Runway Incursion
Joint Safety Implementation Team

Detailed Implementation Plan
For
Commercial Aircraft Upgrade and Installation

DRAFT

Statement of Work

The purpose of this project is to reduce runway incursion incidents by improving pilot situational awareness using cockpit/vehicle moving map technology in commercial aircraft. This JSIT recognizes that some aircraft may alternate between commercial and GA classifications, and therefore recommends that the "Detailed Implementation Plan for GA Aircraft Upgrade and Installation" be consulted as well. Ultimately, equipment selection will be dependent on not only aircraft operations, but also sophistication of existing avionics and upgrade investment costs for each individual aircraft being considered.

Federal Aviation Administration (FAA) data shows that runway incursion incidents are increasing. An independent analysis, by Professor Albert Barnett, MIT, 1999, has concluded that runway incursions are emerging risk factors in the National Airspace System (NAS). Barnett predicts that there will be 15 fatal accidents, three of them jet-to-jet, in the next two decades if not otherwise constrained. The runway incursion Joint Safety Analysis Team (JSAT) has determined that moving map technology is highly effective (the four moving map interventions rated in the top ten out of 146 interventions) for reducing the threat of accidents caused by runway incursions. National Aeronautics and Space Administration (NASA) and the National Transportation Safety Board (NTSB) also support the addition of this technology into the cockpit for the purpose of runway incursion prevention. The FAA Safeflight 21 Program performed an analysis that estimated 43% of runway incursion incidents (attributable to pilot deviations) could be eliminated using a cockpit moving-map (with airport diagram) that showed own ship position (enabled by GPS). They also estimated that by displaying proximate traffic on the moving map significant additional runway incursion incidents would be eliminated [enabled by Automatic, Dependant Surveillance Broadcast (ADS-B) and Traffic Information Service Broadcast (TIS-B) technologies]. Finally, the addition of runway occupancy advisory systems and data-linked, graphical taxi clearance/limit systems when will further reduce incursion incidents and accidents.

Operator implementation of moving map technology is voluntary. However, in addition to safety benefits, capacity and/or efficiency benefits (enabled by ADS-B/TIS-B functionality) have been identified to justify near to mid-term equipage. Several methods of implementation are envisioned in a stepwise fashion to achieve safety and productivity enhancements from moving map technology in the near through long-term. Data requirements and certification issues exist for each method. Windows of opportunity for implementation on next generation aircraft (e.g., Boeing Sonic Cruiser and Airbus A-380) need to be met in order to avoid missing opportunities that are likely to induce decade-long delays into integrated cockpit solutions. System-wide improvements to digital map products as well as wide distribution of this data to industry are integral to success for each method. Cockpit airport moving map display systems shall incorporate industry "best practices" for computer-human interface (CHI) design to enhance and support flight crew situational awareness.

Integration of moving map technology into the continuum of current cockpit layouts will require a full range of avionics solutions from stand-alone systems to fully integrated displays (see Appendix A for a detailed description of User Categories of cockpit layouts). End state incorporation of the varied levels of technology into the commercial aviation fleet will be determined by the need to meet industry safety standards and the productivity needs of individual operators.

Certain types of regional air carrier aircraft and small, light commercial aircraft may equip as described in the General Aviation implementation plan.

The project requirements were developed from the intervention strategies outlined in the Runway Incursion JSAT list of interventions, paraphrased as follows:

- Promote installation of graphic cockpit displays (airport surface moving map) that depict the airport surface with own-ship position (enabled by GPS), cleared taxi routes and taxi clearance limits to all commercial operators. Apply data link technology to allow cockpit display to show ATC cleared routes and clearance limits. Systems should be developed for different equipage schemes.
- Promote installation of graphic displays with traffic information and runway occupancy advisory systems to all commercial operators. Systems must be developed for different equipage schemes. ADS-B and TIS-B are the enabling technologies for traffic information.
- Regulators and industry will develop and implement heads-up guidance (HUD) systems that display information for ground operations.

