

# FAA FRANGIBILITY RESEARCH

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By: Joseph Breen

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**Federal Aviation  
Administration**



# FAA Frangibility Research

- The overall objective of this research is to develop a better methodology for measuring and evaluating the frangibility characteristics of connections/structures intended for use on Airport Runway Safety Areas (RSAs) and Taxiway Safety Areas (TSAs).
- FAA Frangibility Research is being conducted under contract with Select Engineering Services (SES) and their subcontractors (Applied Research Associates (ARA), MIRA, and TriDynamic Solutions Inc.)



# Frangibility Research Elements

- **Task 1 Requirements Analysis**
- **Task 2 Identify Frangible Structures for Evaluation**
- **Task 2 Finite Element Development**
- **Task 3 Test Setup Development**
- **Task 4 Test Plans / Procedures Development**
- **Task 5 Test Setup Fabrication**
- **Task 6 Dynamic Testing and Evaluation**
- **Task 7 Guidebook Development**



# Task 1 - Requirements Analysis

- **AC 150/5220-23**
  - AC 150/5300-13 – Airport Design
  - AC 150/5345-44 – Signs, Runway and Taxiway
  - AC 150/5345-45 – Low Impact Resistant Structures
  - AC 150/5345-46 – Light Fixtures, Runway and Taxiway
  - FAA Drawing C-6046 – PAPI's and REIL's
  
- **Additional Reference**
  - Engineering Brief No. 79 – Determining RSA NAVAID Frangibility and Fixed-By-Function Requirements
  - NCHRP Report 350 – Recommended Procedures for the Safety Performance Evaluation of Highway Features
  - FAA-E-2702 – Low Impact Resistant Structures
  - FAA Drawings D-6155-1 through 46
  - FAA-E-2159E – Performance Specification REIL
  - FAA-E3007 – Performance Specification PAPI



## Task 2 - Identify Frangible Structures for Evaluation

- FAA Approved Approach Lighting Systems including those mounted in EMAS Beds
- Frangible Configuration of the End Fire Glide Slopes (EFGS)
- Composite Jet Blast Deflectors

