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SYSTEMS ENGINEERING CAPSTONE REPORT

**TAXONOMY OF SITUATIONAL AWARENESS
INFORMATION FOR THE FUTURE LONG-RANGE ASSAULT
AIRCRAFT (FLRAA) MEDICAL EVACUATION (MEDEVAC)
CO-PILOT**

by

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ABSTRACT

This study identifies and classifies situational awareness information for copilots in the MEDEVAC mission set of Future Long-Range Assault Aircraft (FLRAA) platforms. It also provides a basis for follow-on projects to conduct similar research and analysis into other aircrew members, other FLRAA missions, and other Future Vertical Lift (FVL) platforms including Future Attack Reconnaissance (FARA) and the future unmanned platforms. This report describes a five-phased methodology that is both repeatable and expandable. Follow-on capstone projects can leverage this method to identify the top situational awareness information for the various mission sets and crew positions. Once the critical situational awareness information is identified and classified, the latest technologies can be proposed against those functions to maximize situational awareness. In addition, the situational awareness drivers can then be leveraged toward the identification of cognitive workload drivers when combined with user surveys.

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LIST OF ACRONYMS AND ABBREVIATIONS

3D	Three Dimensional
ACAT	Acquisition Category
AH	Attack Helicopter
ARL/HRED	Army Research Laboratory Human Research and Engineering Directorate
AURA	Attack Utility Replacement Aircraft
ASA	Advance Situational Awareness
ASRS	Aviation Safety Reporting System
ATC	Air Traffic Control
ATM	Aircrew Training Manual
BFT	Blue Force Tracker
CASEVAC	Casualty Evacuation
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CD&RR	Competitive Demonstration and Risk Reduction
CDU	Central Display Unit
DOD	Department of Defense
EGI	Embedded Global Positioning/Inertial Navigation
EICAS	Engine Indicating and Crew Alerting System
ERFS	Extended Range Fuel System
FARA	Future Attack Reconnaissance Aircraft
FLRAA	Future Long-Range Assault Aircraft
FMS	Flight Management System
FOUO	For Official Use Only
FVL	Future Vertical Lift
HDBK	Handbook
HH	Search and Rescue/MEDEVAC Helicopter
HMI	Human Machine Interface

HOGE	Hover out of Ground Effect
HSA-DM	Holistic Situational Awareness – Decision Making
HSI	Human Systems Integration
HUD	Heads Up Display
IAW	In Accordance With
ICRD	Initial Capabilities Refinement Document
ICS	Intercommunication System
IMPRINT	Integration Improved Performance Research Integration Tool
IOC	Initial Operating Capability
LZ	Landing Zone
MBSE	Model-Based Systems Engineering
MDAP	Major Defense Acquisition Program
MEDEVAC	Medical Evacuation
MFD	Multi-Functional Display
MIL	Military
MOSA	Modular Open Systems Approach
NASA	National Aeronautics and Space Administration
OT	Observation Technique
OTA	Operator Task Analysis
OV-1	Operational Viewpoint
OVI	Operator Vehicle Interface
PFPS	Portable Flight Planning Software
PPC	Performance Planning Card
SA	Situational Awareness
SART	Situation Awareness Rating Technique
S&T	Science and Technology
SE	Systems Engineering
TC	Training Circular
TSAS	Tactical Situational Awareness System
TM	Technical Manual

UH	Utility Helicopter
UID	Unique Identification Number
U.S.	United States
USAMCE	United States Army Maneuver Center of Excellence

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EXECUTIVE SUMMARY

This capstone project created a framework for current aircrew situational awareness requirements that could be leveraged across platforms and aircrew positions. This framework used the medical evacuation (MEDEVAC) mission set under the Future Long-Range Assault Aircraft (FLRAA) as a starting point, focusing on the copilot aircrew position. The conclusions of the report build to answer the overarching question: What is the significant situational awareness (SA) information relevant to the Future Attack Reconnaissance Aircraft and FLRAA copilot in a MEDEVAC mission scenario? This question was answered using five stand-alone sub questions which together provide the qualifications that constitute “significant” in the overarching question.

This capstone project concluded that MEDEVAC tasks often include multiple function types simultaneously which challenge the crew to apply their training and knowledge in multiple simultaneous situations. Most tasks assigned to a copilot fall under the Communicate and Subsystem Status overarching functions with 67.5% and 52.1% tasks, respectively. The SA information with the most relationships within copilot tasks are visual observations, maps, information received via radio calls, calculated weight, and fuel information. Most tasks, require the copilot to have an SA of Level II, which requires the copilot to both perceive and comprehend the information presented to him/her. Multiple tasks require the copilot to use more than one observation technique at the same time; in addition, most tasks require the use of the visual observation technique. Lastly, it is concluded that the multi-function display in the cockpit is an essential system that has a high degree of utilization, currently supporting SA for the completion of 28.2% of tasks.

This capstone project recommends that all the results presented herein are used to design the FLRAA cockpit and to further analyze the top five pieces of SA information identified since they are involved with the most U.S. Army aviation functions. It is also recommended to use a Model-Based Systems Engineering tool to conduct future analysis on the Operator Task Analysis and spider diagram modeled in this capstone project to further break down tasks into functions that can be linked to a material solution. Another recommendation is to survey the user community through questionnaires and using the

Taylor's Situation Awareness Rating Technique evaluation tool on the HH-60 and UH-60 crew members would aid in capturing the significant cognitive workload drivers during a mission. This capstone report also recommends that a market analysis is conducted to identify the latest or emerging technologies for the FLRAA cockpit that would improve how the SA information is presented to the copilot with focus on maps, information transmitted via radio calls, visual observations, OV-1 information, and fuel information. Lastly, this capstone report recommends leveraging this framework to analyze other users, platforms, and missions.

I. INTRODUCTION

Throughout the years of United States (U.S.) Army aviation, across all aircraft and mission sets, a level of situational awareness (SA) has been required for each member of the aircrew to successfully perform their respective tasks. SA can be defined as “the state of one’s ability to perceive relevant information within one’s sphere of interest, understand the impact of that information on the task(s) at hand, and project future states based on possible actions” (Joint Publication 3-50 Personnel Recovery 2007). The evolution of technology over the years has affected the type, quality, medium, and amount of SA information available. The digital cockpit in Army rotorcraft has enabled innovative new ways to provide SA, and numerous companies and government organizations have leapt at the opportunity to develop and introduce their version of SA information technologies to integrate onto the various platforms. These capabilities can increase the level of mission effectiveness; however, improper organization of the information limits the benefits of SA for the user. To avoid creating extra work, Copeland and Mance urge that the information “must be correct for the task to be performed and be presented in a way that is understandable” (Copeland and Mance 2014). If the information is incorrect, outdated, latent, or misleading, then a potentially hazardous situation could result (Copeland and Mance 2014).

The science and technology (S&T) community must evaluate and organize the growing amount of SA capabilities currently under development so that the right information is being presented to the aircrew member. This information must also be presented in the best medium, to the appropriate member, and at the right time to perform the correct task. Currently, SA solutions are being developed ahead of any functional analysis and being pieced together post-development without an overarching plan for how each solution should map together. This capstone project documents the methodology and results for performing systems engineering (SE) analyses on the future long-range assault aircraft (FLRAA) medical evacuation (MEDEVAC) copilot tasks. The results capture the current levels of SA information required for the copilots to perform their respective tasks as well as identify the current forms in which the copilots receive the SA information.

The U.S. Army is modernizing its aviation program through the Future Vertical Lift (FVL) initiative (Gertler 2021). Under this program, the Army plans to develop up to five new aircraft of different sizes with a mixture of manned and unmanned systems. The plan is for the systems to share as much common hardware as possible, including sensors, avionics, engines, and countermeasures. By understanding the technologies capable of supporting the design, the shared hardware is anticipated to reduce costs and accelerate design, development, and deployment of these systems. (General Services Administration (GSA) 2020).

In an effort to prioritize workload assistive technologies for the FVL platforms and missions, the Holistic Situational Awareness–Decision Making (HSA–DM) program has initiated actions to identify the cognitive workload drivers for the FVL platforms and missions. According to HSA–DM, the current priority platform sets are the Future Attack Reconnaissance Aircraft (FARA) and the FLRAA, both of which are manned aircraft. According to the Initial Capabilities Refinement Document (ICRD) for the FVL program, the plan for the FARA and FLRAA platforms is to incorporate a family of systems modular open systems approach (MOSA) to aircraft design (Murray 2020). MOSA provides the U.S. government with an avenue for maximum adoption and innovation from industry and facilitates tailorable hardware and software solutions for the warfighter (Murray 2020). The goal is not identical cockpit designs; rather, it is to incorporate a common approach to the design, layout, and task management structure, resulting in high reusability between like functions when applicable. Under a common human machine interface (HMI) concept, the primary focus is the operator vehicle interface (OVI) which will incorporate a common aviation approach that directs control station commonality across Army platforms (Murray 2020). To accomplish this, the program will leverage available data and digital networking formats, filtering that content into a layout that accommodates the roles and responsibilities of the operators with respect to the varying levels of automation. This initiative requires three major lines of effort including information and task management, controls and displays, and ergonomics.

This capstone project supports the overall FVL program by addressing the FLRAA platform in the information and task management line of effort. It will focus on the

responsibilities of the copilot in the MEDEVAC mission set. The copilot, also known as “the pilot not flying,” is the aircrew position typically holding the responsibilities of radio transmissions, mission information receipt, fuel state calculations, intercom communication with the back seat aircrew, and management of other onboard resources. This capstone project provides a starting framework that can be replicated for additional platforms, aircrew positions, and mission sets.

A. THE SYSTEM: FVL - FLRAA

The FVL initiative began in 2008 in response to increasing concerns that the Department of Defense (DOD) focused much of its financial resources and workforce on existing rotorcraft variants and not new innovative programs (VTOL n.d.). According to Andrew Feickerk from the Congressional Research Service, the “FVL is an ambitious plan to replace all U.S. DOD’s helicopters with next-generation rotorcraft to increase speed, range, altitude, automation, connectivity, reliability, and maintainability of the fleet.” Additionally, FVL is listed as one of the top six priorities in the 2019 Army Modernization Strategy (Feickert 2020). FVL technology is also planned to be incorporated by the Marine Corps and Navy, which will allow for co-development in their next-generation rotorcraft known as the Attack Utility Replacement Aircraft (AURA) (Beinart 2019). Although a benefit the joint services, the Army is the lead service provider of FVL (Gertler 2021). Five different sizes of aircraft are being developed in the FVL programs, sharing standard hardware components. Two of the five aircraft are currently undergoing active development, FLRAA, and FARA (Gertler 2021). FLRAA is being designed to replace the Army UH-60 Black Hawk and Marine H-1 “Huey” utility helicopters, and FARA is being developed to replace the current Apache attack helicopter (Gertler 2021).

As requested by the HSA-DM program, the FLRAA platform will be the focus of this research concerning copilot SA in a MEDEVAC mission. According to the Program Executive Office (PEO) Aviation, “the FLRAA is a pre-Major Defense Acquisition Program (MDAP) Acquisition Category (ACAT) 1C that will develop and field the next generation of affordable vertical lift tactical assault/utility aircraft for the Army” (Aviation 2020). PEO Aviation states that the “FLRAA will provide the Joint Force with an aircraft that possesses increased speed, range, survivability, and maneuverability to

allow the Army to retain overmatch against enemy forces” (Aviation 2020). Bell Textron Inc. and Sikorsky Aircraft Corporation (in partnership with The Boeing Company) have each developed their own unique prototypes for demonstrating their capability for meeting FLRAA’s requirements (Gertler 2021). Both companies are taking different approaches to their efforts. Bell has designed their V-280 (Figure 1) as a “tiltrotor aircraft like the V-22 Osprey, with engines and rotors at the end of its wings that swivel” (Gertler 2021). Sikorsky/Boeing has designed their SB-1 (Figure 2) as a “compound helicopter using twin coaxial rotors to provide lift and a pusher propeller to enhance speed” (Gertler 2021). The program is currently in the Competitive Demonstration and Risk Reduction (CD&RR) phase II, and Initial Operating Capability (IOC) is expected in 2030 (Gertler 2021).



Figure 1. Bell V-280. Source: Gertler (2021).



Figure 2. Sikorski/Boeing SB-1. Source: Gertler (2021).

B. PROBLEM STATEMENT

To date, stakeholders have indicated that the plan for organizing SA information has not been fully addressed under FVL. As a result, the U.S. Army has begun research and investigation in the area of SA for the human systems integration (HSI) aspects of the FVL systems, according to HSA-DM. This capstone project will focus on addressing the SA aspects of the FLRAA platform copilot that is engaged in a MEDEVAC mission set. This capstone project will provide the HSA-DM program with the background information required to implement maintainable SA information to the aircrew. This capstone report will answer the following primary question:

- What is the significant SA information relevant to the FLRAA copilot in a MEDEVAC mission scenario?

This primary question will be answered through the culmination of answering the following sub questions:

- What overarching functions hold the highest proportion of tasks expected to be performed by the MEDEVAC copilot?
- What are the most frequently observed interactions between SA information and the various tasks that the copilot performs?

- What level of SA is the most frequently required by a MEDEVAC copilot?
- What observation techniques (OT) are the most frequently used by a MEDEVAC copilot?
- What technologies are used most frequently to manage the copilot's SA and decision making?

C. RESEARCH OBJECTIVES

To address the research questions, this capstone project will develop a taxonomy for SA demands on the MEDEVAC copilot through completion of the following incremental objectives:

1. Identify previous studies related to Army aviation and SA that can be applied to the FLRAA MEDEVAC mission.
2. Define the overarching Army aviation functions (aviate, navigate, communicate, subsystem status, operational viewpoint (OV-1) awareness, weapon engagement, survivability, and localized threat awareness) related to the MEDEVAC copilot responsibilities.
3. Identify the overarching function (s) with the most tasks assigned to the MEDEVAC copilot
4. Determine and classify the SA information required to perform the overarching Army aviation functions.
5. Identify the interactions and relationships between the SA information and the functions.
6. Align functional requirements with generic system components (i.e., specific C4ISR and flight control systems) and identify which of these systems aid in achieving optimum situational awareness of the MEDEVAC copilot.

D. CAPSTONE OVERVIEW

This capstone project provides a framework for addressing SA from the perspective of the MEDEVAC copilot. Chapter II provides a literature review of studies, papers, reports and Army publications related to SA in order to inform the problem statement and methodology for analysis. Chapter III provides a five phased methodology utilized to answer the questions raised in the problem statement. It leverages the concepts and procedures laid out in the literature to flesh out copilot SA related responsibilities and requirements into a multi-tabbed spreadsheet, an Innoslate diagram, and a function to form diagram. Chapter IV provides the results of these analyses along with the capstone team's observations. Lastly, in Chapter V, this capstone project provides recommendations for follow-on initiatives.

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II. LITERATURE REVIEW

The Literature Review covers research on the FVL-FLRAA system, MEDEVAC mission, SA studies, and its application to future military aviation systems. The objective of this chapter is to lay out the mission set framework and describe previous work focused on aligning the SA state of the copilot with the multitude of factors that contribute both positively and negatively to the copilot's SA during the MEDEVAC mission. This chapter will also identify successes and shortfalls of previous studies, providing insight that will guide the systems engineering methodology and results contained in the subsequent chapters of this capstone report.

A. AIRCREW TRAINING MANUAL, UTILITY HELICOPTER, H-60 SERIES

The aircrew of the H-60 series aircraft are trained in accordance with (IAW) – Aircrew Training Manual (ATM), Utility Helicopter, H-60 Series dated 15 June 2020 (United States Army Maneuver Center of Excellence (USAMCE) 2020). This ATM is a “how to” source for performing aircrew member functions and responsibilities. The ATM provides performance standards and evaluation guidelines to clearly communicate the expectations to all aircrew members. A comprehensive list of mandatory tasks as shown in Figure 3 below, must be completed and evaluated for the aircrew members to qualify on the aircraft (USAMCE 2020). Each task is evaluated in accordance with the standards in the ATM. The capstone team will use the ATM to define the functions that the copilot is responsible for which will be further discussed in Section 2. An example list of potential copilot responsibilities is shown below in Figure 3.

Task Number	M/O	Title	H-60A/L	H-60M/V	Training										PFE			Annual Evaluation					
Aviator (PI): Base Task Training					T	D	I	N	G	V	C	AMS	A	G	V	I	G	C	S	M	AMS		
ACC-1000	M	Participate in a Crew Mission Briefing	X	X	T								A	G		I				S			
SRW-1004	M	Plan a Visual Flight Rules Flight	X	X	T															S			
SRW-1006	M	Plan an Instrument Flight Rules Flight	X	X	T											I							
60Z-1010	M	Prepare a Performance Planning Card	X	X	T								A	G		I				S			
60Z-1011	M	Determine Dynamic Inflight Performance	X	X	T											I				S			
60Z-1012	M	Verify Aircraft Weight and Balance	X	X	T															S			
60Z-1013	M	Operate Mission Planning System	X	X	T											I				S			
60Z-1014	M	Operate Aviation Life Support Equipment	X	X	T											I				S			
60Z-1016	M	Perform Internal Load Operations	X	X	T															S			
60Z-1020	M	Prepare Aircraft for Mission	X	X	T															S			
ACC-1022	M	Perform Pre-flight Inspection	X	X	T								A	G		I				S			
60Z-1024	M	Perform Before-Starting Engine through Before-Leaving Helicopter Checks	X	X	T						C		A	G		I	G	C	S				
60Z-1026	M	Maintain Airspace Surveillance	X	X		D	I	N	G		C		A	G		I	G	C	S				
60Z-1028	M	Perform Hover Power Check	X	X	T						C		A	G		I	G	C	S				
60Z-1032	M	Perform Radio Communication Procedures	X	X	T								A	G		I				S			
60Z-1034	M	Perform Ground Taxi	X	X		D		N	G				A	G			G	C	S				
60Z-1038	M	Perform Hovering Flight	X	X		D		N	G		C		A	G			G	C	S				
60Z-1040	M	Perform a Visual Meteorological Conditions Takeoff	X	X		D		N	G		C		A	G			G		S				
60Z-1044	M	Navigate by Pilotage and Dead Reckoning	X	X		D		N	G										S				
60Z-1046	M	Perform Electronically Aided Navigation	X	X	T											I				S			
60Z-1048	M	Perform Fuel Management Procedures	X	X	T								A	G		I	G		S				
60Z-1052	M	Perform Visual Meteorological Condition Flight Maneuvers	X	X		D		N	G				A	G			G		S				
60Z-1054	M	Select Landing Zone - Pickup Zone - Holding Area	X	X	T																		
60Z-1058	M	Perform Visual Meteorological Condition Approach	X	X		D		N	G		C		A	G			G	C	S				
60Z-1062	M	Perform Slope Operations	X	X		D		N	G				A	G			G	C	S				
60Z-1064	M	Perform a Roll-On Landing	X	X		D		N	G				A	G			G		S				
60Z-1066	O	Perform Extended Range Fuel System Operations	X	X	T																		
60Z-1068	M	Perform a Go-Around	X	X		D		N	G								G		S				
SRW-1070	M	Respond to Emergencies	X	X		D	I	N	G				A	G			G		S				
60Z-1082	M	Perform Autorotation	X	X		D		N	G										S				
60Z-1148	M	Perform Digital Communications	X	X	T														S				
60Z-1155	M	Negotiate Wire Obstacles	X	X		D		N	G										S				
60Z-1162	M	Perform Emergency Egress	X	X	T														S				
60Z-1166	M	Perform Instrument Maneuvers	X	X			I									I							
60Z-1167*	M	Perform Instrument Maneuvers with Standby Flight Display		X	T																		
60Z-1168*	M	Perform Command Instrument System Procedures	X	X	T											I			S				
60Z-1169*	M	Perform Flight Director Operations		X	T											I			S				
60Z-1170	M	Perform Instrument Takeoff	X	X			I									I							
60Z-1174	M	Perform Holding Procedures	X	X			I									I							
60Z-1176	M	Perform Non-Precision Approach	X	X			I									I							
60Z-1178	M	Perform Precision Approach	X	X			I									I							
60Z-1182*	M	Perform Unusual Attitude Recovery	X	X		D	I	N	G							I			S				
60Z-1184	M	Respond to Inadvertent Instrument Meteorological Conditions	X	X		D		N	G								G		S				
60Z-1194	M	Perform Refueling Operations	X	X	T																		
60Z-1253	M	Operate Flight Management System		X	T														S				
60Z-1254	M	Operate Multifunction Display		X	T														S				
60Z-1260	M	Operate Digital Map		X	T														S				
SRW-1425	O	Employ Aviator Night Vision Imaging System	X	X					G				G				G						
SRW-1426	O	React to Aviator Night Vision Imaging System Failure	X	X					G				G				G						
SRW-1427	O	Operate Heads-Up Display	X	X	T																		
ACC-1500	M	Participate in a Crew-Level After-Action Review	X	X	T								A	G		I			S				

Figure 3. ATM Aviator Task List. Source: Aircrew Training Manual (ATM), Utility Helicopter, H-60 Series dated 15 June (2020).

The U.S. Army Maneuver Center of Excellence is the proponent of Training Circular (TC) 3–22.69, Advance Situational Awareness (ASA) (USAMCE Directorate of Training and Doctrine, Doctrine and Collective Training Division 2021). This document outlines techniques and requirements for ASA training for Soldiers, especially the ones assigned to integrate ASA concepts into training of their troops. The main purpose of the training, according to the manual, is to develop ASA and “optimize human performance through building the skills necessary to develop agile, resilient, adaptive, and innovative

Soldiers who thrive in conditions of uncertainty and chaos” (USAMCE 2021). The TC explains that when one uses the senses at full capacity, it requires the brain to perform many processes. Diligence and training are necessary to improve these skills . According to the manual, “the use of the sensory system provides input into a soldier’s decision-making process” (USAMCE 2021). The TC explains in detail how to enhance ASA by using OT (i.e., the five senses: sight, sound, touch, smell, and taste). The information gathered through the senses is then analyzed and this analysis is called critical thinking, where the brain is used to perform cognition, memory and perception. These three are considered to be key functions (USAMCE 2021). Cognition is the ability of “processing information and applying knowledge, using existing knowledge, and creating new knowledge” (USAMCE 2021). Memory is the ability of retaining that knowledge over time. Perception requires “the mental, physical, and physiological filters through which a person views the world around them” (USAMCE 2021). The OT explained in this document will be leveraged to develop the methodology for this capstone report in Chapter III. The team will use the information provided in the TC as a reference when identifying the significant interactions between SA information and the various tasks that the copilot performs. Additionally, this information will help to identify the proper technologies to manage the copilot’s SA and decision making.

