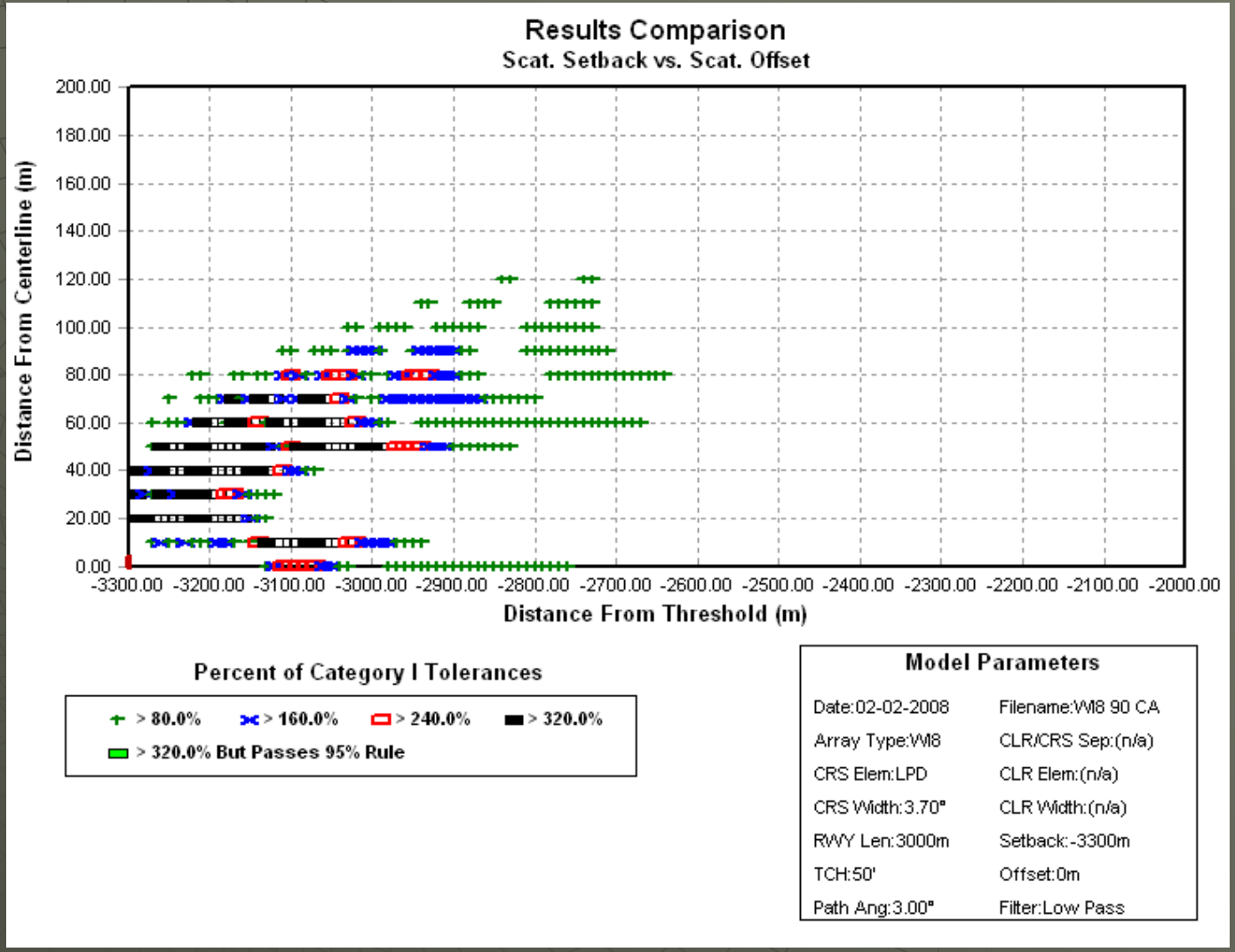
Localizer Validation



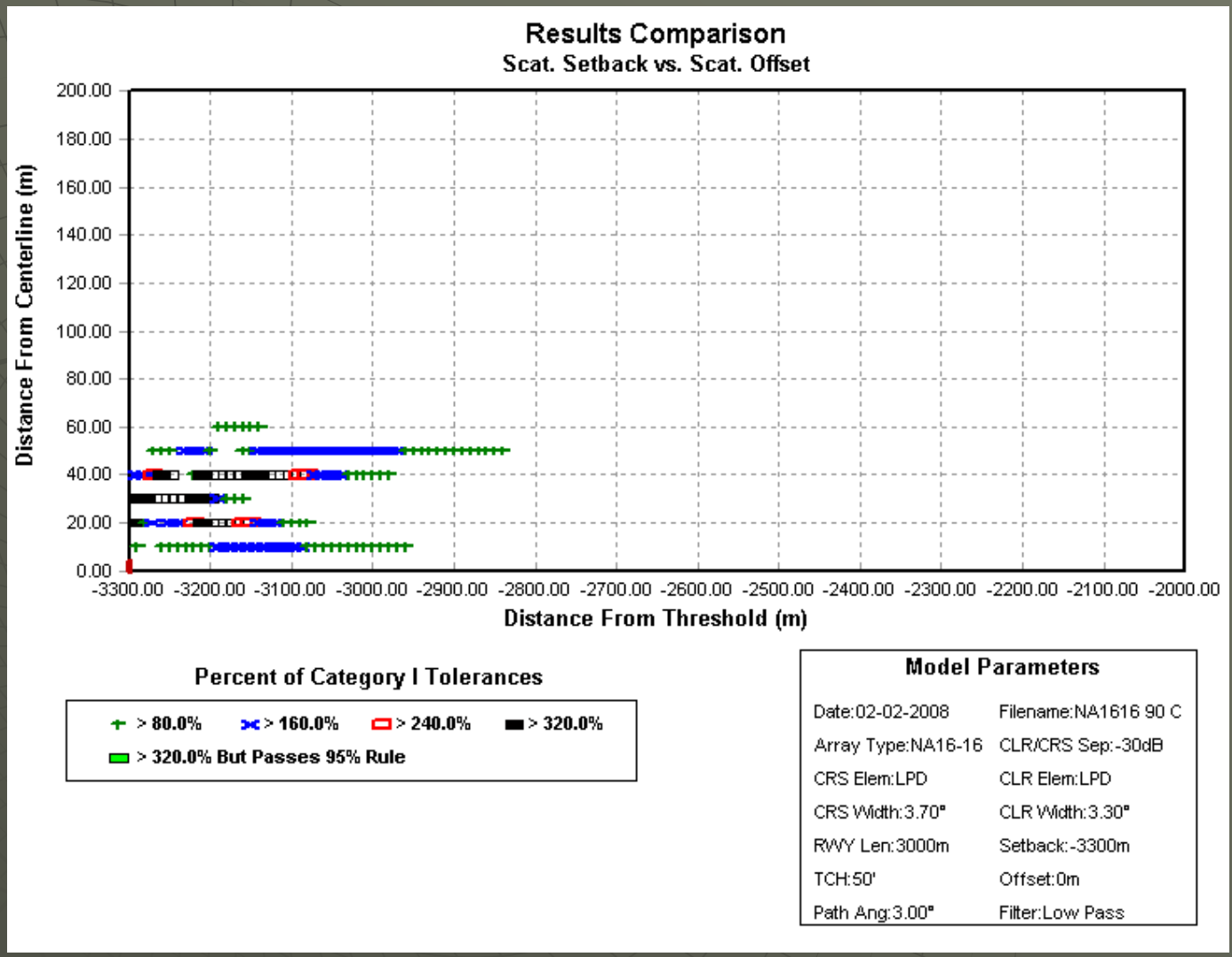