The project requirements for the moving map implementation are organized into four phases. The phases are listed in a "best estimate" chronological order. Phase 1 will address development and installation of cockpit moving map (airport) displays with own-ship position (enabled by GPS). Phase 2 will add display functionality for data-linked traffic, ground and air, utilizing ADS-B and TIS-B. Phase 3 will add functionality for runway occupancy advisory systems. Phase 4 will add functionality for data-linked taxi routes and clearance limits. Each phase will also address heads-up guidance display systems (HUDs). Each phase will require the continuing development and certification of cockpit display equipment and the formation of standards, guidelines and procedures for use of the equipment

Lead Organization for Overall Project Coordination (LOOPC): FAA AVR-1

Safety Enhancement 1: Commercial Aircraft Cockpit Moving Map Display Installations (Phases 1,2,3,&4 SE-61)

The development and installation of cockpit airport surface moving map displays in all commercial aircraft will improve aviation safety by reducing runway incursions through enhanced own ship situational awareness, traffic awareness, runway occupancy alerting and graphical taxi clearances. Commercial, light aircraft will most likely install in accordance with the detailed plan for GA aircraft, if applicable. Certain regional air carrier aircraft may also fall under the GA plan. It is desirable to have all aircraft equipped with ADS-B transmitters (on the appropriate links) so they may be seen.

Accident Prevention Index: (to be completed by JIMDAT)

Resource Requirements:

Avionics costs for integrated and new generation aircraft were obtained from Safe Flight 21 cost benefit analysis. The costs were provided from aircraft and avionics manufacturers. The costs are based on FAA Safe Flight 21 estimates as contained in Appendix B, and represent the worst-case average cost for the purchase and installation for Phase 1-3. The Safeflight 21 worst-case costs included avionics, installation, (includes maintenance and downtime costs) and certification costs for Phase 1 through 3 of this safety enhancement. Phase 4 costs could be software or hardware upgrades depending on previous installation. Please note that a significant cost was allocated to maintenance and downtime.

Stand-alone, panel-mounted and Electronic Flight Bag (EFB) hardware and software costs are delineated below based on an avionics manufacturer's rough order of magnitude (ROM) fleet (> 100 units) estimate. This is shown to give an example of actual costing versus the worst-case scenario described in the Safe Flight 21 cost benefit study. Installation costs will vary depending on operator capabilities, functionality, certification requirements, and type of installation and are not included in the stand-alone, panel mounted or EFB cost estimates below. The fleet discount cost is a ROM cost and may not represent, either more or less, the actual discount that could be negotiated by a particular operator.

PHASE 1 (moving map display with GPS own-ship position)

- Output 1
  - Operator cost (see Appendix B)
    - Forward fit (next generation, newly manufactured) aircraft (include Phase 1-4 functionality)
      - Fully integrated - $200K/aircraft
      - Stand-alone, panel mounted - $40.25K/aircraft (display, GPS sensor and software)
      - Electronic Flight Bag (dual) - $25K/aircraft (displays, GPS sensor and software)
    - Retrofit aircraft
      - Classic aircraft
        - Stand-alone, panel mounted – $40.25K/aircraft (display, GPS sensor and software)
        - Electronic Flight Bag (dual) – $25K/aircraft (displays, GPS sensor and software)
      - Neo - classic aircraft
        - Fully integrated - $520K/aircraft (includes Phase 1-4 functionality—high cost due to symbol generator and display replacement)
        - Stand-alone, panel mounted - $40.25K/aircraft (display, GPS sensor and software)
        - Electronic Flight Bag (dual) - $25K/aircraft (displays, GPS sensor and software)
      - Modern/Integrated aircraft (includes phase 1-4 functionality)
        - Fully integrated-$313K/aircraft (includes installation costs)
        - Stand-alone, panel mounted - $40.25K/aircraft (display, GPS sensor and software)
        - Electronic Flight Bag (dual) - $25K/aircraft (displays, GPS sensor and software)
  - FAA cost—est-7 FTE
  - Industry/Operators--.15 FTE/year/company or operator
  - Associations (ATA, RAA, NBAA) with Industry/Government participation -- .15 FTE/year/participant
- Output 2
  - FAA cost—est-20 FTE
  - NOAA cost—est.-2 FTE/year + $30K/airport
  - Industry/Operators—est-.25 FTE /company or operator

PHASE 2 (adds traffic to moving map—enabled by ADS-B/TIS-B)

- Output 4
  - Operator cost (Additive cost to Phase 1 unless otherwise noted) (see Appendix B)
    - Forward fit (next generation, newly manufactured) aircraft
      - Fully integrated – no additional cost from initial installation
      - Stand-alone - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously—$77K/aircraft
      - Electronic Flight Bag (dual) - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously-$73K/aircraft
    - Retrofit aircraft
      - Classic aircraft
        - Stand-alone - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously—$77K/aircraft
        - Electronic Flight Bag (dual) - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously-$73K/aircraft
      - Neo - classic aircraft
        - Fully integrated – no additional cost from initial installation
        - Stand-alone - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously—$77K/aircraft
        - Electronic Flight Bag (dual) - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously-$73K/aircraft
      - Modern/Integrated aircraft (includes phase 1-4 functionality)
        - Fully integrated-no additional cost for phase 2
        - Stand-alone - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously—$77K/aircraft
        - Electronic Flight Bag (dual) - $48K/aircraft (adds link system, ADS-B functionality and GPS, if needed) If Phase 1 & 2 done simultaneously-$73K/aircraft

PHASE 3 (adds runway occupancy advisory system to moving map + traffic display)

- Output 6
  - Operator cost (see Appendix B)
    - Forward fit (next generation, newly manufactured) aircraft
      - Fully integrated – no additional cost from initial installation
      - Stand-alone - $2K/aircraft
      - Electronic Flight Bag (dual) - $1K/aircraft
    - Retrofit aircraft
      - Classic aircraft
        - Stand-alone - $2K/aircraft
        - Electronic Flight Bag (dual) - $1K/aircraft
      - Neo - classic aircraft
        - Fully integrated – no additional cost from initial installation
        - Stand-alone - $2K/aircraft
        - Electronic Flight Bag (dual) - $1K/aircraft
      - Modern/Integrated aircraft
        - Fully integrated – no additional cost from initial installation
        - Stand-alone - $2K/aircraft
        - Electronic Flight Bag (dual) - $1K/aircraft

PHASE 4 (adds data-linked taxi clearance and clearance limit to moving map display)

- Output 8
  - Operator cost (see Appendix B)
    - Forward fit (next generation, newly manufactured) aircraft
      - Fully integrated – no additional cost from initial installation
    - Retrofit aircraft
      - Classic aircraft
        - Stand-alone - $2K/aircraft
        - Electronic Flight Bag (dual) - $1K/aircraft
      - Neo - classic aircraft
        - Fully integrated - $2K/aircraft
        - Stand-alone - $2K/aircraft
        - Electronic Flight Bag (dual) - $1K/aircraft
      - Modern/Integrated aircraft
        - Fully integrated – no additional cost from initial installation
        - Stand-alone - $2K/aircraft
        - Electronic Flight Bag (dual) - $1K/aircraft

Additional Personnel Costs

- Outputs 4, 6 & 8
  - FAA—2 FTE/output

Industry/Operators—.25 FTE/output/company or operator

- Outputs 3, 5, 7, 9
  - Industry/manufacturer—HUD R&D efforts—est.-2 FTE/manufacturer
  - FAA—.5 FTE/output

Completion Date: FY 2002-FY 2015

PHASE 1 (SE-110)

Output 1

- FAA will encourage commercial aircraft operators to install cockpit airport surface moving map displays with own ship position (provided by GPS) in **all next generation, newly manufactured and specified existing** commercial aircraft.

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators, Associations, DOT

Timeline: FY 2002-2015

Actions:

- FAA will provide safety and cost benefit information, National Airspace System (NAS) roadmaps, and any other support information to operators to encourage equipage. Support documentation should be provided from other government agencies (e.g., NTSB, DOT, congressional hearings).
- FAA (AND, AIR, AFS) will work with RTCA to establish standards (MASPS, MOPS) for cockpit moving map displays.
  - FAA (AIR) will provide airworthiness criteria developed from standards and requirements defined by cooperation with industry for cockpit airport surface moving map displays. Own ship position will have defined accuracy requirements.
- FAA (AND) will award contracts to avionics manufacturers for the development of cockpit moving map displays.
- FAA (AND, AFS, AIR) will provide guidance/assistance to avionics/aircraft manufacturers for the expeditious certification of moving map displays.
- FAA (AFS, AIR) will develop appropriate installation, maintenance, operations procedures and training guidance for use in commercial aircraft:
  - Certification of moving map display—AIR (LOOC) — Initial certification - FY 2002
  - STCs granted—AIR (LOOC) — When Approved
  - No FAA field approvals (AFS 300 Policy Letter) — Completed
  - Operation guidance issued—AFS (LOOC)
    - AFM requirements (AFS, AIR)
      - Forward fit aircraft — FY 2004- FY 2007
      - Retrofit aircraft — FY 2002-FY 2007
    - Advisory Circular (AFS) — FY 2002
    - Handbook Bulletin (AFS) — FY 2002
  - Maintenance guidance issued—AFS (LOOC)
    - Advisory Circular Part 25 (ANM) — FY 2002
    - Advisory Circular Part 23 (ACE) — FY 2002

Forward fit (next generation, newly designed) aircraft:

- Aircraft/avionics manufacturers should develop and make available cockpit display solutions for all categories of commercial aircraft (including transport category, regional jet, and turboprop commuters) that are cost effective and appropriate to type of operation. Newly designed, integrated display systems should be designed to allow easy, low cost upgrades to add additional functionality for future applications.
- Associations (ATA, RAA, NBAA) and operators will work with manufacturers to develop the appropriate equipment for their respective operations.