B. COPILOT RESPONSIBILITIES

There are many responsibilities which may affect SA functions that the aircrew members must perform to execute MEDEVAC missions within their assigned aircraft. In this section, the copilot functions are discussed IAW the ATM. The copilot performs all responsibilities delegated to him/her by the pilot-in-command. The copilot monitors all mission equipment and uses the flight management system/central display unit (FMS/CDU) for communication, navigation (I.e., operation of digital maps), and mission information (USAMCE 2020). The copilot assists the pilot-in-command with the following (not all inclusive) tasks: pre-flight checks and planning, maintaining airspace surveillance, monitoring the flight instruments and the flight director/display control panel (FD/DCP) selected mode annunciator lights, performing radio communication procedures related to evacuation requests using the 9-line evacuation request form and monitoring radio and air

traffic control (ATC) information not monitored by the pilot-in-command, performing fuel management functions, monitoring and providing warning of obstacles (such as trees or other terrain), unannounced drift, and altitude changes using the horizontal situation indicator and vertical situation indicator (USAMCE 2020). The copilot will audibly announce each task when conducted for the aircrew's, specifically the pilot-in-command's, awareness. In addition, the copilot assists the pilot with the identification of conditions prior to takeoff and at landing. When performing navigation by pilotage or dead reckoning, the copilot monitors and provides to the pilot-in-command information such as the heading, altitude, and airspeed changes. The copilot uses tabular data, or other in-flight dynamic instrumentation or software to determine if hover out of ground effect (HOGE) capability exists. Additionally, the instruments are used to determine if the maximum power is available and what ingress or egress route is best suited for the environment. (USAMCE 2020). The copilot also assists with sling load operations, emergency, and communication procedures (USAMCE 2020).

All of these aforementioned procedures and processes affect the SA of the copilot in maneuvering the aircraft to perform mission tasks. In chapter 8 of the ATM, aircrew coordination training is discussed which requires the following: communicating positively, being explicit, announcing actions, acknowledging actions, directing assistance, offering assistance, coordinating action sequence and timing, and finally, providing aircraft control and obstacle advisories (USAMCE 2020). Furthermore, these coordination elements ensure the interaction between aircrew members foster safe, efficient, and effective performance of tasks. These elements are required to be briefed by the pilot-in-command and stressed as critical elements of each and every mission (USAMCE 2020).

The stakeholder, HSA-DM, provided the HSA-DM Task Decomposition Database to the team to assist with the determination of tasks/functions that the copilot may complete for this capstone project. The stakeholder-provided database provides a comprehensive master task list that is derived from the H-60 ATM. The master task list is broken into tabs by mission type (i.e., Air Assault, Resupply, MEDEVAC-CASEVAC, etc.). In each tab the tasks associated with that specific mission type are further broken down and defined.

The database information will be further discussed in Chapter III of this project report. The database may be found in Appendix A.

The HH-60M Operator's Manual, TM 1-1520-280-10, contains descriptions of the aircraft and its internal systems including avionics and mission equipment (Department of Army 2017). The Operator's Manual describes each procedure performed by the copilot including checklist steps. It also describes each of the onboard systems leveraged by the aircrew members to accomplish the MEDEVAC mission. This manual will be leveraged in Chapter IV of this capstone project to identify the current equipment onboard related to task accomplishment and SA.

C. SITUATIONAL AWARENESS (MILITARY AVIATION)

Following the information gathering phase with the study team and the stakeholder organization (HSA-DM), the capstone project team combined the stakeholder's guidance with previous SA studies. The studies were reviewed to better understand the concept of SA and how the considerations would apply to the future military aviation systems. The most common definition for SA, which will be used throughout this capstone project, is "the state of one's ability to perceive relevant information within one's sphere of interest, understand the impact of that information on the task(s) at hand, and project future states based on possible actions" (Joint Publication 3-50 Personnel Recovery 2007). This definition provides a comprehensive understanding of SA. According to Copeland and Mance, "SA is not a thing, rather it is a psychological, iterative process of perception, understanding and decision making" (Copeland and Mance 2014). Figure 4 is a pictorial representation of how the SA process works. This capstone project leverages the concept in Figure 4 as the methodology for the receipt of inputs to the user (perception), the understanding of that information (comprehension), and the resulting actions taken considering some internal analysis (decision making). Since the main research objective for this capstone project is to identify the significant SA information relevant to a FLRAA copilot in a MEDEVAC mission scenario, it was imperative for the capstone team to understand the concept of SA.

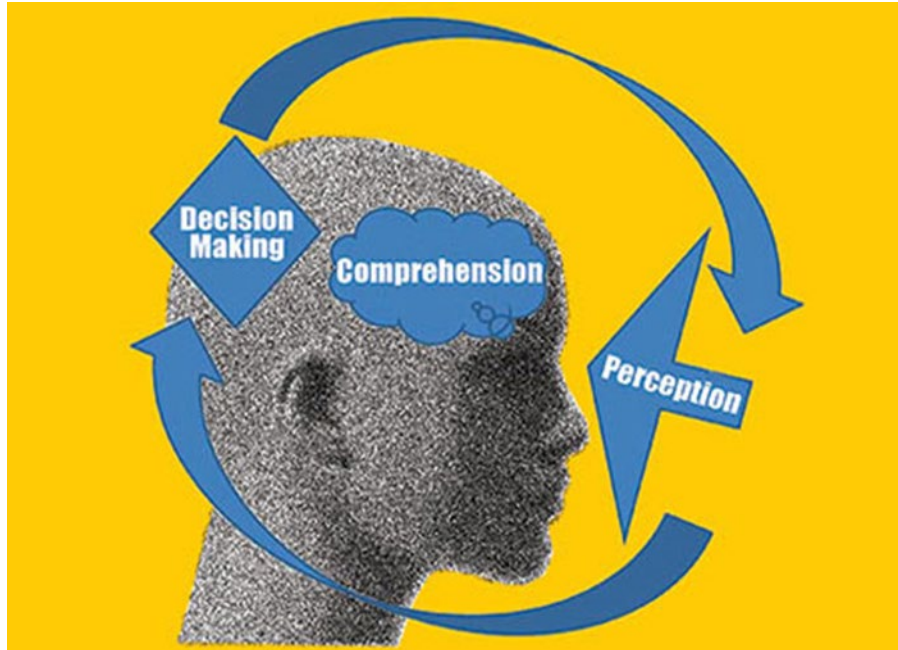


Figure 4. Psychological Iterative Process. Source: Copeland and Mance (2014).

1. Information Overload Affects SA

In 2009, Major Tom Deveans and Lieutenant Colonel Robert H. Kewley (2009) from the West Point Operations Research Center released a report detailing their findings on SA information and how they contribute to overcoming information overload in the UH-60 and AH-64 cockpits. This effort had three objectives:

1. Identify and establish a hierarchy of information requirements for pilots/copilots.
2. Research and identify current commercial state-of-the-art intuitive display technologies and research possible Heads-Up Display (HUD) symbology layout and design.
3. Calculate the visual, cognitive, auditory, motor, speech, and tactile workload on pilots/copilots and determine if, how, and where workload can be reduced by changing user interface elements and display technologies. (Devean and Kewley 2009, 1)

The methodology for Devean and Kewley's (2009) study is shown in the diagram in Figure 5, and their approach will be leveraged to develop the methodology for this capstone report in Chapter III.

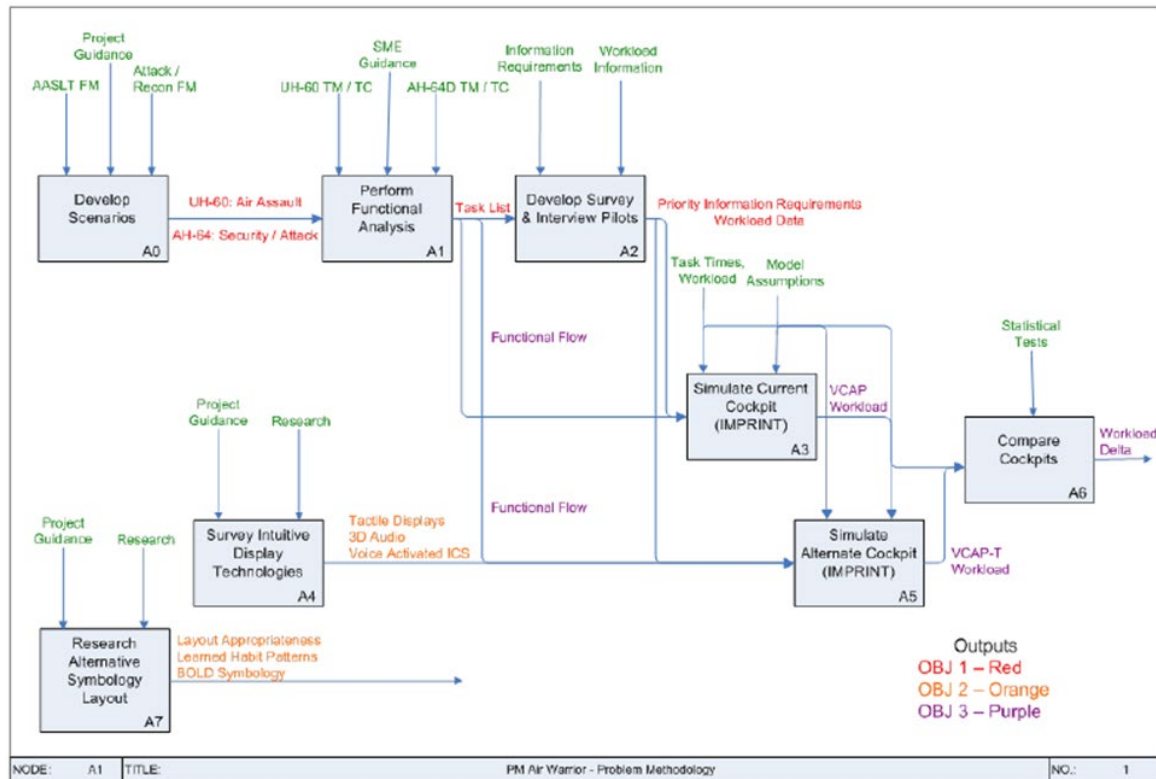


Figure 5. Methodology for Overcoming Information Overload in the Cockpit Study. Source: Deveans and Kewley (2009).

Deveans and Kewley (2009) accomplished the first objective by performing a functional analysis for two missions. Due to time constraints, they focused on a Black Hawk air assault mission and an Apache convoy security mission to perform a functional breakdown of the pilot and copilot tasks; then, they derived the associated SA information required to accomplish each of these tasks. Different variables were applied to the missions to simulate unplanned situations that could be encountered; examples of the conditions include severe weather, minor aircraft malfunctions, or rerouting to a different landing zone (LZ). The functional analysis for the UH-60 mission is shown in Figure 6. In this figure, the top level function of delivering internal payload with a UH-60 is broken down into thirteen subfunctions; it also shows how the first nine subfunctions are conducted serially, while the last four subfunctions are conducted in parallel throughout the mission. Once the SA information was derived and mapped out, MAJ Deveans and LTC Kewley (2009) conducted pilot/copilot surveys to rank the SA information from most important to least

important to develop a prioritized hierarchy. The hierarchy for the UH-60 mission tasks is shown in Table 1 and provides a better understanding of which portions of SA information should receive the most focus for each mission task. In this table, each subfunction contains a list of applicable SA information in that row required to perform that subfunction. The list is prioritized with the most important information starting at the left.

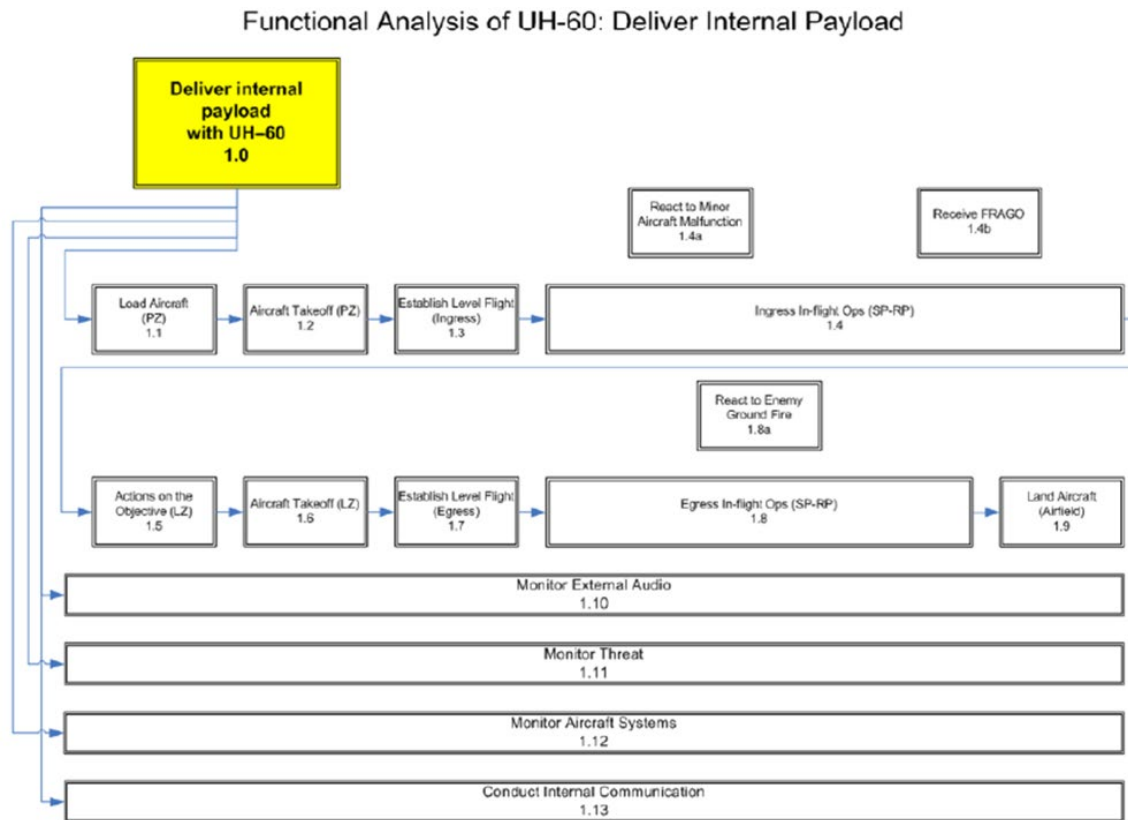


Figure 6. UH-60 Functional Analysis for Delivering Internal Payload. Source: Deveans and Kewley (2009).

Table 1. UH-60 Task Hierarchy. Source: Deveans and Kewley (2009).

Function	Sub-Function	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10	Rank 11	Rank 12
Aircraft Takeoff	Perform Before Takeoff Checks	Status of Flight Inst.	Fuel Status	Power Lever	Crew Status	Status of MC	Radio Status	Infrared CM Status	Transponder Status	Chaff Dis. Status	Radar Jam Switch	Satellite Coverage	Armor Panel Status
	Perform Hover	Obstacle Location	Drift	% Torque	Altitude	Heading	Attitude	Trim	000000	000000	000000	000000	000000
	Establish Climb	Obstacle Location	% Torque	Airspeed	Rate of Climb	Heading	Altitude	Attitude	Trim	000000	000000	000000	000000
In-flight Operations	Control Flight Parameters	Airspeed	Altitude	Heading	% Torque	Time	Attitude	Trim	000000	000000	000000	000000	000000
	Perform Navigation	Obstacle Location	GPS Data	Heading	Map Information	Groundspeed	000000	000000	000000	000000	000000	000000	000000
Non-standard Events	React to Aircraft Malfunction	Emergency Procedures	Systems Status	Status of MC	000000	000000	000000	000000	000000	000000	000000	000000	000000
	Receive FRAGO	New LZ Location	RPL Location	New Route	New Landing Heading	Wind Direction on LZ	Satellite Coverage	000000	000000	000000	000000	000000	000000
	React to Enemy Ground Fire	Threat Location	Obstacle Location	Alt Change IM	Chaff Dispensing	Head Change IM	Alt Change EM	Torque Change EM	CMWS Warning	Speed Change EM	Location	Heading to ACP	000000
Land Aircraft	Perform Before Landing Checks	LZ Location	Crew Status	Radio Status	Tailwheel Light	Jamming Status	Chaff Dis. Status	Infrared CM Status	Paraling Break	000000	000000	000000	000000
	Initiate Approach	Obstacle Location	Rate of Descent	Airspeed	Altitude	% Torque	Drift	Heading	Attitude	Trim	000000	000000	000000
	Land	Obstacle Location	Rate of Descent	Wind Direction	Altitude	Attitude	Heading	Door Status	Status of Unloading	000000	000000	000000	000000
Systems	Monitor Aircraft Systems	Rotor RPM	Status of MC	Eng 1,2 RPM	Fuel Quantity	Status of Advisory Panel	Fuel Consumption Rate	000000	000000	000000	000000	000000	000000
	Conduct Communications	Internal	Serial	Ground CDR	AVN CMD	ATC	000000	000000	000000	000000	000000	000000	000000
Resource-P	Overall	Auditory	Visual	Cognitive	Fine Motor	Speech	000000	000000	000000	000000	000000	000000	000000
	Auditory	Internal Radio	Comms w/ Serial	AVN CMD Noise	Aircraft Noise	Comms w/ Ground	Comms w/ ATC	CMWS Tones	000000	000000	000000	000000	000000
	Visual	Friendly Aircraft	Gauges	Displays	Indicator Lights	Ground Obstacles	Objective Area / LZ	Ground Forces	000000	000000	000000	000000	000000
	Cognitive	Planning	Map Reading	Systems Decisions	Calculations	GPS / Course Tracking	000000	000000	000000	000000	000000	000000	000000
	Fine Motor	Tagging	Adjusting Cycle	Writing	Adjusting Pedals	000000	000000	000000	000000	000000	000000	000000	000000
	Speech	Internal	Serial	ATC	Ground	000000	000000	000000	000000	000000	000000	000000	000000
Resource-CP	Overall	Cognitive	Auditory	Visual	Speech	Fine Motor	000000	000000	000000	000000	000000	000000	000000
	Auditory	Internal Radio	Comms w/ Serial	Aircraft Noise	AVN CMD Noise	Comms w/ ATC	Comms w/ Ground	CMWS Tones	000000	000000	000000	000000	000000
	Visual	Gauges	Friendly Aircraft	Ground Obstacles	Displays	Objective Area / LZ	Indicator Lights	Ground Forces	000000	000000	000000	000000	000000
	Cognitive	Planning	Systems Decisions	GPS / Course Tracking	Map Reading	Calculations	000000	000000	000000	000000	000000	000000	000000
	Fine Motor	Adjusting Cycle	Adjusting Collective	Tagging	Adjusting Pedals	Writing	000000	000000	000000	000000	000000	000000	000000
	Speech	Internal	Serial	ATC	Ground	000000	000000	000000	000000	000000	000000	000000	000000

Following completion of the first objective, Deveans and Kewley (2009) researched multiple innovative technological solutions to determine if they could be used to reduce cognitive workload for the users. The tactical situational awareness system (TSAS) is a system that utilizes various haptic signals to relay SA information to the pilot and copilot through wearable vests and belts (Deveans and Kewley 2009). Other technologies presented similar haptic feedback through different mediums that conformed to the users' skin or were felt through the seat (Deveans and Kewley 2009). Despite the advantages from the technologies providing additional SA, there were certain issues that required consideration (Deveans and Kewley 2009). Wearing additional gear can be cumbersome and uncomfortable to the users; the users' attention could be drawn away unnecessarily to the discomfort of the gear, or there may be an unwillingness to utilize the

gear for the mission (Deveans and Kewley 2009). Also, the vibration coming from the aircraft could disrupt the tactile signals being relayed to the pilot or copilot (Deveans and Kewley 2009). Other cueing researched included audio cueing and three-dimensional (3D) audio (Deveans and Kewley 2009). They demonstrated that 3D audio cueing provides additional context to the user by producing commands from different directions. For example, they explained that navigational commands can provide heading information from the required direction, in the headset. In addition to tactile and audio cueing, Deveans and Kewley (2009) researched variations of heads up display (HUD) symbology that could be used to provide SA information.

Upon conclusion of the available technologies research, both current and alternative cockpit designs using the new technologies were input by the West Point Operations Research Center team into the human systems integration improved performance research integration tool (IMPRINT). The purpose of this was to simulate the amount of cognitive workload for each cockpit design in a given mission scenario. The simulations showed significant workload reduction for the Black Hawk and Apache alternative cockpit designs compared to the baseline designs. Deveans and Kewley (2009) concluded that the available haptic technologies, especially TSAS, combined with 3D audio would significantly reduce individual resource and overall workload experienced by pilots and copilots (Deveans and Kewley 2009). The results for the UH-60 simulations are shown in Figure 7. It is apparent in the top two pie graphs that the visual and cognitive resources account for the majority of the UH-60 pilots' and copilots' overall workload in the current configuration, so targeted focus from new technologies on these resources could show significant impact to reducing the workload (Deveans and Kewley 2009). By applying tactile technologies, 3D audio, and the voice activated intercommunication system (ICS) into an alternate cockpit configuration, the results in the bottom two pie charts indicated that the visual workload was reduced and shifted to the tactile resources (Deveans and Kewley 2009).

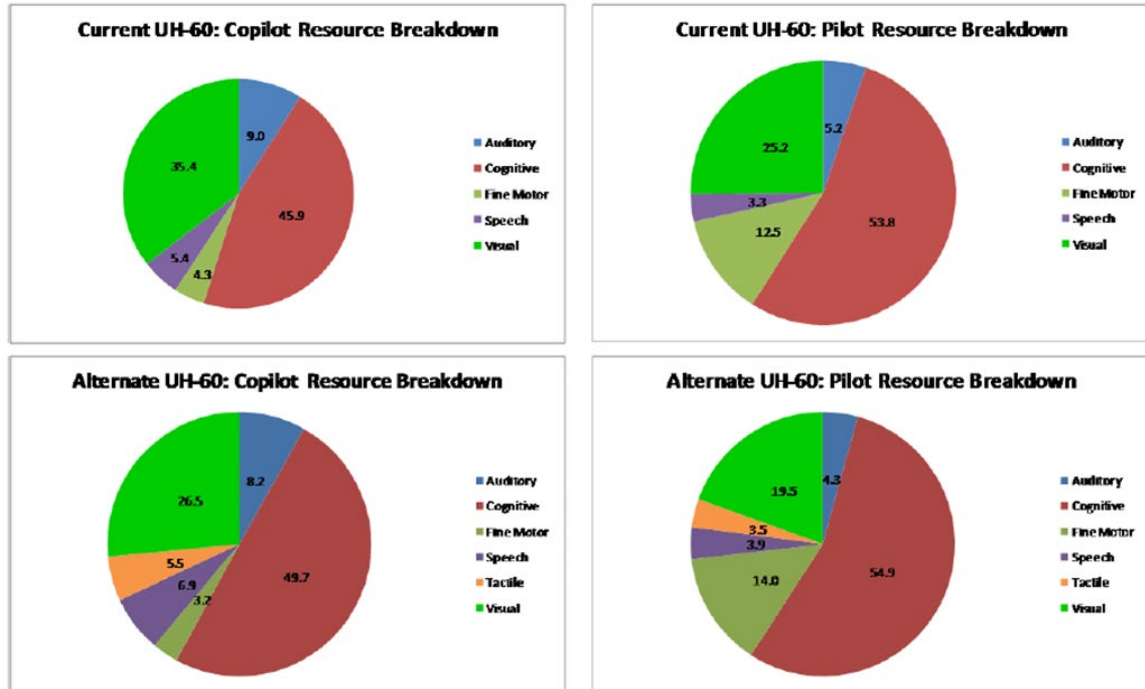


Figure 7. UH-60 Workload Simulation Results. Source: Deveans and Kewley (2009).

