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# Risk Assessment of RSA Alternatives at San Francisco International Airport

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# Outline

- Objective
- RSA Alternatives
- ACRP Methodology
- Analysis with EMAS
- SFO Scenarios
- Results
- Conclusions

# Objective

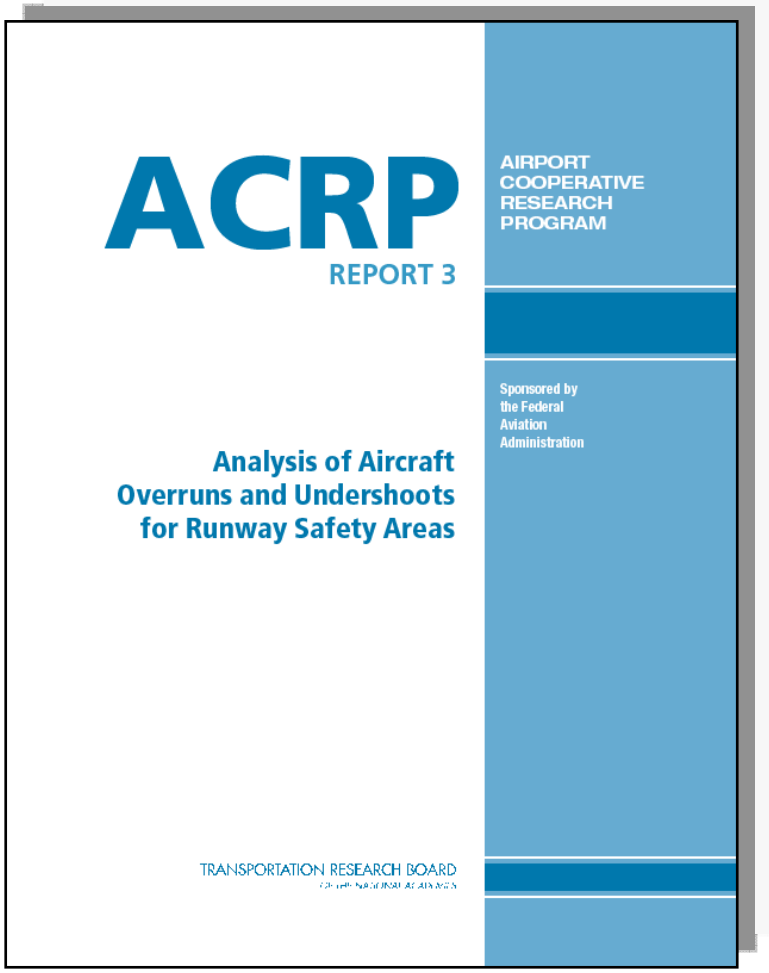
- Present Case-Study for probability assessment of aircraft overruns and undershoots in support of cost-benefit studies to select infrastructure alternatives for existing SFO RSAs, including the use of Engineered Materials Arrestor Systems (EMAS).

# Alternatives to Improve RSAs

- Extend existing RSA
- Modify or relocate the runway
- Implemente declared distances
- Use arresting systems (e.g. EMAS)

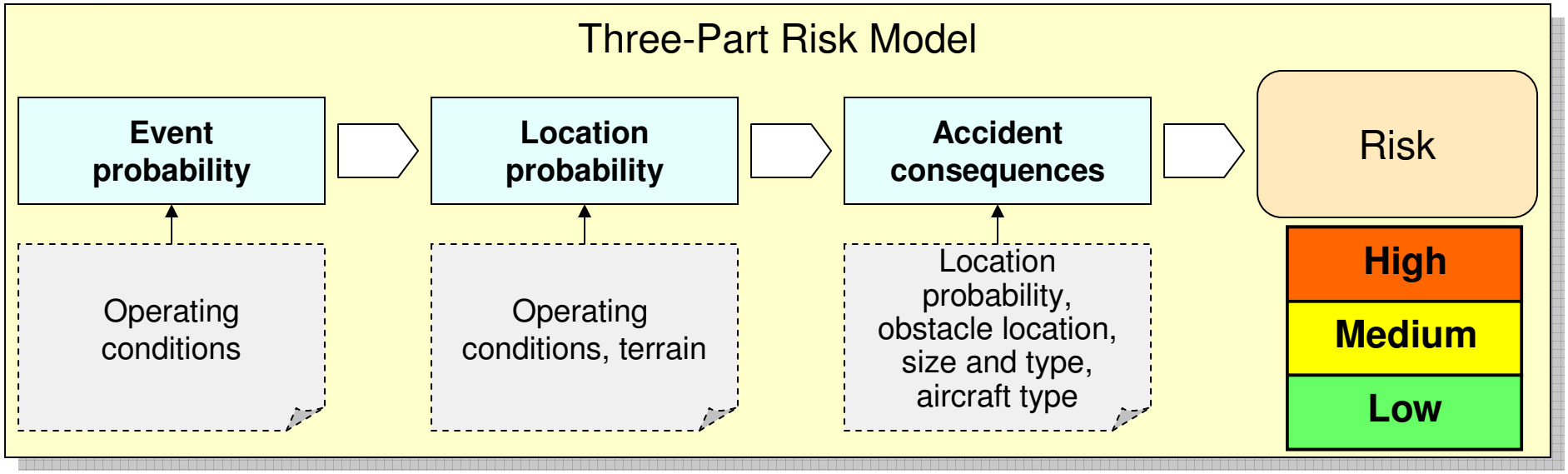
# ACRP Methodology

- ACRP Report 3 – Analysis of Aircraft Overruns and Undershoots for Runway Safety Areas
- Methodology for quantitative assessment of Runway Safety Areas