Retrofit aircraft (existing and newly manufactured):

- FAA with cooperation from manufacturers, operators and associations will determine which commercial aircraft should be equipped with moving map displays. Consideration should be given to cost/safety benefit, type of operation, cost of equipment vs. worth of equipment, and age/size of aircraft.

  Modern & Integrated Aircraft:
  - Aircraft/avionics manufacturers should develop and make available integrated cockpit moving map display solutions for advanced aircraft of all categories.
  - Associations (ATA, RAA, NBAA) and operators will work with manufacturers to develop the appropriate equipment for their respective operations.

Neo-Classic aircraft:
- Aircraft/avionics manufacturers should develop and make available integrated cockpit display solutions for standard cockpits. This solution may require either symbol generator replacement or display replacement.
- Avionics manufacturers should develop and make available stand-alone panel-installed cockpit moving map displays.
- Avionics manufacturers should develop and make available electronic flight bag (EFB) display solutions that have cockpit moving map functionality.
- Associations (ATA, RAA, NBAA) and operators will work with manufacturers to develop the appropriate equipment for their respective operations.

Classic aircraft:
- Avionics manufacturers should develop and make available stand alone panel-installed cockpit moving map displays.
- Avionics manufacturers should develop and make available electronic flight bag (EFB) display solutions that have cockpit moving map functionality.
- Associations (ATA, RAA, NBAA) and operators will work with manufacturers to develop the appropriate equipment for their respective operations.

Output 2:
- FAA will coordinate with the appropriate government agencies for collection of airport survey data, validation of survey data, application of airport attributes (e.g., taxiway, runway labels), and dissemination of airport databases for use in cockpit surface moving maps.

Resources: ATA-100 (LOOC), AVN, AFS, AIR, NOAA/NGS, NACO, RTCA, NIMA, Manufacturers, and Data Providers

Timeline: FY 2001-FY 2004

Actions:
- FAA (ATA) will provide NOAA/NGS with prioritized survey schedule.
- NOAA/NGS will acquire/provide airport survey data for all Part 139 airports that meets the requirements of RTCA SC-193 Airports document.
- National Aeronautics Charting Organization (NACO), AVN, will apply attributes to NOAA/NGS survey data and made available to the industry in appropriate formats.
- FAA infrastructure must be established to prioritize, collect and revise airport data for all Part 139 airports.

Output 3:
- FAA will encourage HUD manufacturers to provide airport surface moving map displays with own ship position (provided by GPS) for their HUD systems.

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators

Timeline: FY 2003-FY 2008

Actions:
- Requirements and standards are same as for moving map display.
- Aircraft/avionics manufacturers and operators should examine HUD functionality for appropriateness and cost effectiveness.

PHASE 2: (Phase 1 & 2 SE-111)

Output 4:

- The FAA will encourage commercial aircraft operators to upgrade cockpit moving map displays to **add air/ground traffic functionality to cockpit surface map displays.** ADS-B and TIS-B are the enabling technologies for this output. This output applies to all types of commercial aircraft that have installed cockpit moving map displays.

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators.

Timeline: FY 2002—Traffic information is provided by ADS-B.
FY 2003—FY 2007—Traffic information is provided by both ADS-B and TIS-B.
FY 2015 – Projected date of total ADS-B aircraft equipage.

Actions:

- FAA (AND, AIR, AFS) will work with RTCA to establish standards (MASPS, MOPS) for air/ground traffic on a cockpit moving map display.
- FAA (AND) will continue to fund development of moving map display to add air/ground traffic functionality.
- FAA (AFS, AIR) will establish certification requirements and procedural requirements for this functionality.
- Aircraft/avionics manufacturers should make this functionality available for all cockpit moving map displays.

Output 5:

- FAA will encourage HUD manufacturers to **add ground/air traffic functionality to HUD moving map displays.**

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators

Timeline: FY 2003-FY 2008

Actions:

- Requirements and standards are same as for moving map display.
- Aircraft/avionics manufacturers and operators should examine HUD functionality for appropriateness and cost effectiveness.

PHASE 3: (Phase 1, 2, & 3 SE-112)

Output 6:

- The FAA will encourage commercial aircraft operators to upgrade, cockpit moving map displays to **add runway occupancy advisory systems to cockpit moving map displays**. This output applies to all types of commercial aircraft that have installed cockpit moving map displays.

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators

Timeline: FY 2003-FY 2008

Actions:

- FAA (AND, AIR, AFS) will work with RTCA to establish standards (MASPS, MOPS) for runway occupancy alerting on a cockpit moving map display.
- FAA (AND) will continue to fund development of moving map display to add runway occupancy alerting functionality.
- FAA (AFS, AIR) will establish certification requirements and procedural requirements for this functionality.
- Aircraft/avionics manufacturers should make this functionality available for all cockpit moving map displays.

Output 7:

- FAA will encourage HUD manufacturers to **add runway occupancy advisory systems to their HUD moving map displays.**

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators

Timeline: FY 2006-FY2009

Actions:

- Requirements and standards are same as for moving map display.
- Aircraft/avionics manufacturers and operators should examine HUD functionality for appropriateness and cost effectiveness.

PHASE 4: (Phases 1, 2, 3, &4 SE-61)

Output 8:

- The FAA will encourage commercial aircraft operators to upgrade cockpit moving map displays to **add data linked taxi clearance and clearance limit functionality to cockpit moving map displays**. This output applies to all types of commercial aircraft that have installed cockpit moving map displays.

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators

Timeline: FY 2005 – FY 2008

Actions:

- FAA (AND, AIR, AFS) will work with RTCA to establish standards (MASPS, MOPS) for data linked taxi clearance and clearance limits on a cockpit moving map display.
- FAA (AND) will continue to fund development of moving map display to add data linked taxi clearance and clearance limit functionality.
- FAA (AFS, AIR) will establish certification requirements and procedural requirements for this functionality.
- Aircraft/avionics manufacturers should make this functionality available for all cockpit moving map displays.

Output 9:

- FAA will encourage HUD manufacturers to **add graphical taxi clearance and clearance limit functionality to their HUD moving map displays.**

Resources: AFS (LOOC), AIR, AND, RTCA, Manufacturers, Operators

Timeline: FY 2007-FY2010

Actions:

- Requirements and standards are same as for moving map display.
- Aircraft/avionics manufacturers and operators should examine HUD functionality for appropriateness and cost effectiveness.

Relationship to Current Aviation Initiatives

- Creation of Runway Safety Program Office within the FAA
- Regional Runway Safety Program Managers added to FAA Regional Offices
- Runway Safety Program Office in conjunction with Runway Incursion JSIT created Top Ten Initiatives For Reducing Runway Incursions
- Joint Industry/Government Runway Incursion Summits
- FAA published guidance material (AC, HBAT, PTS, etc.)
- Runway Safety Actions Teams (RSAT)
- Linking of Runway Safety Program Initiatives to Runway Incursion Joint Safety Implementation Team Initiatives
- Safeflight 21 Runway Surface Roadmap
- NAS Operational Evolution Plan (OEP)
- Free Flight Phase I and II activities
- RTCA activities
- NASA Aviation Safety Programs, Runway Incursion Prevention Systems (RIPS)

Performance Goals and Indicators

- Goal: Reduction of runway incursions where a pilot deviation was the causal factor.
  Indicator: Reduction in the number and rate of runway incursions resulting from pilot deviations as measured by the FAA Runway Safety Program office by 2007.

- Goal: All commercial aircraft equipped with cockpit moving map displays
  Indicator: Actual aircraft equipage will meet or exceed Safeflight 21 Cost/Benefit equipage projection.

Programmatic Approach

Organizational Strategy

The Runway Incursion JSIT identified Jim Walton, UPS Airline, as the JSIT project lead for Runway Incursion Aircraft Equipment/Vehicle Upgrade/Installation subgroup. The project lead will coordinate implementation activities outlined in the Implementation Plan and will provide progress reports to the Runway Incursion JSIT until receipt of CAST G Level approval. Implementation is viewed as a shared responsibility between the FAA and the commercial air carriers. The FAA offices of primary responsibilities (OPR) for this plan are AVR, (AFS and AIR) and AND. The primary responsibility for industry is shared between CAST and JSC member organizations.

Implementation Activities

Major activities include the establishment of avionics standards and requirements for moving map systems, the standards and infrastructure for the survey of airports and dissemination of airport databases, and the certification and operational approval of moving map systems in commercial aircraft. These activities will provide avionics to pilots that will reduce runway incursions by improving airport surface and airport traffic situational awareness.