2. Situational Awareness Ratings

In 2014, the U.S. Army Research Laboratory Human Research and Engineering Directorate (ARL/HRED) published a report by Hicks et al. with the results of more than 3,000 pilot SA ratings collected for U.S. Army aircrafts including the UH-60 (Hicks et al. 2014). To understand SA, Hicks et al. used the Endsley model of SA as seen in Figure 8. According to Endsley, “the model provides a basis for discussing SA in terms of its role in the overall decision-making process” (Endsley 1995). The model includes three (3) levels of SA: Level 1 “Perception of Element in Current Situation,” Level 2 “Comprehension of Current Situation,” and Level 3 “Projection of Future Status.” According to Hicks et al., each task, mission segment, and stimulus may require different levels of SA and ideally, SA is “transferred at different levels among relative variable occurrences, and an overall concept of the mission and aircraft parameters is established that is constantly revised throughout the mission and based on pilot actions” (Hicks et al. 2014). The assessment of SA is important, as it directly impacts the pilot and aircraft performance. The findings of

this report intended to prove that “SA should increase the probability of decision making and performance by aircrews when conducting flight and mission tasks” (Hicks et al. 2014).

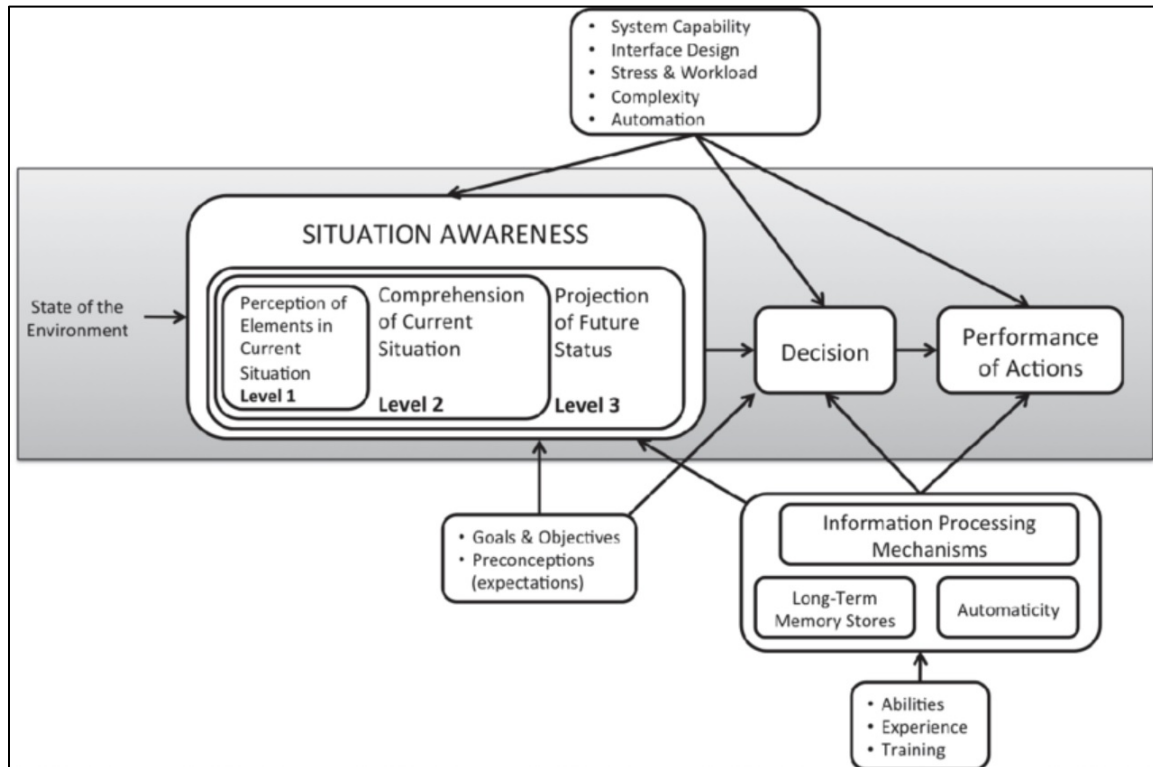


Figure 8. Endsley's SA Model. Source: Hicks et al. (2014).

Hicks et al. used Situation Awareness Rating Technique (SART) scale rating to evaluate the SA of a group of pilots. The pilots from different aircraft platforms followed up each mission by completing a SART questionnaire to record the levels of SA they experienced. “The interview data provides information on how well the pilots perceived the simulation environment and potential threats” (Hicks et al. 2014). Hicks et al. described that Taylor (1989) developed SART in order to evaluate the demand, supply, and understanding SA components of various aircrew systems. The components are subcategorized in ten (10) dimensions as shown in Figure 9. According to Hicks et al., “Taylor proposed that SA depends on the pilot’s understanding (U) (e.g., quality of information they receive) and the difference between the demand (D) on the pilot’s

resources (e.g., complexity of mission) and the pilot's supply (S) (e.g., ability to concentrate)" (Hicks et al. 2014). "When D exceeds S, there is a negative effect on U and an overall reduction of SA" (Hicks et al. 2014). The formula $SA = U - (D - S)$ was used by Hicks et al. to obtain an overall SART score. Hicks et al. derived from Endsley (2000) that "the SART is one of the most thoroughly tested rating scales for estimating SA.." Hicks et al. then requested the pilots and copilots to rate each SA dimension on a seven-point rating scale (1 = low, 7 = high). This measurement technique was derived from Salmon, Walker and Green (2006) as a subjective measure of SA. The results of this study indicate that the UH-60 pilots and copilots "typically experienced moderate to above moderate levels of SA" (Hicks et al. 2014). The methodology followed by the ARL/HRD's study, and the Endsley's SA model will be leveraged to develop the methodology for this capstone report in Chapter III.

Situation Awareness Rating Technique (SART)	
DEMAND	
Instability of Situation	Likelihood of situation to change suddenly
Variability of Situation	Number of variables which require your attention
Complexity of Situation	Degree of complication (number of closely connected parts) of the situation
SUPPLY	
Arousal	Degree to which you are ready for activity
Spare Mental Capacity	Amount of mental ability available to apply to new tasks
Concentration	Degree to which your thoughts are brought to bear on the situation
Division of Attention	Amount of division of your attention in the situation
UNDERSTANDING	
Information Quantity	Amount of knowledge received and understood
Information Quality	Degree of goodness or value of knowledge communicated
Familiarity	Degree of acquaintance with the situation

Figure 9. SART Multidimensional rating scale for pilots to report their perceived SA. Source: Hicks, Durbin, and Morris (2014).

3. SA Error Taxonomy

In 2000, Endsley and Garland published a paper "Pilot Situation Awareness Training in General Aviation." In this paper they derived from Endsley's 1995 study about accidents among major airlines that "88% of those involving human error could be attributed to problems with SA as opposed to problems with decision-making or flight skills" (Endsley and Garland 2000). Additionally, Endsley and Garland published that the

National Aeronautics and Space Administration (NASA) Aviation Safety Program has “identified SA as one of the seven major task areas targeted for human error reduction” (Endsley and Garland 2000). According to Endsley and Garland, NASA’s Aviation Safety Reporting System (ASRS) and Endsley’s SA error taxonomy were used by Jones and Endsley to examine SA aviation errors (Endsley and Garland 2000). As shown in Figure 10, the SA Error Taxonomy table shows that SA errors can be allocated to different levels of SA and attributed to a wide range of factors such as “data not available,” “data hard to detect,” “misperception of data” and “incomplete/poor mental model” (Endsley and Garland 2000). The SA Error taxonomy will be leveraged to conduct the methodology for this capstone report in Chapter III.

Level 1 SA Errors	76.3 %
• Data not available — <i>System & design failures, failure of communication, failure of crew to perform needed tasks</i>	11.6 %
• Data hard to detect — <i>Poor runway markings, poor lighting, noise in the cockpit</i>	11.6 %
• Failure to monitor/observe data — <i>Omission from scan, attentional narrowing, task related distractions, other distractions, workload</i>	37.2 %
• Misperception of data — <i>Prior expectations</i>	8.7 %
• Memory loss — <i>Disruptions in routine, high workload, distractions</i>	11.1 %
Level 2 SA Errors	20.3 %
• Incomplete mental model — <i>Automated systems, unfamiliar airspace</i>	3.5 %
• Incorrect mental model — <i>Mismatching information to expectations of model or model of usual system</i>	6.4 %
• Over-reliance on default values — <i>General expectations of system behavior</i>	4.7 %
Level 3 SA Errors	3.4 %
• Incomplete/Poor mental model	.4 %
• Over-projection of current trends	1.1 %
• Other	1.9 %

Figure 10. SA Error Taxonomy. Source: Endsley and Garland (2000).

2. SA Criteria for Airworthiness

The U.S. Military Handbook, MIL-HDBK-516C “establishes the airworthiness certification criteria, standards and methods of compliance to be used in the determination of airworthiness of all manned and unmanned fixed and rotary wing air systems” (Department of Defense 2014). According to the handbook, SA is defined as “the ability to identify, process, and comprehend critical, perceived elements of information in one’s environment in order to make decisions about a future state and/or needed actions” (Department of Defense 2014). This definition supplements the SA definition used throughout this capstone report. The capstone team used the reference described in this

handbook in the development of the methodology described in Chapter III. According to the handbook, information presented to the MEDEVAC copilot “can, or will, affect SA” therefore, “if a system or information presented to the copilot is for ‘SA purposes’, performance must be demonstrated to prove that the information or system contributes (increases SA) and does not increase workload or present potentially hazardous and misleading information” (Department of Defense 2014).

III. METHODOLOGY AND APPROACH

This chapter of the capstone report describes the methodology for the analysis used to answer the questions posed in the problem statement in Chapter I. The questions involve the identification of SA information, interactions between functions and tasks affecting SA, and technologies that provide and manage SA. A five-phased approach is described which leverages the systems engineering framework depicted in Figure 11 to create a taxonomy of data organization and refinement, ultimately leading to a concise excel data file and function to form diagram that answers the objectives of the problem statement. In the previous chapters of the capstone report, the first steps for the systems engineering framework are addressed, including information gathering, problem definition; and initial concept development including the problem statement identification. This chapter will outline the process for completing the remaining concept and engineering development efforts depicted in Figure 11. This effort includes analysis of the MEDEVAC mission set, collecting aircrew tasks and relating them to the seven overarching aviation functions; applying critical thinking principles leveraged from the SA studies in Chapter II to identify SA requirements for those aircrew tasks within the overarching functions; refinement of the resulting data down to specific MEDEVAC-unique copilot tasks and SA requirements; modeling the interactions between tasks under the seven functions to provide a graphic depiction of SA requirements; and lastly, creation of a function to form diagram outlining the technologies that currently provide SA information to the copilot.

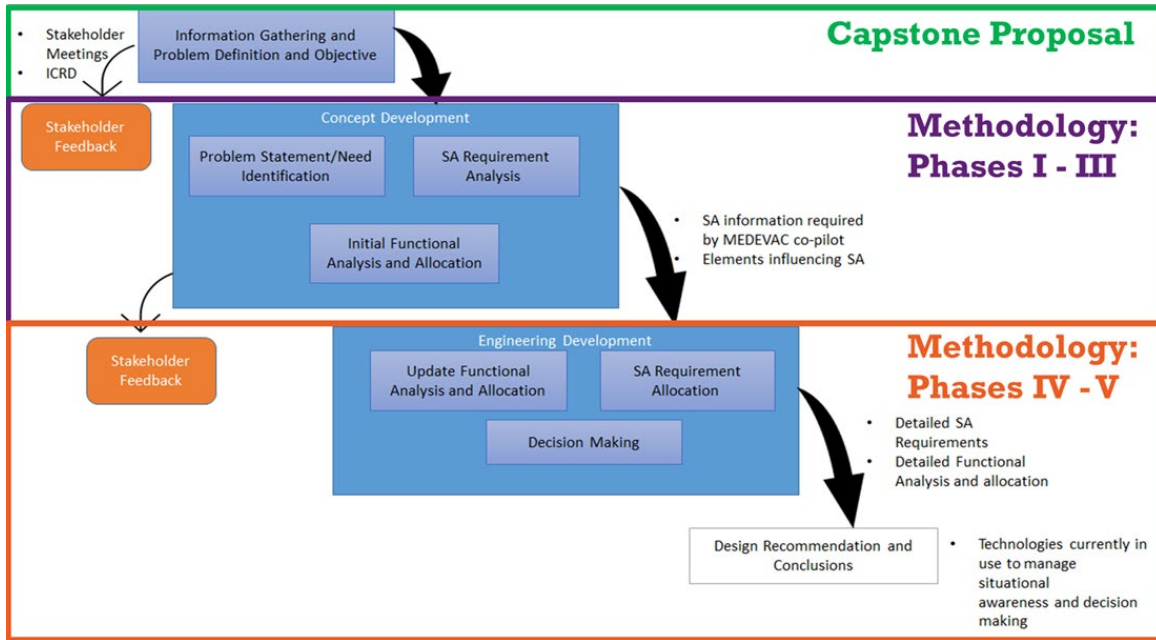


Figure 11. Capstone Project Systems Engineering Framework.
Adapted from Blanchard and Fabrycky (2011).

A. PHASE I: CLASSIFICATION OF TASKS

The U.S. Army aviation functions in general can be broken down into seven areas according to the HSA-DM program. The below definitions were developed by the capstone team and then agreed upon by HSA-DM:

1. Aviate: The control inputs required to effectively maneuver the aircraft from takeoff to final landing in accordance with designated procedures to meet performance standards, observe operating limits and ensure safety of flight.
2. Navigate: The required monitoring, actions, and updating of the aircraft's altitude, course, and speed to safely transit toward the intended destination.
3. Communicate: The internal, external, verbal, and non-verbal communication of the pilot's intentions, requests, or other essential information with air traffic controllers, other aircraft, other members of the crew and ground personnel during flight.

4. Subsystem Status: The monitoring and response to flight, mission, and weapon systems statuses and diagnostics affecting safety of flight or mission accomplishment.
5. OV-1 Awareness: The awareness and perception supported by the available user interfaces depicting the mission, class of mission, or mission scenario information.
6. Weapon Engagement: Procedures supporting the identification, targeting and employment of weapon systems at designated targets.
7. Survivability and Localized Threat Awareness: The “capability of [the aircraft] and its crew to avoid or withstand a hostile environment without suffering an abortive impairment of its ability to accomplish its designated mission” (Defense Acquisition University [DAU] n.d.).

Phase I was the initial step toward answering the overarching question from the problem statement of this capstone project: What is the significant SA information relevant to the FLRAA copilot in a MEDEVAC mission scenario?

During Phase I, the capstone team used the Task Decomposition Database, provided by the stakeholders and discussed in Chapter II, to organize the provided aircrew tasks into one or more of the seven overarching U.S. Army aviation functions. Approximately 411 tasks were initially included in the database referenced from technical manuals. Tasks that were marked as “FOUO” were removed in order to keep this project and the associated data as an unclassified, distribution A releasable document. Using the original database as a starting point, a new column was added to the spreadsheet which identified which of the seven U.S. Army aviation overarching functions the task applies to (aviate, navigate, communicate, subsystem status, OV-1 awareness, threat/survivability). A common key was identified which described the overarching functions to assist with identifying the abbreviations used in the new column. Initially, the group identified these functions jointly but quickly realized that “group think” was limiting the amount of input from individual team members. The capstone team used this realization to readjust the method of decomposing each task so that each team member individually decomposed each

task. This action not only allowed the group to think individually but also allowed each team member to better understand the provided tasks. The capstone team members then consolidated the individual responses and came to consensus on each task. Next, columns not required for this project were eliminated from the database to reduce the data down to only the tasks and descriptors required to fully understand each task.

The database was shared with an academic advisor to provide a pilot's input into the rationale. The input was incorporated into the database, and, in some cases, additional functions were added to the tasks based on pilot experience that the team was not aware of. The database was also provided to a panel of Army pilots for validation.

B. PHASE II: DATABASE TASK REFINEMENT

Phase II analysis answered the problem statement sub question: What overarching function holds the highest proportion of tasks expected to be performed by the MEDEVAC copilot?

During Phase II, the capstone team assigned unique identification numbers (UID) to the 408 unique tasks initially included in the Task Decomposition Database for the purpose of traceability. To organize the overarching functions with their allocated tasks, a tabbed spreadsheet was created (one tab per overarching function). The capstone team further analyzed each task within each of the overarching functions and applied the criteria defined below. The criteria were applied to remove non-relevant tasks outside of the scope of this capstone project. Additionally, this process aided in the determination of which of the overarching functions contains the most tasks performed by a MEDEVAC copilot. The tasks with the following characteristics were inside the scope of this capstone project:

Criteria 1: Tasks specific to the MEDEVAC mission.

- Weapons engagement and Survivability and Localized Threat Awareness functions were eliminated.

Criteria 2: Tasks completed from engine start to engine shutdown.

- All preflight and postflight tasks were eliminated.

Criteria 3: Tasks performed by the copilot.

- The pilot-in-command assigns tasks to the copilot dependent on mission; tasks involving the use of flight controls were eliminated, including all tasks that fell strictly under the Aviate overarching function.

C. PHASE III: SA REQUIREMENTS ANALYSIS (INTERACTIONS)

The Phase III analysis answered the problem statement sub question: What are the most frequently observed interactions between SA information and the various tasks that the copilot performs?

During this phase, human factors analysis was conducted on the remaining tasks from Phase II by identifying the SA information required to complete these MEDEVAC copilot tasks and determine the interaction and relationships between the different pieces of applicable SA information and the tasks. A tailored operator task analysis (OTA) was conducted to understand the human interactions required for each task and to identify the associated SA information required to complete each task. The output from this analysis included the following for each task:

- SA Information: The information that alerts the user of a certain condition.
- Required action: The action that is performed by the user based on the stimulus.
- Feedback: The change in the action stimulus that happens based upon the user's response.
- Potential errors: Provides the potential sources of human error that would cause task failure.

The OTA format used on this capstone project was tailored from a sample OTA derived from Blanchard and Fabrycky (2011) as shown in Figure 12. The sample format includes columns for action stimulus, task classification, time allowable and time necessary, workstation, and skill level. The capstone team decided the definition for SA

information included the action stimulus. Action stimulus is the stimulus that initiates the user to perform an action; SA information is defined in this project as information that alerts the user of a certain condition and information required for copilot to perform task. Therefore, the capstone team used the term “SA Information” in the OTA in place of “Action Stimulus.” The other columns from the sample OTA format previously mentioned were removed due to time constraints, subject matter expertise constraints, or lack of applicability due to the narrow scope of the capstone project. For example, capturing the workstation for each task was not applicable, since all of the tasks would be performed from the copilot seat. Also, defining the time allowable and the time necessary for each task required dedicated MEDEVAC copilot input which was not available during the limited time constraints. It was also determined that the timing requirements for each task could vary in length depending on the unique situations that could arise during each mission.

Function	Drive car from A to B								
Task	Manage the car subsystems								
Subtask	Action Stimulus	Required Action	Feedback	Task Classification	Potential Errors	Time		Work Station	Skill Level
						Allowable	Necessary		
Fill up the gas	Gas Gauge	Insert gasoline into the gas tank	Increased level on gas gauge	Operator task	a. Misread gas gauge b. Fail to fill up gas tank c. Insert wrong type of gas	30 minutes	15 minutes	Driver's Seat	Low

Figure 12. Sample format for OTA. Source: Blanchard and Fabrycky (2011).

The capstone team divided the tasks and used inherent knowledge, the UH-60 ATM, and the Operator’s Manual to determine the data for the tailored OTA. Once the draft was composed, it was shared with the advisors and the stakeholders for further refinement.

With the SA information identified for each of the tasks, the relationships between the SA information and the tasks were developed in Microsoft Excel and modeled in the model-based systems engineering (MBSE) tool Innoslate. The purpose for this step was to ensure that SA information was available for each task, to identify certain tasks that require a significant amount of SA information, and to identify SA information that was required

for several tasks. Understanding these relationships helped identify SA informational overload or underload for any given task as well as determine the priority for specific SA information over another. These relationships were also modeled in Innoslate as a spider diagram. The spider diagram visually mapped out the relationships and interactions of different system aspects. In this case, the system aspects being modelled were the MEDEVAC copilot tasks and the SA information.

D. PHASE IV: SA REQUIREMENT ANALYSIS (ENGINEERING DEVELOPMENT)

Phase IV analysis answered the following two problem statement sub questions: What level of SA is the most frequently required by a MEDEVAC copilot, and what OT are the most frequently used by a MEDEVAC copilot?

To assist in answering these questions, the capstone team created a new spreadsheet to initiate the Phase IV Requirements Analysis. The capstone team's analysis used the 117 refined tasks as a result from Phase III's OTA to determine the SA level, the SA error taxonomy, and the OT. Endsley's (2005) SA Model was used to analyze each copilot task and SA information to determine what level of SA will be required by the copilot. According to the model, "Level I – perception of elements in current situation, Level II – comprehension of current situation, or Level III – projection of future situation" (Endsley 2005). The capstone team found that Level II tasks included Level I tasks. Level III tasks comprised of both Level II and Level I. In this capstone project, each task was evaluated individually with its own SA level rating and not grouped with multiple SA levels. Each task was reviewed in order on the spreadsheet and assigned the respective SA Level based on the capstone team's process of asking the following questions:

When making a decision –

1. Does this task use perception of what may happen in a current situation?
2. Does this task use the data of what is currently happening in the situation (comprehension)?
3. Does this task project what could occur in a future situation (something that has not happened yet)?

If a task alluded to the perception of something that may potentially occur, the capstone team assigned a level of I. If a task alluded to using data from a current situation and comprehension of that data to make a decision, the level II was assigned. Level III was assigned if a task alluded to the perception, comprehension, and projection of something occurring in the future.

Next, the capstone team analyzed each copilot task to determine the potential SA errors at each SA level (I, II, or III). Endsley and Garland's (2000) Error Taxonomy was used to analyze each task with its assigned SA level. To determine the appropriate error taxonomy, the capstone team first looked at the SA level that was assigned to the task. Next, the capstone member used the Error Taxonomy model to determine if the potential SA errors could be caused by the low SA level. If the level and definition of the error corresponded to the task, the appropriate potential errors were added to the Potential SA Errors column in the spreadsheet. For example, the copilot task is "Monitor the remaining fuel quantity and the continuing rate of consumption," and the SA level assigned was I. The potential errors using the Error Taxonomy could be – failure to monitor/observe data – the copilot did not monitor the fuel quantity and the continuing rate of consumption. Or a potential SA error could be – misperception of data – the copilot did not perceive the fuel data correctly.