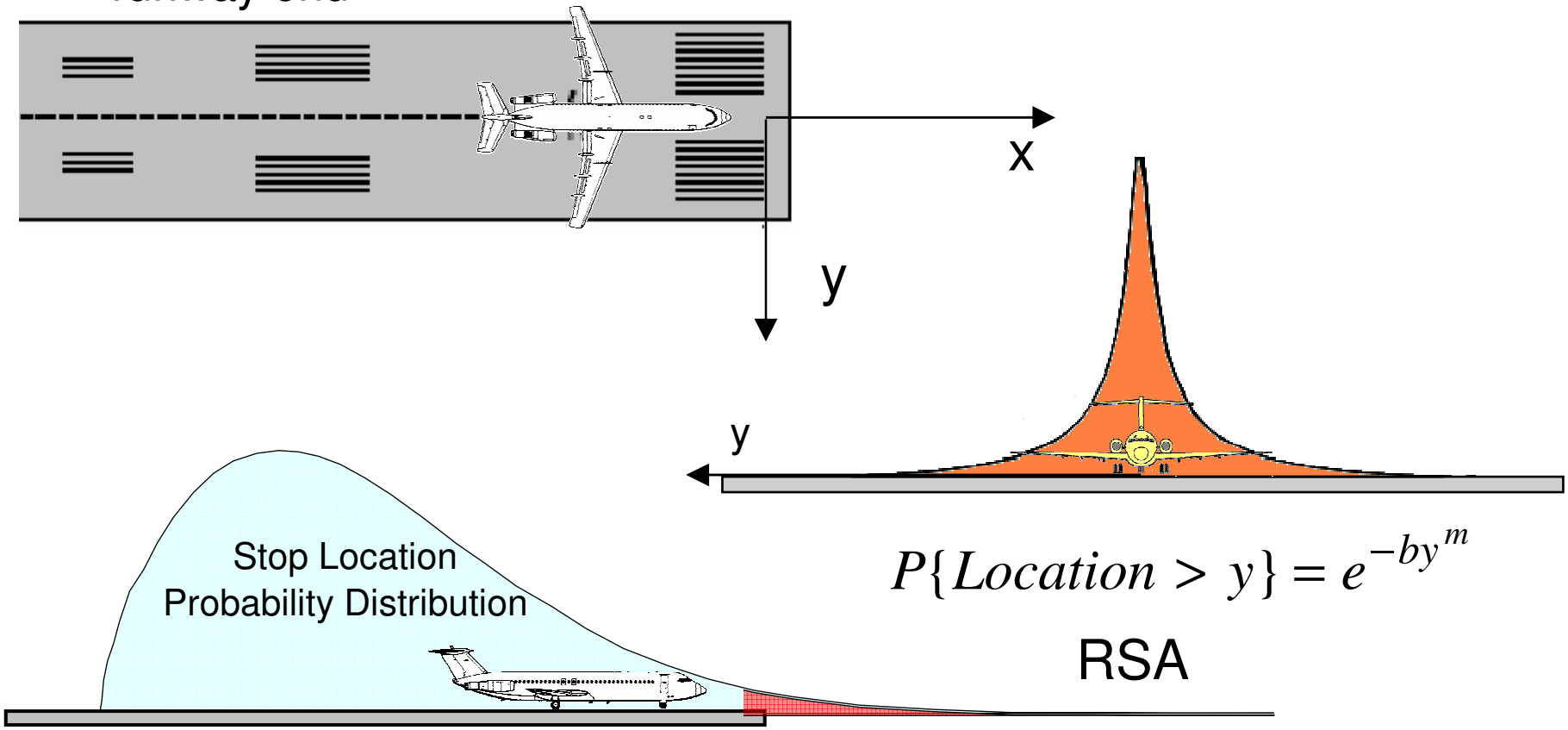

http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_003.pdf

# Model Structure



# ACRP Report 3

- Approach to quantitatively estimate the probability that an aircraft will exit the runway and stop beyond a given distance from the runway end




$$P\{Location > y\} = e^{-by^m}$$

$$P\{Location > x\} = e^{-ax^n}$$

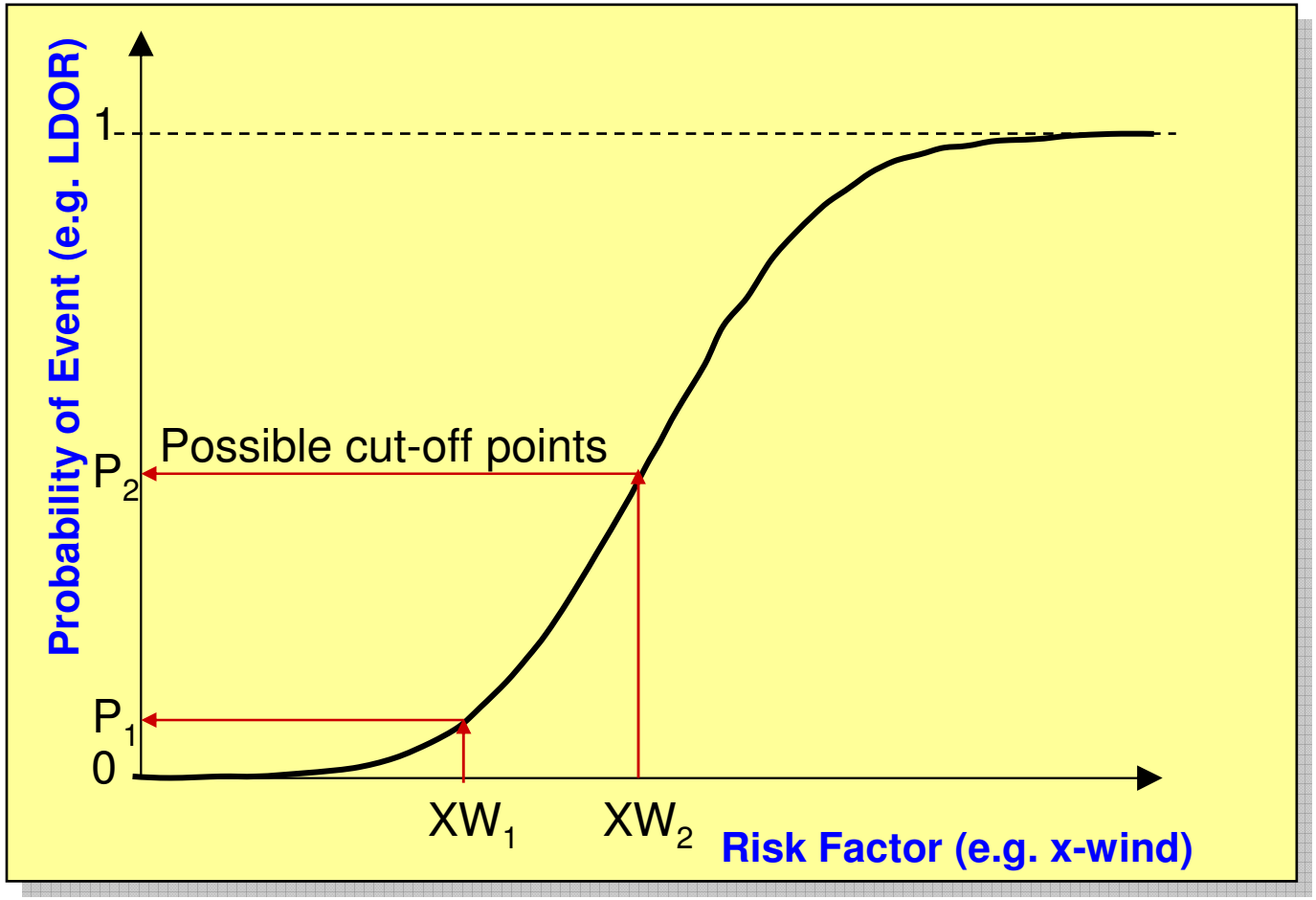
# Frequency Models

- Probability = $N_{i/a}$ / $N_n$ (under certain operation conditions)

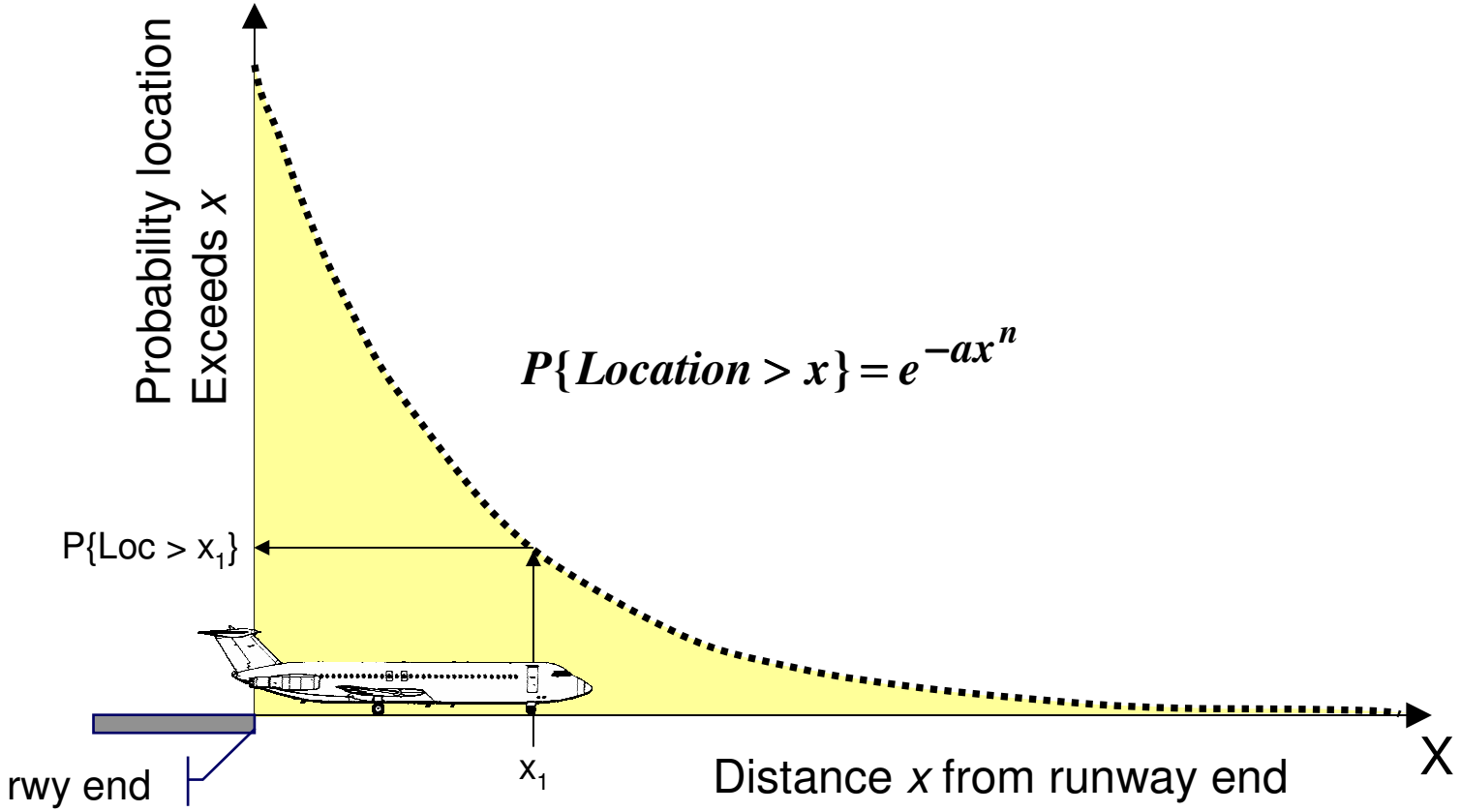
$$P\{Event\} = \frac{1}{1 + e^{b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + \ldots}}$$

- P{Event} is the probability (0-100%) of an accident type occur given certain operational conditions.
- $X_i$ = f(ceiling, visibility, crosswind, gusts, rain, type of aircraft, etc.)

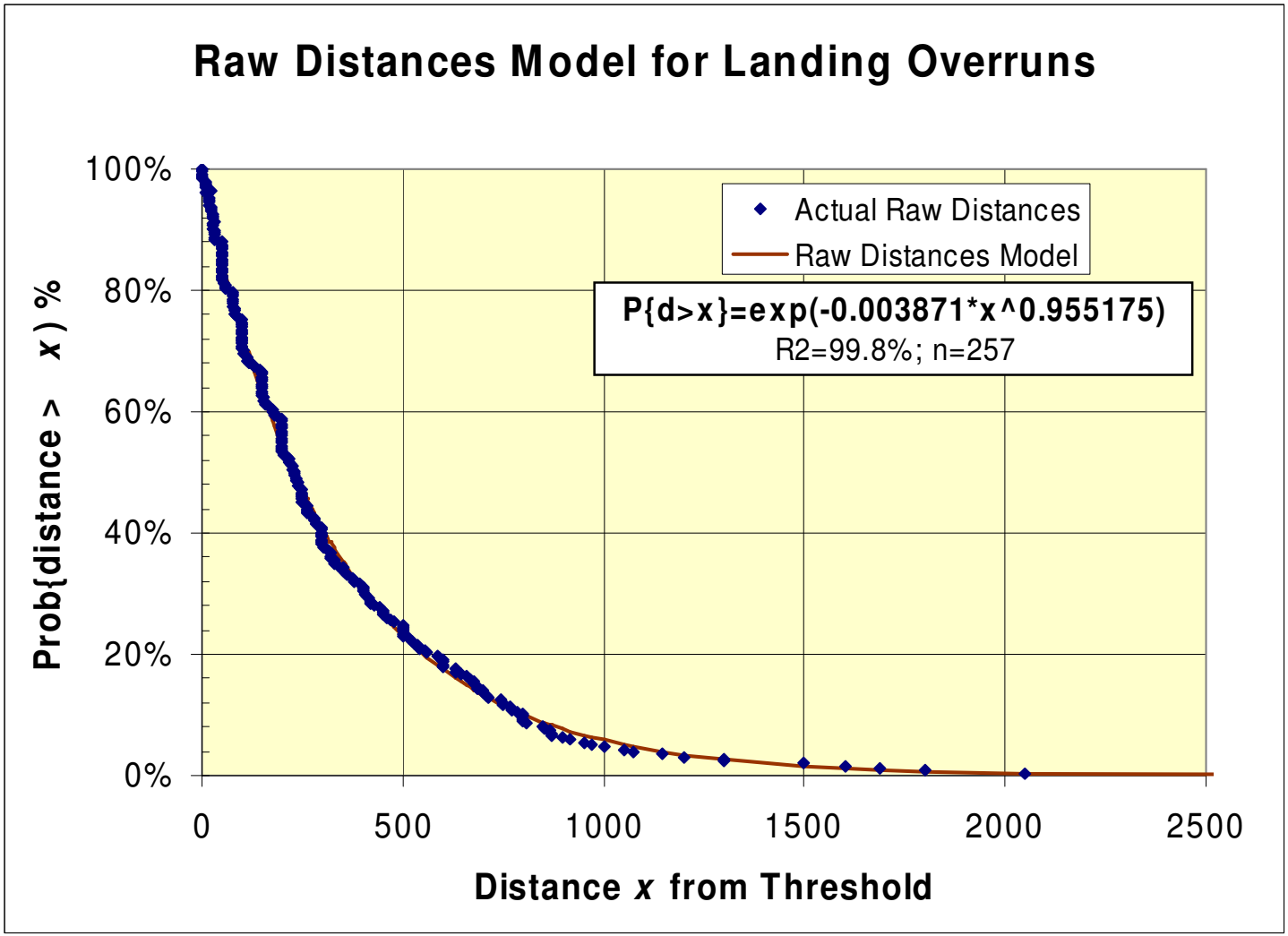
# A Simple Example



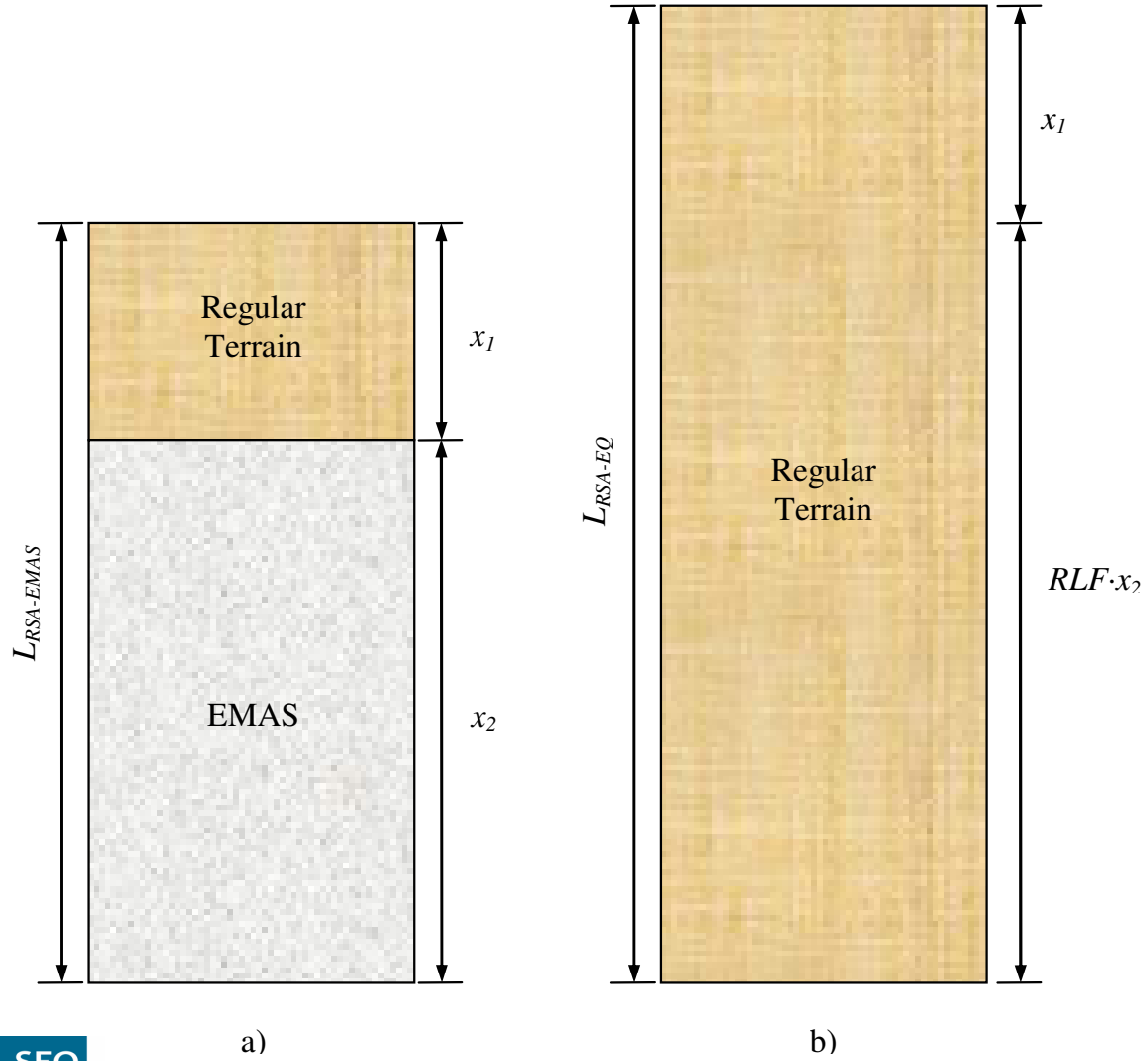
# Location Models



# Location Model - Example

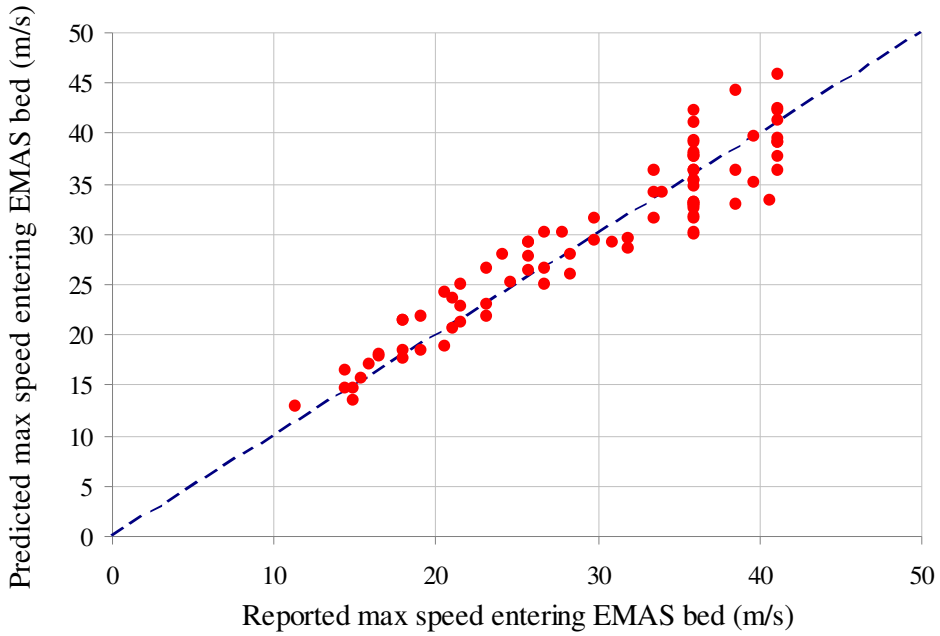


# Analysis with EMAS – Basic Concept



# Analysis with EMAS

$$v = 3.0057 - 6.8329\log(W) + 31.1482\log(S)$$

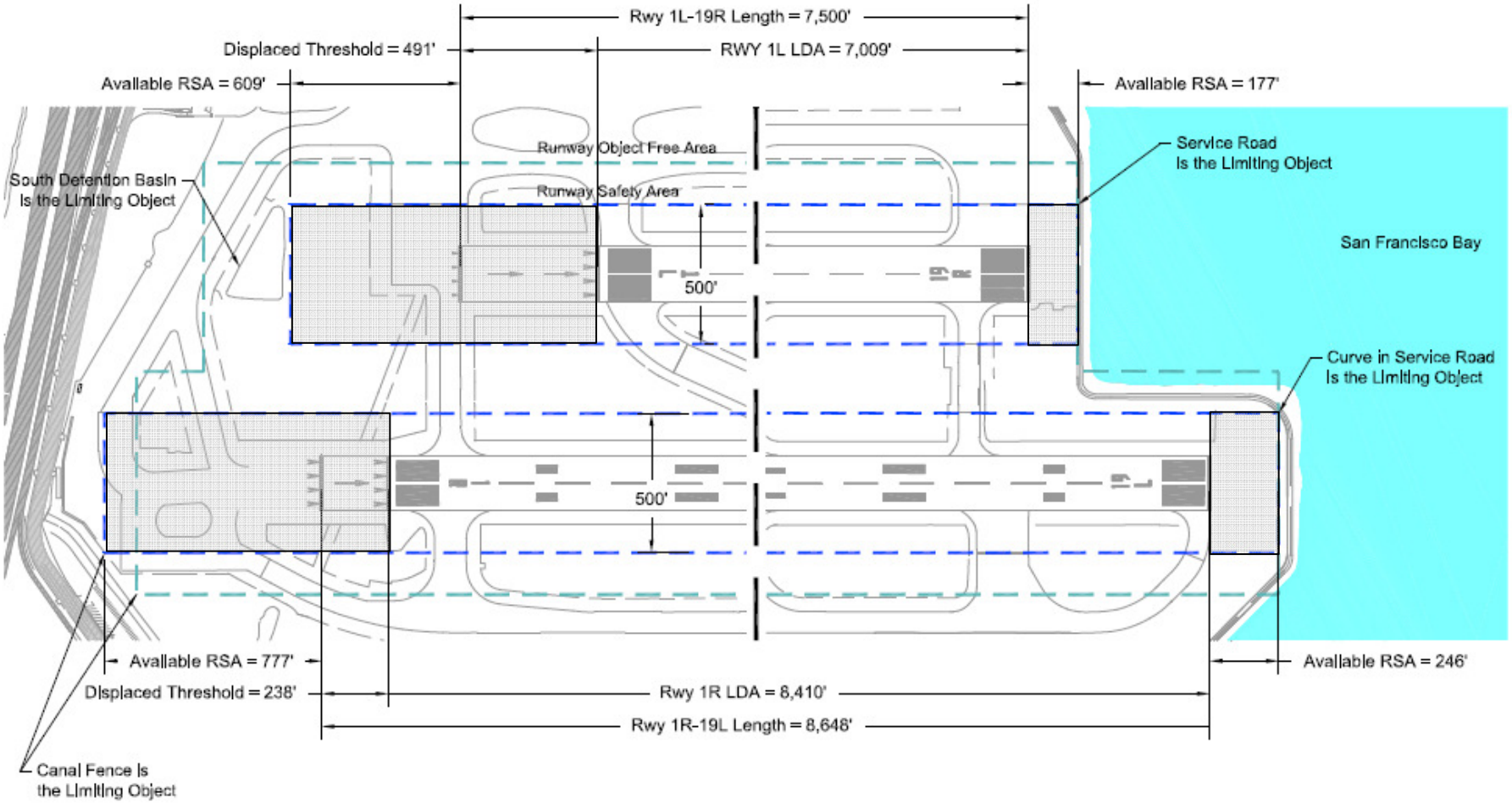



$$S_{RSA} = \frac{a_{EMAS}}{a_{RSA}} S_{EMAS} = RLF \cdot S_{EMAS}$$

# Aircraft Movements

| Arrival End/RSA | LDOR | LDUS | TOOR | Total # of Movements Challenging the RSA |
|---|---|---|---|---|
| 19R | 17 | 3,864 | 75,728 | 79,609 |
| 19L | 101 | 17,660 | 138,738 | 156,499 |
| 01R | 17,660 | 101 | 294 | 18,055 |
| 01L | 3,864 | 17 | 1,355 | 5,236 |
| 28R | 433 | 189,570 | 12,160 | 202,163 |
| 28L | 251 | 131,294 | 11,809 | 143,354 |
| 10R | 131,294 | 251 | 51,806 | 183,351 |
| 10L | 189,570 | 433 | 49,322 | 239,325 |
| Total | 343,190 | 343,190 | 341,212 | 1,027,592 |

# Existing Conditions – Rwys 01/19

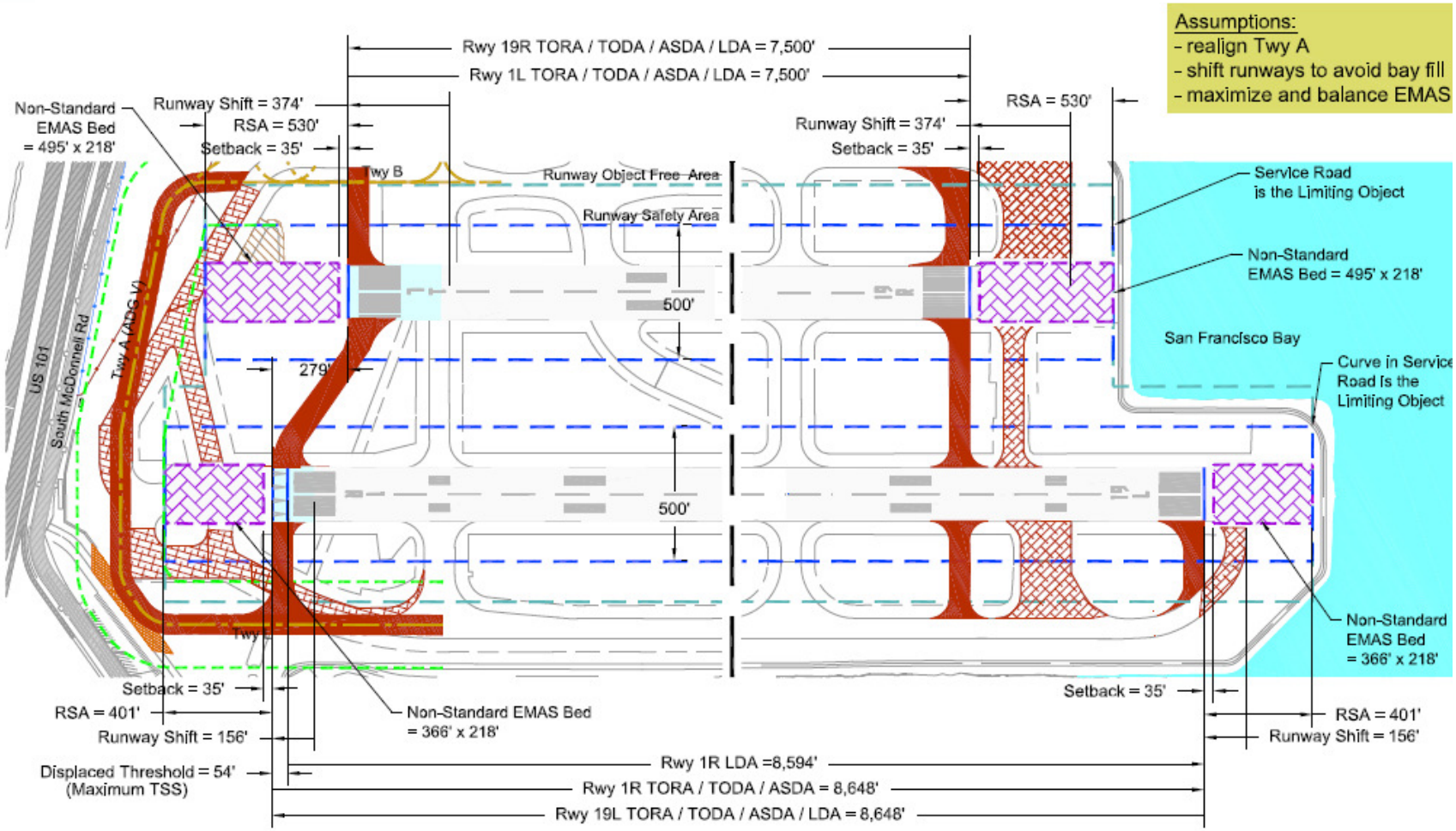


# SFO RSA Alternatives

- Refinement A
  - *Bay fill to install standard EMAS on 19s*
  - *Shift 1R/19L north*