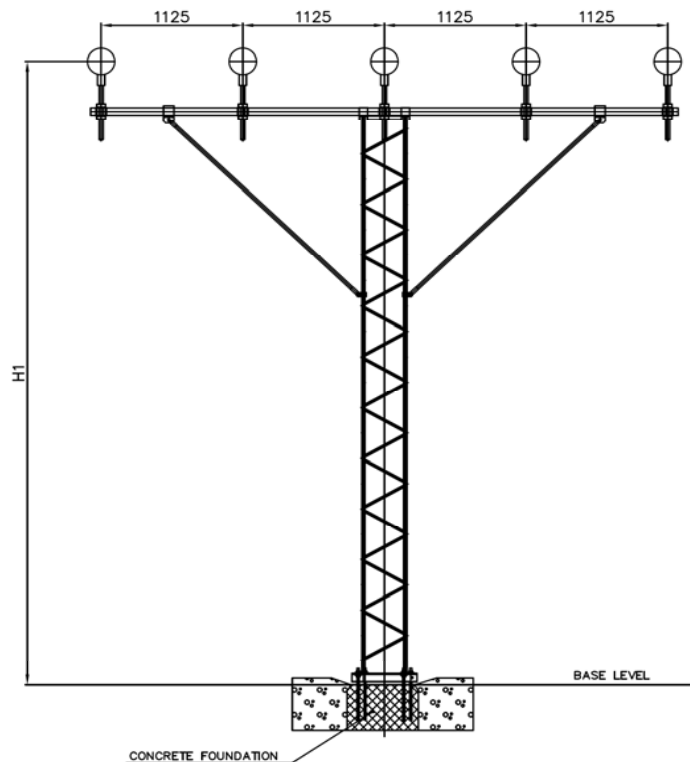


## **Task 3 Finite Element Development**

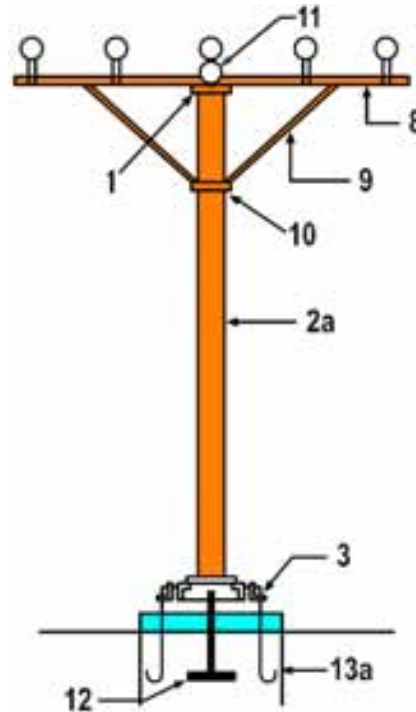
- **Collect structural information for Frangible Structures and Piper Navajo Aircraft (Max. Takeoff Weight is 2,948 kg. (6500 lb))**
  - **Material properties**
  - **Dimensions**
  - **Assembly and Installation Information**
  - **Test reports**
- **Generate Finite Element Models**
  - **Using LS Dyna, models can be created and simulations can be run.**
- **Run Simulation**
  - **Adjust simulation parameters to generate a reasonable model.**
  - **Analyze results and generate final report.**



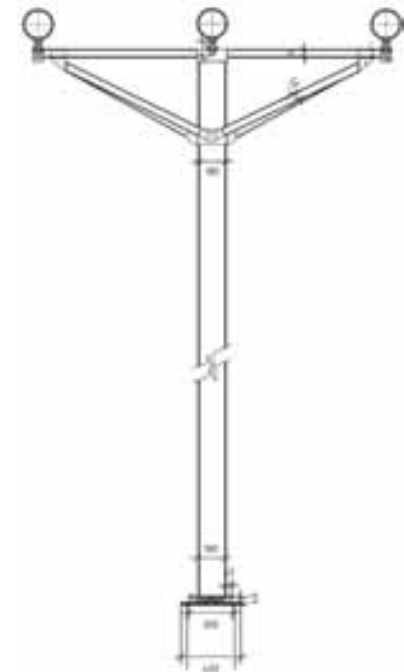
# ALS Towers Selected for Simulation and Testing



•Exel L400

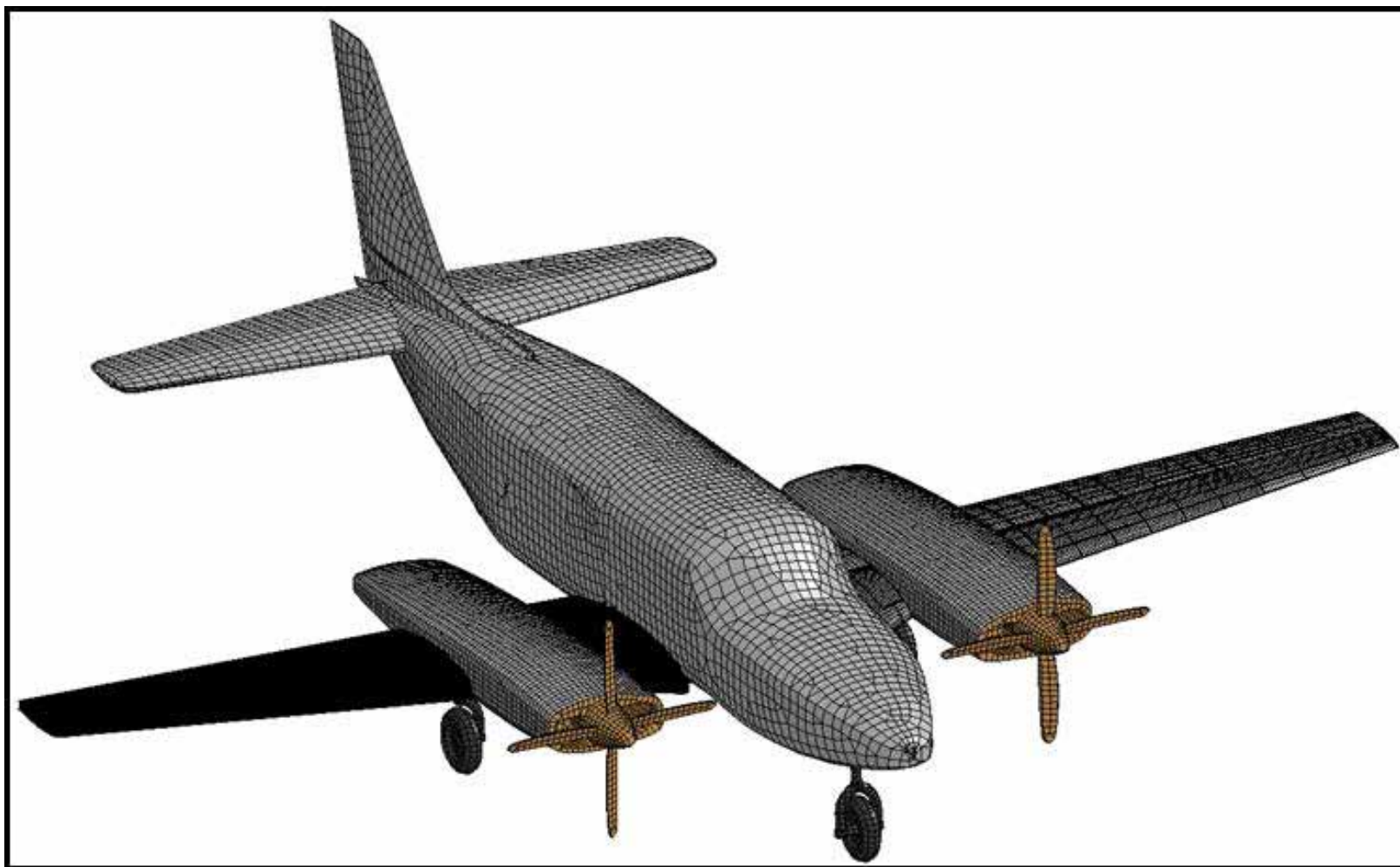


•Jaquith M-20



•Pollite 3LM

# Piper Navajo Aircraft





# FAA AC 150/5220-23

- **Structural Integrity Criteria for Frangible Connections**
  - **Withstand wind and jet blast loads**
  - **Break, distort, or yield when subject to collision force of a 6,600 pound (3,000 kg) aircraft either moving on the ground at 31 mph (50 km/h) or airborne and traveling at 87 mph (140 km/h).**
  - **Under an aircraft collision condition to not impose a force on an aircraft in excess 13,000 pounds force (58 kN) and limit the energy imparted to the aircraft to 40,500 foot-pounds (55kJ).**
  - **Frangibility point no greater than 3.0 inches above surrounding grade.**



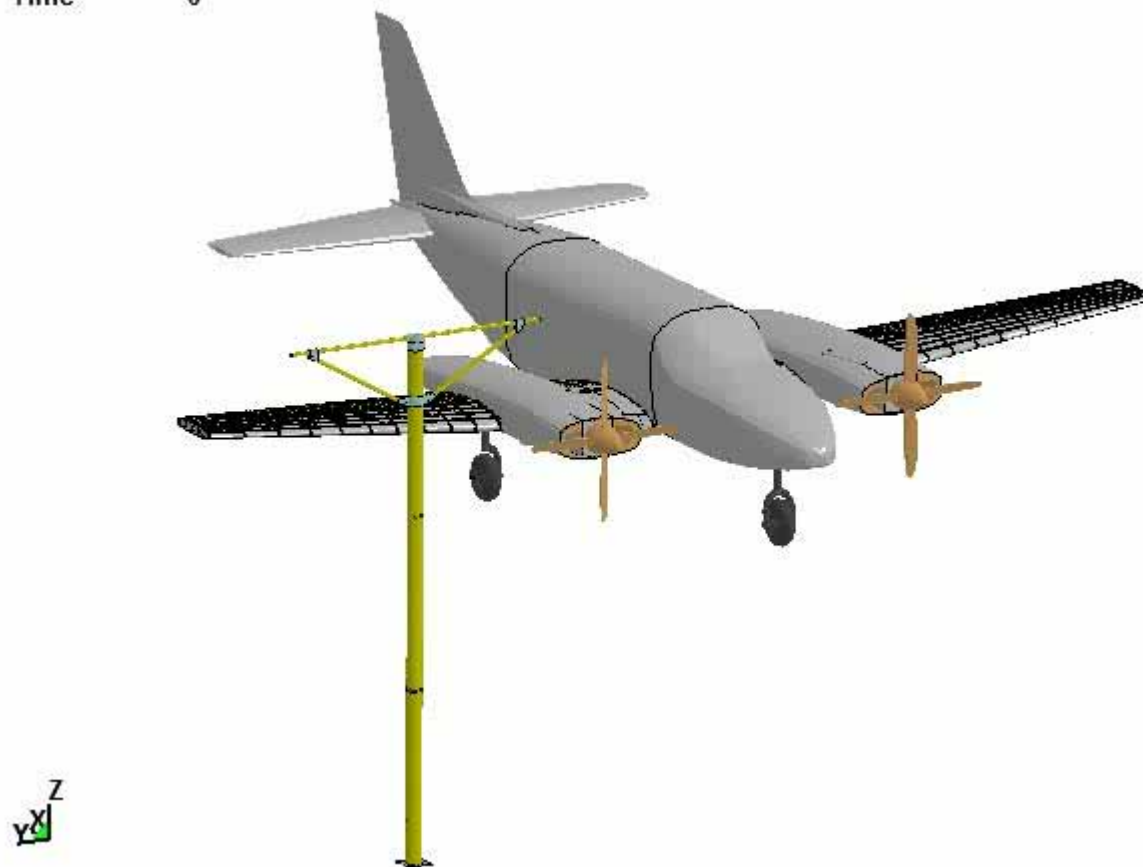
## FAA AC 150/5220-22

- Approach light standards mounted in EMAS Beds must be designed to fail at two points.
- First point of frangibility to be 3 inches or less above top of EMAS Bed.
- Second point of frangibility to be 3 inches or less above the expected residual depth of the EMAS Bed after the passage of a design aircraft.