Finally, the capstone team used TC 3–22.69 ASA Chapter 3 to analyze and determine the OT of each copilot task. Dependent on the task, the following OT were selected: visual, sound (receiver), and sound (sender). At the time of analysis, haptic/tactile observation was not used in this project. If a task could be perceived by the sense of sight, it required a visual technique, therefore that task was assigned "visual" in the spreadsheet's OT column. In the example used above, the task was assigned "visual" due to the task and its applicable data being only observed from a visual perspective. If a task could be perceived by the sense of sound, it required a sound technique, therefore the task was assigned "sound" in the spreadsheet's OT column. The capstone team then used the Process of Listening as shown in Figure 13 to determine which role (sender or receiver) the operator would perform to complete the applicable task. In some instances, multiple OTs were assigned.

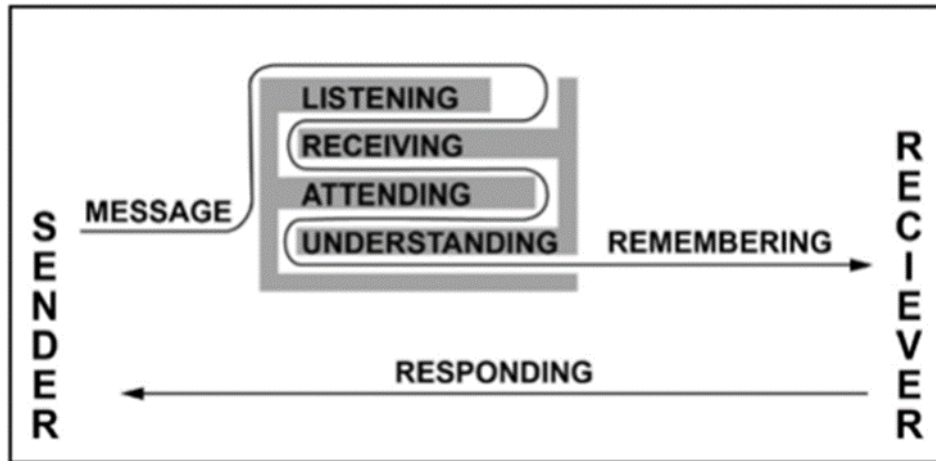


Figure 13. Process of Listening. Source: United States Army Maneuver Center of Excellence, Directorate of Training and Doctrine, Doctrine and Collective Training Division (2021).

E. PHASE V: FUNCTION TO FORM DIAGRAM

Phase V of the approach addressed the final problem statement sub question: What technologies are used most frequently to manage the copilot's SA and decision making?

The OTs from the SA requirements analysis developed in Phase IV were leveraged, along with the SA information and required actions identified in the OTA, to identify the technologies from the HH-60M Operator's Manual (described in Chapter II) that are necessary to perform each task. This phase identified the form for deriving SA information (SA system), as well as the form used to complete any required action (action system), in a spreadsheet that also includes the task UID, overarching function(s), task description, and OTs. The SA systems were then mapped through the task UID to the overarching functions associated with those tasks in six function-to-form diagrams. These diagrams provide the framework for identifying future technologies with greater capabilities for optimizing SA for the MEDEVAC copilot (such as haptic, audible, or visual aids).

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IV. RESULTS

A. PHASE I RESULTS AND OBSERVATIONS

After organizing the spreadsheet into a workable document, the overarching functions were identified for each task. An example of the spreadsheet is indicated in Figure 14.

Function	Abbreviation	Definition							
Aviate	A	The control inputs required to effectively maneuver the aircraft from takeoff to final landing in accordance with designated procedures to meet performance standards, observe operating limits and ensure safety of flight.							
REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE	Overarching Function	Capstone Team Assumptions	Verification
JHNA-TM-2005	MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(c)_1_ Effects on visibility and flight operations	052-270-3002	Analyze Weather Effects on Operations	--	--	A, N, T		X
JHNA-TM-2005	MEDEVAC - CASEVAC - Aviation Team	2.c.(3)(c) Selects aircraft employment techniques and formations that support the tempo of the route reconnaissance and provide necessary airspace de-confliction .	171-123-1300	Conduct a Route Reconnaissance	--	--	A, N		X
JHNA-TM-2005	MEDEVAC - CASEVAC - Aviation Team	2.c.(3)(d) Specifies actions to be taken upon contact with enemy forces or civilians.	--	--	--	--	A, C, W, T		X
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(5) Determines tempo (rapid or deliberate) and level of covertness (stealthy or forceful) of the reconnaissance effort and locations where more deliberate reconnaissance is required according to LTIOV.	171-123-1313	Plan a Reconnaissance Mission	171-123-1301	Conduct an Area or Zone Reconnaissance	A, C, O, T		X

Figure 14. Screenshot of Phase 1 Database Spreadsheet

Some of the rows in the database did not constitute actual tasks, rather they were headings over multiple tasks. Those rows were not included in the total task count. After identifying the overarching functions for each task, most tasks were identified as falling into the aviate, navigate, communicate, and subsystem status functions. Of the 408 tasks provided in the Task Decomposition Database, 50% of the tasks were identified as communicate functions, 38% of the tasks were identified as subsystem status functions, 35% of the tasks were identified as aviate functions, and 25% were identified as navigate functions. Table 2 indicates the percentages of tasks for each function.

Table 2. Phase I Task to Function Statistics

Overarching Function	Tasks Quantity	Tasks Percentage
Aviate	144	35.3% (144/408)
Navigate	100	24.5% (100/408)
Communicate	205	50.2% (205/408)
Subsystem Status	157	38.5% (157/408)
OV-1	69	16.9% (69/408)
Weapons Engagement	34	8.3% (34/408)
Threat-Survivability	59	14.5% (59/408)

B. PHASE II RESULTS AND OBSERVATIONS

After the analysis of the 408 tasks from the Task Decomposition Database, a total of 291 tasks were found not to meet the criteria defined in Chapter III. Subsequently, 117 tasks were found to be within the scope of the capstone project and further analyzed during Phase III. To determine which of the overarching functions contains the most tasks to be performed by a MEDEVAC copilot, the quantity of tasks per overarching function was calculated. The tasks percentage for each function was calculated by dividing the total number of tasks in a function by the total tasks evaluated. A summary can be seen in Table 3. Communicate and Subsystem Status overarching functions have the most tasks with 67.5% and 52.1% tasks, respectively.

Table 3. Summary of Tasks per Overarching Function Analyzed

Overarching Function	Tasks Quantity	Tasks Percentage
Communicate	79	67.5% (79/117)
Subsystem Status	61	52.1% (61/117)
OV-1 Awareness	35	29.9% (35/117)
Navigate	33	28.2% (33/117)

C. PHASE III RESULTS AND OBSERVATIONS

The Phase III analysis resulted in a tailored OTA for the 117 tasks derived in Phase II. The resultant OTA is captured in Appendix C and an excerpt of the OTA is captured in Table 4. The OTA identified a total of 91 unique pieces of SA information that are required, and several of these pieces of information are required for multiple tasks. This OTA verified that each MEDEVAC copilot task had a corresponding piece of SA information and vice versa.

Table 4. MEDEVAC Copilot Tailored OTA Excerpt

UID	Overarching Function	Task	Situational Awareness Information	Required Action	Feedback	Potential Errors
14	N, C	Obtains specific air route coordinates, including the start point, release point, and other critical points along the route.	Radio call	Listen to radio call and copy info onto kneeboard	Confirm information with sender	Incorrect translation
15	O, C	Obtains mission line of departure (LD) time and designate a completion time.	Radio call	Listen to radio call and copy info onto kneeboard	Confirm information with sender	Incorrect translation
17	N	Conducts terrain analysis and determines the best route.	Terrain Information OV-1 Information	Analyze terrain	Plotted route	Incorrect analysis of the terrain information

These relationships were captured in a spreadsheet found in Appendix D and an excerpt is presented in Table 5; the relationships were also modeled in Innoslate and can be built upon for further analysis beyond this capstone project.

Table 5. MEDEVAC Copilot SA Information and Task Relationships Excerpt

SA Info UID	SA Information	Task UID
11	Maps	104, 240, 244, 245, 246, 247, 269, 368, 369, 370
12	Altitude	104, 321
13	Waypoints	104
14	Planned Route Information	104, 116, 117, 227
15	Progress	104
16	Fuel Information	105, 230, 233, 234, 235, 268, 269

Utilizing the data created from the relationship spreadsheet in Appendix D, a Pareto chart was developed to show the most frequent SA information that is required for the 117 MEDEVAC copilot tasks which is shown in Figure 15. Of note, the five top pieces of information with the most relationships with copilot tasks include visual observations (11), maps (10), information received via radio calls (10), calculated weight (8) and fuel

information (7). Conversely, some tasks were identified that required several pieces of SA information. For example, the task of performing electronically aided navigation required the aircraft heading, maps, altitude, waypoints, planned route information, and the current progress of the route.

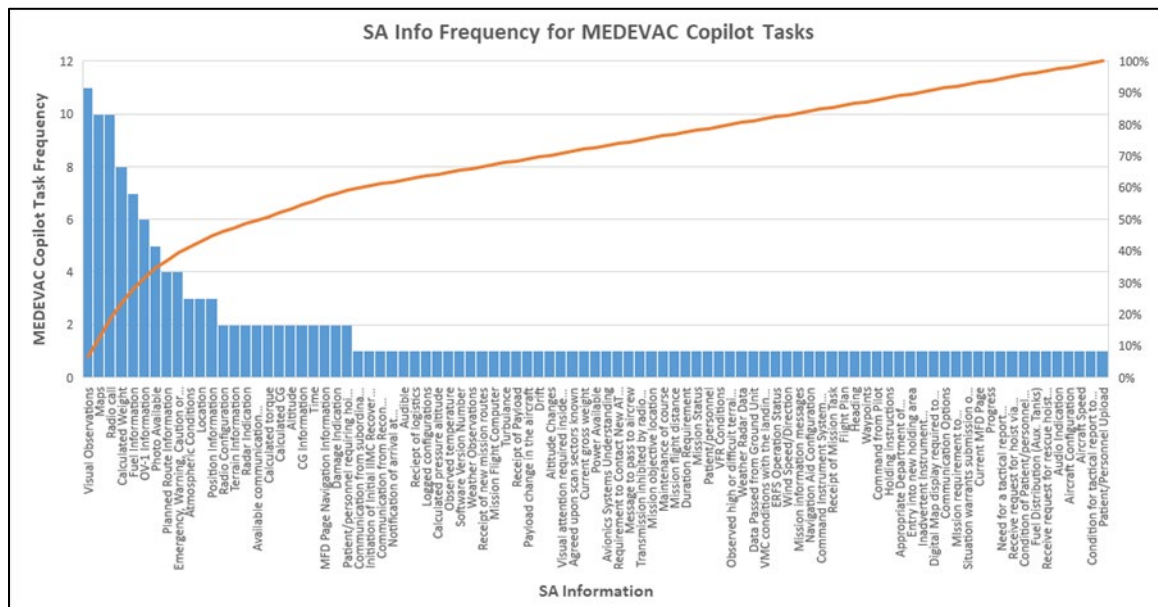


Figure 15. SA Information Frequency for MEDEVAC Copilot Tasks

D. PHASE IV RESULTS AND OBSERVATIONS

Phase IV highlighted the fact that there are multiple potential SA errors that could occur when a copilot does not receive the appropriate SA information to perform a task. In addition, there may be multiple OTs required for each task. Table 6 provides an excerpt to visualize the requirements analysis spreadsheet, and the full results are located in Appendix E. The capstone team found the following after conducting the Phase IV requirements analysis: when the capstone team assigned the SA levels to the tasks, the team found that 16 of the 117 tasks were identified to be Level I tasks, 58 tasks were identified as Level II, and 43 tasks as Level III. These results show that 13.7% of the tasks required the copilot to have perception of his/her current situation only, 49.6% required the copilot to perceive and comprehend his/her current situation, and 36.7% required the copilot to have a higher

level of SA (perception, comprehension, and prediction of decision). When the team assigned the SA Errors IAW Endsley and Garland's the Error Taxonomy (2019), it was found that 81 of the copilot tasks had the potential for multiple SA errors. Of those 81 tasks, five were Level I, 48 were Level II, and 28 were Level III. When the capstone team assigned the OTs, it was found that 83 of the 117 total tasks had multiple OTs associated with them. This result shows that 70.9% of the copilot tasks require the use of multiple OTs. Of those 83 tasks, 14.5% require SA Level I, 43.4% require SA Level II and 42.2% require SA Level III. Further analysis revealed that 73.5% of the 117 tasks require visual OT, 46.1% of the tasks require sound (receiver), and 62.3% require sound (sender).

Table 6. Requirements Analysis Excerpt

UID	Overarching Function	Task	Situational Awareness Information	Required Action	SA Level	Potential SA Errors	Observation Techniques
248	S	Ensure that sufficient power exists for the type of approach/landing desired.	VMC conditions with the landing area reconnaissance complete	Calculate the power available and communicate with the pilot	Level 3	- Failure to monitor/observe data - Misperception of data - Incomplete/poor mental model	Visual Sound (Sender)
254	A, S	Monitor wind conditions using cockpit indicators (CI).	Atmospheric Conditions	Use Cockpit indicators to monitor wind conditions, techniques for evaluating wind conditions are found in TC 3-04.4	Level 1	- Data not available - Data hard to detect - Failure to monitor/observe data	Visual Sound (Sender)
255	A, C, S	Determine wind direction and velocity at the landing point.	Atmospheric Conditions	Verify whether conditions (surface, wind, and temperature/pressure altitude) are the same as they predicted during the reconnaissance	Level 2	- Misperception of data - Incomplete mental model	Visual Sound (Sender)

A total of 58 tasks required Level II SA. In addition, the Level II tasks had the most multiple potential errors and OTs associated with them. The data in Table 7 is derived from the Phase IV Analysis Spreadsheet and provides evidence that Level II tasks have the greatest number of potential SA errors and OTs associated with them in every category.

Table 7. SA Levels for Copilot Task Breakdown

SA Level	Task Quantity	Tasks with Multiple Errors	Tasks with Multiple OTs	Tasks w/ Visual OT	Tasks w/ Sound (Receiver) OT	Tasks w/ Sound (Sender) OT
I	16	5	12	8	10	11
II	58	48	36	41	30	37
III	43	28	35	37	14	25
Total	117	81	83	86	54	73

E. PHASE V RESULTS AND OBSERVATIONS

The OTA, the SA information provided in Phase III, and the OT provided in Phase IV proved invaluable in identifying the systems currently used on the HH-60M for providing SA to the copilot. Appendix F provides the complete results and breakdown of all systems used to derive SA and systems used to complete the tasks. The six diagrams in Figures 14–18 provide useful visual tools for determining which systems are providing SA for the largest number of copilot tasks. Since many of the copilot tasks fall into multiple overarching aviation functions, several overarching function groups resulted. With the tailored task list including only copilot tasks involved in the navigation, communication, OV-1 awareness, and subsystem status functions, a total of 29 systems are currently leveraged for the MEDEVAC copilot’s SA. These systems are listed in Table 8.

Table 8. Systems Providing Copilot SA

Overarching Function	System	Tasks (UIDs)
Communicate	Air Speed Indicator via Multi-Functional Display (MFD)	433
Communicate	Any/All Internal Systems	212, 220
Communicate	Authentication Document	449
Communicate	Intercommunication System (ICS) Panel	103, 110, 362, 448
Communicate, OV-1 Awareness, Subsystem Status	Blue Force Tracker (BFT) via MFD	116, 117, 121, 131, 133, 290
Communicate, OV-1 Awareness, Subsystem Status	Transponder Control Screen via Flight Management System (FMS)	356
Communicate, Subsystem Status	AN/ARC-231 via FMS	451, 477
Communicate, Subsystem Status	Checklist	174, 175, 176, 177, 179
Communicate, Subsystem Status	DD Form 365–4 (Form F)	170, 175, 176, 177, 180, 214, 215, 231, 271
Communicate, Subsystem Status	Digital Clock	233, 234
Communicate, Subsystem Status	Flight Information Publication (FLIP)	305, 306, 447

Overarching Function	System	Tasks (UIDs)
Communicate, Subsystem Status	HH-60 Emergency Indicator Lights & Sounds	273, 278, 280, 281
Communicate, Subsystem Status	Operator's Manual	170, 174, 175, 176, 177, 179, 180, 181, 182, 214, 215, 218, 231, 271, 360
Communicate, Subsystem Status	Performance Planning Card (PPC) via FMS	172, 216
Communicate, Subsystem Status	Standard Operating Procedure and/or Signal Operating Instruction	367, 382, 389, 397, 468
Navigate	Embedded Global Positioning/Inertial Navigation (EGI) via the FMS	225
Navigate, Communicate, OV-1 Awareness, Subsystem Status	Multi-Band Radio via Headset/Helmet	14, 15, 115, 116, 117, 121, 122, 130, 132, 133, 135, 185, 186, 188, 219, 221, 243, 255, 296, 305, 385, 386, 387, 388, 389, 449, 450
Navigate, Communicate, OV-1 Awareness, Subsystem Status	EICAS Display via Multi-Functional Display (MFD)	229, 230, 231, 233, 234, 235, 268, 269, 271
Navigate, Communicate, OV-1 Awareness, Subsystem Status	Eyes Outside	130, 185, 220, 240, 241, 242, 243, 244, 245, 246, 247, 248, 335, 379, 380, 397, 433, 465, 480
Navigate, Communicate, OV-1 Awareness, Subsystem Status	Flight Management System (FMS)	100, 104, 172, 216, 225, 226, 227, 291, 365, 368, 369, 370, 447, 451
Navigate, Communicate, OV-1 Awareness, Subsystem Status	Two or more Systems Simultaneously via the Multi-Functional Display (MFD)	100, 104, 105, 130, 168, 185, 211, 213, 226, 227, 229, 230, 231, 233, 234, 235, 241, 242, 243, 254, 255, 268, 269, 271, 291, 300, 341, 342, 368, 369, 370, 396, 433
Navigate, Communicate, OV-1 Awareness, Subsystem Status	Portable Flight Planning Software (PFPS) via Laptop	184, 187, 189, 299

Overarching Function	System	Tasks (UIDs)
Navigate, Communicate, OV-1 Awareness, Subsystem Status	Tablet/Kneeboard	116, 117, 121, 131, 229, 230, 240, 241, 244, 245, 246, 247, 299
Navigate, Communicate, OV-1 Awareness, Subsystem Status	WX-500 Stormscope via Multi- Functional Display (MFD)	130, 185, 242, 243
Navigate, Communicate, Subsystem Status	Altimeter	171, 211, 321
Navigate, Communicate, Subsystem Status	Heads Up Display (HUD)	211
Navigate, Communicate, Subsystem Status	Intercommunication via Headset/Helmet	193, 194, 301, 397, 410, 443
Subsystem Status	Extended Range Fuel System (ERFS)	272
Subsystem Status	Physical Equilibrium	193

The embedded electronic system on the aircraft that provides SA for the greatest quantity of tasks is the multi-band radio, with 27 tasks. The overarching function overlap of communication and subsystem status mapped to the largest number of devices for providing the SA, at nine devices, as shown in Figure 16 and Figure 17. Figure 18, Figure 19, and Figure 20 depict the remaining function-to-form relationships, which contain less tasks and systems overall.

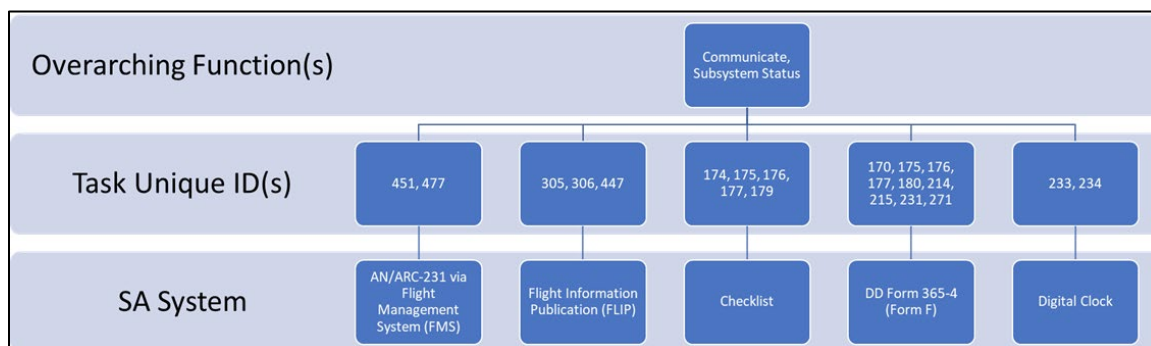


Figure 16. Function-to-Form Sub-Diagram 1

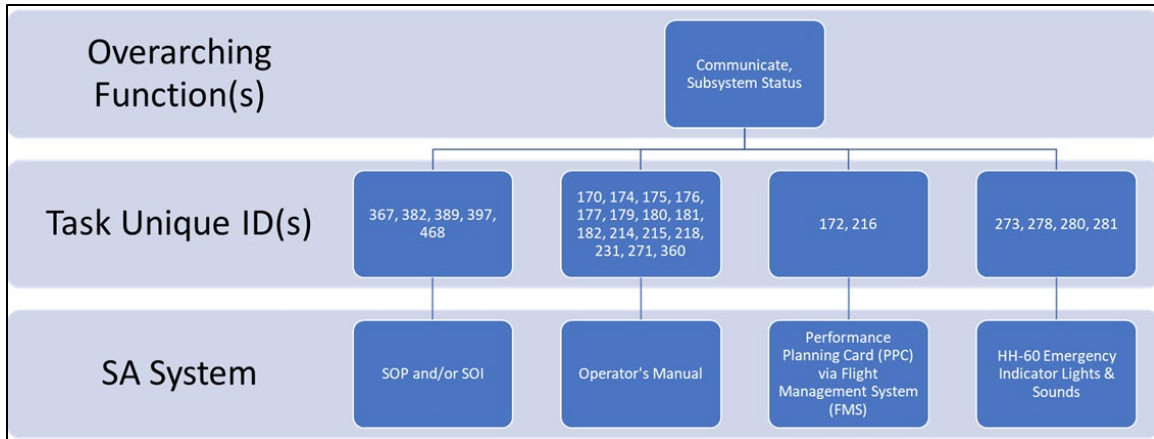


Figure 17. Function-to-Form Sub-Diagram 2

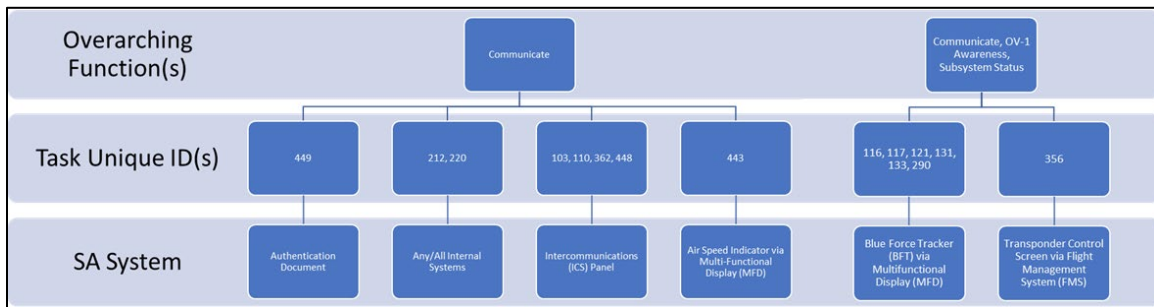


Figure 18. Function-to-Form Sub-Diagram 3

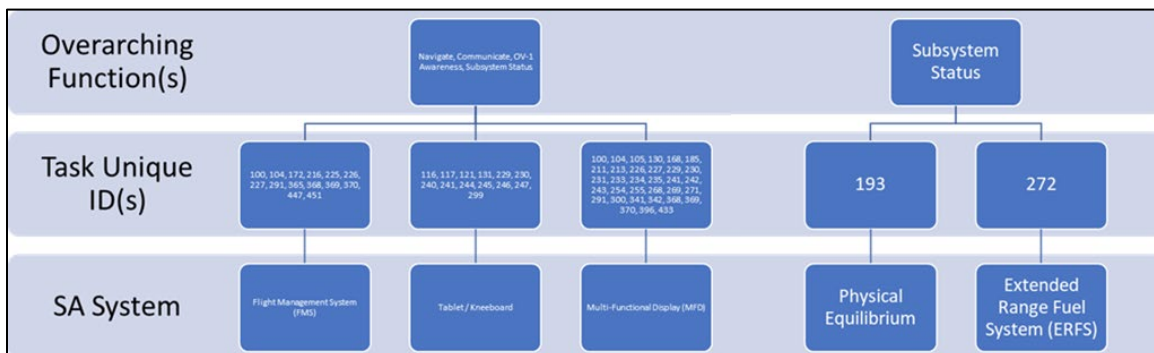


Figure 19. Function-to-Form Sub-Diagram 4

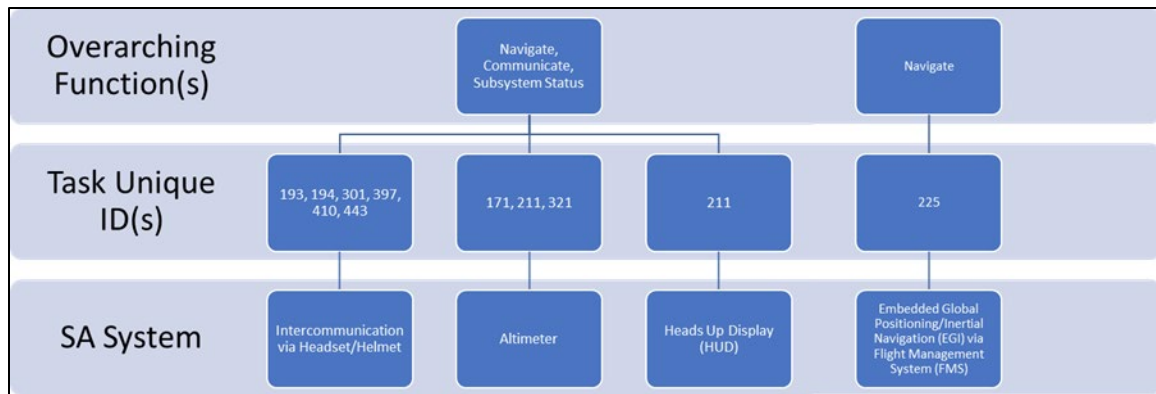


Figure 20. Function-to-Form Sub-Diagram 5

V. CONCLUSIONS AND RECOMMENDATIONS

The capstone team was able to reach multiple conclusions regarding the FLRAA MEDEVAC copilot SA research questions. The capstone team confidently developed a methodology and approach to address the FVL programs concerns pertaining to SA demands on the MEDEVAC copilot. The capstone utilized a five phased approach to answer the primary question raised in the problem statement:

- What is the significant SA information relevant to the FLRAA copilot in a MEDEVAC mission scenario?

The primary question was answered through the culmination of answering the following sub questions:

- What overarching function holds the highest proportion of tasks expected to be performed by the MEDEVAC copilot?
- What are the most frequently observed interactions between SA information and the various tasks that the copilot performs?
- What level of SA is the most frequently required by a MEDEVAC copilot?
- What observation techniques (OT) are the most frequently used by a MEDEVAC copilot?
- What technologies are used most frequently to manage the copilot's SA and decision making?

The five phased approach also provides a framework for evaluation of systems to increase SA under each of the U.S. Army aviation overarching functions. Additionally, this capstone project provides the HSA-DM a framework to implement maintainable SA information to a FLRAA copilot engaged in a MEDEVAC mission. The literature review revealed multiple studies, methodologies and tools have been performed and utilized to understand and evaluate the SA of military and commercial pilots and copilots. The

objectives of these evaluations are to increase and maintain the SA of pilots and copilots while identifying areas to reduce cognitive workloads.

A. CONCLUSIONS

The task classification analysis revealed that MEDEVAC tasks may include multiple function types simultaneously which challenge the crew to apply their training and knowledge in multiple simultaneous situations. The 144 identified aviate functions, 34 weapon engagement functions, and 59 survivability and localized threat awareness functions were excluded for further analysis since these typically do not fall under the copilot activities during MEDEVAC missions. However, the pilot could potentially request that the copilot perform any of the tasks, which would only increase the SA burden on the copilot.

1. Sub Question: What overarching functions hold the highest proportion of tasks expected to be performed by the MEDEVAC copilot?

A taxonomy of data organization and refinement was completed and revealed that during a MEDEVAC mission, the most tasks assigned to a copilot are under the Communicate and Subsystem Status overarching functions. This conclusion supports the sub question: What overarching functions hold the highest proportion of tasks expected to be performed by the MEDEVAC copilot? The results show that 67.5% and 52.1% of the MEDEVAC copilot tasks fall under Communicate and Subsystem Status functions, respectively. While 29.9% and 28.2% of the MEDEVAC copilot tasks fall under OV-1 Awareness and Navigate, respectively. During the communicate function, the copilot is expected to have internal, external, verbal, and non-verbal communications of the pilot's intentions, requests, or other essential information with air traffic controllers, other aircraft, other members of the crew and ground personnel during flight. During Subsystem Status the copilot is expected to monitor and respond to flight, mission, and weapon systems statuses and diagnostics affecting safety of flight or mission accomplishment.

2. Sub Question: What are the most frequently observed interactions between SA information and the various tasks that the copilot performs?

An OTA was performed to analyze the human interactions required for each of the MEDEVAC copilot tasks. This analysis resulted in the identification of the required SA information for each of the tasks. The relationships between the SA information and the tasks were captured in an Excel spreadsheet as well as modeled in Innoslate, and the analysis of these relationships revealed through the pareto chart in Figure 15 that the most significant SA information to the FLRAA copilot in a MEDEVAC mission scenario is composed of visual observations, maps, information received via radio calls, calculated weight, and fuel information. From the pareto chart, the top 5 most frequent SA information for the 117 tasks made up 28% of the cumulative total of interactions.

3. Sub Question: What level of SA is the most frequently required by a MEDEVAC copilot?

The analysis of the copilot tasks to determine the SA level, potential errors, and OTs led the capstone team to conclude that most tasks, 49.6% require the copilot to have an SA of Level II. SA Level II requires the copilot to perceive and comprehend the data in order to make a decision in the current environment or situation, which requires an elevated level of SA.

4. Sub Question: What observation techniques are the most frequently used by a MEDEVAC copilot?

The data from the analysis revealed that when a MEDEVAC copilot requires the use of multiple OTs, most of the tasks require him/her to perceive and comprehend the data (Level II) and that most tasks, 73.5%, in a MEDEVAC mission are observed visually

5. Sub Question: What technologies are used most frequently to manage the copilot's SA and decision making?

The Function to Form analysis revealed multiple useful factors to consider in the future when selecting the onboard systems for FLRAA platforms. As shown in Table 8, the MFD is currently supporting SA for the completion of 33 out of 117 tasks, which is

22% more than the next highest system (the radio). This is not surprising since, as the name indicates, it is multi-functional. It is an essential system that has a high degree of utilization. It provides visual representations of information derived from a multitude of instruments (such as the airspeed indicator and altimeter), fuel levels from the engine indicating and crew alerting system (EICAS), blue force tracking, weather radar, and more, on multiple selectable screens tailorable to the copilot's needs and preferences. Table 8 also demonstrates that the system with the next highest number of SA deriving tasks is the radio. This also comes as no surprise since the MEDEVAC mission requires coordination with multiple controlling agencies and ground forces. The potential for advancement in this case may be to alleviate the necessity for the copilot to manually copy down information passed over voice. Automated generation of text from voice communications would allow the copilot to maintain visual focus outside of the aircraft, which happens to be the method for deriving the next highest level of task SA.

B. RECOMMENDATIONS

This capstone report has two primary audiences which include the HSA–DM program office and FVL program office. The following five recommendations are provide for future studies.

1. Use Phase III results to design the FLRAA cockpit.

The capstone team recommends that the stakeholders further evaluate the top five pieces of SA information identified in this capstone project that are involved with the most U.S Army aviation functions. Based on this information, focus cockpit designs to provide this SA information in the most meaningful way to the copilot. Some areas involving a high volume of tasks which could be focus areas for improved technologies are:

1. How maps are presented
2. How fuel information is provided
3. How radio communication is provided
4. The best way for the copilot to make visual observations outside of the aircraft unobstructed

5. How the aircraft weight and balance are presented

It would be most advantageous to assess the presentation for all 91 identified pieces of SA information required for the MEDEVAC copilot tasks, but in today's budget-constrained environment, it is likely not feasible to assess all these mechanisms at first. Therefore, it is recommended to place the most focus on the SA information that is the most frequently required for the copilot tasks.

2. Build upon MBSE model for future analysis.

The capstone team recommends any future capstone teams and stakeholders utilize MBSE tools (such as Innoslate) to further analyze the OTA and spider diagram modeled by the capstone team. The OTA presented the relationships between the tasks and the SA information. MBSE tools can further break down tasks into functions that can be linked to a material solution. Tasks can also be time-phased to show stacked tasks running in parallel and subsequently when related SA information could be overwhelming or underwhelming at any given time during a mission scenario. The spider diagram can be used as a visual tool to organize the relationships between the different segments of SA and demonstrate where the highest concentrations of relationships reside.

3. Survey the user community.

The capstone team recommends that the stakeholders perform Taylor's SART model on the HH-60 and UH-60 crew members through surveys to capture the significant cognitive workload drivers during a mission. The questions should be tailored to capture information related to crewmember's experiences in flight and how their SA is impacted. The data from the surveys can uncover onboard device shortfalls or areas of improvement within the cockpit to improve overall SA.

4. Complete a market analysis to identify the latest or emerging technologies for cockpit SA.

The capstone team recommends that the HSA-DM program office complete a comprehensive market survey of current and emerging technologies for cockpit SA. The market analysis should seek technologies that would improve SA in maps, information

transmitted via radio calls, visual observations, OV-1 information, and fuel information as found in this study. These five items impacted the copilot the most during mission operations, and technologies in these areas would be beneficial to include in cockpit designs and layouts in the future.

5. Expand the study to other users/platforms/missions.

The capstone team recommends that the HSA-DM program office expand the capstone study to other users, platforms and missions. The HSA-DM program office requested that the capstone team focus its efforts on the MEDEVAC mission and copilots SA. The capstone team's five-phased methodology can easily be repeated to evaluate other tasks within various mission sets and aircraft variants. The HSA-DM can leverage the information and templates within this capstone study to request capstone teams consider other missions in the future that require further analysis.

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[illegible]

REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE
UH60-ATM-				
ATM Task	Crew Task	Task Steps		
60-ATM-1000	Participate in a Crew Mission Briefing	1. The pilot in command (PIC) will acknowledge an understanding of DA Form 3484 and will actively participate in a crew mission briefing. 2. The PIC will ensure a mission briefing is conducted using table 4-1, or a more detailed unit-approved crew briefing CL. 3. Crewmembers will acknowledge a complete understanding of the aircrew mission briefing.		
60-ATM-1004	Plan a Visual Flight Rules Flight	1. Determine whether the aircrew and aircraft are capable of completing the assigned mission. 2. Determine whether the flight can be performed under VFR IAW AR 93-1, applicable Federal Aviation Regulations (FARs)/host-nation regulations, local regulations, and SOPs. 3. Determine the departure, en route, and destination procedures. 4. Select route(s) and altitudes that avoid hazardous weather conditions; do not exceed aircraft or equipment limitations, and conform to VFR cruising altitudes IAW DOD FLIP. 5. For cross-country flights, determine the distance ± 1 nautical mile, true airspeed ± 5 knots, ground speed ± 5 knots, and estimated time en route (ETE) ± 1 minute for each leg of the flight. Compute magnetic heading(s) ± 5 degrees. 6. Determine the fuel required IAW AR 93-1, ± 100 pounds. 7. Complete and file the flight plan IAW AR 93-1 and DOD FLIP.		
60-ATM-1010	Prepare a Performance Planning Card	1. Compute all applicable items of the PPC using the most current software. 2. Input the appropriate information into the software. 3. Compute PPC values using accurate conditions for the time of takeoff within the following parameters: a. Free air temperature (FAT) ± 5 degrees Celsius. b. Pressure altitude (PA) $\pm 1,000$ feet. c. Gross weight ± 500 pounds. d. Engine torque factor (ETF) ± 0.03. 4. When manual calculations are required, calculate PPC values IAW the current operator's manual and IAW the instructions in appendix D (now known as TSP 011-602-IMCA and located at: FTB website.) Compute values within following parameters: a. Torque values ± 2 percent. b. Weight values ± 500 pounds. c. Fuel flow ± 100 pounds per hour. d. Airspeeds ± 5 knots. 5. Correlate planning information to determine aircraft and mission capabilities.		
60-ATM-1011	Determine Dynamic Inflight Performance	1. Verify planned performance values as required by environmental and aircraft configuration differences. 2. Update aircraft performance data when either of the following conditions apply with intent to land or takeoff:		

APPENDIX B. 7 OVERARCHING FUNCTIONS SPREADSHEET

Function	Abbreviation	Definition				
Aviate	A	The control inputs required to effectively maneuver the aircraft from takeoff to final landing in accordance with designated procedures to meet performance standards, observe operating limits and ensure safety of flight.				
REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	2.c.(3)(c)1. Effects on visibility and flight operations	052-270-9002	Analyze Weather Effects on Operations	—	—
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	2.c.(3)(c) Selects aircraft employment techniques and formations that support the tempo of the route reconnaissance and provide necessary airspace de-confliction.	171-123-1300	Conduct a Route Reconnaissance	—	—
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	2.c.(3)(d) Specifies actions to be taken upon contact with enemy forces or civilians.	—	—	—	—
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	2.c.(3) Determines tempo (rapid or deliberate) and level of covertness (discreet or forceful) of the reconnaissance effort and locations where more deliberate reconnaissance is required according to LTICD.	171-123-1313	Plan a Reconnaissance Mission	171-123-1301	Conduct an Area or Zone Reconnaissance
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team				60-ATM-1008	Perform Power Check
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team				60-ATM-1008	Perform Fuel Management
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team				60-ATM-1008	Perform Visual Meteorological Conditions Flight Measurements
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team				60-ATM-1008	Perform Visual Meteorological Conditions Approach
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team				60-ATM-1008	Perform Slope Operations
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team				60-ATM-1108	Perform Command Instrument System Procedures (A/C)
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	6.b.(1) Moves to the LO.	071-450-0050	REF1	60-ATM-1109	REF1
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	6.c.(2) Deploys in the area according to the OPORD and the mission variables of MIET-TC.	171-123-4057	REF1	—	—
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	6.c.(3) Controls movement to prevent gaps in the section's sector.	171-123-4057	REF1	—	—
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	6.c.(6) Conducts tactical movement to bypass enemy security forces in sector according to bypass criteria, if given a series of RL2s to reconnoiter.	171-123-4057	REF1	—	—
JNNA-TM-2005	Conduct MISSEVAC - CASEVAC - Aviation Team	6.b. The section returns to base.			60-ATM-2006	Perform Terrain Flight
60-ATM-1004	Plan a Visual Flight Rules Flight	1. Determine whether the aircraft and crew are capable of completing the assigned mission.				
60-ATM-1004	Plan a Visual Flight Rules Flight	2. Determine whether the flight can be performed under VFR (AW AR 95-1, applicable Federal Aviation Regulations (FARs)/host-nation regulations, local regulations, and SOPs.				

Function Abbreviation Definition

Navigate

N

The required monitoring, actions, and updating of the aircraft's altitude, course, and speed to safely transit toward the intended destination.

REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.3.(1) Obtains specific air route coordinates, including the start point, release point, and other critical points along the route.	05-CO-0410	Conduct Reconnaissance Planning	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.3.(4) Conducts terrain analysis and determines the best route.	052-274-5103	Conduct Terrain Analysis In Support of Decisive Action	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(a)_2_ Section movement plan.	05-CO-0410	Conduct Reconnaissance Planning	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(c)_1_ Effects on visibility and flight operations	052-270-3002	Analyze Weather Effects on Operations	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(2)(a) Obtains intelligence products to include terrain analysis results and intelligence collection plan/matrix.	150-MC-5112	Conduct Mission Analysis	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(2)(b) Verifies primary helicopter landing zone (HLZ) and alternate HLZ, as required.	150-MC-5112	Conduct Mission Analysis	171-610-0001	Perform a Map Reconnaissance
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(3) Plans air route, as follows:	171-123-1300	Conduct a Route Reconnaissance	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(3)(a) Identifies requirements to reconnoiter and classify the air or ground route or portions of the route.	171-123-1300	Conduct a Route Reconnaissance	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(3)(b) Identifies requirements to conduct area reconnaissance to the flanks of the route.	171-123-1300	Conduct a Route Reconnaissance	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(3)(c) Selects aircraft employment techniques and formations that support the tempo of the route reconnaissance and provide necessary airspace de-confliction.	171-123-1300	Conduct a Route Reconnaissance	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(3)(e) Identifies key terrain that will require more deliberate reconnaissance efforts.	171-123-1300	Conduct a Route Reconnaissance	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(4) Develops and refines the focus (terrain, enemy, or civil considerations along specified routes, lateral routes or adjacent terrain) of the reconnaissance effort by determining the priority of reconnaissance objectives and assigns tasks to subordinate elements.	171-123-1300	Conduct a Route Reconnaissance	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(10)(b) Confirms FARP Plan with higher and plans routes to and from its location.	052-243-9112	Coordinate Sustainment Requirements	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(10)(d) Plans and coordinates casualty evacuation.	171-123-1313	Plan a Reconnaissance Mission	07-FLT-06507	Evacuate a Casualty - Platoon
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(1) LD and subsequent phase lines (PL).	150-LDR-0020	Establish Control Measures	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(2) Boundaries for the assigned air route.	150-LDR-0020	Establish Control Measures	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(3) NAI or TAI to be observed.	150-LDR-0020	Establish Control Measures	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(4) Rally points, linkup points, contact points, release points, start points, and checkpoints.	150-LDR-0020	Establish Control Measures	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(5) AO or boundaries for subordinate elements.	150-LDR-0020	Establish Control Measures	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(6) Limit of advance (LOA).	150-LDR-0020	Establish Control Measures	—	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team				60-KTM-2046	Perform Electronically Aided Navigation
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team				60-KTM-2048	Perform Fuel Management Procedures
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team				60-KTM-2054	Select Landing Zone - Pickup Zone - Holding Area
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.3.(1) Moves to the LD.	071-450-0030	8REF1	60-KTM-1169	8REF1

Function	Abbreviation	Definition
Communicate	C	The internal, external, verbal, and non-verbal communication of the pilot's intentions, requests, or other essential information with air traffic controllers, other aircraft, other members of the crew and ground personnel during flight.

REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	1. The section gathers and maintains situational understanding using available communications equipment, maps, intelligence summaries, terrain, and weather.	JNNA-TM-2006	Conduct Resupply -	150-MC-5130	Assess the Current Situation
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.a. The section leader conducts mission analysis that focuses on the directed mission, enemy forces and their capabilities, terrain and weather	011-ACC-6030	Aviation Team	05-CO-0410	Conduct Reconnaissance Planning
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.b.(1) Obtains specific air route coordinates, including the start point, release point, and other critical points along the route.	65-CO-0430	Conduct Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.b.(2) Obtains mission line of departure (LOD) time and designate a completion time.	65-CO-0430	Conduct Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.b.(3) Updates the common operational picture, if equipped, providing current situational understanding by supplying timely and accurate	65-CO-0430	Conduct Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c. The section leader plans the air assault mission and takes the following actions:	011-ACC-6030	Conduct Troop Loading Procedures	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(1) Plans for an air assault mission by reviewing and considering the following:	65-CO-0430	Conduct Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(2)(a) Friendly force considerations, including the following:	--	--	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(2)(b) CCIR.	65-CO-0430	Conduct Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(2)(c) Enemy situation, including the following:	301-35F-1100	Evaluate the Threat	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(2)(d) Terrain and weather effects:	052-270-0002	Analyze Weather Effects on Operations	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(2)(e) Implements and integrates the higher headquarters movement and security plan, to include:	150-MC-5132	Conduct Mission Analysis	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(2)(f) Specifies actions to be taken upon contact with enemy forces or civilians.	--	--	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(3) Develops and refines the focus (terrain, enemy, or civil considerations along specified routes, tactical nodes or adjacent terrain)	171-123-5100	Conduct a Route Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(3) Determines tempo (rapid or deliberate) and level of covertness (stealthy or forceful) of the reconnaissance effort and locations where	171-123-5113	Plan a Reconnaissance	171-123-1301	Conduct an Area or Zone Reconnaissance
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(3) Establishes engagement, disengagement, and bypass criteria based on the following:	171-123-5113	Plan a Reconnaissance	JNNA-GSR-1017	Course of Action Development: Determinative Actions at Decision Points
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(3)(a) Higher headquarters order.	JNNA-LDR-5017	Course of Action Development:	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(3)(b) ROE.	JNNA-LDR-5017	Course of Action Development:	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(7) Integrates and synchronizes air and ground reconnaissance operations to include:	171-123-5113	Plan a Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(7)(a) Prioritizes and assigns tasks for subordinate elements to perform.	171-123-5113	Plan a Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(7)(b) Integrates the use of ground reconnaissance assets.	171-123-5113	Plan a Reconnaissance	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(8) Develops the fire support plan, as follows:	171-123-5113	Plan a Reconnaissance	171-620-0019	Plan Fire Support at Company Level
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(10) Plans sustainment to ensure freedom of action, sustain combat power, sustain operational reach, and protect endurance as follows:	171-123-5113	Plan a Reconnaissance	052-243-0112	Coordinate Sustainment Requirements
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(10)(a) Confirms HARP Plan with higher and plans routes to and from its location.	052-243-0112	Coordinate Sustainment	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(10)(b) Forecasts and reports estimated consumption rates of supplies to higher headquarters (HQ) according to the OPOB/MAB or	052-243-0112	Coordinate Sustainment	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(10)(c) Plans and coordinates casualty evacuation.	171-123-5113	Plan a Reconnaissance	07-PLT-09507	Evacuate a Casualty - Platoon
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.c.(10)(d) Plans and coordinates maintenance and recovery plan.	171-123-5113	Plan a Reconnaissance	551-8084-1152	Perform Preventive Maintenance Checks
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.d. The section leader identifies and plans graphic control measures needed during air route, to include the following:	011-ACC-6030	Conduct Troop Loading Procedures	150-LDR-5020	Establish Control Measures
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.e. The section leader integrates risk management throughout TLP.	011-ACC-6030	Conduct Troop Loading Procedures	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.f. Supervises subordinate TLP and continues priorities of work.	JNNA-SEC-1030	Conduct an Aerial Route	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	2.g. Issues fragmentary orders, as necessary, to address changes to the plan identified during the rehearsal	JNNA-SEC-1030	Conduct an Aerial Route	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	3. The section re-routes the route from LOD or start point to the LOA or release point as follows:	JNNA-SEC-1030	Conduct an Aerial Route	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.a. Deploys UAS and external reconnaissance assets prior to the LO, if available.	171-103-0066	Employ Unmanned Aircraft Systems (UAS)	01-PLT-7909	Conduct Unmanned Aircraft System (UAS) Flight Operations Procedures
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.b. Moves to and deploys along the LO and taking the following actions:	60-ATM-2005	REFI	60-ATM-5004	REFI
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC				60-ATM-5012	Perform Radio Communication Procedures
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC				60-ATM-5142	Perform Digital Communications
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC				60-ATM-5168	Perform Command Instrument System Procedures (A/C)
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.3.(4) Reports "set" to the commander, once subordinate leaders report they are set.	071-453-0033	REFI	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.3.(5) Coordinates movement with the supporting maneuver and air reconnaissance elements, as applicable.	071-453-0033	REFI	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.3.(6) Conducts coordination at contact points and coordinates lanes with adjacent units as terrain permits directed otherwise.	JNNA-SEC-7030	REFI	171-123-4034	REFI
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.c. The section covers the LO and conducts tactical movement in the area to be reconnoitered and takes the following actions:	JNNA-SEC-7030	REFI	171-123-4037	REFI
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.c.(1) Reports to the section leader the execution of all graphic control measures within the assigned area of responsibility.	171-123-4037	REFI	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.c.(2) Incorporates real-time information from reconnaissance and security assets into the operation.	171-123-4037	REFI	--	--
JNNA-TM-2005	Conduct MEDIVAC - CAS/EVAC	6.c.(3) Clears or conducts surveillance of assigned checkpoints and holds within the area of responsibility and reports to the section leader.	171-123-4037	REFI	60-ATM-2169	REFI

Function Abbreviation Definition

Subsystem Status 5

The monitoring and response to flight, mission, and weapon system statuses and diagnostics affecting safety of flight or mission accomplishment.

REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.b.(3) Identifies internal resources to be used in the mission effort.	05-CO-0410	Conduct Reconnaissance Planning	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(a), 3. Section load/bump plan.	05-CO-0410	Conduct Reconnaissance Planning	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(10)(a) Integrates refueling, rearming, and resupply activities into the scheme of maneuver.	052-243-0112	Coordinate Sustainment Requirements	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(10)(c) Forecasts and reports estimated consumption rates of supplies to higher headquarters (HQ) according to the OPORD/VMB or unit standard operating procedures.	052-243-0112	Coordinate Sustainment Requirements	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(10)(a) Plans and coordinates maintenance and recovery plan.	171-123-1313	Plan a Reconnaissance Mission	351-68M-1352	Perform Preventive Maintenance Checks
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	5.c. Conducts precombat checks and inspections.	JHMA-SEC-2008	Conduct an Aerial Route Reconnaissance - FARA Section	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team				60-KTM-1048	Perform Fuel Management Procedures
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team				60-KTM-1168	Perform Command Instrument System Procedures (A/L)
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	7.a. Continuously monitoring the situation to collect relevant information.	JHMA-RAS-1010	8REF1	JHMA-RAS-7022	8REF1
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.b.(1) Ground personnel rearm, refuel, and conduct post-operations maintenance on the aircraft.				Perform Refueling Operations
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.b.(2)(a) Removable Multi Media (RMM/PCMCA)			60-KTM-1134	
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.b.(2)(c) . Notes taken during flight to include grid locations, times, ammunition expenditures, and observations during flight.	60-KTM-1500	Participate in a Crew-Level After-Action Review		
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.b.(2)(d) Digital camera with any reconnaissance photos taken during flight.	60-KTM-1500	Participate in a Crew-Level After-Action Review		
60-KTM-1004	Plan a Visual Flight Rules Flight	1. Determine whether the aircraft and aircraft are capable of completing the assigned mission.				
60-KTM-1004	Plan a Visual Flight Rules Flight	6. Determine the fuel required IAW AR 95-1, 1500 pounds.				
60-KTM-1010	Performance Planning Card	1. Compute all applicable items of the PFC using the most current software.				
60-KTM-1010	Performance Planning Card	2. Input the appropriate information into the software.				
60-KTM-1010	Performance Planning Card	3. Compute PFC values using accurate conditions for the time of takeoff within the following parameters:				
60-KTM-1010	Performance Planning Card	3.a. Free air temperature (FAT) 15 degrees Celsius.				
60-KTM-1010	Performance Planning Card	3.b. Pressure altitude (PA) 11,000 feet.				
60-KTM-1010	Performance Planning Card	3.c. Gross weight 1500 pounds.				
60-KTM-1010	Performance Planning Card	3.d. Engine torque factor (ETF) 1 0.05.				
60-KTM-1010	Performance Planning Card	4. When manual calculations are required, calculate PFC values IAW the current operator's manual and IAW the instructions in appendix D (now known as TSP 013-602-IMCA and located at: PFB website.)				
60-KTM-1010	Performance Planning Card	4.a. Torque values 82 percent.				
60-KTM-1010	Performance Planning Card	4.b. Weight values 1500 pounds.				

Function	Abbreviation	Definition				
OV-1 Awareness	O	The awareness and perception supported by the available user interfaces depicting the mission, class of mission, or mission scenario information.				
REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	1. The section	JHNA-TM-2005	Conduct Resupply - Aviation Team	150-MC-5130	Assess the Current Situation
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.b.(2) Obtains	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.b.(3) Identifies	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.b.(5) Updates	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(a) 1.	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(a) 2.	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(a) 3.	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(a) 4.	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(a) 5.	05-CO-0410	Conduct Reconnaissance Planning	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(b) 3.	--	--	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(2)(b) 2.	150-MC-5112	Conduct Mission Analysis	171-610-0001	Perform a Map Reconnaissance
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(4) Develops	171-123-1300	Conduct a Route Reconnaissance	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(5) Determin	171-123-1313	Plan a Reconnaissance Mission	171-123-1301	Conduct an Area or Zone Reconnaissance
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(7)(a) 2.	171-123-1313	Plan a Reconnaissance Mission	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(7)(b) 2.	171-123-1313	Plan a Reconnaissance Mission	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(10)(a) 2.	052-243-9112	Coordinate Sustainment Requirements	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(10)(d)) Plans	171-123-1313	Plan a Reconnaissance Mission	07-PLT-D9507	Evacuate a Casualty - Platoon
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(1) LD and	150-LDR-5020	Establish Control Measures	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(2) Boundari	150-LDR-5020	Establish Control Measures	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(3) NAI or	150-LDR-5020	Establish Control Measures	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(4) Rally	150-LDR-5020	Establish Control Measures	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(5) AO or	150-LDR-5020	Establish Control Measures	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.d.(6) Limit of	150-LDR-5020	Establish Control Measures	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.a. Deploys	171-300-0066	Employ Unmanned Aircraft Systems (UAS) in a Tactical	01-PLT-7999	Conduct Unmanned Aircraft System (UAS) Flight Operations Procedures
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team				60-ATM-1054	Select Landing Zone - Pickup Zone - Holding Area
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.b.(5) Coordinat	071-450-0030	#REF!	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.b.(6) Conducts	JHNA-SEC-7000	#REF!	171-121-4034	#REF!
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.c.(4) Clears or	171-121-4057	#REF!	60-ATM-2169	#REF!
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.k.(1) Mission.	60-ATM-1054	#REF!	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.k.(2) Location.	60-ATM-1054	#REF!	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.k.(3) Security.	071-410-0010	#REF!	--	
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	7.a. Continuo	JHNA-RAS-1010	#REF!	JHNA-RAS-7022	#REF!
JHNA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	7.b. Evaluatin	JHNA-RAS-7022	#REF!	--	

Function	Abbreviation	Definition				
Weapon Engagement						
W						
Procedures supporting the identification, targeting and employment of weapon systems at designated targets.						
REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(d) 2. weapons ranges and optics.	052-270-3000	Analyze Weather Effects on Operations	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(d) Specifies actions to be taken upon contact with enemy forces or civilians.		--	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) Higher headquarters order.	JHNA-LDR-1017	Course of Action Development: Determine	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) ROE.	JHNA-LDR-1017	Course of Action Development: Determine	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(c) Size of the enemy force.	JHNA-LDR-1017	Course of Action Development: Determine	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(d) Formation or type of enemy unit.	JHNA-LDR-1017	Course of Action Development: Determine	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) Activity of enemy unit.	JHNA-LDR-1017	Course of Action Development: Determine	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(f) Location of enemy unit.	JHNA-LDR-1017	Course of Action Development: Determine	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) Provides refinement to the higher headquarters fire support plan, as follows:	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 3. Supports the scheme of maneuver by refining fire support coordination measures.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 3. Coordinates fire support to suppress enemy air defense assets and support the reconnaissance mission.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 3. Assigns priority of fires to provide responsive fires to the lead elements, if available.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) Develops the section fire support plan, as follows:	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 3. Develops fire support tasks in the task, purpose, method, and effect format.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 3. Establishes priority of fires by phase.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 3. Develops the primary and alternate observer plan.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 4. Incorporates restrictions and attack guidance from higher.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) 5. Establishes assessments and effectiveness of fires.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) Develops direct fire that focuses on long range targets, minimizes exposure, and engages the priority targets first.	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) Terrain-based fire control measures (TRPs or Quadrants).	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	2.c.(1)(h) Threat-based fire control measures (Fire Pattern or Target Array).	171-620-0019	Plan Fire Support at Company Level	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	5.c. Conducts precombat checks and inspections.	JHNA-SEC-2006	Conduct an Aerial Route Reconnaissance - FARA	--	
JHNA-TM-2005	Conduct MEDIVAC - CASEVAC - Airlift Team	6.a. Deploys UAS and external reconnaissance assets prior to the LD, if available.	171-300-0066	Employ Unmanned Aircraft Systems (UAS) in a Tactical	01-PL7-7959	Conduct Unmanned Aircraft System (UAS) Flight
60-ATM-2112	Operate Armament Subsystem	1. Install and preflight the appropriate weapon IAW the aircraft current operator's manual and the appropriate weapon technical				
60-ATM-2112	Operate Armament Subsystem	2. Load and safe the weapon.				
60-ATM-2112	Operate Armament Subsystem	3. Acquire and identify target.				
60-ATM-2112	Operate Armament Subsystem	4. Estimate range to target.				
60-ATM-2112	Operate Armament Subsystem	5. Engage target(s) IAW weapon control measures, mission briefing, and rules of engagement (ROE).				
60-ATM-2112	Operate Armament Subsystem	6. Apply appropriate firing techniques.				
60-ATM-2112	Operate Armament Subsystem	7. Suppress, neutralize, or destroy as applicable.				
60-ATM-2112	Operate Armament Subsystem	8. Describe or perform emergency procedures for misfire, hangfire, cook off, runaway gun, ruptured cartridge, and double				
60-ATM-2112	Operate Armament Subsystem	9. Clear and safe the weapon.				
60-ATM-2169	Perform Aerial Observation	2. Identify the target.				
60-ATM-2169	Perform Aerial Observation	3. Locate the position of the target.				

Function	Abbreviation	Definition
Survivability & Localized Threat Awareness	T	The capability of the aircraft and its crew to identify, avoid or withstand a hostile environment without suffering an abortive impairment of its ability to accomplish the designated mission.

REFERENCE NUMBER	REFERENCE TITLE	TASK STEP	PARENT TASK NUMBER	PARENT TASK TITLE	SUPPORTING TASK NUMBER	SUPPORTING TASK TITLE
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	1. The section gains and maintains situational understanding using available communications equipment, maps, intelligence summaries, situation reports, and other available information sources. Intelligence sources include human intelligence, signal intelligence, and imagery intelligence teams to include unmanned aircraft systems (UAS) and unattended ground sensors.	JHMA-TM-2006	Conduct Resupply - Aviation Team	150-MC-5130	Assess the Current Situation
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.b.(5) Updates the common operational picture, if equipped, providing current situational understanding by supplying timely and accurate information for intelligence preparation of the battlefield, risk management, and the planning process.	05-CO-0410	Conduct Reconnaissance Planning	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(b) ₁ Type and capabilities of likely enemy air defense weapon systems, radar, and related systems.	301-35F-1103	Evaluate the Threat	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(b) ₂ Enemy courses of action including situation templates depicting composition, known and templated dispositions, and kill zones.	301-35F-1103	Evaluate the Threat	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(b) ₃ Locations of communications networks.	—	—	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(c) ₁ Effects on visibility and flight operations	052-270-3002	Analyze Weather Effects on Operations	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(1)(c) ₃ Effects on assets for reconnaissance, transport, resupply, and casualty evacuation.	052-270-3002	Analyze Weather Effects on Operations	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(2)(a) Obtain intelligence products to include terrain analysis results and intelligence collection plan/matrix.	150-MC-5112	Conduct Mission Analysis	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(3)(d) Specifies actions to be taken upon contact with enemy forces or civilians.	—	—	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(5) Determines tempo (rapid or deliberate) and level of covertness (stealthy or forceful) of the reconnaissance effort and locations where more deliberate reconnaissance is required according to LTICV.	171-123-1313	Plan a Reconnaissance Mission	171-123-1301	Conduct an Area or Zone Reconnaissance
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(5)(c) Size of the enemy force.	JHMA-LDR-1017	Course of Action Development; Determine Actions at Decision Points	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(5)(d) Formation or type of enemy unit.	JHMA-LDR-1017	Course of Action Development; Determine Actions at Decision Points	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(5)(e) Activity of enemy unit.	JHMA-LDR-1017	Course of Action Development; Determine Actions at Decision Points	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	2.c.(5)(f) Location of enemy unit.	JHMA-LDR-1017	Course of Action Development; Determine Actions at Decision Points	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.c.(3) Incorporates real-time information from reconnaissance and security assets into the operation.	171-123-4037	8REF1	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.c.(4) Clears or conducts surveillance of assigned checkpoints and NAs within the area of responsibility and reports to the section leader.	171-123-4037	8REF1	60-ATM-2369	8REF1
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.c.(5) Conducts tactical movement to bypass enemy security forces in sector according to bypass criteria, if given a series of HJTs to reconnoiter.	171-123-4037	8REF1	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	6.k.(3) Security. The force required to provide security during the assault.	071-400-0050	8REF1	—	—
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	7.a. Continuously monitoring the situation to collect relevant information.	JHMA-RAS-1010	8REF1	JHMA-RAS-7022	8REF1
JHMA-TM-2005	Conduct MEDEVAC - CASEVAC - Aviation Team	8.b.(2)(c) . Notes taken during flight to include grid locations, times, ammunition expenditures, and observations during flight.	60-ATM-1500	Participate in a Crew-Level After-Action Review	—	—
60-ATM-1006	Plan a Visual Flight Rules Flight	4. Select route(s) and altitudes that avoid hazardous weather conditions; do not exceed aircraft or equipment limitations, and conform to VFR cruising altitudes IAW DOD FUP.	—	—	—	—

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APPENDIX C. MEDEVAC COPILOT TAILORED OTA

UID	Overarching Function	Task (HQDA 2017)	Phase III - SA Requirements Analysis (Interactions)			
			Situational Awareness Information	Required Action	Feedback	Potential Errors
14	N, C	Obtains specific air route coordinates, including the start point, release point, and other critical points along the route.	Radio call	Listen to radio call and copy info onto kneeboard	Confirm information with sender	Incorrect translation
15	Q, C	Obtains mission line of departure (LD) time and designate a completion time.	Radio call	Listen to radio call and copy info onto kneeboard	Confirm information with sender	Incorrect translation
17	N	Conducts terrain analysis and determines the best route.	Terrain Information OV-11 Information	Analyze terrain	Plotted route	Incorrect analysis of the terrain information
18	Q, C, T	Updates the common operational picture, if equipped, providing current situational understanding by supplying timely and accurate information for intelligence preparation of the battlefield, risk management, and the planning process.	Mission Status	Communicates the mission status	Confirmation of receipt	Delayed or incorrect communication
100	O, C, W	Deploys UAS and external reconnaissance assets prior to the LD, if available.	OV-1 Information Location Wind Speed/Direction	Check the mission status and the atmospheric conditions and deploy the UAV's	Deployed UAV's	Receipt of bad information Misinterpretation of the information
103	C	Perform Radio Communication Procedures	Available communication configuration	Determine the correct radio to communicate and follow procedures to communicate	Successful communication	Utilizing the wrong radio
104	N	Perform Electronically Aided Navigation	Heading Maps Altitude Waypoints Planned Route Information Progress	Input mission parameters into the navigation suite for the pilot to follow	Arriving at the correct location	Misinterpreting the navigation outputs Inputting the wrong information
105	A, N, S	Perform Fuel Management Procedures	Fuel Information Fuel Distribution (Aux. Tanks)	Check the status of the fuel levels and redistribute as necessary	Fuel management system indicates any changes in fuel levels	Misinterpreting the fuel levels Incorrectly redistributing the fuel
110	C	Perform Digital Communications	Available communication configuration	Determine the correct radio to communicate and follow procedures to communicate	Successful communication	Utilizing the wrong radio
115	C	Reports "set" to the commander, once subordinate leaders report they are set.	Communication from subordinate leaders	Listen for notification from subordinate leaders and forward the notification to the commander	Receipt confirmation	Misunderstood receipt of communication Incorrect relay of information
116	C, O	Coordinates movement with the supporting maneuver and air reconnaissance elements, as applicable.	OV-1 Information Location Planned Route Information	Relays current and planned route information to the maneuver and air reconnaissance elements as applicable	Receipt confirmation	Misinterpreted navigation information Incorrect communication of navigation information
117	C, O	Conducts coordination at contact points and coordinates lanes with adjacent units on flanks unless directed otherwise.	OV-1 Information Location Planned Route Information	Relays current and planned route information to the maneuver and air reconnaissance elements as applicable	Receipt confirmation	Misinterpreted navigation information Incorrect communication of navigation information
121	C, T	Incorporates real-time information from reconnaissance and security assets into the operation.	OV-11 Information Communication from Recon/Security Assets	Communicates with the reconnaissance and security assets and relays real-time information or updates the system accordingly	Receipt confirmation	Misinterpreted security and reconnaissance information Incorrect communication of security and reconnaissance information
122	C, O, T	Clears or conducts surveillance of assigned checkpoints and NAI's within the area of responsibility and reports to the section leader.	Notification of arrival at checkpoints and NAI's within the area of responsibility	Clears or conducts surveillance of assigned checkpoints and NAI's within the area of responsibility and reports to the section leader.	Receipt confirmation	Conducts surveillance in the wrong area Relays incorrect information
130	C, O, T, S	Continuously monitoring the situation to collect relevant information.	Visual Observations Audible Atmospheric Conditions	Various Actions dependent on provided information	Various depending on provided information	Misunderstanding of situation
131	O	Evaluating progress toward attaining end state conditions, achieving objectives, and performing tasks, as necessary.	OV-1 Information	Study OV-1 and mission information and monitor progress toward completing objective. Notify pilot of progress.	Pilot acknowledgement	Mixed objective Mixed task
132	C, O	Directing adjustments to ensure that operations remain aligned with the higher headquarters commander's intent.	Radio call	Inform crew of received information	Adjustment to operation	Misunderstanding of received information
133	C, O	Receiving updates on the location and status of all subordinate elements to include attachments.	Radio call Radial indication	Flight adjustment to deconflict flight paths	Coordination with other aircraft/crew	Miscommunication with other aircraft/crew
135	C, O	The section receives logistics via a FARP and crew management dependent, reports ready to receive follow-on orders.	Receipt of logistics	Request of Follow-on orders	Acknowledged follow-on orders, Various depending on provided information	Misunderstanding of received information
168	C, S	Verify planned performance values as required by environmental and aircraft configuration differences.	Logged configurations	Copy information on knee board for verification	Comparison with documented planned values	Documentation of incorrect values
170	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff: Increase of 3,000 pounds of MAX ALLOWABLE GWT OGE.	Calculated Weight	Update to aircraft performance data	Recalculated aircraft performance data	Incorrect weight calculation
171	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff: Increase of 1,000 feet pressure altitude from the PPC.	Calculated pressure altitude	Update to aircraft performance data	Recalculated aircraft performance data	Incorrect pressure altitude calculation
172	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff: Increase of 5 degrees Celsius from the PPC.	Observed temperature	Update to aircraft performance data	Recalculated aircraft performance data	Incorrect temperature calculation

UID	Overarching Function	Task (HQDA 2017)	Phase III - SA Requirements Analysis (Interactions)			
			Situational Awareness Information	Required Action	Feedback	Potential Errors
174	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers Q for the following items Maximum torque available.	Calculated torque	Update to aircraft performance data	Recalculated aircraft performance data	Incorrect torque available calculation
175	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers Q for the following items Maximum allowable gross weight OGE.	Calculated weight	Update to aircraft performance data	Recalculated aircraft performance data	Incorrect weight calculation
176	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers Q for the following items Torque required to hover at maximum gross weight OGE and IGE.	Calculated weight	Update to aircraft performance data	Recalculated aircraft performance data	Incorrect calculation
177	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers Q for the following items Aircraft gross weight.	Calculated weight	Update to aircraft performance data	Recalculated aircraft performance data	Incorrect weight calculation
179	C, S, A	When not utilizing automated software determine values within following parameters Torque values ± 2 percent.	Calculated Torque	Copy information on knee board	Recalculated Torque Values	Incorrect calculation
180	C, S, A	When not utilizing automated software determine values within following parameters Weight values ± 500 pounds.	Calculated Weight	Copy information on knee board	Recalculated weight values	Incorrect calculation
181	C, S, A	Verify that CG and gross weight remain within aircraft limits for the duration of the flight IAW the aircraft current operator's manual.	Calculated CG Calculated Weight	Copy information on knee board	Confirmation that limits are not exceeded	Incorrect calculation
182	C, S, A	Identify all mission or flight limitations imposed by weight or CG.	Calculated CG Calculated Weight	Identification on known limitations	Flight operation readjustment for known limitations	Unknown limitations
184	C, O	Configure and operate the approved mission planning software.	Calculated CG Calculated Weight	Confirm SW Version is approved	Update SW if not approved	Incorrect transcription of SW version number
185	C, O	Evaluate and enter all pertinent weather data, as appropriate.	Radio Call Radar Indication Weather Observations	Copy information on knee board	Flight operation readjustment for known conditions	Abrupt weather changes
186	C, N, O	Select and enter appropriate primary and alternate routes.	Receipt of new mission routes	Input the new route into the navigation suite	New routes would be loaded and displayed	Incorrect coordinates entered
187	C, N, O	Select and enter appropriate tactical/terrain flight mission planning control features.	Terrain Information	Analyze terrain	Plotted Route	Incorrect Analysis of terrain information
188	C, O	Select and enter appropriate communication data.	Radio Call	Input communication frequency	Test communication	Incorrect communication frequency
189	C, O	Load mission data to data transfer device, if applicable.	Mission Flight Computer	Upload data to transfer device	Data transferred to device	Not all data is transferred to device
193	S	Ensure that the passengers/cargo is restrained.	Turbulence Receipt of Payload	Request verbal confirmation that restraints are secured	Confirmation that Passengers/cargo restrained	Restraints insufficient or defective
194	S, A	Ensure that floor loading limits are not exceeded.	Payload change in the aircraft	Compute weights	UNK	Incorrect weight calculation
211	C, N, S, T, A	Announce any unplanned drift or altitude changes, clear the aircraft, and immediately inform other crewmembers of all air traffic or obstacles that pose a threat to the aircraft.	Drift Altitude Changes	Announce observation of drift or altitude change	Crew acknowledgement and pilot correction	- Change unnoticed - Pilot misses announcement
212	C, A	Announce when attention is focused inside the aircraft using a time limit that is appropriate for the conditions and announce when attention is focused back outside.	Visual attention required inside the aircraft	Verbally communicate eyes inside	Crew acknowledgement	- Copilot distracted to inside without announcing - Pilot misses announcement
213	C, T	Maintain airspace surveillance in assigned scan sectors.	Agreed upon scan sectors known	Visually scan required sector	UNK	Copilot scans outside of assigned sector
214	A, S, C	Determine whether aircraft weight exceeds maximum gross weight.	Current gross weight	Adjust/reduce weight for landing	UNK	Incorrect computation of gross weight
215	A, S, C	Verify aircraft gross weight.	Calculated Weight	Calculate gross weight	UNK	Incorrect computation of gross weight
216	A, S, C	Determine sufficient power is available to perform the mission.	Power Available	Calculate power needs & compare with available	Sluggish aircraft response	Required power under calculated
218	C, S, A	Program, check, and operate aircraft avionics.	Avionics Systems Understanding	Complete checklist items	Proper or improper avionics system indications	- Missed checklist step - Incorrect input into system
219	C	Establish radio contact with the desired unit or air traffic control (ATC) facility. When communicating with ATC facilities, use correct radio communication procedures and phraseology IAW the DOD FUP and Department of Transportation/Federal Aviation Administration (DOT/FAA) 7110.65.	Requirement to Contact New ATC Facility	Perform proper radio call to ATC	Response call from ATC	- Improper use of brevity - Incorrect frequency
220	C	Operate intercommunication system.	Message to pass to aircrew	Toggle intercom and transmit message	Acknowledgement by aircrew	- Switch not fully depressed - Transmission stepped on by radio comm

UID	Overarching Function	Task (HQDA 2017)	Phase III - SA Requirements Analysis (Interactions)			
			Situational Awareness Information	Required Action	Feedback	Potential Errors
221	C, S	Perform two-way radio failure procedures IAW the OOD FLIP or host-nation regulations.	Transmission inhibited by radio failure	Follow FLIP or Host-Nation procedure	UNK	Missed procedural step
225	N	Operate the installed electronically aided navigational system IAW the current TM.	Mission objective location	Input route and navigation parameters into Nav suite	Route and data displayed on Multi-Functional Display	Incorrect coordinate, route or other parameter entered
226	N, O	Determine the position of the aircraft along the route of flight within 300 meters.	Maintenance of course	Locate aircraft position by global positioning system (GPS) or inertial navigation system (INS)	Aircraft symbol offset from route on multi-functional display	- Improper route input into Flight Management System - Failure to update the INS
227	N, S	MCConfigure the FD/ODP and MFD for desired processed data.	Planned Route information	Input data manually or using PCMCIA card	Proper route displayed on MFD	Corrupt data on card Input incorrect data manually
229	S	Verify that the required amount of fuel is onboard at the time of takeoff.	Mission Flight Distance Duration Requirement	View fuel quantity on ECAS and calculate fuel required	Fuel Low Caution illuminates on ECAS	Insufficient fuel calculated for mission
230	C, N, O, S, A	Initiate an alternate course of action if the actual fuel consumption varies from the planned value and the flight cannot be completed without the planned use of the required reserve.	Fuel Information	Initiate early return to base (RTB) or divert location	UNK	Improper fuel calculation for mission
231	S, A	Balance/manage fuel tank levels to maintain aircraft within CG limits.	CG Information	Operate ENG FUEL SYS selector to equalize fuel levels	Fuel tanks approach proper level balance	Burn from improper tank increasing imbalance
233	C, S	Initiate an in-flight fuel consumption check within 10 minutes of leveling off or within 10 minutes of entering into the mission profile.	Fuel Information Time	Check that actual fuel consumption matches planned	Fuel levels on ECAS match projected levels	- Fuel planned incorrectly - Levels observed premature before tanks properly leveled
234	S	Within 15 to 30 minutes after taking the initial readings, compute the fuel consumption rate ±50 pounds per hour and complete the fuel consumption check.	Fuel Information Time	Check that actual fuel consumption matches planned	Fuel levels on ECAS match projected levels	- Fuel planned incorrectly - Aircraft climb or descent screw tank levels
235	S	Monitor the remaining fuel quantity and the continuing rate of consumption.	Fuel Information	Periodically view fuel quantity on ECAS and calculate fuel consumption	Fuel consumption/levels consistent with plan and sufficient for mission	Consumption rate miscalculation
240	O, N, T, A	Perform map, photo, or visual reconnaissance.	Maps Photo Available VFR Conditions	Survey map, photo or actual landscape if visible through aircraft windows	UNK	- Poor quality map or photo - Poor visibility outside aircraft
241	O, N, T	Determine that the IZ, PZ, or holding area is suitable for operations and provide accurate and detailed information to supported unit (if applicable).	Visual Observations	Observe IZ, PZ or Holding Area visually, determine suitability for landing, pickup or holding, and relay information to unit over radio	Supporting unit acknowledges receipt and understanding of information	- Missed obstacle to aircraft or supporting unit - Inadequate information passed to unit
242	A, N, S	(For power or fuel landings), Establish altitude, airspeed, and flight path for conducting a high reconnaissance commensurate with terrain and environmental conditions.	Observed high or difficult terrain in reconnaissance area	Assist pilot with determination of proper flight path altitude and airspeed calculations to conduct a power or fuel landing	Pilot agreement with plan	- Group think - Miscalculation of required parameters to execute landing
243	A, N, O	Determine approximate wind direction and velocity at touchdown point and identify other pertinent wind characteristics in proximity to IZ.	Radio Call Weather Radar Data Data passed from Ground Unit Visual Observations	Utilize available sensors or communications to determine wind parameters at planned landing zone	Aircraft instability outside of anticipated parameters during landing	- Variability of wind not observed due to short visual - Radio transmissions incorrectly copied
244	O, T, A	Assess the LZ size, axis, surface conditions, and obstacles.	Maps Photo Available Visual Observations	Use cockpit or visual cues to confirm wind predictions, verify the suitability of the landing point, confirm that the escape routes identified are viable, confirm the altitude of the landing point, and verify environmental conditions are the same as those selected in the tabular data.	Provide information / conclusion of LZ conditions *Increase situational awareness of the pilot to land (?)	Miscalculate size, axis, surface conditions and obstacle
245	O, C, N	Plan ingress and egress routes to include escape routes required above and below ETL.	Maps Photo Available Visual Observations	Use cockpit or visual cues to confirm wind predictions, verify the suitability of the landing point, confirm that the escape routes identified are viable, confirm the altitude of the landing point, and verify environmental conditions are the same as those selected in the tabular data.	Provide information / conclusion of LZ conditions *Increase situational awareness of the pilot to land (?)	Miscalculate routes
246	C, N, A	Confirm the winds and tentative plan formulated in the high reconnaissance by performing a thorough low reconnaissance.	Maps Photo Available Visual Observations	Use cockpit or visual cues to confirm wind predictions, verify the suitability of the landing point, confirm that the escape routes identified are viable, confirm the altitude of the landing point, and verify environmental conditions are the same as those selected in the tabular data.	Provide information / conclusion of LZ conditions *Increase situational awareness of the pilot to land (?)	Fail to confirm information
247	N, C	Select a suitable landing area (analyze suitability, barriers, wind, approach path, touchdown point, and takeoff direction).	Maps Photo Available Visual Observations	Use cockpit or visual cues to confirm wind predictions, verify the suitability of the landing point, confirm that the escape routes identified are viable, confirm the altitude of the landing point, and verify environmental conditions are the same as those selected in the tabular data.	Provide information / conclusion of LZ conditions *Increase situational awareness of the pilot to land (?)	Fail to identify an obstacle
248	S	Ensure that sufficient power exists for the type of approach/landing desired.	VMC conditions with the landing area reconnaissance complete	Calculate the power available and communicate with the pilot	Acknowledgement of receipt	Miscalculation
254	A, S	Monitor wind conditions using cockpit indicators (OI).	Atmospheric Conditions	Use Cockpit indicators to monitor wind conditions, techniques for evaluating wind conditions are found in TC 3-06.4	Confirm the suitability of the area	Misevaluate wind conditions Fail to inform if conditions are not as predicted
255	A, C, S	Determine wind direction and velocity at the landing point.	Atmospheric Conditions	Verify whether conditions (surface, wind, and temperature/pressure altitude) are the same as they predicted during the reconnaissance.	Confirm the suitability of the area	Misevaluate whether conditions Fail to inform if conditions are not as predicted
268	S	Verify that the required amount of fuel is onboard at the time of each takeoff.	Fuel Information	Monitor the main fuel quantity indicators and the auxiliary fuel management panel to ensure that the system is operating normally. Operate the fuel management system panel in the AUTO or MANUAL mode, as required.	Cockpit display will indicate the required amount of fuel (ECAS Display)	Misread fuel tank levels Fail to calculate Fuels moments
269	C, N, O, S, A	Initiate an alternate course of action if the actual fuel consumption varies from the planned value and the flight cannot be completed with the required reserve.	Fuel Information Maps	*Monitor the helicopter fuel gauge system to ensure that the system is operating normally. *Operate the fuel management system panel in the AUTO or MANUAL mode, as required. *Balance/manage fuel tank levels *Identify an alternate course of action	Communicate alternate course of action Balance fuel consumption to complete flight with the required reserve	Fail to initiate alternate course of action in a timely manner
271	S	Verify that the aircraft will remain within weight and CG limitations for the duration of the flight.	CG Information	Check cockpit display (ECAS) and calculate weight and CG will remain within limits	Cockpit display will indicate Weight is less than 24,500 lbs (ECAS Display)	miscalculate CG limits miscalculate weight
272	S, A	Recognize and respond to ERFS malfunctions.	ERFS Operation Status	*Communicate ERFS malfunctioned *Perform emergency procedures IAW operator's manual	Receive positive/negative response that information is acknowledge *Emergency procedures are performed	Fail to recognize/respond to ERFS malfunction properly

UID	Overarching Function	Task (HQDA 2017)	Phase III - SA Requirements Analysis (Interactions)			
			Situational Awareness Information	Required Action	Feedback	Potential Errors
273	C, S, A	Perform or describe appropriate emergency procedures IAW the aircraft current operator's manual/CCL	Emergency, Warning, Caution or Advisory Indication	*Communicate emergency procedures	Receive positive/negative response that information is acknowledged *Emergency procedures are performed	*Fail to perform/describe appropriate emergency procedure *Fail to transmit information
278	A, S, C	Conduct the Emergency Response Method (fly, alert, diagnose, execute, communicate-fly (FADEC-F)) upon recognition of an emergency	Emergency, Warning, Caution or Advisory Indication	*Respond to the emergency *Perform as directed or briefed	Safely land aircraft	Fail to follow checklist (deviation)
280	S, C	Identify the emergency condition or system malfunction.	Emergency, Warning, Caution or Advisory Indication	Use the cockpit indicators to determine the emergency condition or system malfunction	Safely land aircraft	Fail to identify the emergency conditions and system malfunction properly
281	A, C	Conduct the emergency procedures.	Emergency, Warning, Caution or Advisory Indication	*Respond to the emergency by accomplishing underlined steps from memory (when time doesn't allow the use of a checklist or situation is hazardous) *Perform as directed or briefed	Safely land aircraft	Fail to remember underlined steps (checklist)
290	S, C	Transmit, receive, review, and delete messages and mission information as required.	Mission Information messages	Operate the system and announce when focused inside Operate system (J-VMF, EDM, and BFT) IAW the current technical manual	Confirmation of receipt (Acknowledged)	Fail to operate system IAW Technical Manual Fail to notice incoming message
291	N, S	Tune and identify appropriate navigational aids (NAVAIDs).	Navigation Aid Configuration	Before using a selected NAV AID for navigation, tune and identify the NAV AID Select and announce radio frequencies	Navigation system/instrumentation will provide vector information	Fail to select/announce correct radio frequencies Fail to select correct NAV AIDs
296	S, N	Configure the HSI/VSU mode select panels and CIS to obtain the desired navigational data and commands.	Command Instrument System Procedures (A/L) Receipt of mission task	Configure the CIS MODE SEL panel and, if required, the HSI/VSU MODE SEL panel, as required IAW the aircraft current operator's manual	Appropriate indication on MFD	Fail to configure system IAW operator's manual
299	N, S	Program the FMS for the desired flight plan.	Flight Plan	Access EGI navigation screen in the cockpit panel	Flight plan will be displayed	Input incorrect information
300	N, S	Select the desired display on the MFD.	Current MFD Page MFD Page Navigation Information	Monitor the flight instruments and the FD/DCP selected mode annunciator lights and will immediately advise the Pilot of any abnormal indications or changes in selected modes	Desired display exhibited	Fail to navigate to correct page Press incorrect button during navigation to correct page (fat fingering)
301	N, S	Select the appropriate modes on the FD/DCP.	Command from Pilot	Select mode on FD/DCP	Acknowledgement of selected mode	Incorrect mode selected
305	C, S	Time and track holding pattern legs.	Holding Instructions Appropriate DoD FUP	compute outbound times and headings to adjust for wind and direct the Pilot to adjust the pattern as necessary	holding pattern depicted on MFD	Miscalculation of timing
306	C	Send the appropriate report to ATC IAW DOD FLIP.	Entry into new holding area	Contact ATC via radio and pass report	ATC acknowledgment of receipt	Required information missing from report
321	A, S	Analyze aircraft altitude.	Altitude	Document Altitude on knee board	Communication with pilot to change or hold altitude	Miscalculation of altitude
335	C, A, N	Contact ATC, as required. Comply with ATC instructions, local regulations, and SOP.	Inadvertent Instrument Meteorological Conditions (IMC) Initiation of initial IMC Recovery Procedures	Contact ATC over radio and pass IMC status	ATC acknowledgment of receipt and passing of instructions	Radio communication failure
341	N, S	Operate bezel keys on the MFD to select desired map (TAC/ND) configuration and orientation.	MFD Page Navigation Information	Turn bezel key	TAC/ND Map configuration/orientation selected	Incorrect selection of map (TAC/ND) configuration and orientation
342	N, S, O	Operate the multi-function slow controller (MFSC) or the collective cursor slow controller to gain desired information and to manipulate desired mission data on the digital map display.	Digital Map display required to display alternative information	Utilize MFSC or collective cursor or slow controller to select proper mission data	Digital Map displays proper data	Incorrect Movement of MFSC or collective cursor slow controller
360	C, S	Test and operate aircraft avionics and voice security equipment IAW the aircraft current operator's manual.	Communication Options	Comply with proper emission control (EMCON) procedures when using comms and avionics	Validate Functional operation	Radio transmission failure or interference Transmission outside appropriate EMCON level Fail to follow the signal operating instructions (SOI)
362	C	Maintain radio discipline.	Radio call	Adherence to radio protocol	Confirmation of message receipt	Radio transmission failure or interference
365	C, S, O, T	Operate Mark XII identification, friend or foe (IFF) system.	Mission requirement to broadcast IFF	Select and broadcast proper IFF based on mission requirement Operate the IFF per the tactical situation	Alert from ATC or other controller	Broadcasting incorrect code Incorrect code loaded during preflight Fail to properly identify friend or foe
367	C	To save time, minimize confusion, and ensure completeness, report information in an established format. Assemble the report in the correct format and transmit it to the appropriate agency. Standard formats may be found in the SOI or other sources.	Situation warrants submission of a TACREP (sufficient information to compile a tactical report)	Generate and transmit TACREP to appropriate agency over radio	Report correctly formatted is transmitted to appropriate agency and acknowledged	Incorrect format used which results in ineffective communication of events / actions
368	N	During NOE flight (surface to 25 feet above highest obstacle (AHO)), know the en route location within 200 meters.	Position Information Maps	Calculate information on knee board and notify pilot if outside of parameters Furnish the pilot with the information required to remain on course	Acknowledgement from pilot (if req)	Miscalculation Fail to know enroute location within required distance
369	N	During contour flight (25 to 80 feet AHO) or low-level flight (80 to 200 AHO), know the en route location within 500 meters.	Position Information Maps	Calculate information on knee board and notify pilot if outside of parameters Furnish the pilot with the information required to remain on course	Acknowledgement from pilot (if req)	Miscalculation Fail to know enroute location within required distance
370	N	Locate each objective within 100 meters.	Position Information Maps	Document position on knee board Furnish the pilot with the information required to remain on course	Calculate difference between desired vs. actual position	Miscalculation Fail to locate objective within distance required
379	S, T	Evaluate any damage to aircraft.	Damage Indication	Evaluate aircraft for visual damage and risk assessed associated with damage	Visible damage, indication on instruments, or system/subsystem failure	-Alert does not engage to indicate damage -False alarm indicating damage when no damage damage not visible to cockpit
380	A, C, N, S, T	Recommend or execute a course of action.	Damage Indication	Determine course of action based on risk assessment of damage is recommended or executed and notify pilot over interphone	Pilot acknowledges receipt of COA recommendation	Does not recommend / execute COA -Pilot does not hear or acknowledge

UID	Overarching Function	Task (HQDA 2017)	Phase III - SA Requirements Analysis (Interactions)			
			Situational Awareness Information	Required Action	Feedback	Potential Errors
382	C	Transmit tactical report IAW signal operating instructions (SQI), unit SOP, and/or mission briefing.	Need for a tactical report received	Transmit tactical report	Report transmitted	- Report does not transmit - Report is delayed in transmission - P/P* does not follow SQI, SOP, or mission briefing req't
385	N	Determine Hoisting location.	Receive request for hoist via comms	Evaluate terrain and select proper hoist location	Hoist location selected	Obstacle at location was not identified
386	S, A	Determine appropriate Hoisting Method (Static or Dynamic).	Condition of Patient/personnel requiring hoist operation	Select static or dynamic hoisting method to suit location / patient(s) condition	Crew agreement w/ hoist method	Incorrect hoisting method selected
387	C, S, A	Perform Hoist Operations IAW the Army Aviation Rescue Hoist SOP.	Patient/personnel requiring hoist operation	Direct crew in hoist operations	Crew acknowledge and performance	SOP not used
388	C	Utilize crew coordination terminology IAW the Army Aviation Rescue Hoist SOP and chapter 8 of this ATM.	Patient/personnel requiring hoist operation	Crew coordination terminology used in order to clearly communicate usage of hoist	Use proper crew coordination terminology	- Terminology is not used - Hoist operation process is unclear with crew
389	C, S, A	Respond to Rescue Hoist Emergencies (if necessary).	Receive request for rescue hoist via comms	Determine location, hoisting method, perform emergency operations, use crew coordination terminology	Emergency rescue hoist operations are performed	Request not received
396	C, S	Confirm aircraft is at appropriate hover height location.	Audio Indication Visual Observations	Confirm aircraft performance - enter onto kneeboard	Verbal hover height confirmation	Hover height not confirmed
397	C, S	Monitor Hoist operations IAW the Army Aviation Rescue Hoist SOP.	Visual Observations	Monitor hoist operation to ensure proper usage IAW SOP	Verbal communication of hoist operation tasks	Hoist used improperly
410	C	Conduct a thorough crew and passenger safety briefing.	Patient/personnel upload	Brief crew / passenger(s) on safety procedures / processes		
433	A, C	Ensure maximum airspeed with caving ladder deployed is 80 KIAS with personnel attached to the ladder and no faster than a brisk walk with no personnel attached.	Aircraft Configuration Aircraft Speed	Monitor airspeed gauges to ensure airspeed is 80 KIAS w/ personnel attached to ladder Airspeed is no faster than brisk walk w/out personnel attached	Verbal notification of airspeed(s)	Airspeeds are not monitored Airspeed(s) are exceeded
443	C	Conduct a thorough crew and passenger briefing.	Patient/personnel	Brief crew/passenger(s)	Verbal confirmation / acknowledgement of briefing	Brief not conducted - crew/passengers unaware of procedures
447	C	Identify and tune the appropriate frequency.	Radio Configuration	Appropriate radio frequency is identified and tuned in order to receive requests for pickup / landing zone / holding area, and any other auditory information	Comms are received without feedback	Frequencies are not adjusted Comms / requests are not received
448	C	Establish contact with the message sender.	Radio Call	Establish contact w/ sender to verify / confirm received information	Verbally acknowledge contact w/ sender	Sender not contacted
449	C	Authenticate, if required.	Radio Call	Authenticate w/ sender to verify identity and information received	Verbally acknowledge and authenticate sender's identity	- Authentication not performed - Identity of sender not verified - Potential danger to mission / crew
450	C	Establish contact with the message receiver.	Radio Call	Contact w/ message receiver	Confirmation of message delivery	Message did not transmit to receiver
451	C, S	Configure the aircraft radios for radio relay.	Radio Configuration	Configure radio for proper usage and relay of messages / information	Physically configuration and verbal notification to crew when up	- Radio not configured - Messages/info not relayed - Potential risk to life / mission
465	T, A	Use visual search techniques.	Visual Observations	Visual search techniques engaged in order to search and rescue POI	Communicate verbally location of found POI using search techniques	- POI location is overlooked
468	C, T	Transmit tactical report.	Condition for tactical report to be transmitted	Physically transmit tactical report to appropriate levels	Physically transmit tactical report and verbally notify crew of transmission	- tactical report not transmitted - SA unknown by command ; potential risk
480	C	Announce if visual contact is lost with other aircraft.	Visual observations	Copilot announces when visual contact is lost with other aircraft	Verbal notification of loss of visual of aircraft	- No notification - Potential mission risk/failure

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APPENDIX D. MEDEVAC COPILOT SA INFORMATION AND TASK RELATIONSHIPS

SA Info UID	SA Information	Task UID
1	Radio call	14, 15, 132, 185, 188, 243, 362, 448, 449, 450
2	Radio Configuration	447, 451
3	Terrain Information	17, 187
4	OV-1 Information	17, 100, 116, 117, 121, 131
5	Mission Status	18
6	Patient/personnel	443
7	Location	100, 116, 117
8	Wind Speed/Direction	100
9	Available communication configuration	103, 110
10	Heading	104
11	Maps	104, 240, 244, 245, 246, 247, 269, 368, 369, 370
12	Altitude	104, 321
13	Waypoints	104
14	Planned Route Information	104, 116, 117, 227
15	Progress	104
16	Fuel Information	105, 230, 233, 234, 235, 268, 269
17	Fuel Distribution (Aux. Tanks)	105
18	Communication from subordinate leaders	115
19	Initiation of Initial IIMC Recovery Procedures	335
20	Photo Available	240, 244, 245, 246, 247
21	Communication from Recon/Security Assets	121
22	Notification of arrival at checkpoints and NAIs within the area of responsibility	122
23	Visual Observations	130, 241, 243, 244, 245, 246, 247, 396, 397, 465, 480
24	Audible	130
25	Atmospheric Conditions	130, 254, 255
26	Radar Indication	133, 185
27	Receipt of logistics	135
28	Logged configurations	168
29	Calculated Weight	170, 175, 176, 177, 180, 181, 182, 215
30	Calculated pressure altitude	171
31	Observed temperature	172
32	Calculated torque	174, 179
33	Calculated CG	181, 182
34	Software Version Number	184
35	Weather Observations	185
36	Receipt of new mission routes	186
37	Mission Flight Computer	189
38	Turbulence	193
39	Receipt of Payload	193
40	Payload change in the aircraft	194
41	Drift	211
42	Altitude Changes	211
43	Visual attention required inside the aircraft	212
44	Agreed upon scan sectors known	213
45	Current gross weight	214

SA Info UID	SA Information	Task UID
46	Power Available	216
47	Avionics Systems Understanding	218
48	Requirement to Contact New ATC Facility	219
49	Message to pass to aircrew	220
50	Transmission inhibited by radio failure	221
51	Mission objective location	225
52	Maintenance of course	226
53	Mission flight distance	229
54	Duration Requirement	229
55	CG Information	231, 271
56	Time	233, 234
57	VFR Conditions	240
58	Observed high or difficult terrain in reconnaissance area	242
59	Weather Radar Data	243
60	Data Passed from Ground Unit	243
61	VMC conditions with the landing area reconnaissance complete	248
62	ERFS Operation Status	272
63	Emergency, Warning, Caution or Advisory Indication	273, 278, 280, 281
64	Mission information messages	290
65	Navigation Aid Configuration	291
66	Command Instrument System Procedures (A/L)	296
67	Receipt of Mission Task	296
68	Flight Plan	299
69	Current MFD Page	300
70	MFD Page Navigation Information	300, 341
71	Command from Pilot	301
72	Holding instructions	305
73	Appropriate Department of Defense Flight Information Publication (DOD FLIP)	305
74	Entry into new holding area	306
75	Inadvertent Instrument Meteorological Conditions (IIMC)	335
76	Digital Map display required to display alternative information	342
77	Communication Options	360
78	Mission requirement to broadcast IFF	365
79	Situation warrants submission of a TACREP (sufficient information to compile a tactical report)	367
80	Position Information	368, 369, 370
81	Damage Indication	379, 380
82	Need for a tactical report received	382
83	Receive request for hoist via comms	385
84	Condition of Patient/personnel requiring hoist operation	386
85	Patient/personnel requiring hoist operation	387, 388
86	Receive request for rescue hoist via comms	389
87	Audio Indication	396
88	Aircraft Configuration	433
89	Aircraft Speed	433
90	Condition for tactical report to be transmitted	468
91	Patient/Personnel Upload	410

APPENDIX E. REQUIREMENTS ANALYSIS

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
14	N, C	Obtains specific air route coordinates, including the start point, release point, and other critical points along the route.	Level 1	- Data not available - Misperception of data - Incomplete Mental Model	Sound (Receiver)
15	O, C	Obtains mission line of departure (LD) time and designate a completion time.	Level 1	- Data not available - Misperception of data - Incorrect Mental Model	Sound (Receiver)
17	N	Conducts terrain analysis and determines the best route.	Level 2	- Failure to monitor/observe data - Data not available - Incorrect Mental Model	Visual Sound (Sender)
18	O, C, T	Updates the common operational picture, if equipped, providing current situational understanding by supplying timely and accurate information for intelligence preparation of the battlefield, risk management, and the planning process.	Level 2	- Misperception of data - Incorrect Mental Model	Sound (Sender)
100	O, C, W	Deploys UAS and external reconnaissance assets prior to the LD, if available.	Level 3	- Data not available - Incomplete Mental Model	Visual Sound (Sender) Sound (Receiver)
103	C	Perform Radio Communication Procedures	Level 2	- Data not available - Memory loss - Incorrect Mental Model	Sound (Sender) Sound (Receiver)
104	N	Perform Electronically Aided Navigation	Level 2	- Misperception of data - Data not available - Memory loss - Incomplete Mental Model	Visual
105	A, N, S	Perform Fuel Management Procedures	Level 2	- Memory loss - Misperception of data - Incorrect Mental Model	Sound (Sender) Visual
110	C	Perform Digital Communications	Level 2	- Memory loss - Data not available - Misperception of data - Incorrect Mental Model	Sound (Sender) Sound (Receiver) Visual
115	C	Reports "set" to the commander, once subordinate leaders report they are set.	Level 2	- Memory loss	Sound (Sender) Sound (Receiver)
116	C, O	Coordinates movement with the supporting maneuver and air reconnaissance elements, as applicable.	Level 3	- Memory loss - Incomplete/Poor mental model	Sound (Sender) Visual
117	C, O	Conducts coordination at contact points and coordinates lanes with adjacent units on flanks unless directed otherwise.	Level 3	- Misperception of data - Incomplete/Poor Mental Model	Sound (Sender) Visual
121	C, T	Incorporates real-time information from reconnaissance and security assets into the operation.	Level 2	- Incorrect mental model	Sound (Sender) Sound (Receiver)

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
122	C, O, T	Clears or conducts surveillance of assigned checkpoints and NALs within the area of responsibility and reports to the section leader.	Level 2	- Data hard to detect - Misperception of data - Over-reliance on default values	Sound (Sender) Sound (Receiver) Visual
130	C, O, T, S	Continuously monitoring the situation to collect relevant information.	Level 2	- Data not available - Misperception of data - Incomplete Mental Model	Sound (Sender) Sound (Receiver) Visual
131	O	Evaluating progress toward attaining end state conditions, achieving objectives, and performing tasks, as necessary.	Level 3	- Over-projection of current trends	Visual
132	C, O	Directing adjustments to ensure that operations remain aligned with the higher headquarters commander's intent.	Level 3	- Over-projection of current trends	Sound (Sender) Sound (Receiver)
133	C, O	Receiving updates on the location and status of all subordinate elements to include attachments.	Level 2	- Misperception of data - Incorrect Mental Model	Sound (Sender) Sound (Receiver) Visual
135	C, O	The section receives logistics via a FARP and crew management dependent, reports ready to receive follow-on orders.	Level 3	- Incomplete/poor mental model	Sound (Sender) Sound (Receiver)
168	C, S	Verify planned performance values as required by environmental and aircraft configuration differences.	Level 3	- Over-projection of current trends	Visual
170	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff When operating within 3,000 pounds of MAX ALLOWABLE GWT OGE.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
171	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff Increase of 1,000 feet pressure altitude from the PPC.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
172	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff Increase of 5 degrees Celsius from the PPC.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
174	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Maximum torque available.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
175	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Maximum allowable gross weight OGE.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
176	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Torque required to hover at maximum gross weight OGE and IGE.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
177	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Aircraft gross weight.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
179	C, S, A	When not utilizing automated software determine values within following parameters Torque values ± 2 percent.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incomplete Mental Model	Visual

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
180	C, S, A	When not utilizing automated software determine values within following parameters Weight values ± 500 pounds.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Incomplete Mental Model	Visual
181	C, S, A	Verify that CG and gross weight remain within aircraft limits for the duration of the flight IAW the aircraft current operator's manual.	Level 3	- Incomplete/poor mental model	Visual
182	C, S, A	Identify all mission or flight limitations imposed by weight or CG.	Level 3	- Over-projection of current trends	Visual Sound (Sender)
184	C, O	Configure and operate the approved mission planning software.	Level 2	- Memory loss - Incomplete mental model	Visual Sound (Sender)
185	C, O	Evaluate and enter all pertinent weather data, as appropriate.	Level 3	- Memory loss - Data not available - Failure to monitor/observe data - Misperception of data - Incomplete Mental Model	Sound (Sender) Sound (Receiver) Visual
186	C, N, O	Select and enter appropriate primary and alternate routes.	Level 3	- Data not available - Misperception of data - Incomplete/poor Mental Model	Sound (Sender) Sound (Receiver) Visual
187	C, N, O	Select and enter appropriate tactical/terrain flight mission planning control features.	Level 3	- Data not available - Misperception of data - Incomplete/poor Mental Model	Visual
188	C, O	Select and enter appropriate communication data.	Level 3	- Data not available - Misperception of data - Incomplete/poor Mental Model	Sound (Sender) Sound (Receiver)
189	C, O	Load mission data to data transfer device, if applicable.	Level 2	- Memory loss - Data not available - Failure to monitor/observe data - Misperception of data - Incomplete Mental Model	Visual
193	S	Ensure that the passengers/cargo is restrained.	Level 2	- Memory loss - Failure to monitor/observe data - Misperception of data - Over-reliance on default values	Visual Sound (Sender) Sound (Receiver)
194	S, A	Ensure that floor loading limits are not exceeded.	Level 3	- Failure to monitor/observe data - Over-projection of current trends	Visual
211	C, N, S, T, A	Announce any unplanned drift or altitude changes, clear the aircraft, and immediately inform other crewmembers of all air traffic or obstacles that pose a threat to the aircraft.	Level 3	- Failure to monitor/observe data - Over-projection of current trends	Visual Sound (Sender) Sound (Receiver)
212	C, A	Announce when attention is focused inside the aircraft using a time limit that is appropriate for the conditions and announce when attention is focused back outside.	Level 3	- Failure to monitor/observe data - Over-projection of current trends	Visual Sound (Sender) Sound (Receiver)
213	C, T	Maintain airspace surveillance in assigned scan sectors.	Level 3	- Failure to monitor/observe data - Over-projection of current trends	Visual
214	A, S, C	Determine whether aircraft weight exceeds maximum gross weight.	Level 3	- Failure to monitor/observe data - Over-projection of current trends	Visual

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
215	A, S, C	Verify aircraft gross weight.	Level 2	- Failure to monitor/observe data - Incorrect Mental Model	Visual
216	A, S, C	Determine sufficient power is available to perform the mission.	Level 3	- Failure to monitor/observe data - Misperception of data - Incorrect Mental Model	Visual
218	C, S, A	Program, check, and operate aircraft avionics.	Level 3	- Memory Loss - Incomplete/poor mental model	Visual
219	C	Establish radio contact with the desired unit or air traffic control (ATC) facility. When communicating with ATC facilities, use correct radio communication procedures and phraseology IAW the DOD FLIP and Department of Transportation/Federal Aviation Administration (DOT/FAA) 7110.65.	Level 3	- Memory Loss - Incomplete/poor mental model	Sound (Sender) Sound (Receiver)
220	C	Operate intercommunication system.	Level 2	- Memory Loss - Incomplete Mental model	Sound (Sender) Sound (Receiver)
221	C, S	Perform two-way radio failure procedures IAW the DOD FLIP or host-nation regulations.	Level 3	- Memory Loss - Incomplete/poor Mental model	Sound (Sender) Sound (Receiver)
225	N	Operate the installed electronically aided navigational system IAW the current TM.	Level 2	- Memory Loss - Incomplete Mental model	Visual
226	N, O	Determine the position of the aircraft along the route of flight within 300 meters.	Level 3	- Data hard to detect - Misperception of data - Incorrect Mental Model - Over-projection of current trends	Visual
227	N, S	M Configure the FD/DCP and MFD for desired processed data.	Level 3	- Over-projection of current trends	Visual
229	S	Verify that the required amount of fuel is onboard at the time of takeoff.	Level 3	- Over-projection of current trends	Visual
230	C, N, O, S, A	Initiate an alternate course of action if the actual fuel consumption varies from the planned value and the flight cannot be completed without the planned use of the required reserve.	Level 3	- Incomplete/poor mental model	Visual Sound (Sender)
231	S, A	Balance/manage fuel tank levels to maintain aircraft within CG limits.	Level 3	- Incomplete/poor mental model	Visual
233	C, S	Initiate an in-flight fuel consumption check within 10 minutes of leveling off or within 10 minutes of entering into the mission profile.	Level 2	- Memory Loss - Over-reliance of default values	Visual
234	S	Within 15 to 30 minutes after taking the initial readings, compute the fuel consumption rate ± 50 pounds per hour and complete the fuel consumption check.	Level 3	- Memory Loss - Over-reliance of default values - Over-projection of current trends	Visual
235	S	Monitor the remaining fuel quantity and the continuing rate of consumption.	Level 1	- Failure to monitor/observe data - Misperception of data	Visual

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
240	O, N, T, A	Perform map, photo, or visual reconnaissance.	Level 2	- Data hard to detect - Failure to monitor/observe data - Misperception of data - Incomplete mental model	Visual
241	O, N, T	Determine that the LZ, PZ, or holding area is suitable for operations and provide accurate and detailed information to supported unit (if applicable).	Level 3	- Misperception of data - Incomplete/poor mental model	Visual
242	A, N, S	(For power critical landings), Establish altitude, airspeed, and flight path for conducting a high reconnaissance commensurate with terrain and environmental conditions.	Level 2	- Memory loss - Over-reliance of default values	Visual Sound (Sender) Sound (Receiver)
243	A, N, O	Determine approximate wind direction and velocity at touchdown point and identify other pertinent wind characteristics in proximity to LZ.	Level 3	- Memory loss - Over-reliance of default values - Over-projection of current trends	Sound (Sender) Sound (Receiver) Visual
244	O, T, A	Assess the LZ size, axis, surface conditions, and obstacles.	Level 2	- Data not available - Failure to monitor/observe data - Misperception of data - Incomplete mental model	Visual Sound (Sender)
245	O, C, N	Plan ingress and egress routes to include escape routes required above and below ETL.	Level 3	- Memory loss - Incomplete/poor mental model	Visual Sound (Sender)
246	C, N, A	Confirm the winds and tentative plan formulated in the high reconnaissance by performing a thorough low reconnaissance.	Level 3	- Memory loss - Incomplete/poor mental model	Visual Sound (Sender)
247	N, C	Select a suitable landing area (analyze suitability, barriers, wind, approach path, touchdown point, and takeoff direction).	Level 3	- Data not available - Misperception of data - Incomplete/poor Mental Model	Visual Sound (Sender)
248	S	Ensure that sufficient power exists for the type of approach/landing desired.	Level 3	- Data not available - Failure to monitor/observe data - Misperception of data - Incomplete/poor mental model	Visual Sound (Sender)
254	A, S	Monitor wind conditions using cockpit indicators (CI).	Level 1	- Data not available - Data hard to detect - Failure to monitor/observe data	Visual Sound (Sender)
255	A, C, S	Determine wind direction and velocity at the landing point.	Level 2	- Misperception of data - Incomplete mental model	Visual Sound (Sender)
268	S	Verify that the required amount of fuel is onboard at the time of each take off.	Level 3	- Failure to monitor/observe data - Misperception of data - Incomplete/poor mental model	Visual
269	C, N, O, S, A	Initiate an alternate course of action if the actual fuel consumption varies from the planned value and the flight cannot be completed with the required reserve.	Level 3	- Memory Loss - Incomplete/poor mental model	Visual Sound (Sender)
271	S	Verify that the aircraft will remain within weight and CG limitations for the duration of the flight.	Level 3	- Incomplete/poor mental model	Visual
272	S, A	Recognize and respond to ERFS malfunctions.	Level 2	- Memory Loss - Misperception of data - Incorrect mental model	Visual Sound (Sender) Sound (Receiver)

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
273	C, S, A	Perform or describe appropriate emergency procedures IAW the aircraft current operator's manual/CL.	Level 2	- Memory Loss - Incorrect mental model	Sound (Sender) Sound (Receiver)
278	A, S, C	Conduct the Emergency Response Method (fly, alert, diagnose, execute, communicate-fly [FADEC-F]) upon recognition of an emergency	Level 2	- Memory Loss - Incorrect mental model	Sound (Sender) Sound (Receiver)
280	S, C	Identify the emergency condition or system malfunction.	Level 2	- Memory Loss - Incorrect mental model	Sound (Sender) Sound (Receiver) Visual
281	A, C	Conduct the emergency procedure.	Level 2	- Memory Loss - Incorrect mental model	Sound (Sender) Sound (Receiver)
290	S, C	Transmit, receive, review, and delete messages and mission information as required.	Level 2	- Memory Loss - Incomplete mental model	Sound (Sender) Sound (Receiver) Visual
291	N, S	Tune and identify appropriate navigational aids (NAVAIDS).	Level 3	- Memory Loss - Incomplete/poor mental model	Sound (Sender) Sound (Receiver) Visual
296	S, N	Configure the HSI/VSI mode select panels and CIS to obtain the desired navigational data and commands.	Level 2	- Incorrect mental model	Sound (Sender) Sound (Receiver) Visual
299	N, S	Program the FMS for the desired flight plan.	Level 2	- Incorrect mental model	Visual
300	N, S	Select the desired display on the MFD.	Level 1	- Memory loss	Visual Sound (Sender)
301	N, S	Select the appropriate modes on the FD/DCP.	Level 1	- Memory loss	Visual Sound (Receiver)
305	C, S	Time and track holding pattern legs.	Level 1	- Memory loss	Visual Sound (Sender)
306	C	Send the appropriate report to ATC IAW DOD FLIP.	Level 2	- Memory loss - Incorrect mental model	Sound (Sender) Sound (Receiver)
321	A, S	Analyze aircraft attitude.	Level 2	- Data not available - Incomplete mental model	Visual
335	C, A, N	Contact ATC, as required. Comply with ATC instructions, local regulations, and SOP.	Level 2	- Memory Loss - Incorrect mental model	Sound (Sender) Sound (Receiver)
341	N, S	Operate bezel keys on the MFD to select desired map (TAC/ND) configuration and orientation.	Level 2	- Incomplete mental model	Visual

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
342	N, S, O	Operate the multifunction slew controller (MFSC) or the collective cursor slew controller to gain desired information and to manipulate desired mission data on the digital map display.	Level 2	- Failure to monitor/observe data - Misperception of data - Incomplete mental model	Visual
360	C, S	Test and operate aircraft avionics and voice security equipment IAW the aircraft current operator's manual.	Level 2	- Incomplete mental model	Sound (Sender) Sound (Receiver) Visual
362	C	Maintain radio discipline.	Level 1	- Memory loss	Sound (Sender) Sound (Receiver)
365	C, S, O, T	Operate Mark XII identification, friend or foe (IFF) system.	Level 1	- Memory loss	Visual Sound (Sender)
367	C	To save time, minimize confusion, and ensure completeness, report information in an established format. Assemble the report in the correct format and transmit it to the appropriate agency. Standard formats may be found in the SOI or other sources.	Level 1	- Memory loss	Sound (Sender) Sound (Receiver)
368	N	During NOE flight (surface to 25 feet above highest obstacle [AHO]), know the en route location within 200 meters.	Level 3	- Incomplete/poor mental model	Visual Sound (Sender)
369	N	During contour flight (25 to 80 feet AHO) or low-level flight (80 to 200 AHO), know the en route location within 500 meters.	Level 3	- Incomplete/poor mental model	Visual Sound (Sender)
370	N	Locate each objective within 100 meters.	Level 3	- Incomplete/poor mental model	Visual
379	S, T	Evaluate any damage to aircraft.	Level 2	- Data not available - Misperception of data - Incorrect mental model	Visual
380	A, C, N, S, T	Recommend or execute a course of action.	Level 3	- Misperception of data - Incomplete/poor mental model	Sound (Sender) Sound (Receiver) Visual
382	C	Transmit tactical report IAW signal operating instructions (SOI), unit SOP, and or mission briefing.	Level 2	- Memory Loss - Incorrect mental model	Sound (Sender) Sound (Receiver)
385	N	Determine Hoisting location.	Level 2	- Data not available - Incorrect mental model	Sound (Sender) Sound (Receiver) Visual
386	S, A	Determine appropriate Hoisting Method (Static or Dynamic).	Level 2	- Memory loss - Failure to monitor/observe data - Incorrect mental model	Visual Sound (Sender) Sound (Receiver)
387	C, S, A	Perform Hoist Operations IAW the Army Aviation Rescue Hoist SOP.	Level 2	- Memory loss - Misperception of data - Incorrect mental model	Sound (Sender) Sound (Receiver)
388	C	Utilize crew coordination terminology IAW the Army Aviation Rescue Hoist SOP and chapter 8 of this ATM.	Level 1	- Memory loss	Sound (Sender) Sound (Receiver)

UID	Overarching Function	Task (HQDA 2017)	Phase IV - SA Requirement Analysis (Engineering Development)		
			SA Level	Potential Human Errors Caused By Low SA (Endsley 1995)	Observation Techniques
389	C, S, A	Respond to Rescue Hoist Emergencies (if necessary).	Level 3	- Incomplete/poor mental model	Sound (Sender) Sound (Receiver)
396	C, S	Confirm aircraft is at appropriate hover height location.	Level 2	- Data not available - Data hard to detect - Misperception of data - Incorrect mental model	Sound (Sender) Sound (Receiver) Visual
397	C, S	Monitor Hoist operations IAW the Army Aviation Rescue Hoist SOP.	Level 1	- Misperception of data - Memory loss	Visual
410	C	Conduct a thorough crew and passenger safety briefing.	Level 2	- Incorrect mental model	Sound (Sender) Sound (Receiver)
433	A, C	Ensure maximum airspeed with caving ladder deployed is 80 KIAS with personnel attached to the ladder and no faster than a brisk walk with no personnel attached.	Level 2	- Data not available - Failure to monitor/observe data - Misperception of data - Incorrect mental model	Visual Sound (Sender)
443	C	Conduct a thorough crew and passenger briefing.	Level 2	- Incorrect mental model	Sound (Sender) Sound (Receiver)
447	C	Identify and tune the appropriate frequency.	Level 2	- Data not available - Data hard to detect - Failure to monitor/observe data - Misperception of data - