Appendix B

Comparative Risk Assessment Form

SEC TRACKING No: This is the number assigned to the CRA by the FAA System Engineering Council (SEC)	**CRA Title**: Title as assigned by the FAA SEC
SYSTEM: This is the system being affected by the change, e.g. National Airspace System Initial Date: Date initiated SEC date: Date first reviewed by the SEC	
REFERENCES: A short list or references. If a long list is used can be continued on a separate page.	

SSE INFORMATION		
SSE Name/Title: Name and title of person who performed or led team	Location: Address and office symbol of SSE	Telephone No.:

SUMMARY OF HAZARD CLASSIFICATION: (worst credible case; see List of Hazards below for individual risk assessments)	
Option A (Baseline): Place the highest risk assessment code for the baseline here	Proposed Change **Option(s) B-X:** Place the highest risk assessment code for the alternatives here.

DESCRIPTION OF (Option A) BASELINE AND PROPOSED CHANGE(s)

Option A: Describe the system under study here in terms of the 5 M Model discussed in chapter 2. Describe the baseline (or no change) system and each alternative. This section can be continued in an appendix if it does not fit into this area. Avoid too much detail, but include enough so that the decision-maker has enough information to understand the risk associated with each alternative.

SEVERITY:

1 CATASTROPHIC – Death, system or aircraft loss, permanent total disability

2 HAZARDOUS - Severe injury or major aircraft or system damage

3 MAJOR - Minor injury or minor aircraft or system damage

4 MINOR – Less than minor injury or aircraft or system damage

5 NO SAFETY EFFECT

PROBABILITY:

A PROBABLE - Likely to occur in lifetime of each system (> 1E-5)

B REMOTE – Possible for each item, several for system (< 1E-5)

C EXTREMELY REMOTE – Unlikely for item, may occur few in system (< 1E-7)

D EXTREMELY IMPROBABLE – so unlikely, not expected in system (<1E-9)

	PROBABILITY			
SEVERITY	A	B	C	D
1				
2				
3				
4				
5	No risk			

HAZARD LIST

No.	Hazard Condition	RISK ASSESSMENT CODE (RAC)				
	List the hazard conditions here. Enter the risk assessment codes for each hazard – alternative to the right.	Baseline Option A	Option B	Option C	Option D	Option E
1	Loss of communication between air traffic controllers and aircraft (flight essential)	1D	1D	1C	1C	1B
2	Loss of communication between air traffic controllers in different domains (ARTCC to ARTCC, ARTCC to TRACON, etc.)	1D				
3	Loss of communication between air traffic controllers and flight service (flight plans, etc.)					
4	Loss of communication between air traffic & ground controllers and vehicles in the airport movement area					
5	Loss of the means for operator and flight service to communicate information relative to planned flight					
6	Loss of the capability to detect, classify, locate, and communicate adverse weather such as: thunderstorms, rain and snow showers, lightning, windshear, tornadoes, icing, low visibility or ceilings, turbulence, hail, fog, etc.					
7	Loss of navigation functions providing aircrew with independently determined 3D present position of the aircraft, defined routes, destination(s), and navigation solution (course, distance) to destination.					
8	Loss of Air traffic control determination of 3D location, velocity vector, and identity of each aircraft operating in a domain.					
9	Loss of Air traffic control determination of location, identity, and velocity vector of each participating vehicle operating in the airport movement area domain.					

10	Loss of approach guidance to runway. Precision – horizontal and vertical guidance; Non-precision – horizontal guidance, vertical procedures.					
11	Loss of ground vehicle or aircraft operator independent determination of present position, destination(s), and navigation solution on the airport movement area.					
12	Hazardous runway surface precludes safe takeoff or touchdown and rollout.					

SAFETY ASSESSMENT SUMMARY
(Conclusions/Recommendations)

Summarize your conclusions. Which option is best (and 2nd, 3rd, etc) and why. Include enough detail to appropriately communicate with the audience.

Recommendations: Provide additional controls to further mitigate or eliminate the risks. Follow the safety order of precedence, i.e., (1) eliminate/mitigate by design, (2) incorporate safety features, (3) provide warnings, and (4) procedures/training. See Chapter 4 for further elaboration of the Safety Order of Precedence). Define SSE requirements for reducing the risk of the design/option(s).

HAZARD CLASSIFICATION RATIONALE Do one of these sheets for each hazard	
1	**Hazard:** Loss of communication between air traffic controllers and aircraft
Summarization	**Summarize** the risk assessments for hazard No. 1 for each alternative that was examined. Baseline Option A Severity: 1-Catastrophic Probability: E-Improbable Assessment: Medium Risk Option B **Severity**: NA **Probability**: NA **Assessment**: NA
Severity	**Rationale for Severity:** In this section explain how you came up with the hazard severity. This is where you will convince the skeptics that you were logical and objective. The hazard is a component of the hazardous conditions required for NMAC, CFIT, WXHZ, NLA, and RIA's. For the baseline NAS system the severity of the "loss of communication" hazard is highly dependent upon the environmental conditions surrounding the event and is therefore categorized as a flight essential function of the NAS. In a "day, VFR, low density" environment the severity is very low resulting in minor effects. During a night/IFR high-density environment the occurrence of this hazard has a good chance of becoming catastrophic. The reason for this is that the purpose of this communication system is to provide aircraft in a region of airspace with direction, clearance, and other services provided by Air Traffic Control (ATC). In an environment of low outside visibility and many aircraft this function becomes critically important to air vehicle separation. The following points highlight the severity: Air Traffic Controllers (ATCs) are able to observe wide volumes of space using airspace surveillance systems. These systems enable the ATCs to observe the location, velocity, and sometimes the identity of the aircraft detected by their systems. The ATCs are trained to direct the flow of traffic safely to prevent midair collisions, flight following, approach clearances, and emergency assistance. Loss of the entire communication system would result in the rapid onset of chaos as approaching aircraft attempt to land and enroute aircraft converge on navigation waypoints and facilities. The risk of mid air is high in these conditions. In the event that a loss of communication occurs, then complex emergency procedures are established for IFR and VFR aircraft. The procedures are necessarily complex and if followed should result in a safe landing, but once initiated can be difficult to follow especially for a single pilot in IFR. The AIM states "Radio communications are a critical link in the ATC system. The link can be a strong bond between pilot and controller or it can be broken with surprising speed and disastrous results".[i]

Probability	**Rationale for Probability:** Use this section to explain how you derived the probability. This may be quantitative or qualitative. In general, the higher risk items will require more quantitative analysis than low or medium risk hazards. The example below is qualitative. Many controls exist to preclude this hazard from occurring- Multiple radios both in the aircraft and in the ATC facility provide redundant communication channels from aircraft to ATC. In the event of failure multiple facilities can be used including FSS, other ARTCC, TRACON, or ATCC, even airborne telephones. 1. Planning systems assist in keeping aircraft at different altitudes or routes. Emergency procedures exist to ensure an aircraft in "lost communication" will not converge on another aircraft's flight path.

[1] Federal Aviation Administration. (1995). Airman's Information Manual. Para. 4-2-1.

Severity Definitions

Catastrophic	Results in multiple fatalities and/or loss of the system
Hazardous	Reduces the capability of the system or the operator ability to cope with adverse conditions to the extent that there would be: Large reduction in safety margin or functional capability Crew physical distress/excessive workload such that operators cannot be relied upon to perform required tasks accurately or completely (1) Serious or fatal injury to small number of occupants of aircraft (except operators) Fatal injury to ground personnel and/or general public
Major	Reduces the capability of the system or the operators to cope with adverse operating condition to the extent that there would be – Significant reduction in safety margin or functional capability Significant increase in operator workload Conditions impairing operator efficiency or creating significant discomfort Physical distress to occupants of aircraft (except operator) including injuries Major occupant illness and/or major environmental damage, and/or major property damage
Minor	Does not significantly reduce system safety. Actions required by operators are well within their capabilities. Include Slight reduction in safety margin or functional capabilities Slight increase in workload such as routine flight plan changes Some physical discomfort to occupants or aircraft (except operators)
No Safety Effect	Has no effect on safety