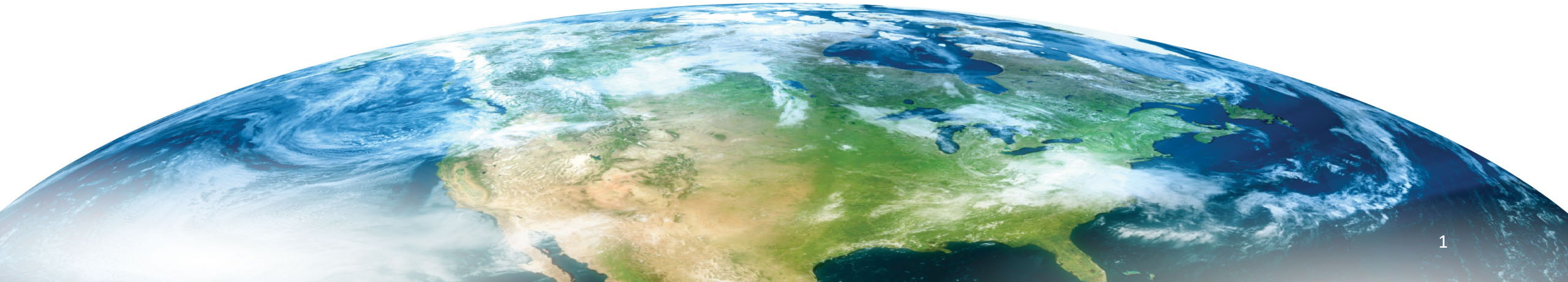
# Flight Deck/Maintenance/System Integration Human Factors Research Program

***Semiannual update to the REDAC Human Factors Subcommittee***

**Presenter:** Chuck H. Perala, Ph.D.
NextGen Human Factors Division, ANG-C1

**Budget Line Item (BLI) Number:** A11G (8AA)

**Date:** March 26, 2024



# Flight Deck/Maintenance/System Integration Human Factors Research Program

## Program Scope

- This program addresses research, engineering, and development requirements defined by technical sponsors in the Aviation Safety (AVS) organization. Requirements are driven by the human factors needs of FAA Aircraft Certification (AIR) and Flight Standards (AFX, AFS) personnel.
- This program also considers rapid changes to current-day technologies, procedures, and emerging issues

## FAA Benefits

- Program outputs are transferred to AVS technical sponsors who develop and maintain, as appropriate, human factors-related regulations, guidance, procedures, Orders, standards, job aids, and other materials
- Work products benefit AIR and AFX personnel who are responsible for the evaluation, certification, approval, and continued airworthiness of aircraft; and certification of pilots and mechanics

## Measures of Success

1. Sponsor Satisfaction – did the research meet AVS's needs?
2. Access to Research – is there sufficient awareness/access to results?
3. Application of Results – did the research support or inform a data-driven decision?
4. Benefits – how did the research contribute to safety, capacity, and/or efficiency?

# Flight Deck/Maintenance/System Integration Human Factors Research Program

## Team Members

- Tara Gibson, Division Manager (Tara.M.Gibson@faa.gov)
- Chuck Perala, Program Manager (Chuck.Perala@faa.gov)

## Researchers and Laboratories

- FAA Civil Aerospace Medical Institute (CAMI)
- Volpe National Transportation Systems Center, Department of Transportation (DOT)
- NASA Langley (LaRC)
- MITRE Corporation, Center for Advanced Aviation System Development (CAASD)
- FAA Center of Excellence for Technical Training and Human Performance (COE TTHP)
- Academia: University of Michigan, University of Central Florida (UCF), Massachusetts Institute of Technology (MIT), Auburn University (AU), The Ohio State University (OSU), Embry-Riddle Aeronautical University (ERAU)

# Overview of the Flight Deck/Maintenance/System Integration Human Factors Research Program

AVS sponsors **11 human factors research requirements** managed by the NextGen Human Factors Division (ANG-C1). Information in this briefing aligns with operational capabilities (OC) in the AVS budget line-item (BLI) plan for A11G.

**OC 1: Improving Pilot Training, Operations, and Procedures**
**Primary Sponsor:** AFS-280, Air Transportation Division, Training and Simulation Group

**OC 2: Mitigating Human Fatigue**
**Primary Sponsor:** AFS-220, Air Carrier Operations Branch

**OC 3: Supporting Improvements in Aviation Maintenance**
**Primary Sponsor:** AFS-320, Aircraft Maintenance Division

**OC 4: Advanced Vision Systems, Head-Up Display, Head-Worn Display: Operation Standards & Approval Criteria**
**Primary Sponsor:** AFS-410, Flight Technologies and Procedures Division

**OC 5: Human Factors Considerations and Emerging Trends in Helicopter Air Ambulance Operations**
**Primary Sponsor:** AFS-220, Air Carrier Operations Branch – Part 135 Operations Section

**OC 6: Improving General Aviation Pilot Response to Unexpected Events**
**Primary Sponsor:** AVP-230, Office of Accident Investigation and Prevention - Integrated Safety Teams

**OC 7: Advances and Innovation in New Technology and Operations**
**Primary Sponsor:** AIR-626, Human Machine Interface Section

**OC 8: Air/Ground Integration of Technology, Systems, Operations, and Procedures for Trajectory-Based Operations**
**Primary Sponsor:** AFS-410; AFS-280, AIR-626
Note: This OC is addressed in a separate briefing package

**OC 9: Integrating Human Factors into Aircraft Certification and Flight Standards Policies and Processes**
**Primary Sponsor:** AFS-100, Aircraft Evaluation Division (AED); AIR-600 Policy and Innovation Division

**OC 10: Pilot Physiological State Monitoring Technologies and Mitigations**
**Primary Sponsor:** AAM2, Office of the Deputy Federal Air Surgeon; AIR-626

**OC 11: Current Flight Deck Operations and Pilot Procedures: Arrival, Approach, Departure**
**Primary Sponsor:** AFS-410

# Flight Deck/Maintenance/System Integration Human Factors Research Program accomplishments since FY2024 Q1

| Operational Capability (OC) Number and Title | Project | Description/Product |
|---|---|---|
| **OC 1:** Improving Pilot Training, Operations, and Procedures | Pilot Response to System Failures, Malfunctions, and Systems not Functioning as Expected | **Operational pilot response to multiple alerts and the use of corresponding checklists, procedures, and memory items:** https://rosap.ntl.bts.gov/view/dot/72503<br>• Conducted a literature review on operational pilot response, training, and system malfunctions<br>• Reviewed 20 records from the aviation safety reporting system (ASRS) database<br>• Analyzed 5 final aircraft accident/serious incident reports |
| | Emerging Pilot Workforce | **Effective training and checking methods for the emerging pilot workforce: publication pending**<br>• Conducted a literature review on pilot workforce composition, learning science, and training methods<br>• Completed an initial evaluation of virtual reality (VR) on a head-worn device with 22 civilian pilot students enrolled in a collegiate aviation program<br>• Documented findings in a technical report. |
| | Modern Training Practices | **Modern air carrier training practices and electronic/distance learning: publication pending**<br>• Literature review on the state of modern training practices and compilation of 3,000+ terms that relate to training and eLearning - results informed two air carrier training (ACT) aviation rulemaking committee (ARC) recommendations: 20-11 and 21-11<br>• Conducted two studies on the use of immersive technology for knowledge training – a laboratory study at the University and field study in collaboration with a major U.S. air carrier<br>• Documented human factors benefits, limitations, and tradeoffs in a technical report |
| | Single Source Reference Document for Flight Standards Human Factors | **Draft section on crew resource management**<br>• Compendium of operating requirements, guidance, recommendations, and example human factors considerations that relate to crew resource management. |

# Flight Deck/Maintenance/System Integration Human Factors Research Program accomplishments since FY2024 Q1 (2 of 2)

| Operational Capability (OC) Number and Title | Project | Description/Product |
|---|---|---|
| **OC 2:** Mitigating human factors | Fatigue mitigation in flight operations | **Technology transfer from research to operations**<br>• Air carriers can record and share fatigue risk management system (FRMS) data in a standard format with relevant FAA stakeholders<br>• FAA can analyze and maintain the operational data to safely implement and oversee recent changes to 14 CFR Part 117 Flight and Duty Limitations and Rest Requirements: Flightcrew Members |
| **OC 4:** Advanced Vision Systems, Head-Up Display, Head-Worn Display: Operation Standards & Approval Criteria | Use of dual head-up display technology | **Human factors and crew coordination aspects of single/dual HUD during Category III flight operations - draft report**<br>• Conducted a human-in-the-loop- (HITL) simulation with line pilot participants to assess the human factors and crew coordination impacts of dual HUD technology on pilot flying (PF) and pilot monitoring (PM) performance – flight technical error/accuracy, early detection of flightpath changes, etc. |
| **OC 9:** Integrating Human Factors into Aircraft Certification and Flight Standards Policies and Processes | Integration of human factors into operational evaluations and Flight Standardization Board (FSB) processes | **Aircraft Evaluation Division (AED) human factors gap analysis - publication pending**<br>• Identified where there are gaps for human factors and operational data in FAA documentation specific to 3 AED functions: Flight Standardization Board (FSB) Operational Evaluations, including T Tests, crew complement determinations through the FSB process, and operational suitability assessments<br>• Obtained data from existing literary sources to fill identified gaps<br>• Provided recommendations for addressing gaps that could not be filled |

# Operational Capability (OC) 1: Improving Pilot Training, Procedures, and Operations

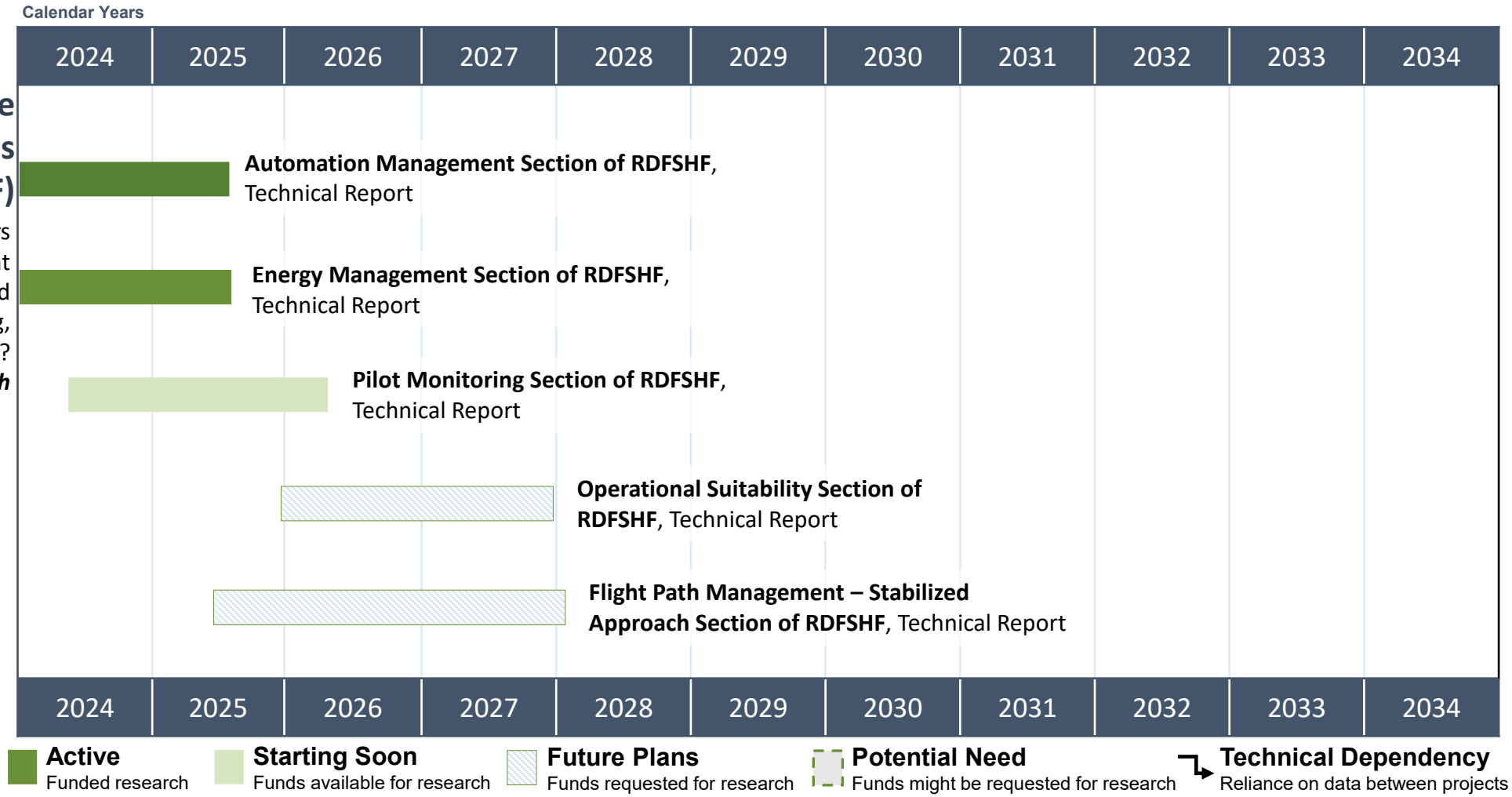
## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Single source reference document for Flight Standards human factors (RDFSHF)

**Research Question:** What human factors research data would support the Flight Standards personnel who must evaluate and approve operational suitability, training, procedures, operations, and maintenance?