Key Products and Milestones

Cost Benefit Analysis (Safeflight 21)	3 months
Safeflight 21 Runway Surface Roadmap	3 months
NAS Operational Evolution Plan (OEP)—Key dates from 12/10/01 OEP, section AD-7	
Surface Moving Map Concept of Operations	2002
Test Broadcast Services at SDF	2002
Complete Surface Operational Safety Assessment	2002
Certified avionics (moving map) as supplemental means of navigation	2003
Deliver airport surface map database for top 65 airports	2003
IOC for surface navigation from cockpit at key sites	2005
FAA Runway Safety Program office campaign to encourage equipage	
And periodic publication of status of industry moving map equipage	36 months

Display and ADS-B Standards	
ADS-B MASPS	Complete
1090 Link MOPS	Complete
1090 Rev A Link MOPS	In Progress
UAT Link MOPS	In Progress

Key Products and Milestones (Cont.)

TIS-B MASPS	18 months
TIS-B MOPS	18 months
CDTI MOPS	12 months
Ongoing Moving Map Development	
SF 21 TESIS-Contract awarded to 4 Vendors	Complete
Contract Due Date	9 months
FAA assistance to manufacturers for Moving Map development /certification	
Safeflight 21 Coordination with vendors and FAA Standards/Certification	In Progress
FAA (AFS, AIR) will develop appropriate installation, maintenance, operations procedures and training guidance for use in commercial aircraft:	
Certification of moving map display—AIR (LOOC)	First certification—FY 2002
STCs granted—AIR (LOOC)	When Approved
No FAA field approvals (AFS 300 Policy Letter)	Completed
Operation guidance issued—AFS (LOOC)	
AFM requirements (AFS, AIR)	
Forward fit aircraft	FY 2004- FY 2007
Retrofit aircraft	FY 2002-FY 2007
Advisory Circular (AFS)	FY 2002
Handbook Bulletin (AFS)	FY 2002
Maintenance guidance issued—AFS (LOOC)	
Advisory Circular Part 25 (ANM)	FY 2002
Advisory Circular Part 23 (ACE)	FY 2002
FAA (ATA) will provide NOAA/NGS with prioritized survey schedule	
Initial 65 airport surveys contracted by SF 21	FY 2003
Prioritization for remaining Part 139 airport surveys	12 months
NOAA/NGS will acquire/provide airport survey data for all Part 139 airports that meets the requirements of RTCA SC-193 Airports document.	In Progress
National Aeronautics Charting Organization (NACO), AVN, will apply attributes to NOAA/NGS survey data and made available to the industry in appropriate formats.	In Progress
FAA infrastructure must be established to prioritize, collect, revise, and distribute airport data for all Part 139 airports.	24 months

Risk Description

- Added cost of avionics procurement and installation.
- Added training cost for air carriers.
- Resistance to voluntary compliance by some carriers.

Risk Mitigation Plan

- Communication to air carriers of the combined safety and operational benefits associated with voluntary equipage of moving map display technologies.
- Minimal additional cost when incorporated with current runway incursion training programs.
- Cooperation between FAA and industry organizations would preclude entering into the rule making process.

Impact on non-General Aviation or International Applications

- Opportunity to set the standard for improved situational awareness through the use of cockpit airport moving map technologies. Opportunity for an exchange of information between FAA and ICAO/JAA to educate, train, and increase the awareness of most international operators through use of moving map technologies. ICAO and JAA are represented on CAST. Both have adopted Runway Incursion prevention procedures and have similar programs.

Appendix A—Aircraft Categories for Moving Map Equipage
Appendix B—2007 Resource Cost—Phase 1 & Phase 1 & 2
Appendix D—Safeflight 21 ADS-B/CDTI Avionics Cost
Appendix E—Safeflight 21 ADS-B/CDTI Benefit/Cost Ratios
Appendix F—Safeflight 21Government/Industry Total Cost—FY03-FY25