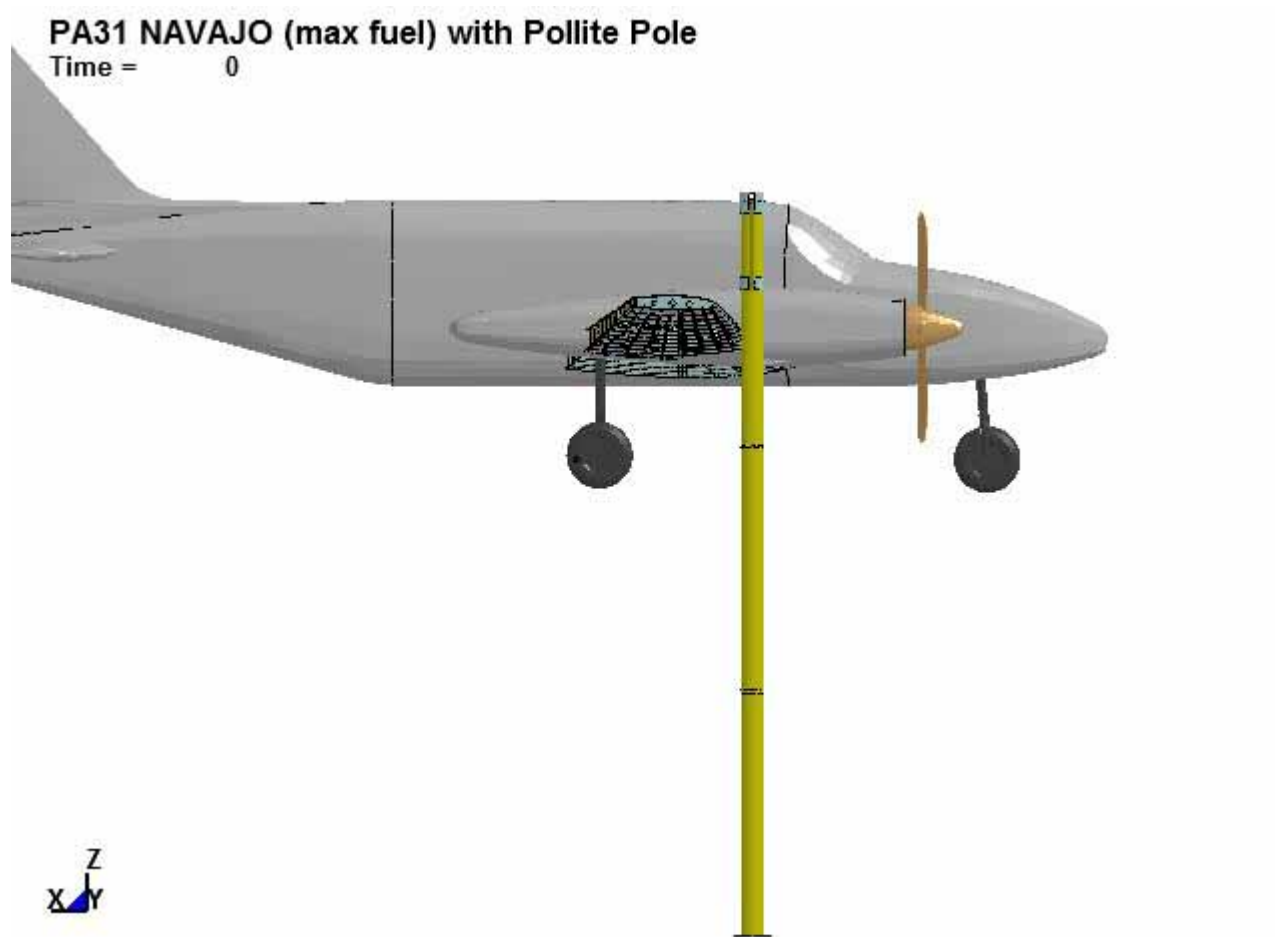


# Aircraft Colliding with Pollite Tower – Front View

PA31 NAVAJO (max fuel) with Pollite Pole  
Time = 0

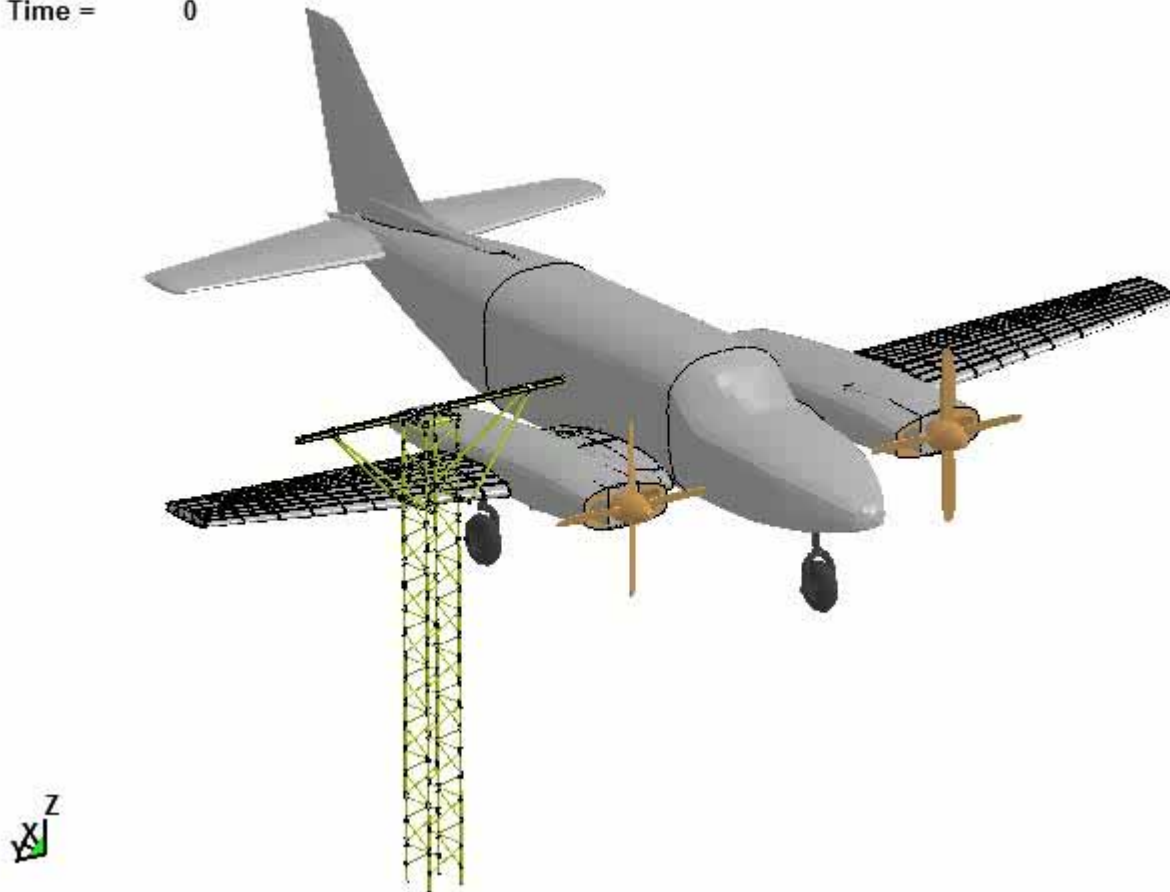


# Aircraft Colliding with Pollite Tower – Side View

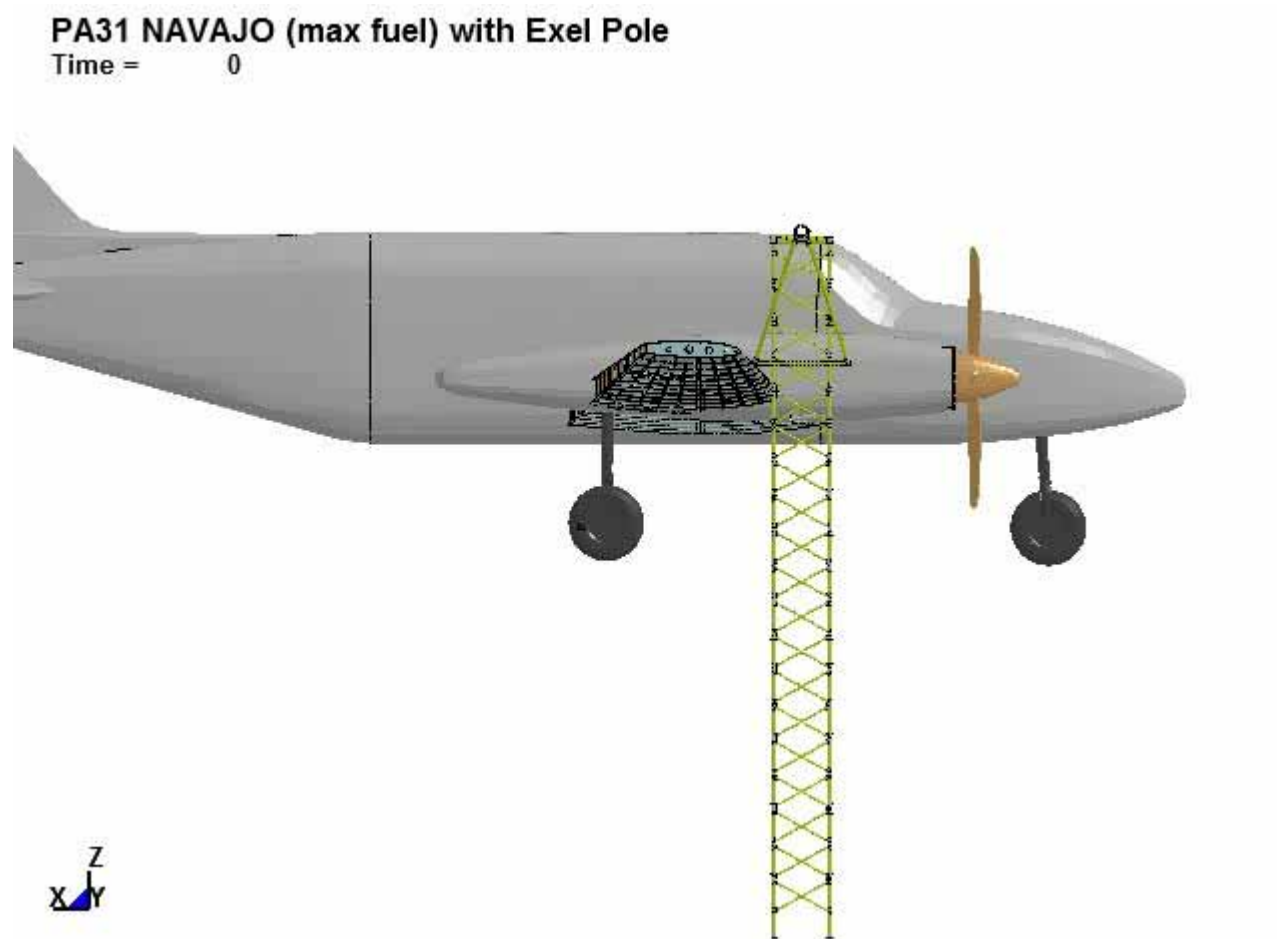


# Aircraft Colliding with Exel Tower – Front View

PA31 NAVAJO (max fuel) with Exel Pole  
Time = 0



# Aircraft Colliding with Exel Tower – Side View





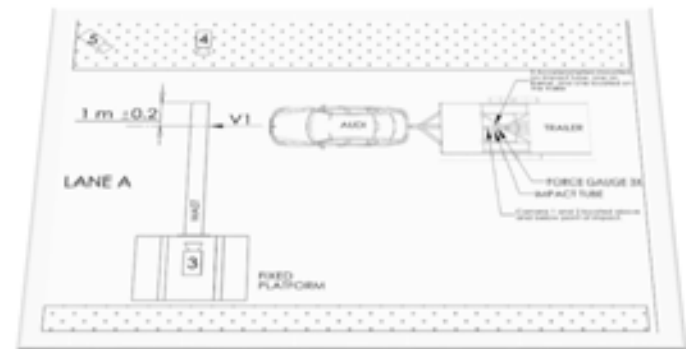
# Task 3 - Test Setup Development

- Testing Setup being developed by MIRA of the UK working with SES.
- Testing to be conducted on a fixed-rail test track 250 meters in length and 4 meters in width.
- Rail-Guided Trolley (3,000 kg mass) will be accelerated to 140 kph utilizing a computer controlled winch system.
- Trolley mounted impactor will engage horizontally oriented frangible structure.
- A combination on-board braking system and external stopping system will be utilized to stop the trolley after collision with the frangible structure.



## Task 4 – Test Plans/Procedure Development

- Specify all Instrumentation including Tri-Axial Load Cells, Accelerometers, Velocity Measuring Device(s), High Speed Cameras, Data Acquisition System, and Data Processing Software/Filters.
- Prepare layout and equipment assembly drawings.
- Perform load analysis as needed.
- Identify accuracy capabilities and acceptable error range.
- Develop risk management strategies.
- Finalize Test Plan.



# Task 5 – Test Setup Fabrication

- Procure and calibrate instrumentation.
- Verify Test Equipment Functionality
- Procure and fabricate parts necessary to assemble trolley test vehicle.
- Perform load tests.
- Update drawings to reflect As-Built Configurations.



# Task 6 – Dynamic Testing and Evaluation

## ■ Crash Testing

- Perform functionality tests on testing equipment
- Run full scale tests on all specified items
- Verify proper data collection

## ■ Analyze Results

- Process testing data
- Correlate test data with simulation results
- Identify repeatable methods for increasing the accuracy in future simulations

## ■ Generate Report Containing Results



# Task 7 – Guidebook Development

- **Develop a Guidebook containing dynamic (crash) test performance requirements for frangible connections/structures.**
- **Guidebook will serve as a supplement to FAA AC 150/5220-23.**



# QUESTIONS ?