Glide Path Validation



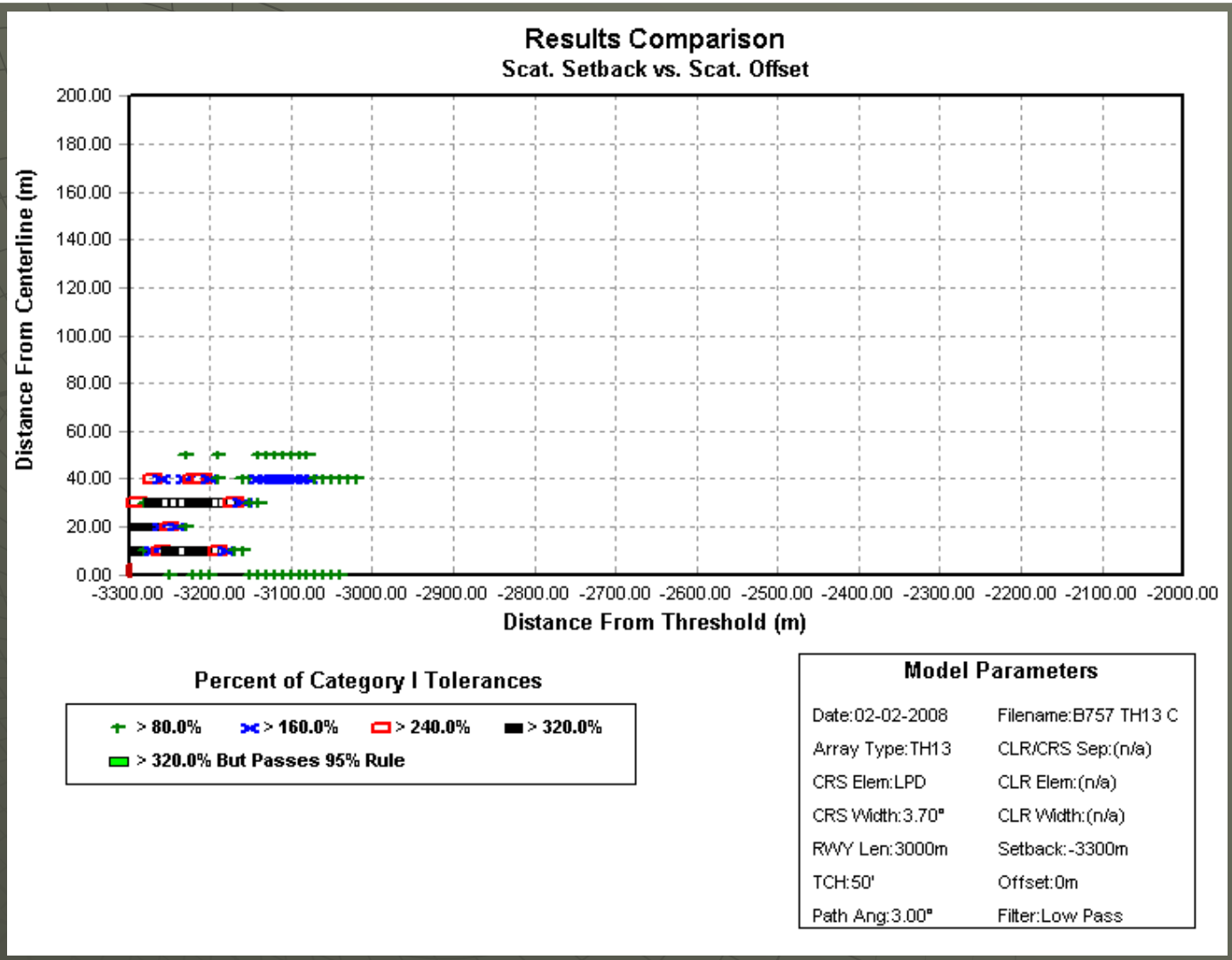
B747 Impact to Small Aperture Localizer



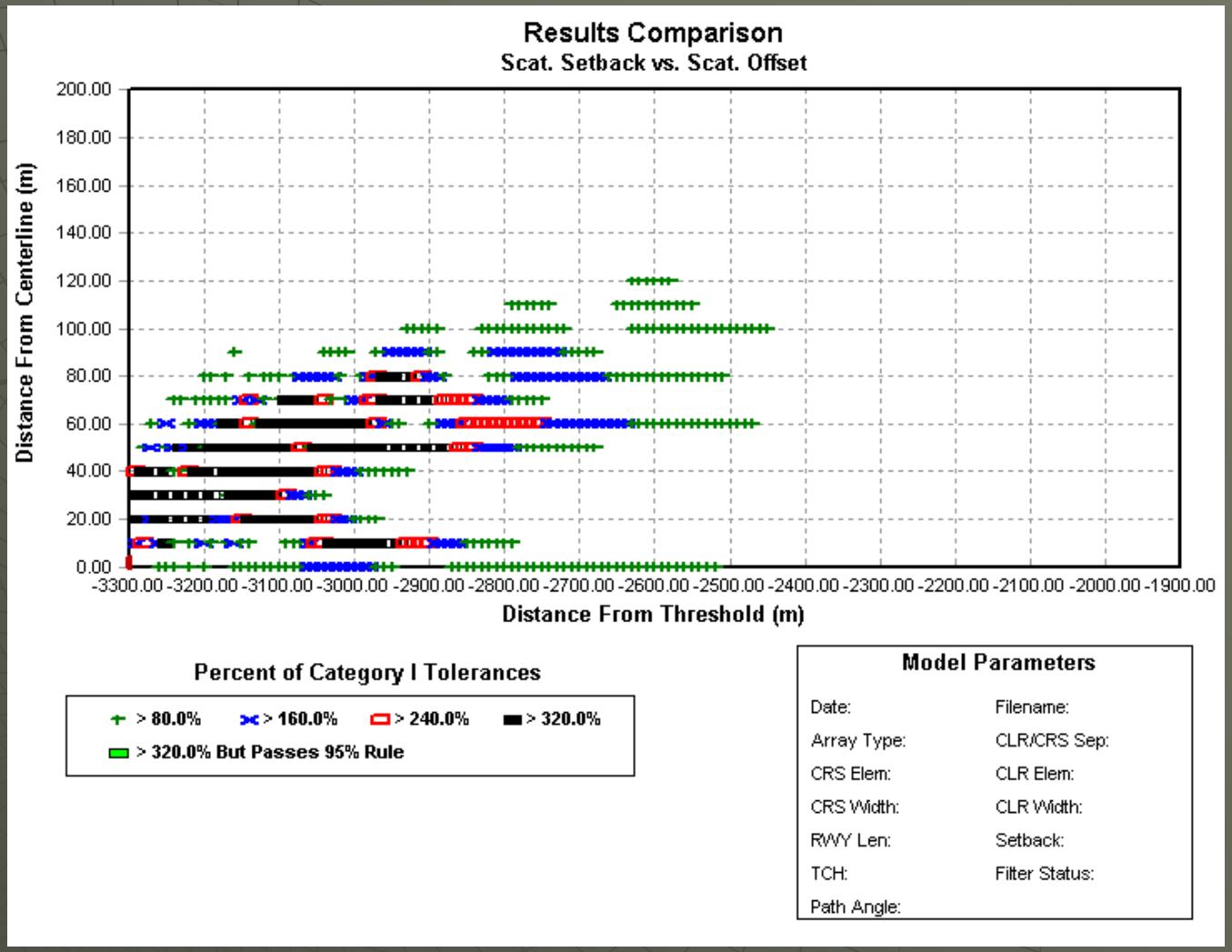
B747 Impact to Large Aperture Localizer



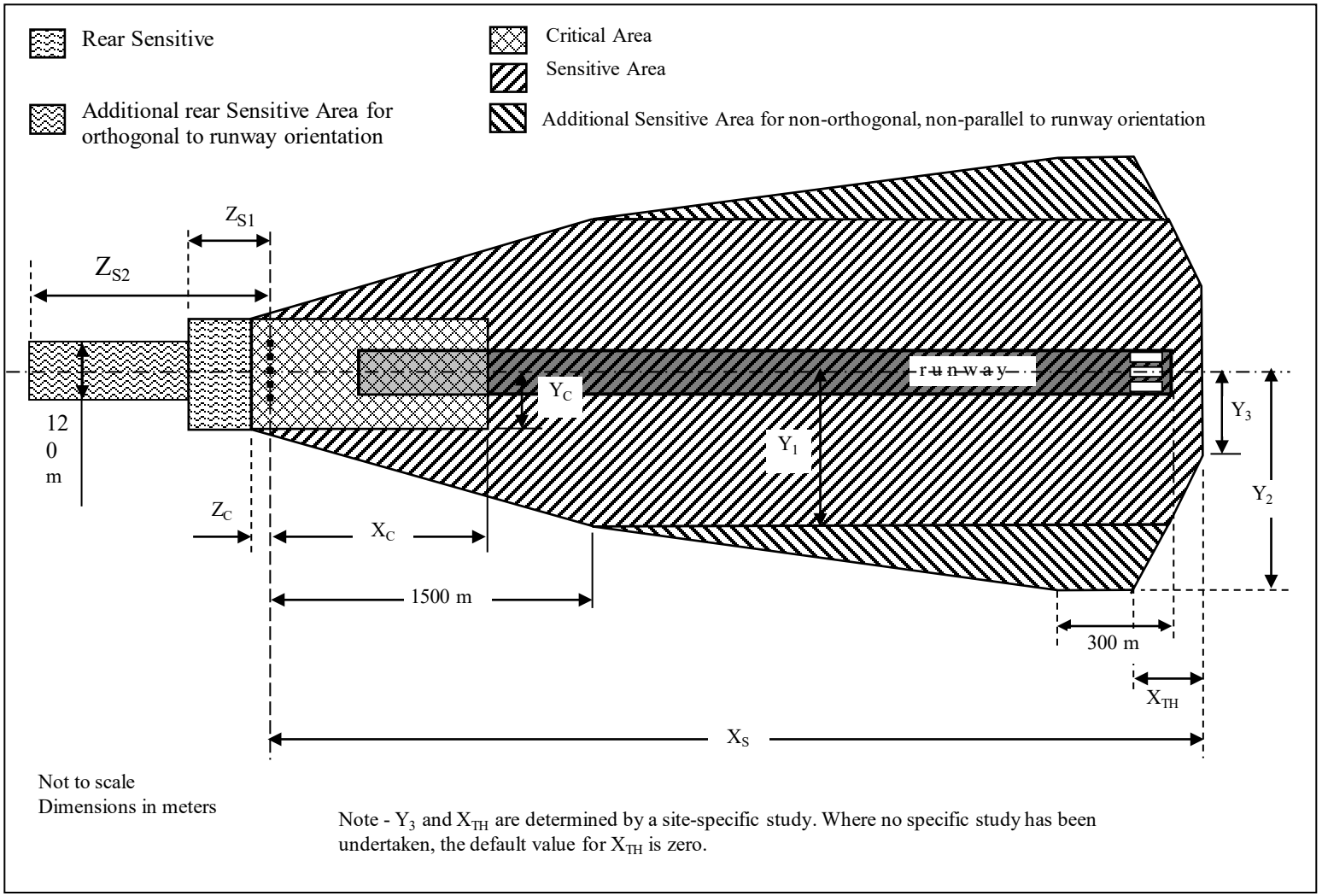
B757 Impact to Medium Aperture Localizer



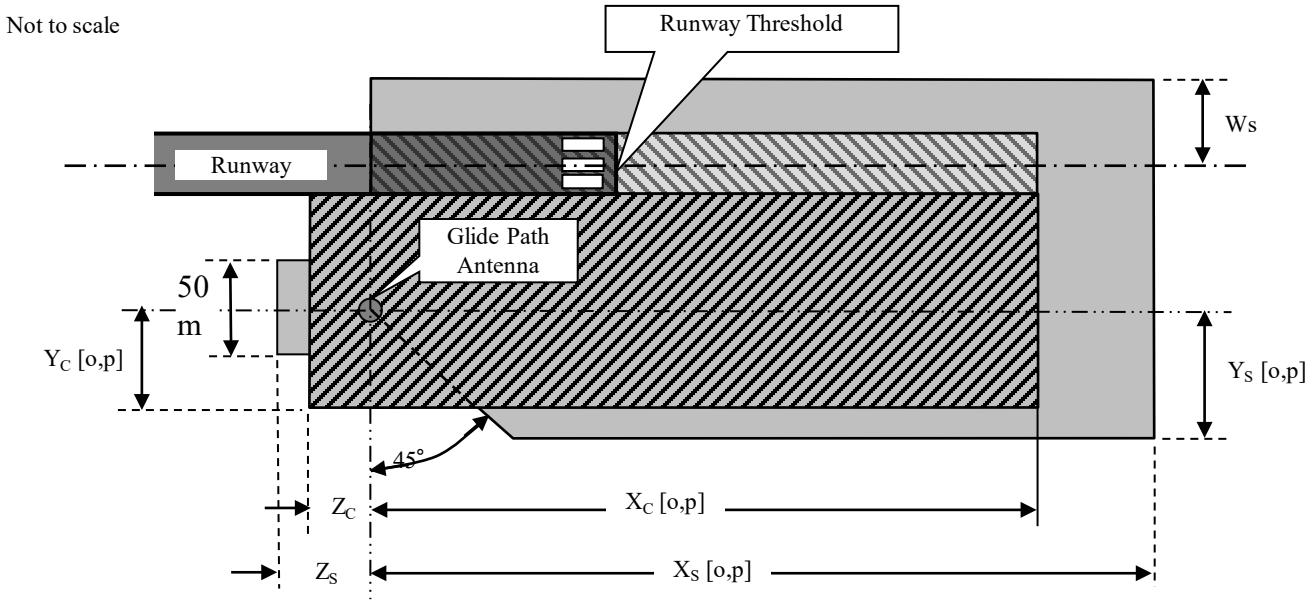
A380 Impact to Medium Aperture Localizer



Localizer Critical and Sensitive Areas



Glide Path Critical and Sensitive Areas



Note –The sensitive area extends on the other side of the runway. If vehicle movements or holding are possible in this area, W_S is assessed through a specific study.

Conclusions

- Critical and Sensitive Area Dimensions are Heavily Influenced by:
  - Aircraft Tail Height and Size
  - Location and Orientation of Reflector
  - Type of Localizer or Glide Path Antenna
- Validated Mathematical Models Can be Used to More Completely Define Critical and Sensitive Areas as Compared to Flight Measurement

Conclusions

- Care Should be Exercised When Using Flight Measurement Techniques Alone to Quantify Effects of an Aircraft or Vehicle on ILS Signal-in-Space Performance as Small Changes in Reflector Location and Orientation Can Result in Varying Levels of Measured Distortion

QUESTIONS?