- Refinement B
  - *Create standard RSAs for 28s*

# Refinement A

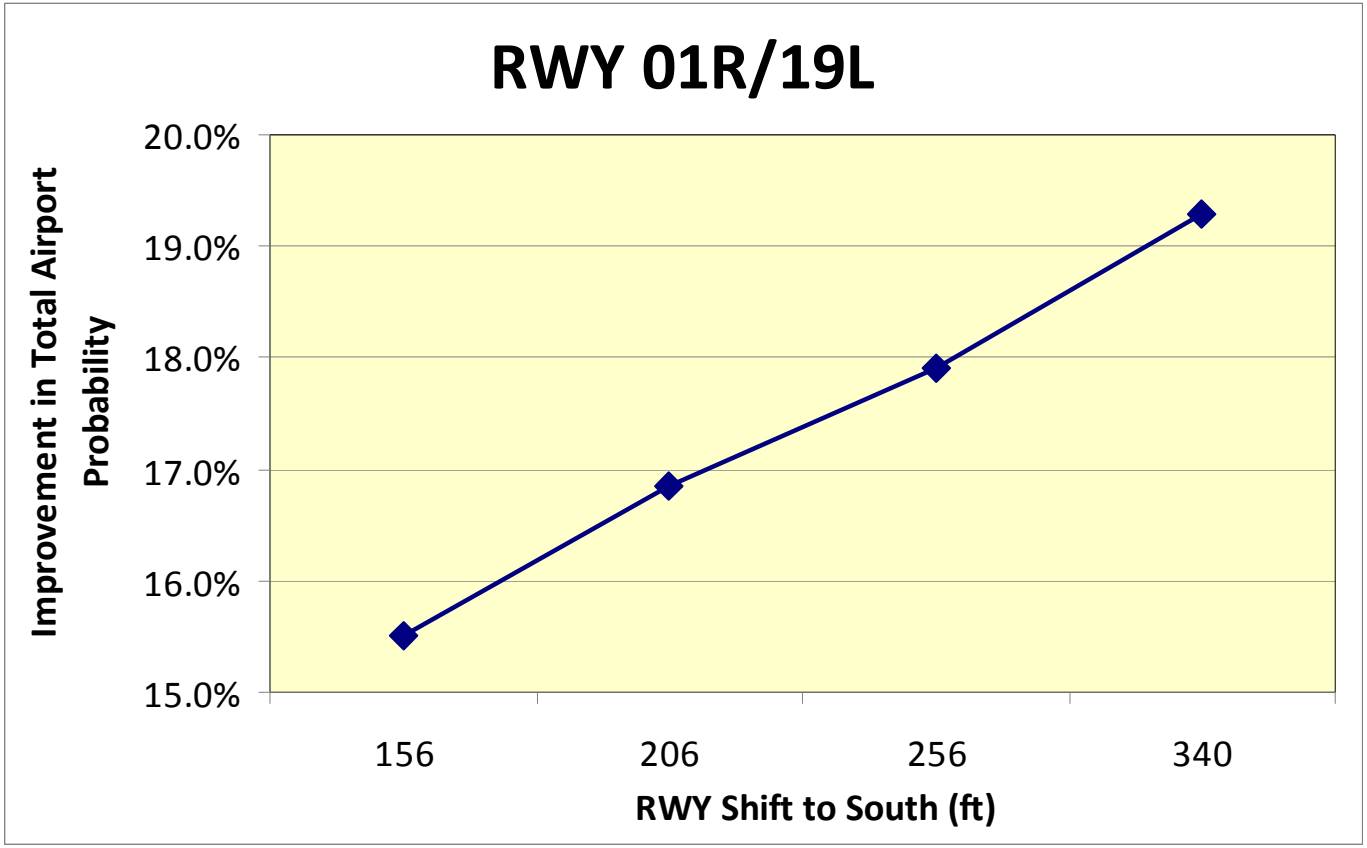


# Summary of Results

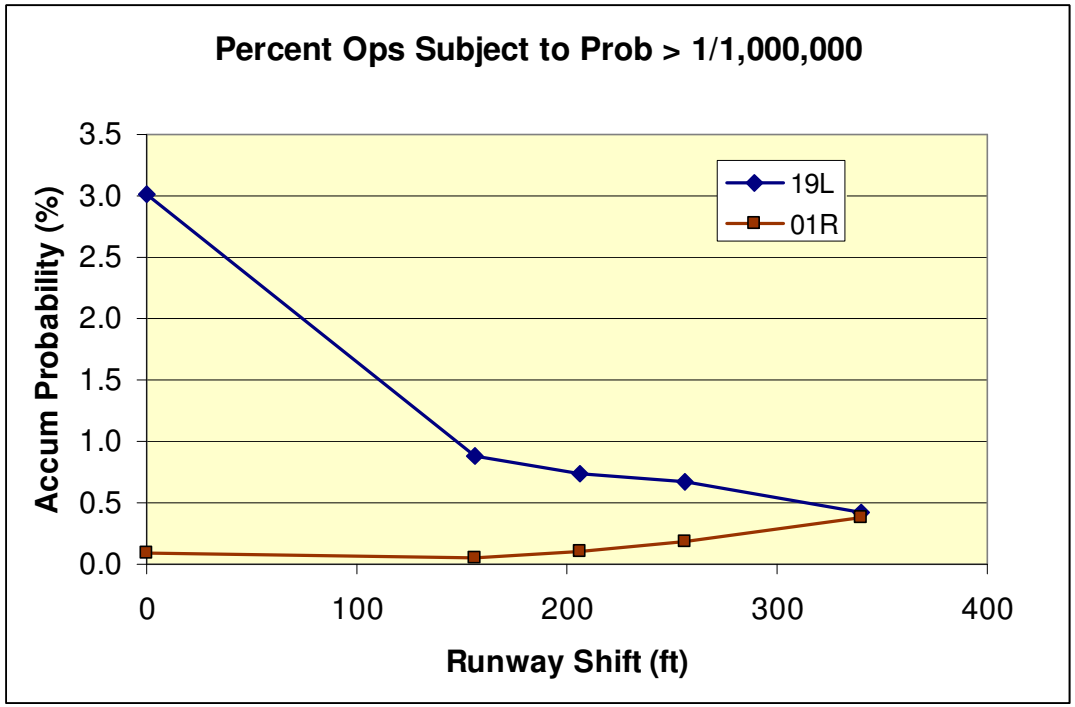
| | | | | |
|---|---|---|---|---|
| **Average Probability for all Movements (Existing)** | **1.41E-07** | | | |
| **Total Airport Probability if Complying w/ Standard** | **7.48E-08** | | | |
| | | **Refinement A** | | |
| **RSA** | **01R** | **01L** | **19R** | **19L** |
| Total Airport Probability | | 1.08E-07 | | |
| RSA Contribution to Airport Probability Decrease | -0.5% | 0.1% | 9.3% | 14.7% |
| % Protection Relative to FAA Standard | | 23.6% | | |
| | | **Refinement B** | | |
| **RSA** | **10R** | **10L** | **28R** | **28L** |
| Total Airport Probability | | 1.12E-07 | | |
| RSA Contribution to Airport Probability Decrease | 0.0% | 0.0% | 13.8% | 6.4% |
| Total % Decrease (all RSAs combined) | | 66.6% | | |

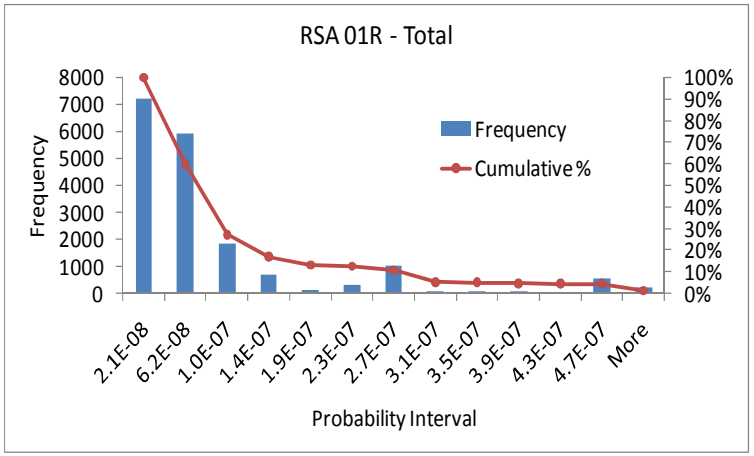
| | |
|---|---|
| **Level of Protection for Refinement A + Refinement B** | **94%** |

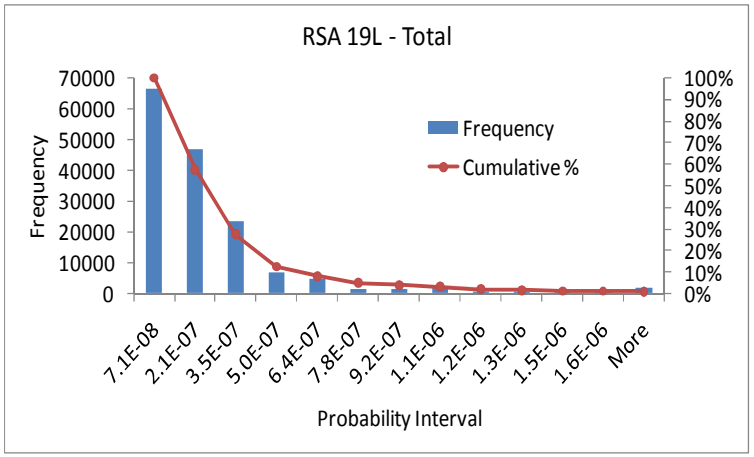
# Impact of Runway Shift on Total Airport Probability



# Impact of Rwy 01R/19L Shift



# Thank You!