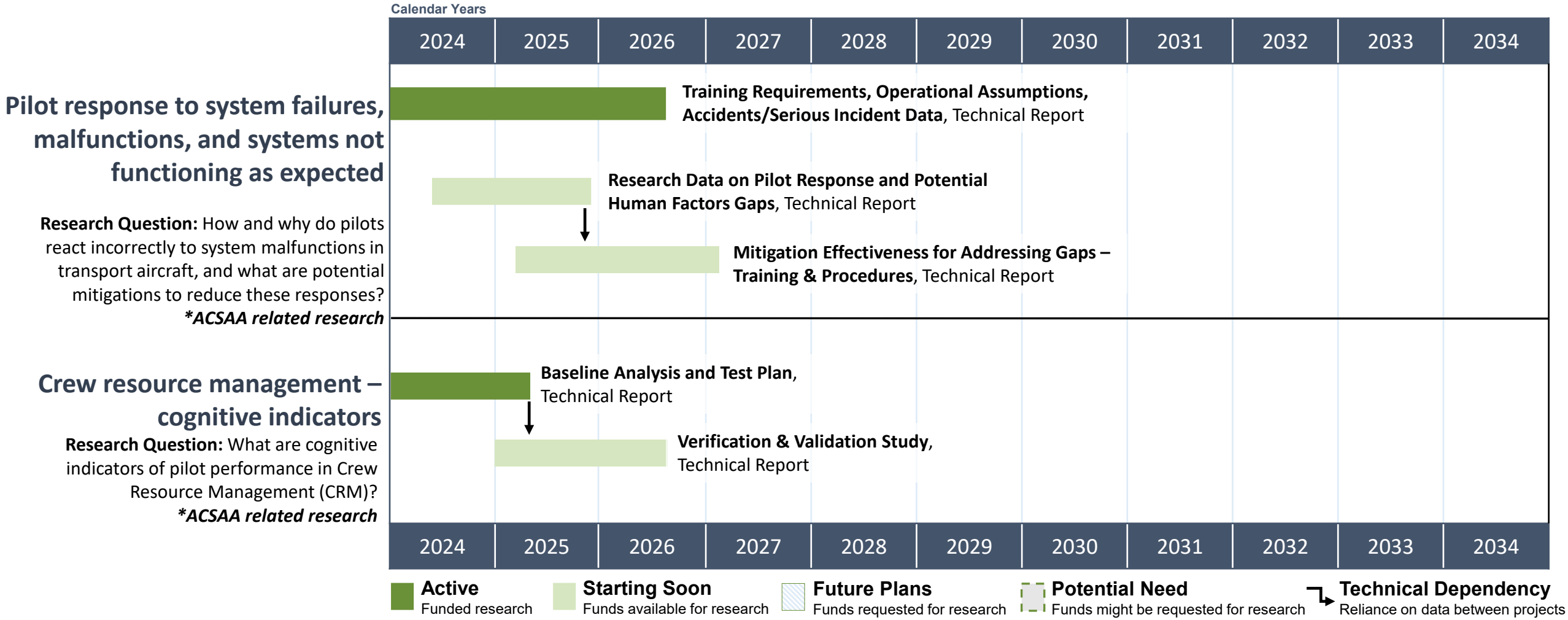
***ACSAA related research**



# OC 1: Improving Pilot Training, Procedures, and Operations

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***



# OC 1: Improving Pilot Training, Procedures, and Operations

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Pilot training and operational effectiveness

**Research Question:** How effective are current pilot training programs, including those using new training technologies and methods? What technologies and methods are most appropriate for which pilot training tasks?
***ACSAA related research***

# OC 1: Improving Pilot Training, Procedures, and Operations

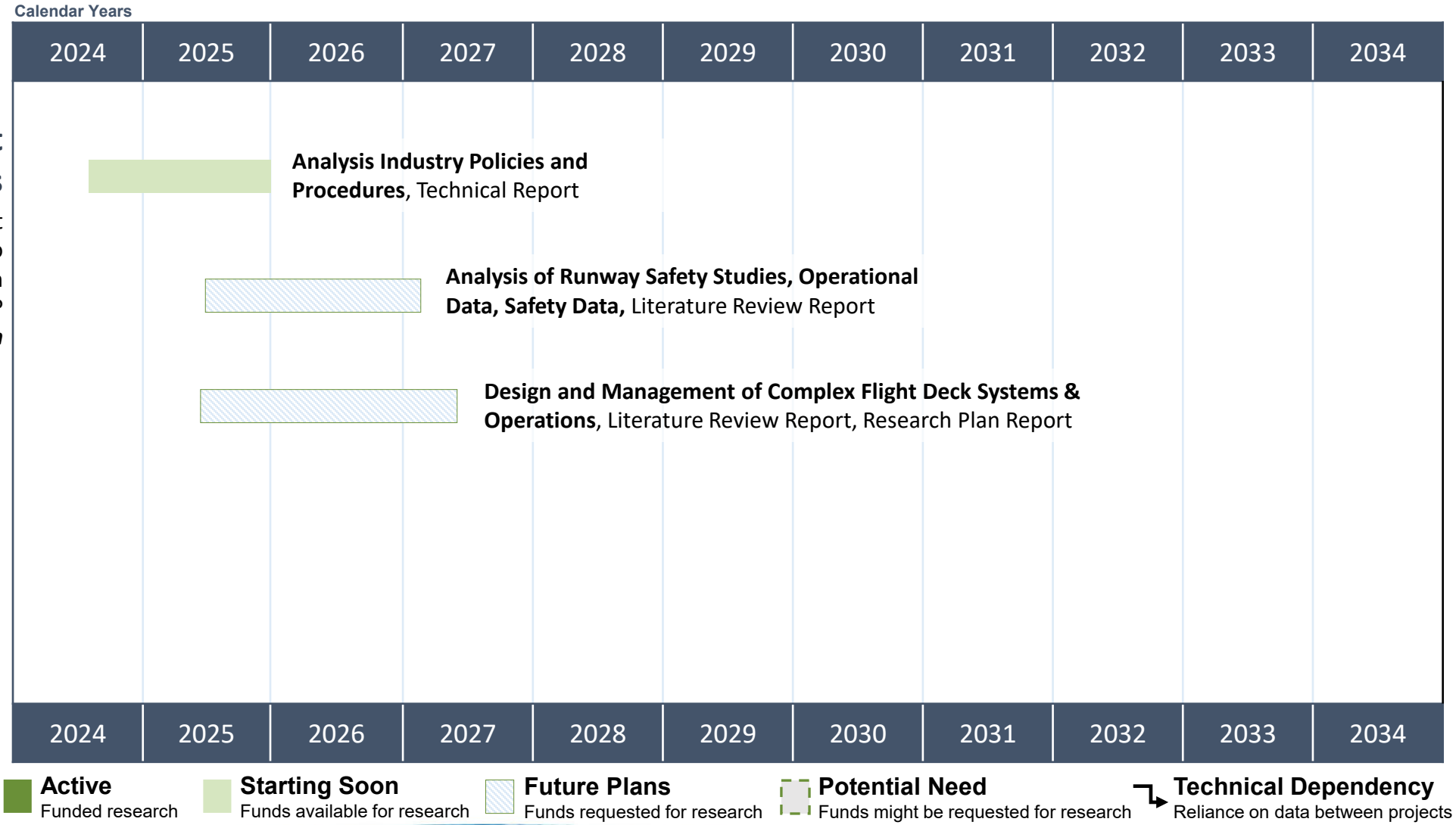
## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Adapting training and flight operations to emerging risks

**Research Question:** How should we adapt training and flight operations to respond to emerging risks, including pilot automation dependencies?

***ACSAA related research***



# OC 2: Mitigating Fatigue in Flight Operations

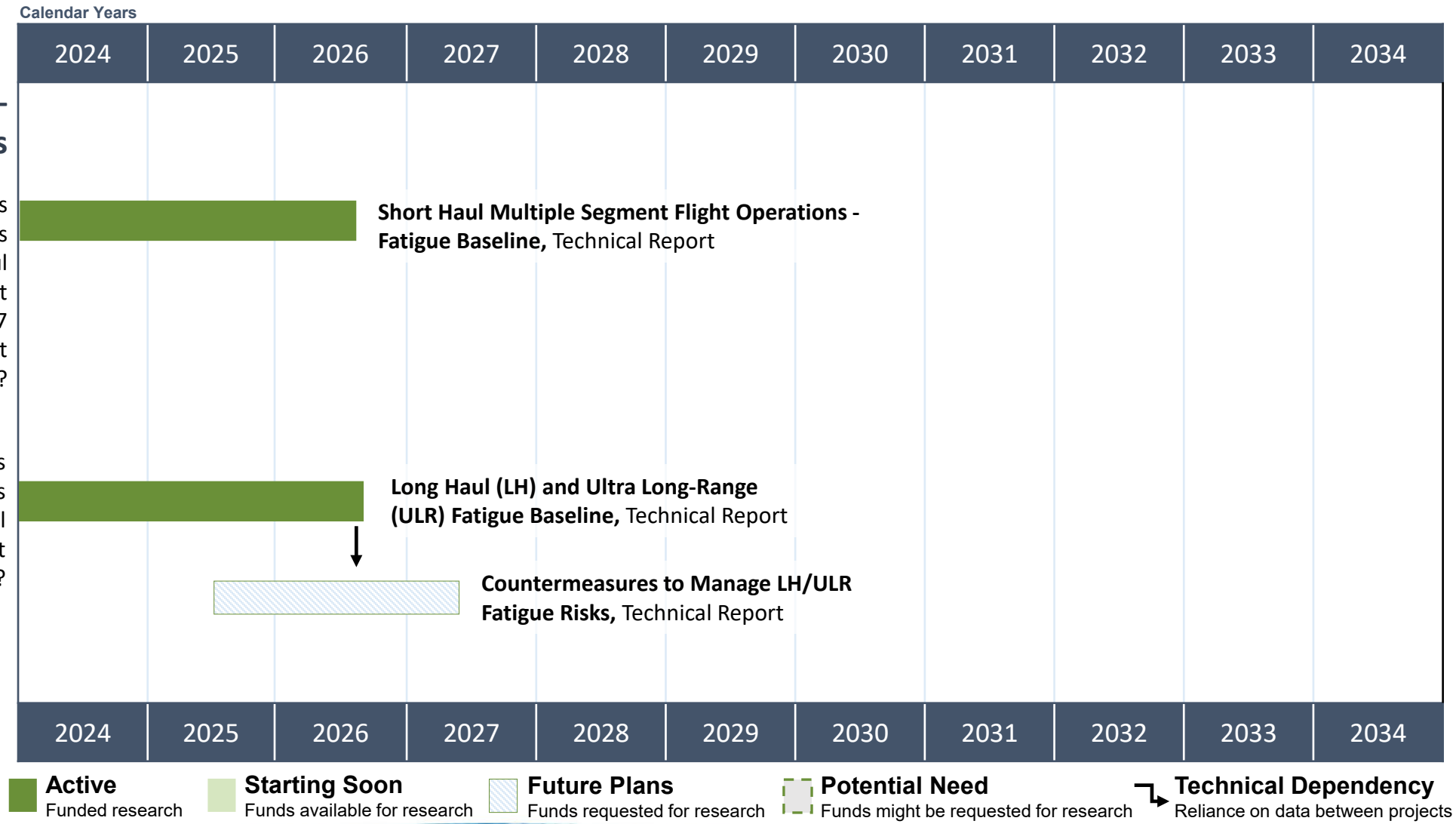
## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Fatigue risk management - current flight operations

**Research Question:** What mitigations effectively manage impacts to human factors and pilot performance caused by long-haul and ultra-long-range flight operations that exceed the table limits of 14 CFR Part 117 "Flight and Duty Limitations and Rest Requirements for Flightcrew Members"?

**Research Question:** What mitigations effectively manage impacts to human factors and pilot performance caused by long-haul and ultra-long-range flight operations that exceed the table limits of 14 CFR Part 117?



# OC 2: Mitigating Fatigue in Flight Operations

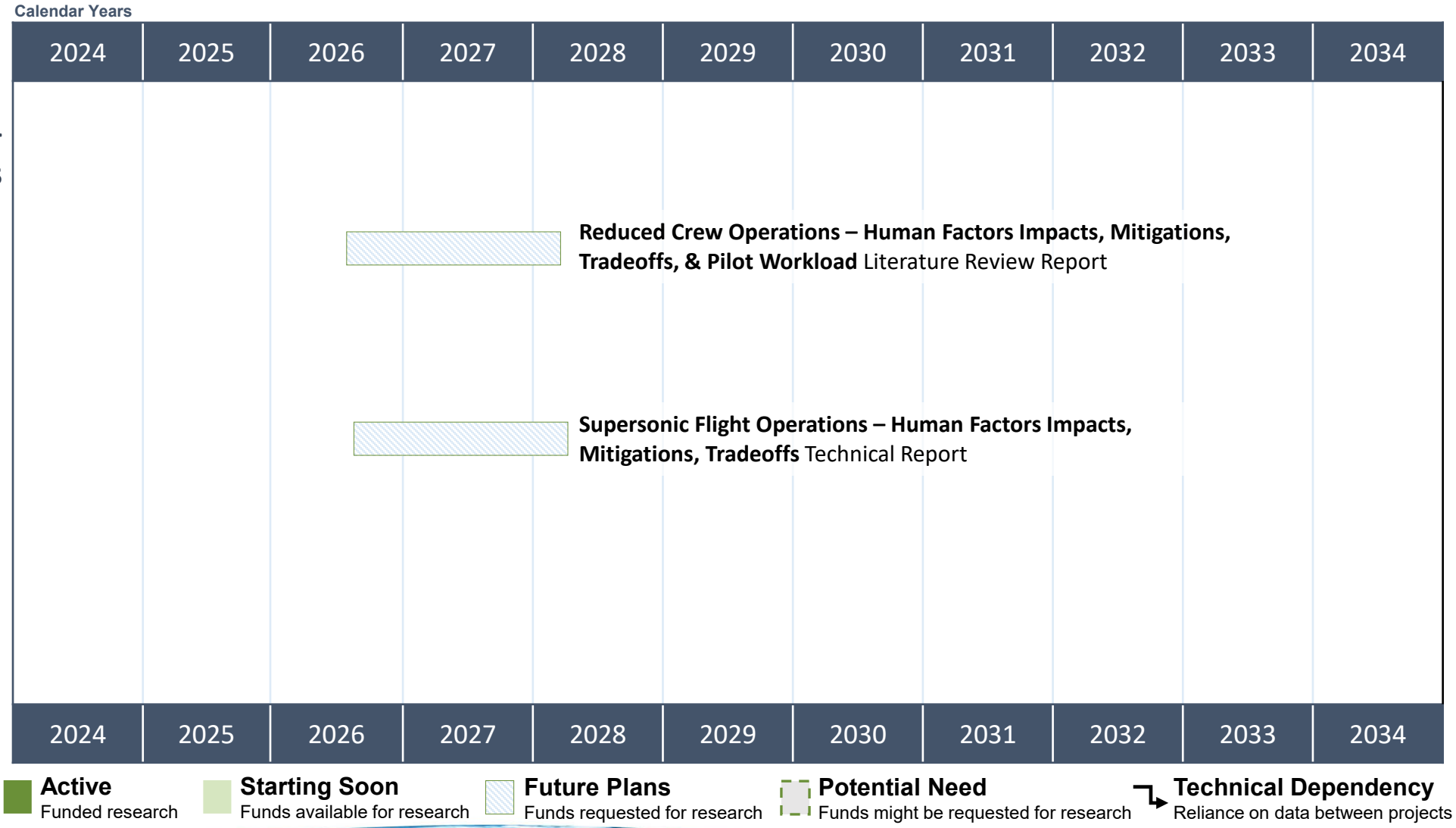
## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Fatigue risk management - future flight operations

**Research Question:** What are current and recommended mitigations to manage fatigue effects on pilot performance in reduced crew operations in transport category aircraft?

**Research Question:** What are current and recommended mitigations to manage fatigue effects on pilot performance in supersonic flight operations?



# OC 3: Supporting Improvements in Aviation Maintenance

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Maintenance training

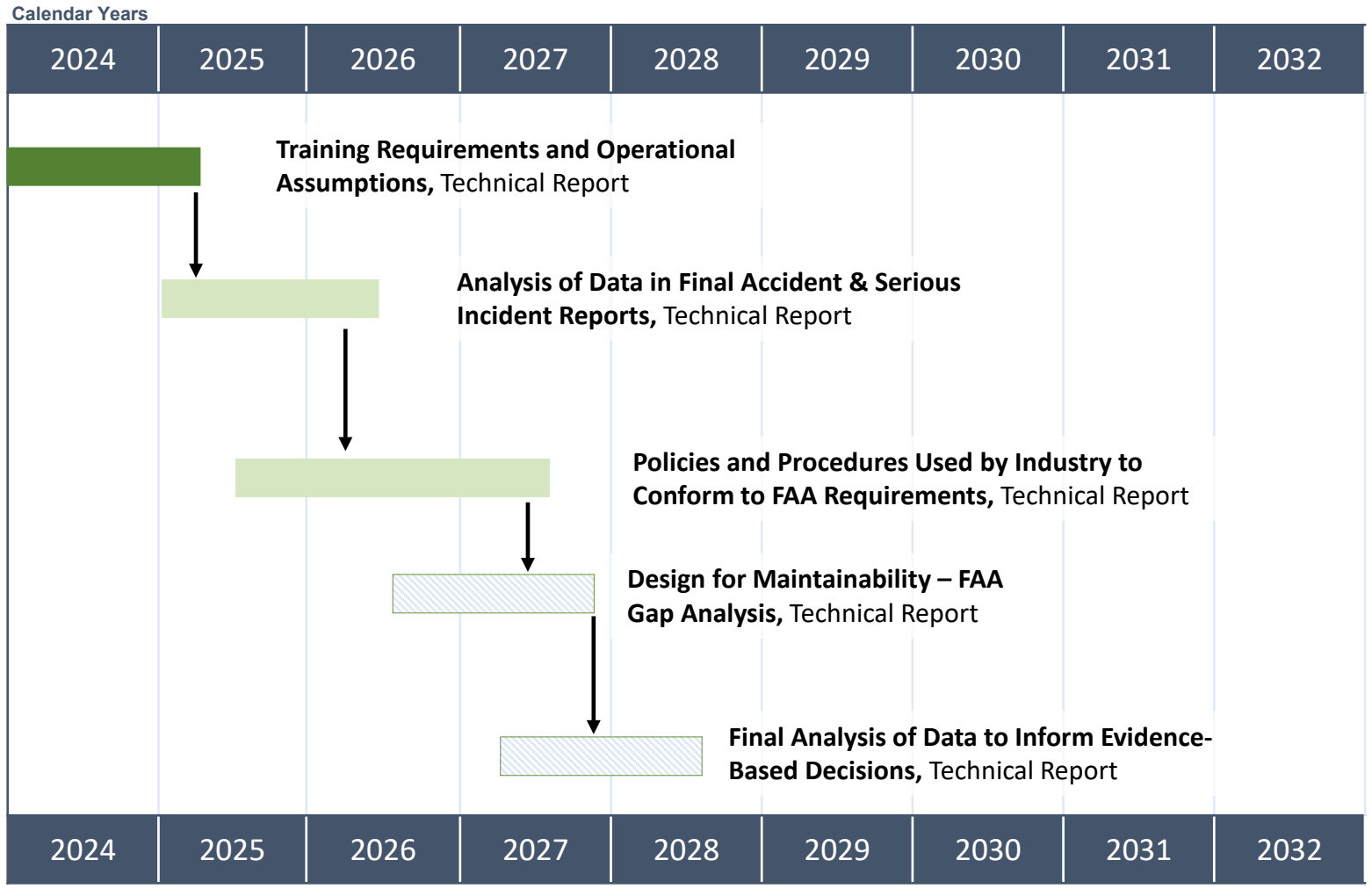
**Research Question:** What requirements & assumptions are currently used for aviation maintenance technician (AMT) knowledge, skills, experience, and training for transport category aircraft & airplane differences?
***ACSAA related research***

**Research Question:** What is the role and frequency of factors involving AMT knowledge, skills, experience, training, assumptions, & design for maintainability in global transport category aircraft accidents 2010-present?
***ACSAA related research***

**Research Question:** What training and operational policies/procedures are used by industry to conform to FAA AMT training requirements for transport category aircraft and airplane differences?
***ACSAA related research***

**Research Question:** What research & engineering data is needed to fill gaps in existing FAA guidance or to inform new guidance on design maintainability?
***ACSAA related research***

**Research Question:** Are FAA regulatory materials, guidance, and assumptions for maintenance training requirements for transport category aircraft adequate?
***ACSAA related research***




**Active** Funded research

**Starting Soon** Funds available for research

**Future Plans** Funds requested for research

**Potential Need** Funds might be requested for research

**Technical Dependency** Reliance on data between projects

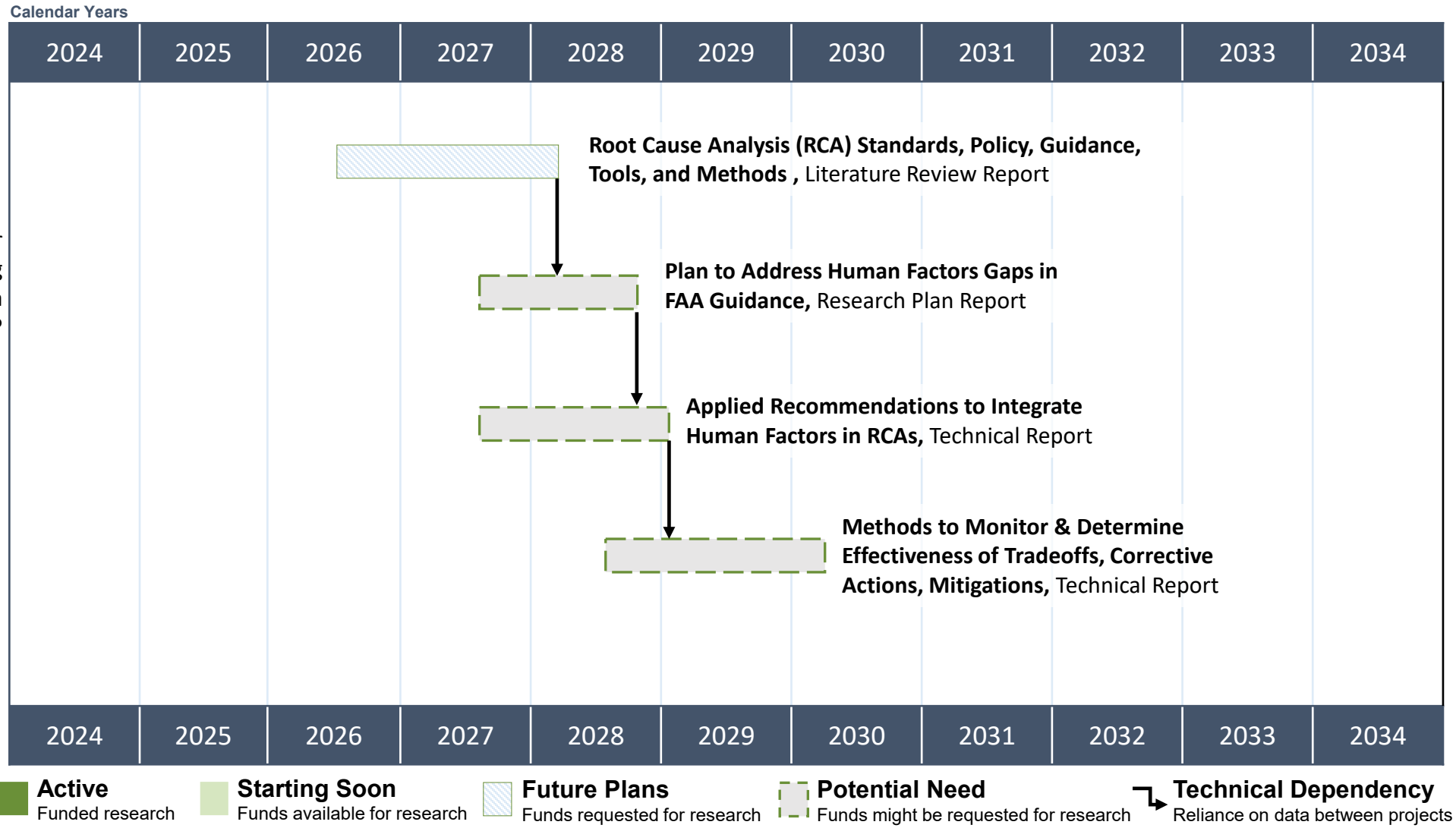
# OC 3: Supporting Improvements in Aviation Maintenance

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Methods to identify root cause(s) of human factors risks in maintenance programs

**Research Question:** Where are there gaps for human factors and operational data recording in existing Safety Assurance System (SAS) data collection tools (DCTs)?



# OC 4: Advanced Vision Systems, Head-Up Displays, Head-Mounted Displays

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

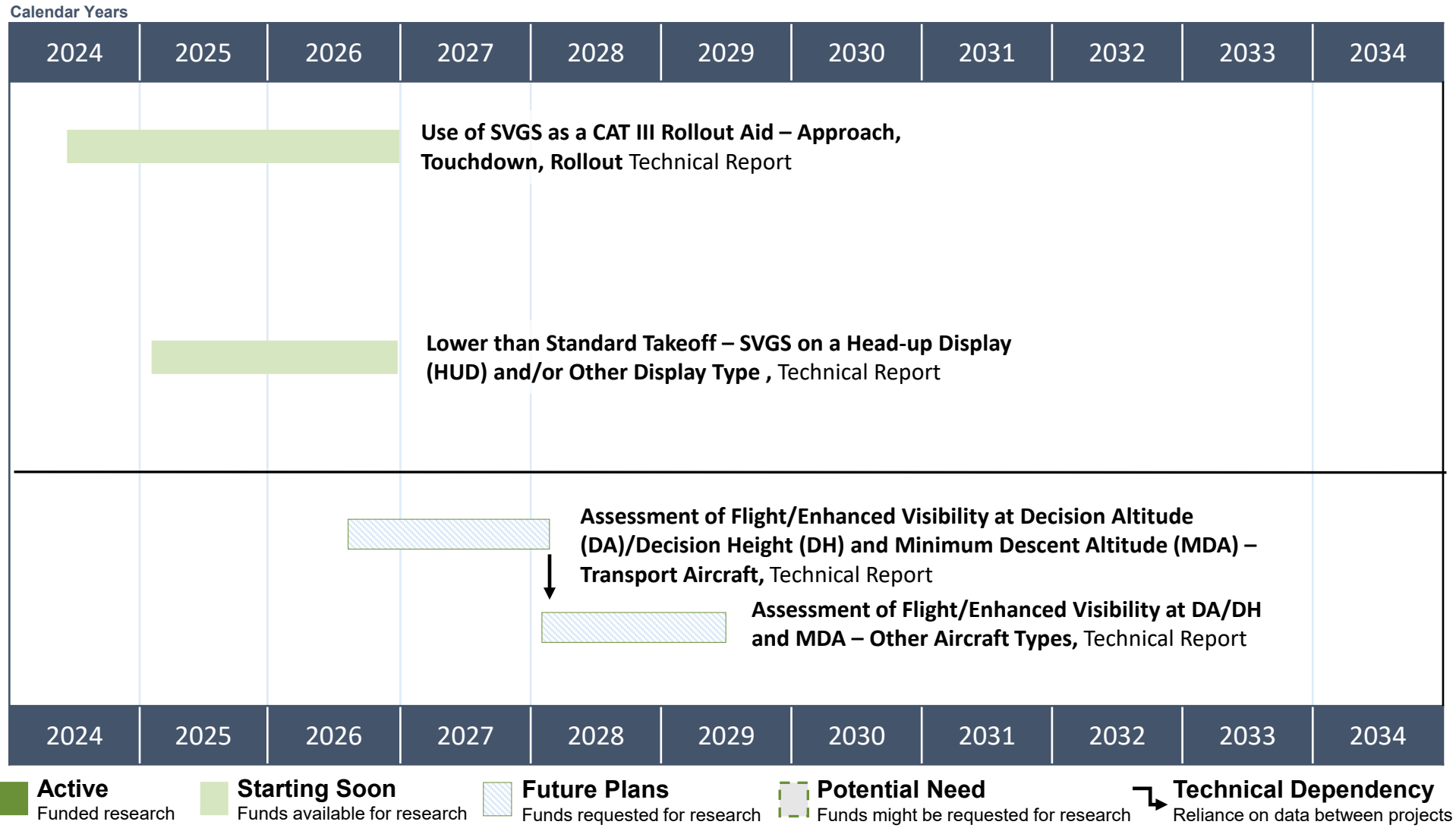
### Synthetic vision guidance system (SVGS)

**Research Question:** Can SVGS technology be used as a substitute for any of the equipage and/or NAS infrastructure required to conduct CAT III flight operations?

**Research Question:** Can SVGS technology can be used as a possible substitute for certain airport/runway infrastructure currently required to conduct lower than standard takeoff minima operations when using natural vision?

### Flight visibility assessment

**Research Question:** Does the use of an enhanced flight vision system (EFVS) on a head-down display to 100’ above touchdown zone elevation (TDZE) support an equivalent level of safety and pilot performance versus EFVS on a head-up display?



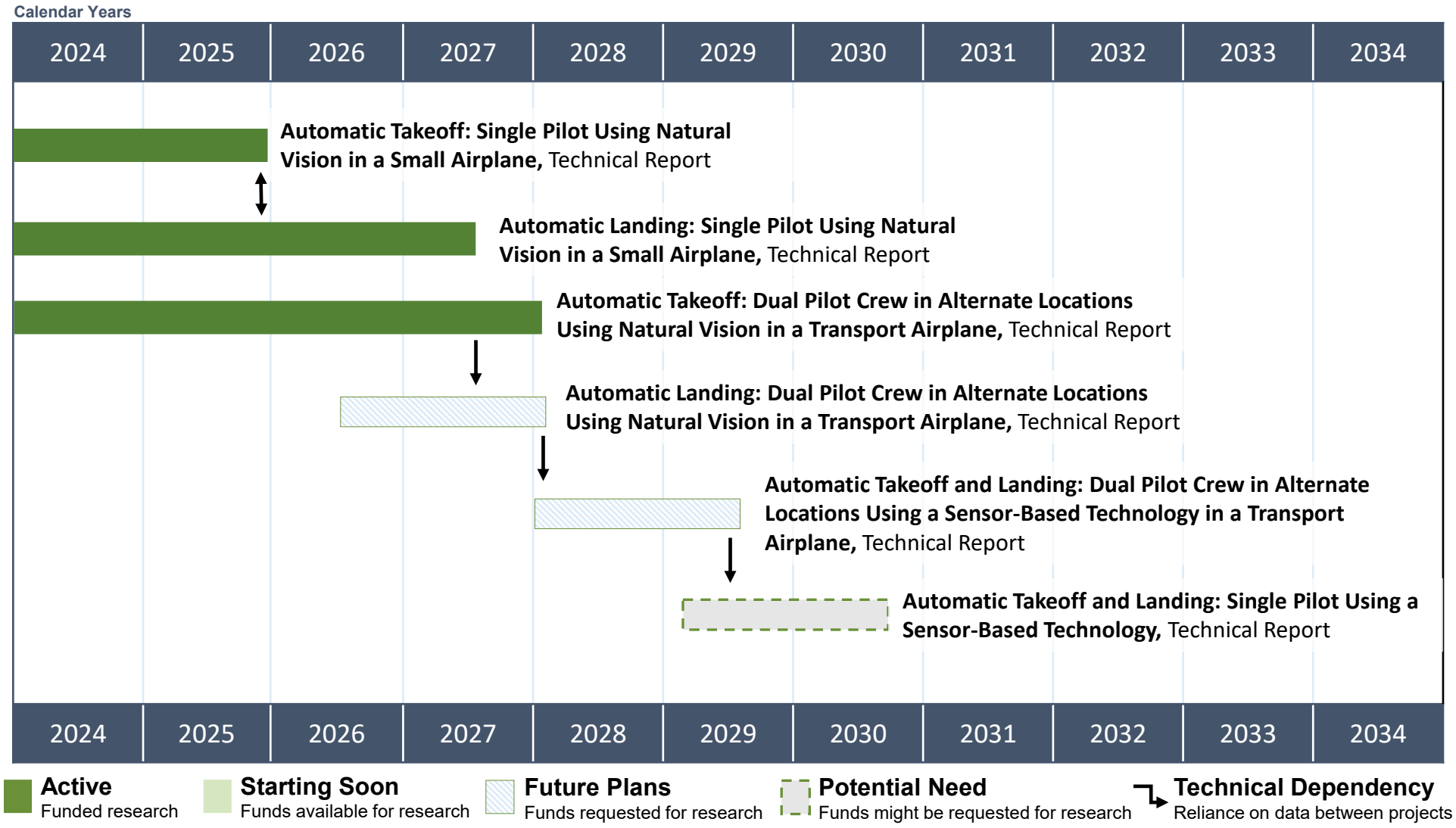
# OC 4: Advanced Vision Systems, Head-Up Displays, Head-Mounted Displays

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Automatic takeoff and landing operations

**Research Question:** Is single/dual pilot workload acceptable during new low visibility automatic takeoff and landing operations using unassisted vision or an emerging vision system technology to conduct and monitor the flight operation?



# OC 4: Advanced Vision Systems, Head-Up Displays, Head-Mounted Displays

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

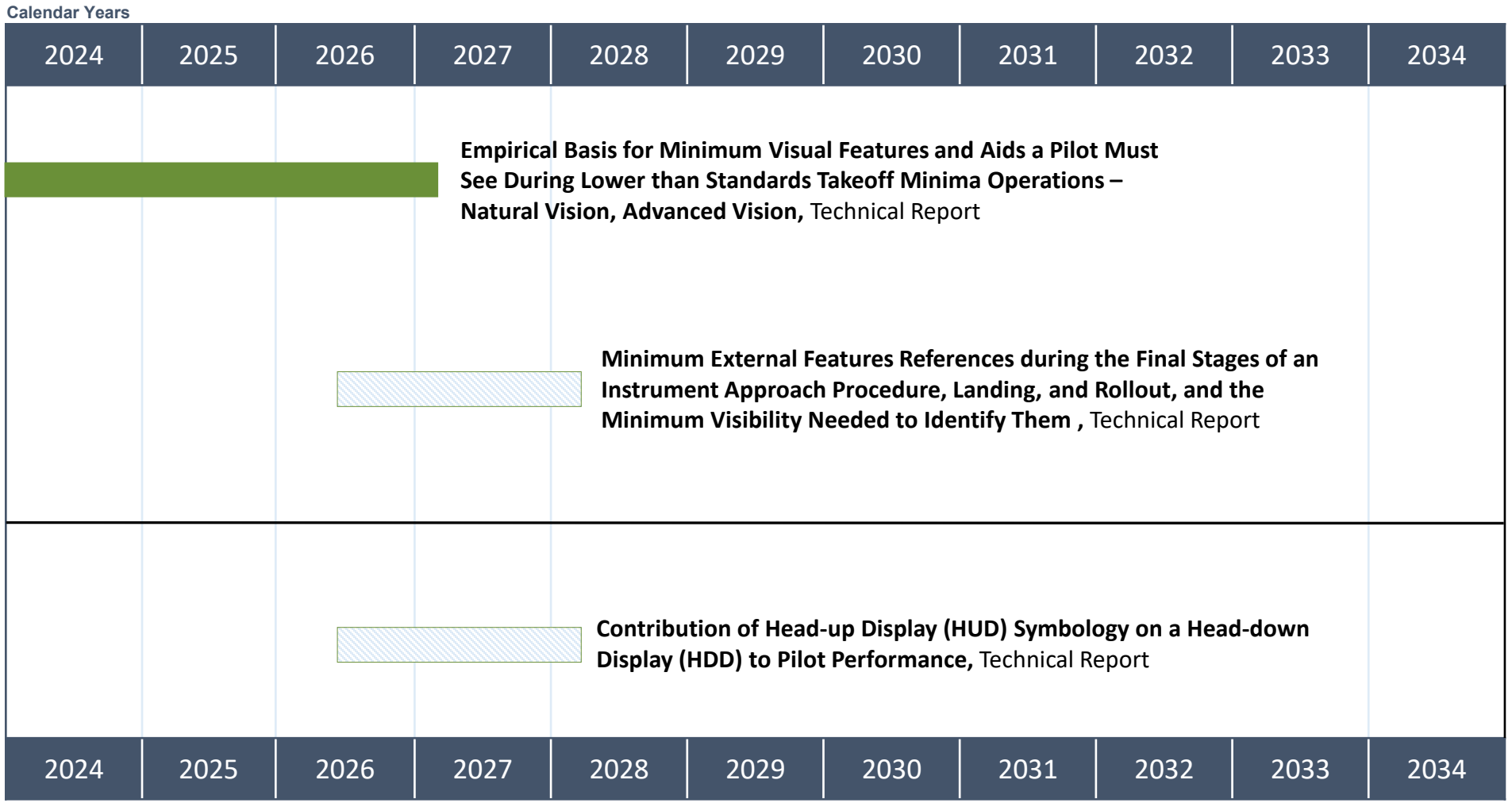
### Minimum visual features and visual aids

**Research Question:** What are the minimum visual features and visual aids a pilot must see to safely takeoff in visibilities that range from 1600 RVR down to 300 RVR using both natural vision (with and without a HUD) and an advanced vision system (on a HUD)?

**Research Question:** What external features do pilots visually reference in the runway environment to manually land an aircraft, and the minimum visibility these references can be identified with natural vision?

### Display symbology

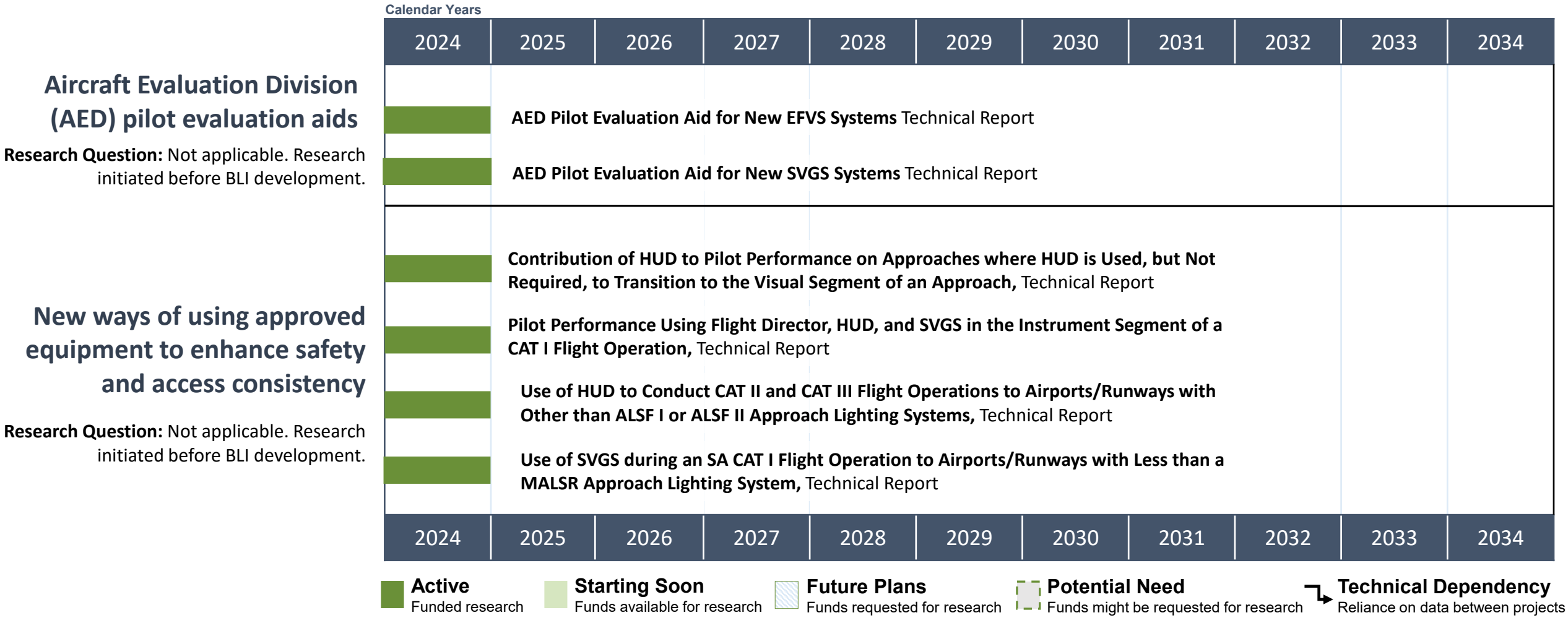
**Research Question:** What is the contribution of head-up display (HUD) symbology on a head-down display (HDD) to pilot performance during low visibility flight operations?



# OC 4: Advanced Vision Systems, Head-Up Displays, Head-Mounted Displays

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***



# OC 5: Human Factors Considerations & Emerging Trends in Helicopter Air Ambulance Operations

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Helicopter air ambulance (HAA) operations

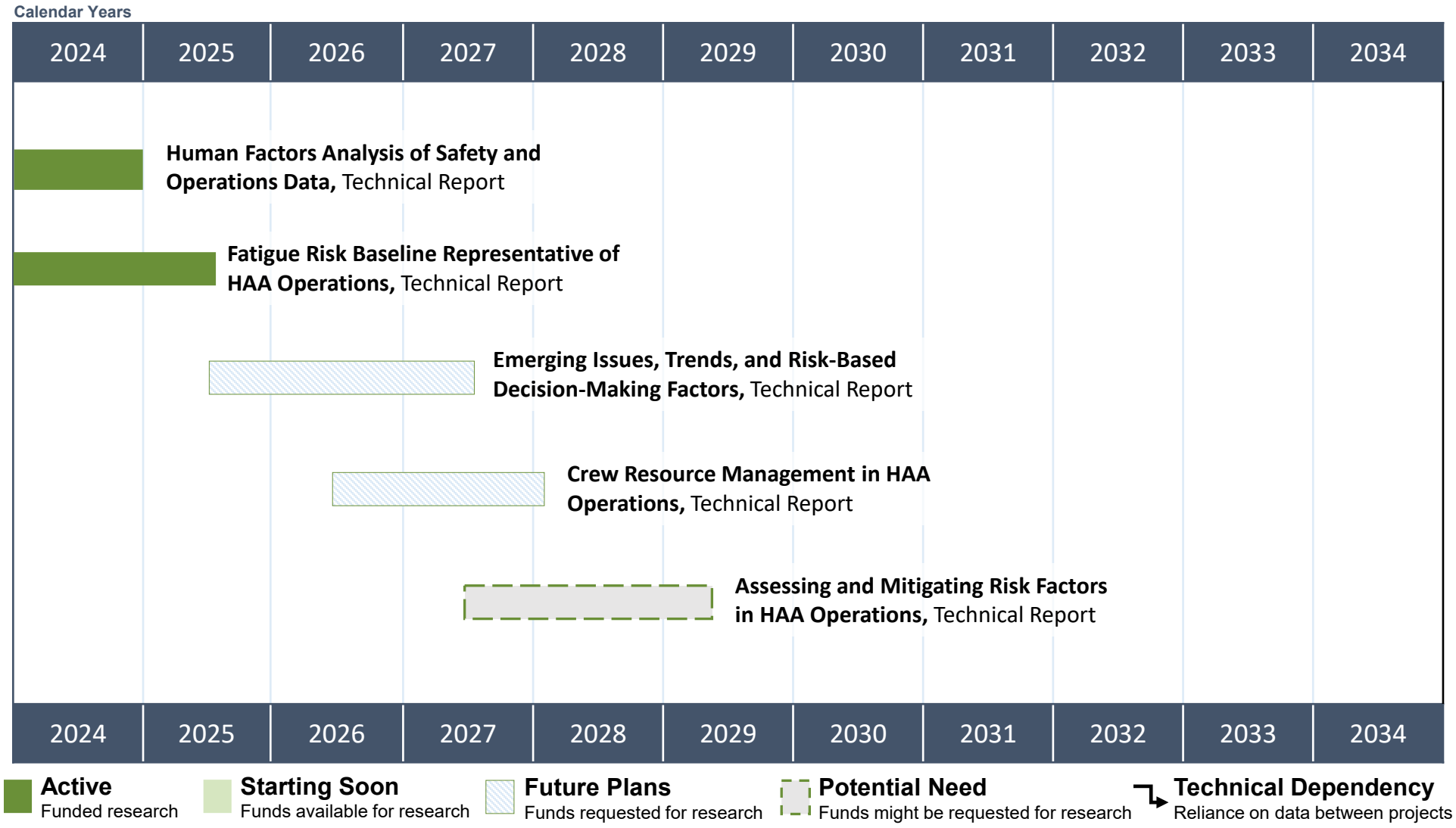
**Research Question:** What are casual or contributing human factors elements associated with HAA accidents and incidents?

**Research Question:** What are the current fatigue risks for the HAA Industry?

**Research Question:** What are human factors-related emerging issues and industry trends for HAA Operations?

**Research Question:** How Should HAA operations address crew resource management research recommendations?

**Research Question:** What are the industry best practices for assessing and mitigating risk factors in HAA Operations?



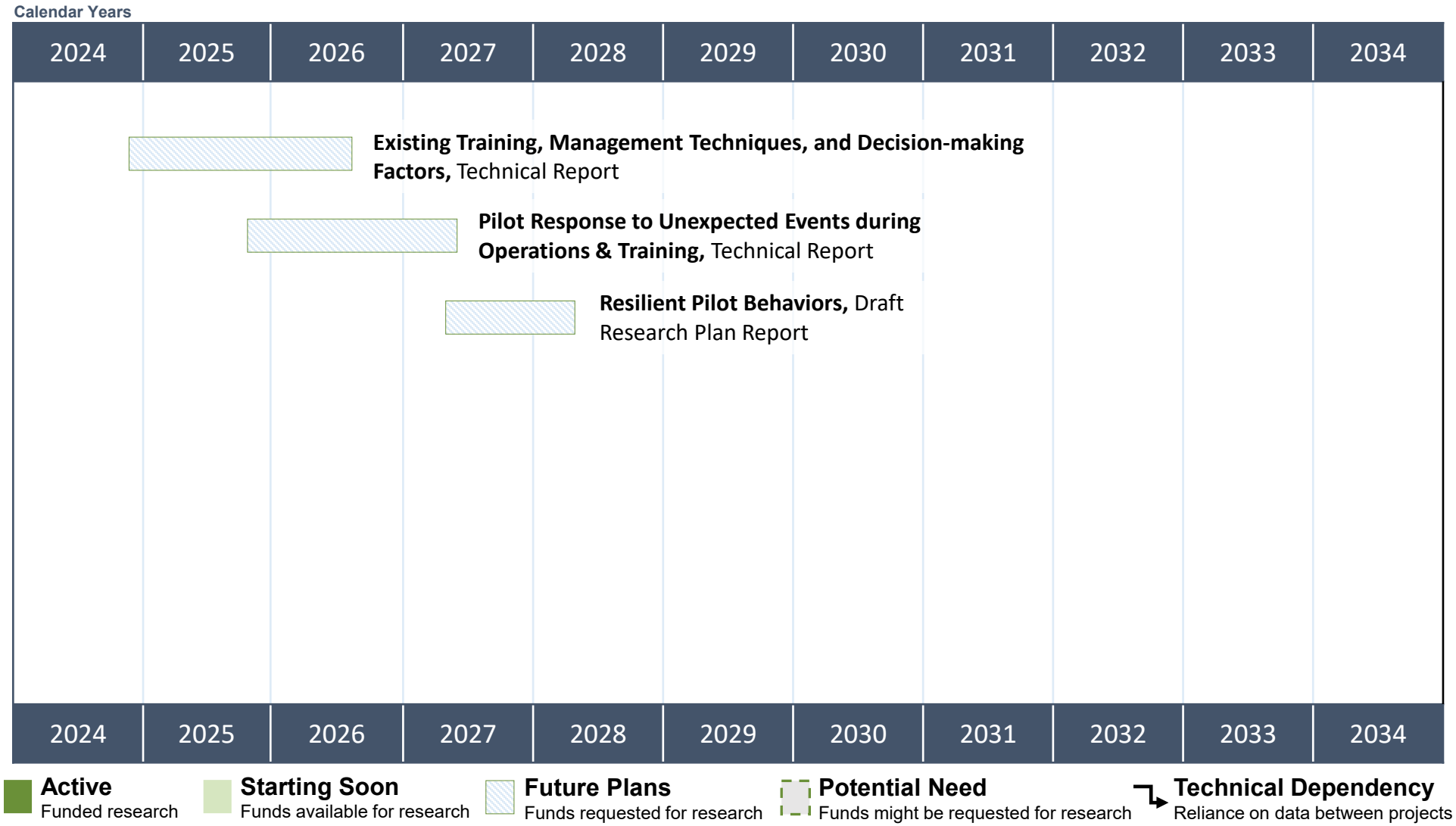
# OC 6: Improving General Aviation Pilot's Response to Unexpected Events

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Unexpected airplane state: general aviation

**Research Question:** How do General Aviation pilots react to unexpected events and what are potential mitigations to supporting appropriate responses?



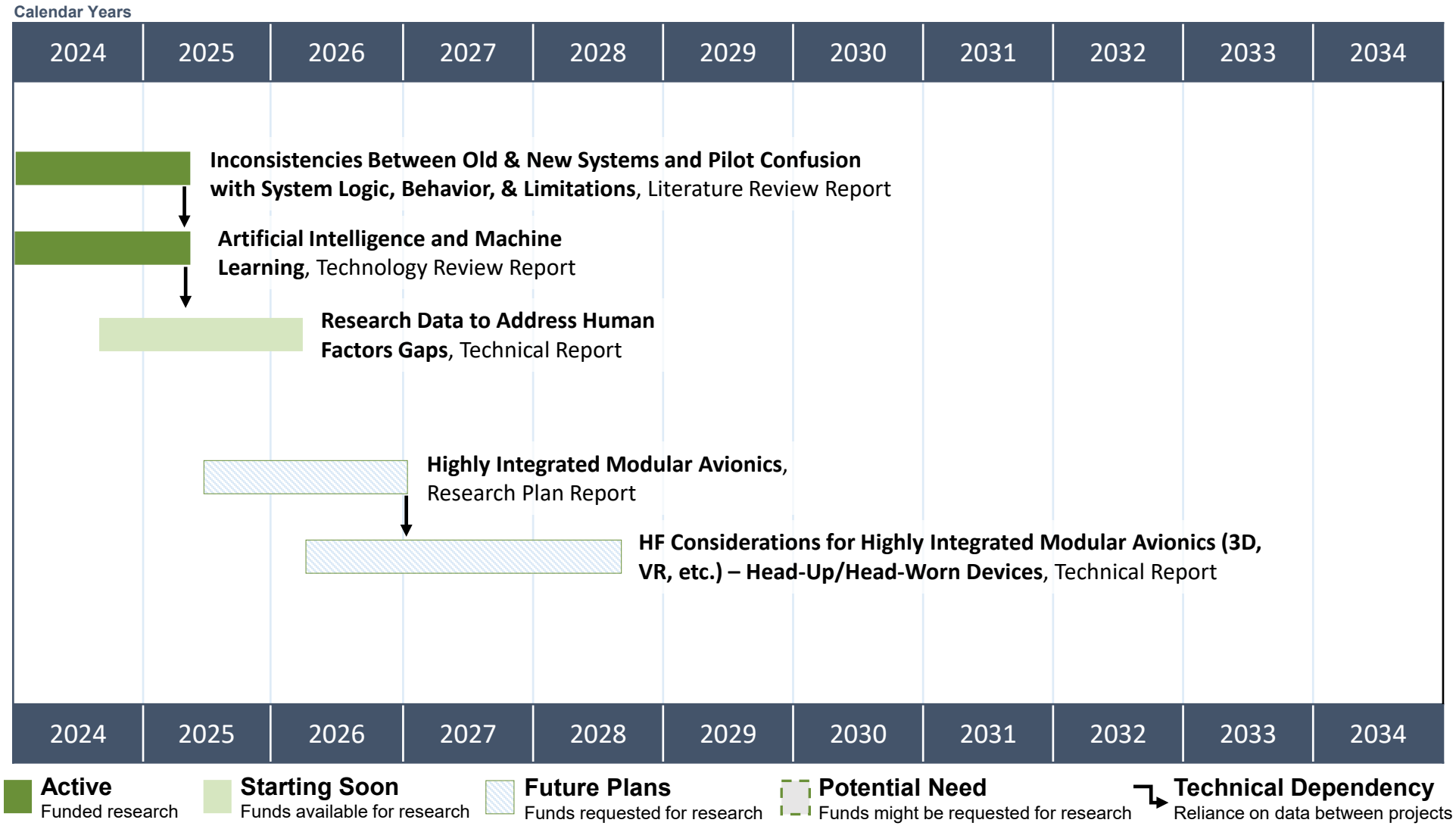
# OC 7: Advances and Innovation in New Technologies and Operations

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Pilot interactions with advanced technologies

**Research Question:** What are the human factors considerations for new flight deck interface technologies?
***ACSAA related research***



# OC 7: Advances and Innovation in New Technologies and Operations

## FY2024 Research and Potential Project Plans

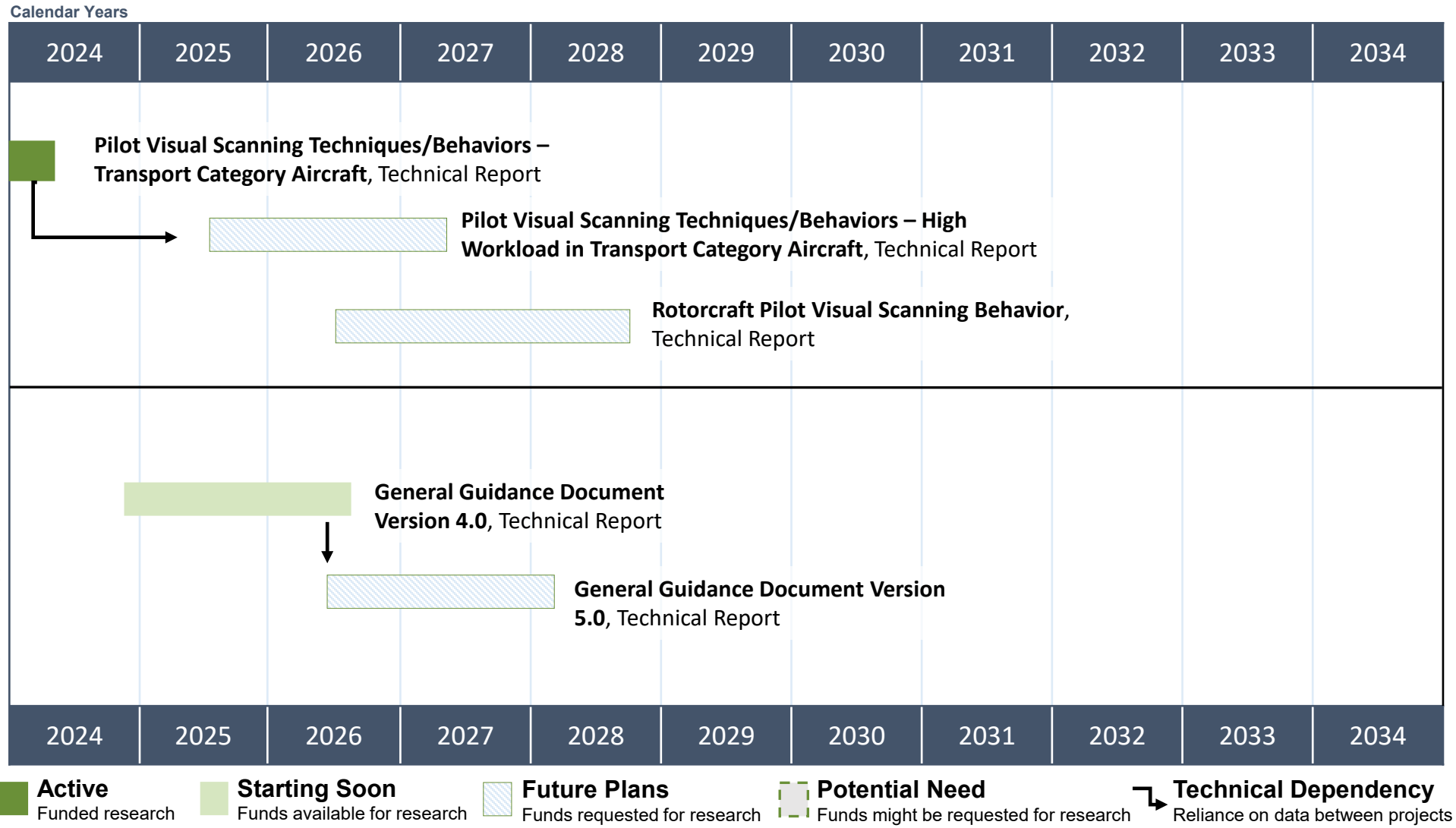
***Potential project plans are subject to change based on FAA needs and availability of funds***

### Pilot visual scanning techniques for flightpath management

**Research Question:** What human factors aspects are involved in and affect flightpath management? What implications do these human factor aspects have on display design?
***ACSAA related research***

### Human factors general guidance document

**Research Question:** What human factors research data would support the engineers, test pilots, and human factors specialists in Aircraft Certification who must evaluate and approve flight deck systems and equipment?
***ACSAA related research***



# OC 7: Advances and Innovation in New Technologies and Operations

## FY2024 Research and Potential Project Plans

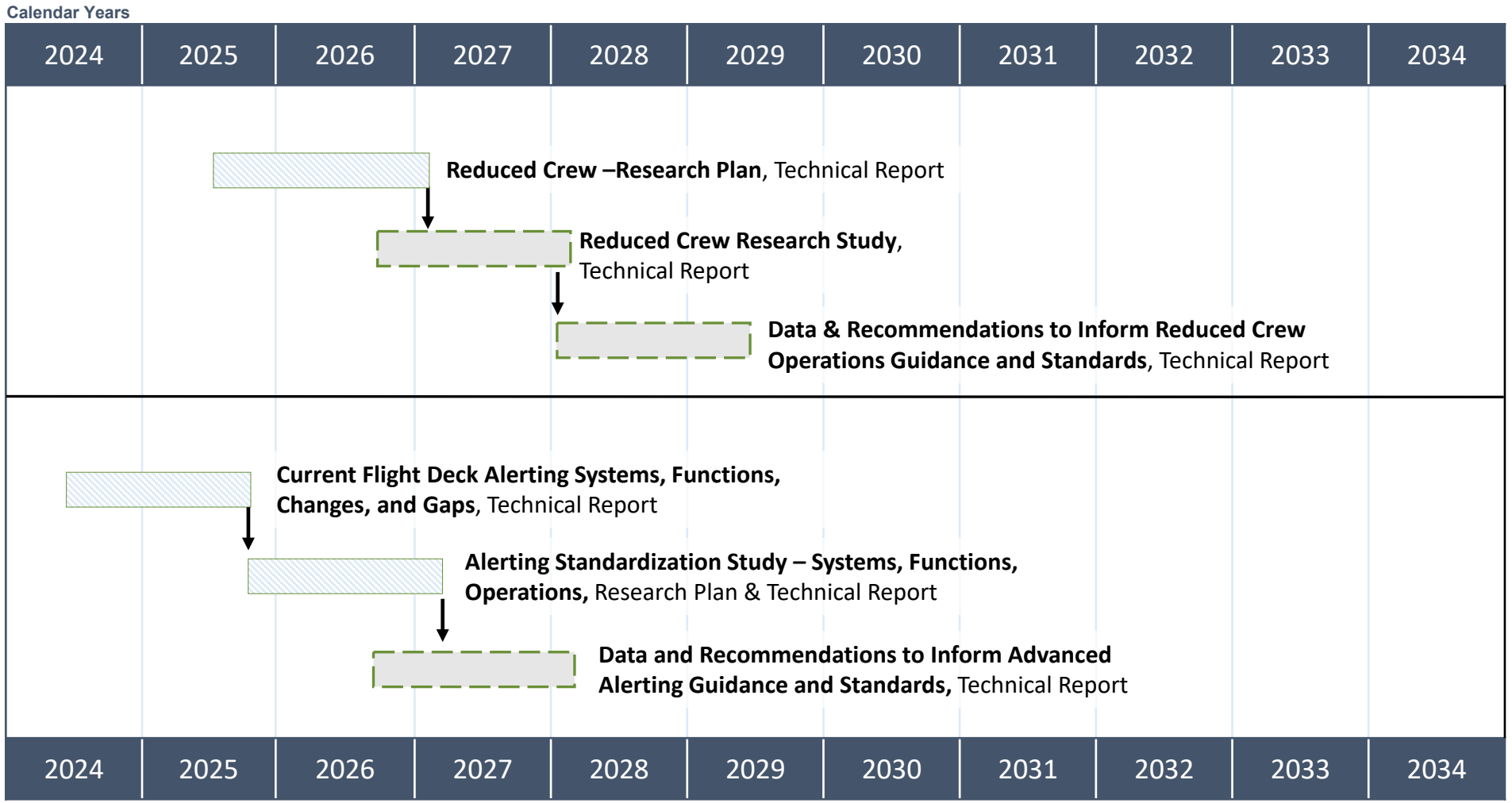
***Potential project plans are subject to change based on FAA needs and availability of funds***

### Reduced crew - transport aircraft

**Research Question:** Can we safely enable reduced crew operations at an equivalent level of safety as transport category operations, and if so, how?
***ACSAA related research***

### Design standards for new and advanced alerting systems

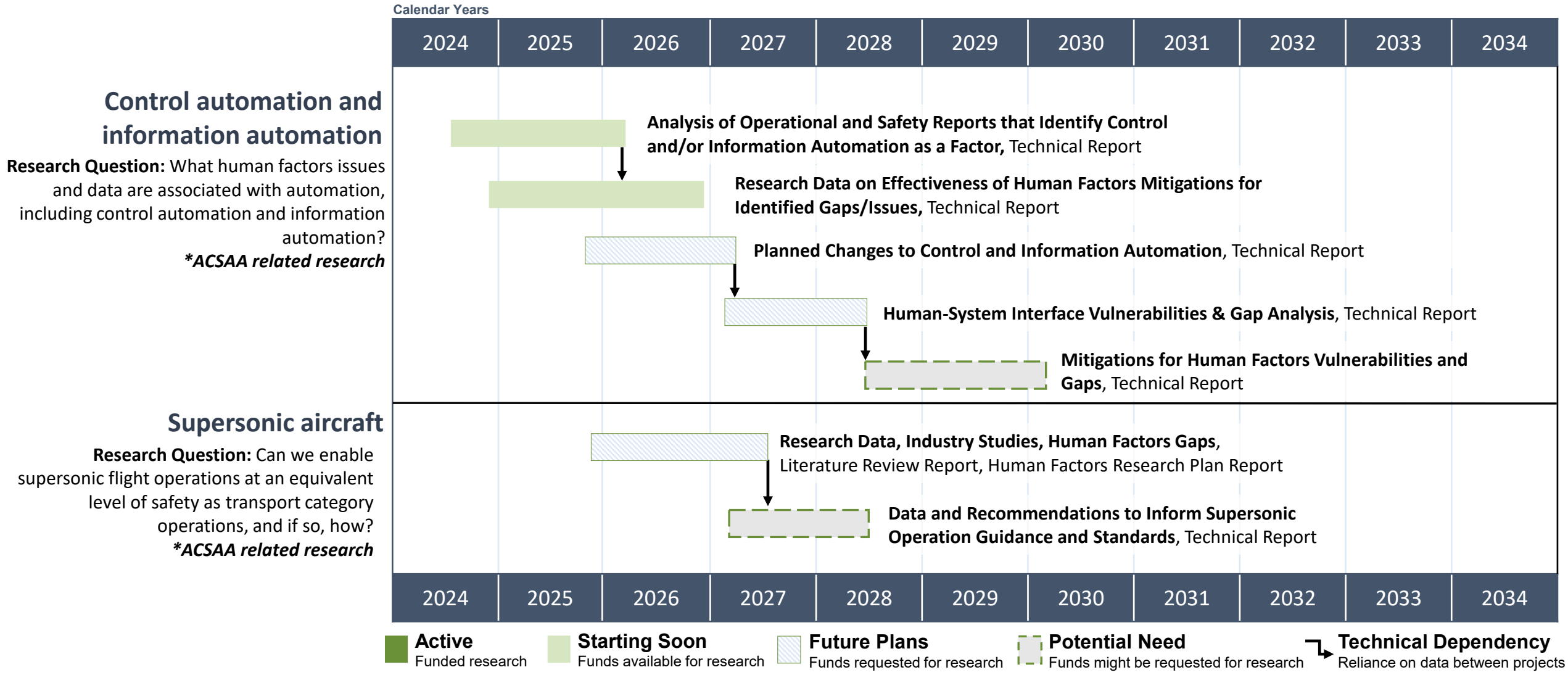
**Research Question:** How should alerting system design standards be updated to reflect new technology and functionality in flight deck alerting systems?
***ACSAA related research***



# OC 7: Advances and Innovation in New Technologies and Operations

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***



# OC 9: Integrating Human Factors into Aircraft Certification & Flight Standards Methods & Processes

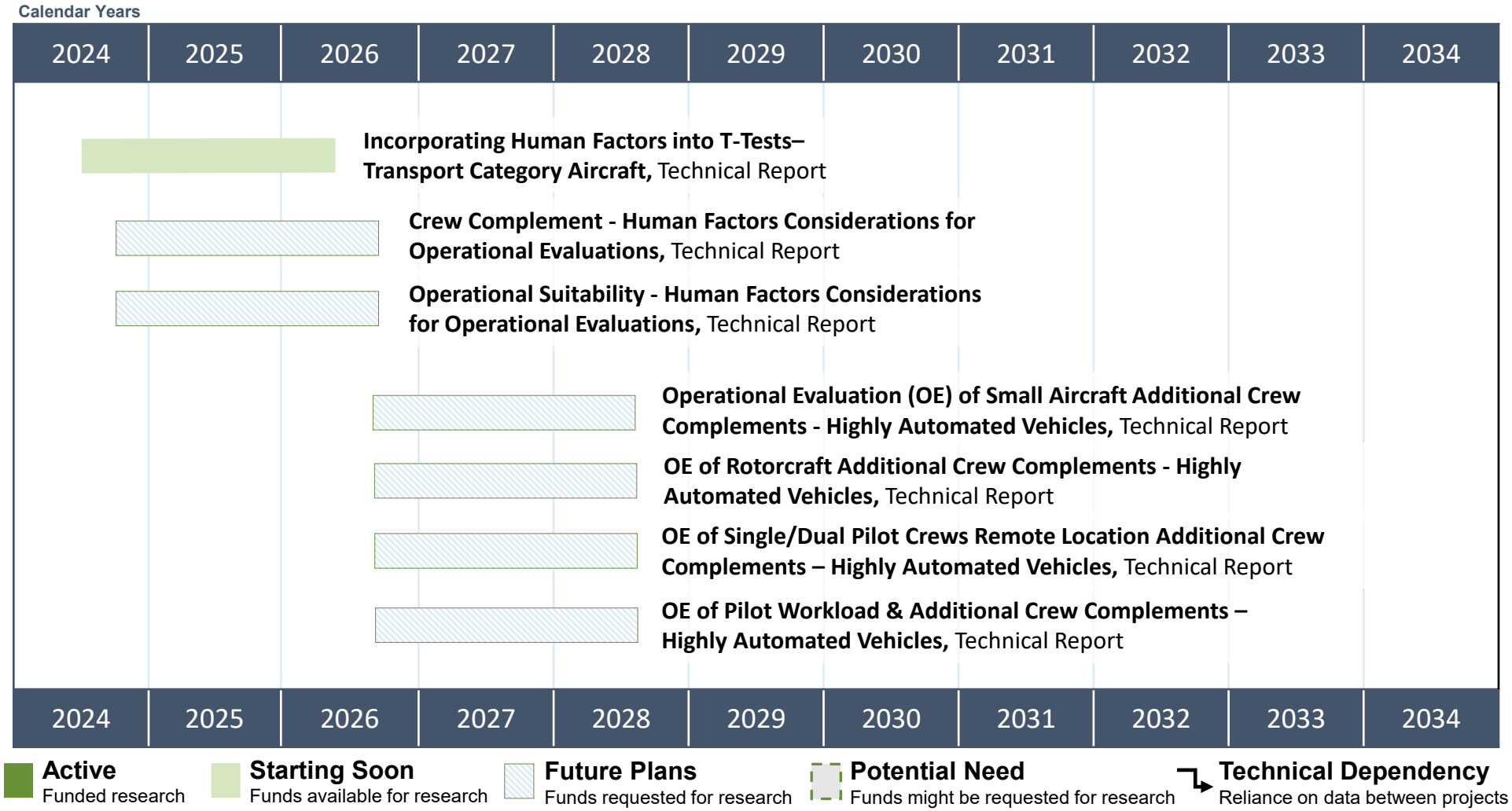
## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Integration of Human factors into the Aircraft Evaluation Division (AED) processes and criteria

**Research Question:** What human factors data, processes, and procedures can support operational suitability evaluations and in the Flight Standardization Board (FSB) process?

***ACSAA related research**



# OC 9: Integrating Human Factors into Aircraft Certification & Flight Standards Methods & Processes

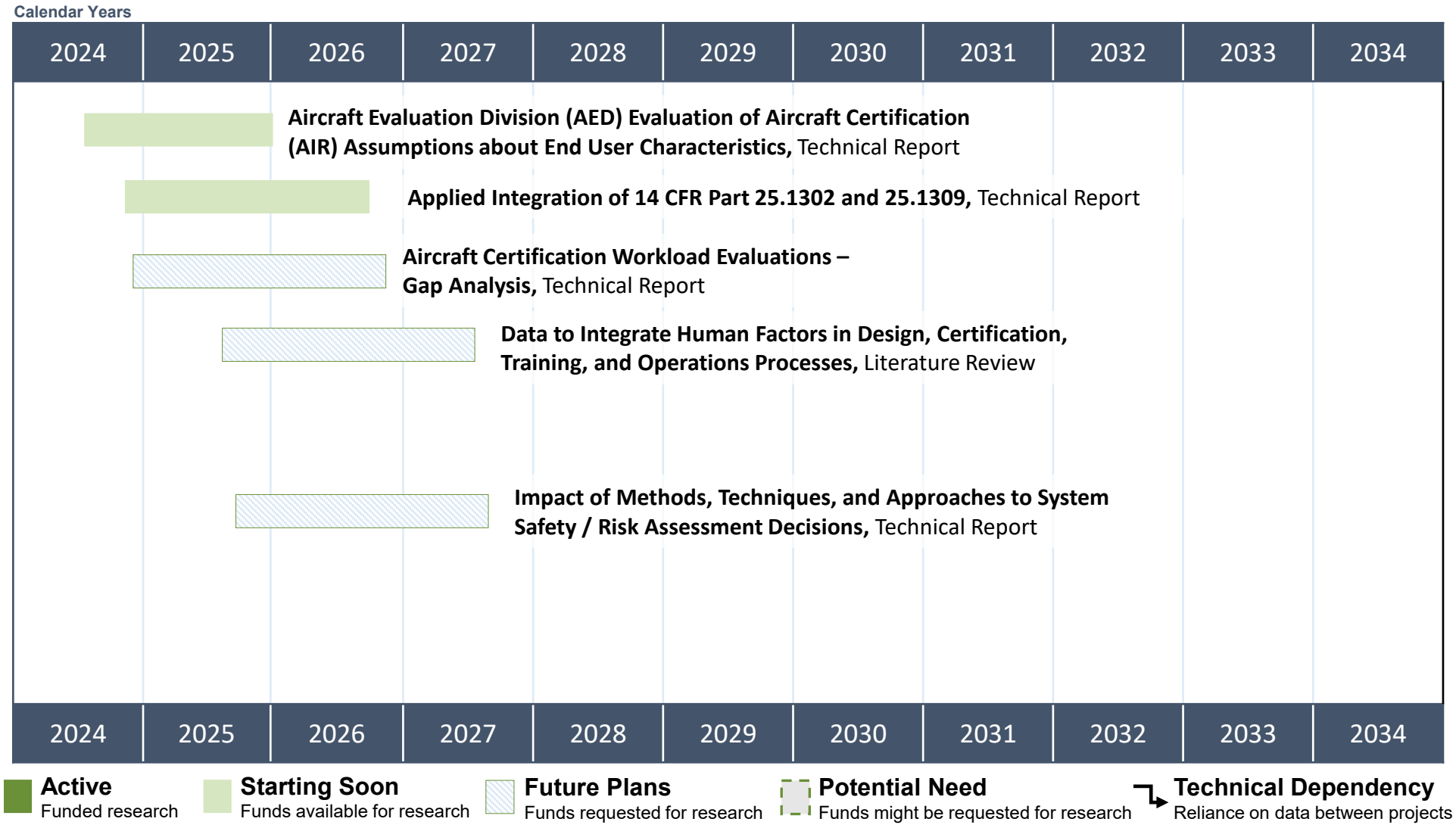
## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Design, certification, training, and operations

**Research Question:** What human factors data, processes, and procedures can support Aircraft Certification in human factors evaluations of aircraft design and certification?
***ACSAA related research***

**Research Question:** What human factors methods, techniques, and approaches are available to integrate human error considerations into system safety assessments, and what factors need to be considered when using these new methods in an aircraft certification application / context?
***ACSAA related research***



# OC 10: Pilot Physiological State Monitoring Technologies and Mitigations

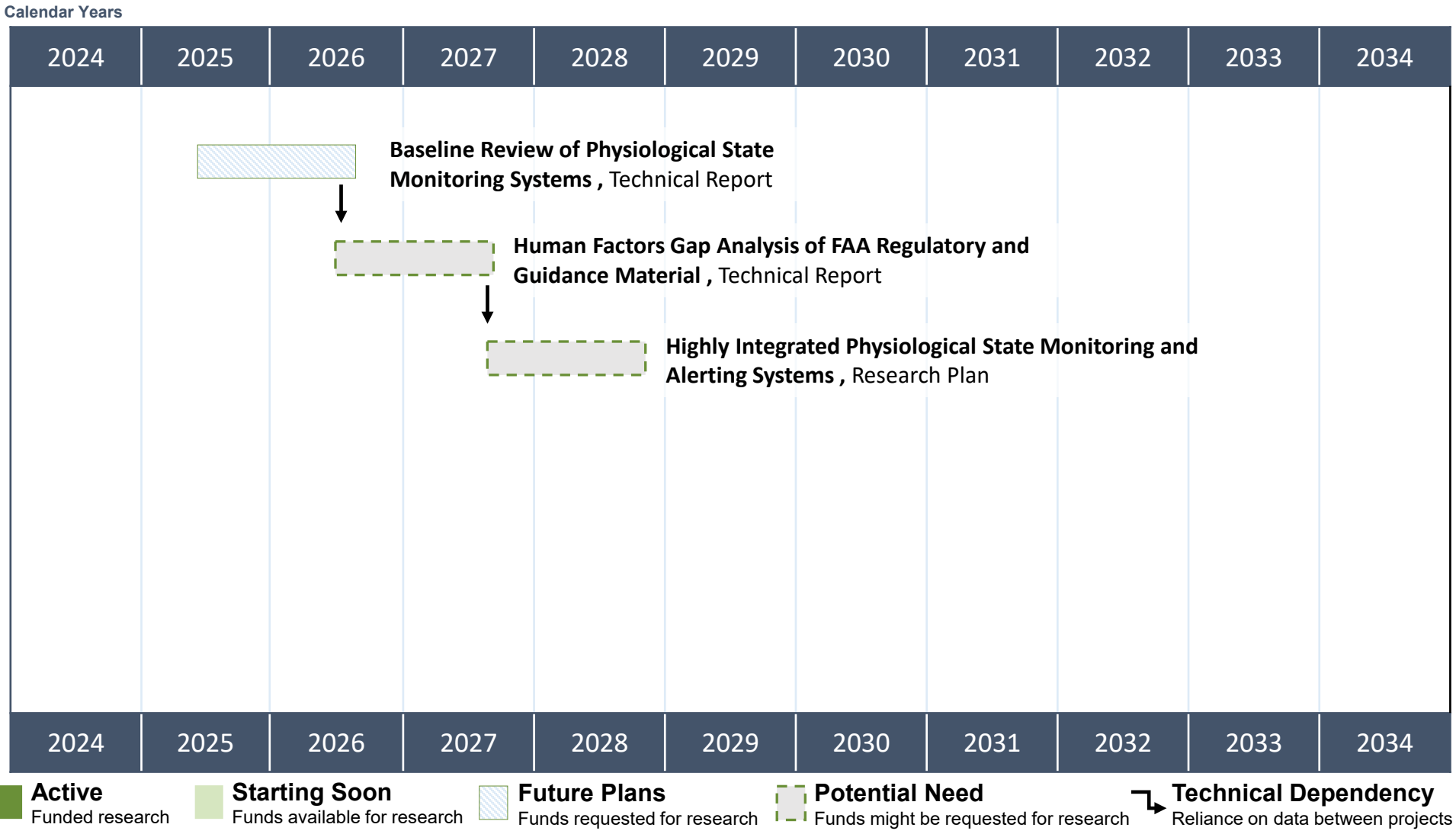
## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Design and operational evaluation considerations

**Research Question:** What is the state of the art for pilot physiological state monitoring technologies and mitigations?

**Research Question:** What are the minimum standards/requirements for pilot physiological state monitoring and mitigations?



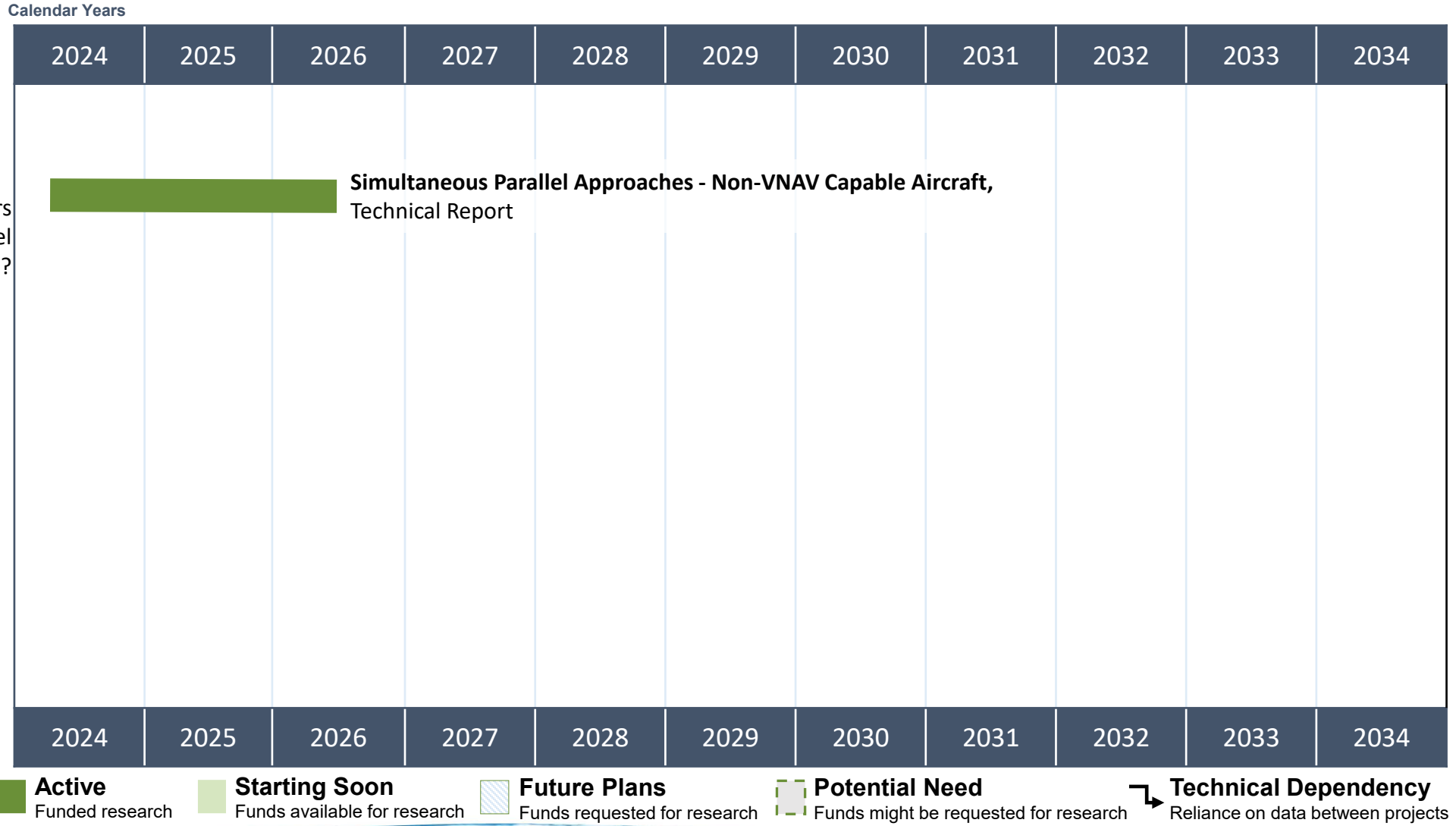
# OC 11: Current Flight Deck Operations and Pilot Procedures: Arrival, Approach, Departure

## FY2024 Research and Potential Project Plans

***Potential project plans are subject to change based on FAA needs and availability of funds***

### Simultaneous parallel approaches

**Research Question:** What are human factors considerations for simultaneous parallel approaches and non-VNAV capable aircraft?



**Chuck H. Perala, Ph.D., PMP**

Program Manager, Flight Deck/Maintenance/System Integration Research Portfolio (A11G BLI)

NextGen Human Factors Division, ANG-C1

Chuck.Perala@faa.gov

**202.267.0768**