Appendix A

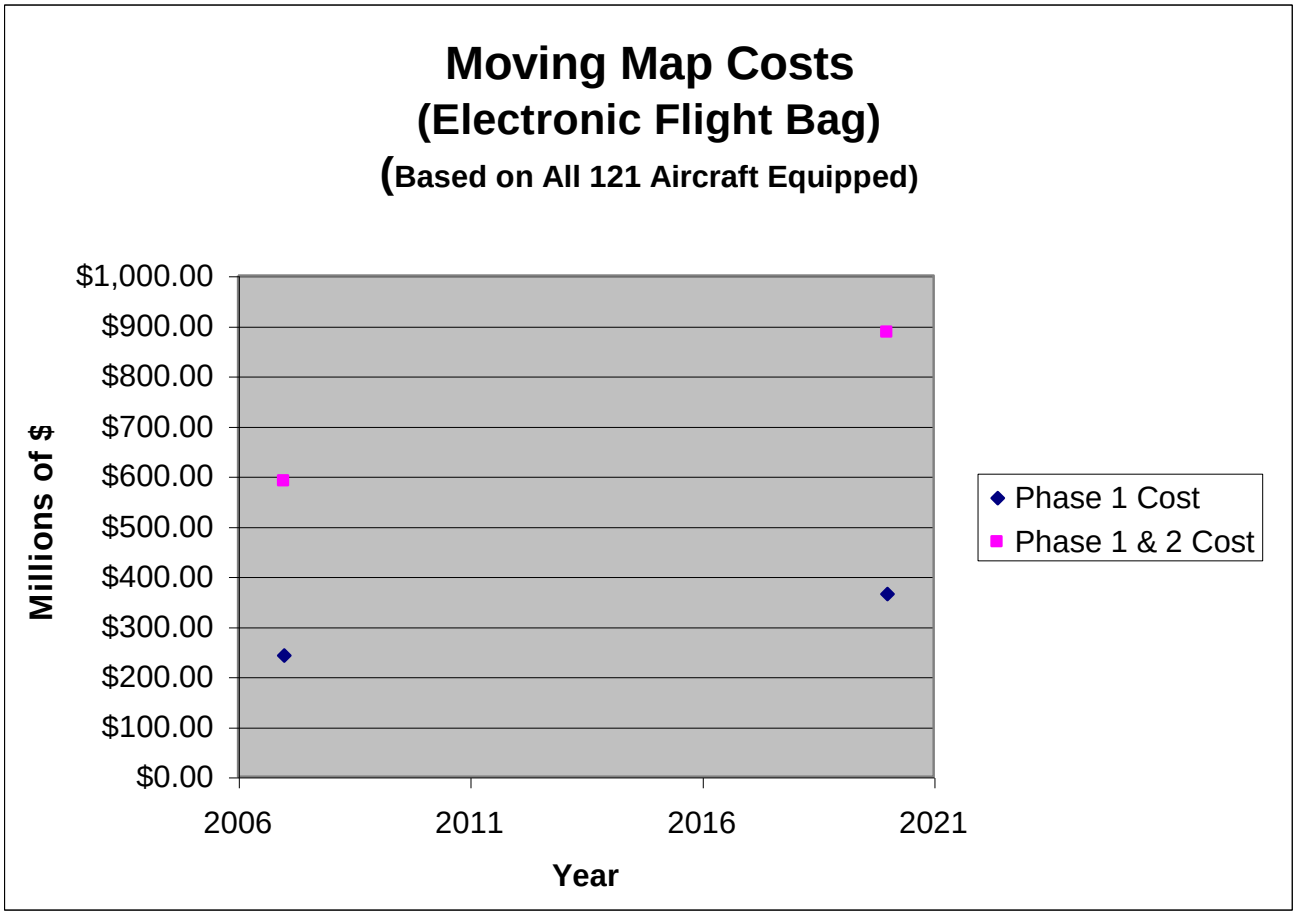
Aircraft Categories for Moving Map Equipage

- Retrofits for Existing Aircraft
  - Classic Aircraft (Traditional round dial, non FMS aircraft)
    (B-727; B-737-200/300; DC-9 Series
  - Neo-Classic Aircraft (Generally, EFIS and FMS aircraft)
    (B-737-400; A-300; Fokker-100; MD-80 & 90 Series; B-757/767)
  - Modern & Integrated Aircraft (Advanced EFIS/FMS aircraft)
    (B-737NG; B-757/767NG; B-777; B-717 and late MD-90 Series)
- Forward fit for New Modern & Integrated Aircraft
  - Newly Designed With Total Integrated Functionality

    (A-380; Boeing Sonic Cruiser)

Appendix B

2007 Resource Cost—Phase 1 & Phase 1 & 2



Appendix C

Safeflight 21 ADS-B/CDTI Avionics Cost

(Includes Phase 1-4 Moving Map Functionality)

Avionics Unit Costs
FY01 ($K)

Display Configuration	GA & Air Taxi Basic Avionics UAT	GA & Air Taxi Advanced Avionics 1090 ES & UAT	Retro-fit Non-PFD (Classic) 1090 ES & UAT	Retro-fit PFD (Neo-Classic) 1090 ES & UAT	Retro-fit PFD (Mod/Integ) 1090 ES & UAT	Forward Fit PFD (Mod/Integ) 1090 ES & UAT
Fully Integrated / Stand Alone	$12.2	$70.5	$186.3	$519.4	$312.8	$199.7
Stand Alone	$12.2	$70.5	$186.3	$194.4	$190.8	$103.5
EFB	$8.0	$56.3	$155.4	$151.4	$147.8	$60.5

Note: Cost includes hardware, software, installation (maintenance and downtime) and certification.

Appendix D

Safeflight 21 ADS-B/CDTI Benefit/Cost Ratios

(Includes Phase 1-4 Moving Map Functionality)

Fully Integrated / Stand Alone

Item	GA & Air Taxi Basic Avionics UAT	GA & Air Taxi Advanced Avionics 1090 ES & UAT	Retro-fit Non-PFD (Classic) 1090 ES & UAT	Retro-fit PFD (Neo-Classic) 1090 ES & UAT	Retro-fit PFD (Mod/Integ) 1090 ES & UAT	Forward Fit PFD (Mod/Integ) 1090 ES & UAT	Total Industry	Total FAA	Overall Total
Total Benefits (PV $M)	$1,446	$247	$16	$154	$758	$1,342	**$3,962**	---	**$3,962**
Total Costs (PV $M)	$595	$571	$20	$241	$717	$920	**$3,063**	**$974**	**$4,037**
B / C Ratio	2.43	0.43	0.80	0.64	1.06	1.46	**1.29**	---	**0.98**

Stand Alone

Item	GA & Air Taxi Basic Avionics UAT	GA & Air Taxi Advanced Avionics 1090 ES & UAT	Retro-fit Non-PFD (Classic) 1090 ES & UAT	Retro-fit PFD (Neo-Classic) 1090 ES & UAT	Retro-fit PFD (Mod/Integ) 1090 ES & UAT	Forward Fit PFD (Mod/Integ) 1090 ES & UAT	Total Industry	Total FAA	Overall Total
Total Benefits (PV $M)	$1,406	$241	$16	$116	$555	$965	**$3,298**	---	**$3,298**
Total Costs (PV $M)	$595	$571	$20	$103	$458	$514	**$2,261**	**$974**	**$3,235**
B / C Ratio	2.36	0.42	0.79	1.13	1.21	1.88	**1.46**	---	**1.02**

EFB

Item	GA & Air Taxi Basic Avionics UAT	GA & Air Taxi Advanced Avionics 1090 ES & UAT	Retro-fit Non-PFD (Classic) 1090 ES & UAT	Retro-fit PFD (Neo-Classic) 1090 ES & UAT	Retro-fit PFD (Mod/Integ) 1090 ES & UAT	Forward Fit PFD (Mod/Integ) 1090 ES & UAT	Total Industry	Total FAA	Overall Total
Total Benefits (PV $M)	$1,446	$247	$16	$154	$758	$1,342	**$3,962**	---	**$3,962**
Total Costs (PV $M)	$489	$465	$18	$85	$368	$331	**$1,756**	**$974**	**$2,730**
B / C Ratio	2.95	0.53	0.86	1.81	2.06	4.05	**2.26**	---	**1.45**

Appendix E

Government/Industry Total Cost

FY03 to FY25
FY01 ($M)

Item		Display Configuration Fully Integrated / Stand Alone	Stand Alone	EFB
GA & Air Taxi Basic Avionics	UAT	$1,499	$1,499	$1,275
GA & Air Taxi Advanced Avionics	1090 ES & UAT	$1,210	$1,210	$990
Retro-fit Non-PFD (Classic)	1090 ES & UAT	$28	$28	$25
Retro-fit PFD (Neo-Classic)	1090 ES & UAT	$373	$157	$128
Retro-fit PFD (Mod/Integ)	1090 ES & UAT	$1,308	$831	$663
Forward Fit PFD (Mod/Integ)	1090 ES & UAT	$2,076	$1,154	$742
Total Industry Costs		**$6,494**	**$4,879**	**$3,823**
F&E		$1,581	$1,581	$1,581
O&M		$632	$632	$632
Total FAA Costs		**$2,213**	**$2,213**	**$2,213**
Total Costs		**$8,708**	**$7,092**	**$6,037**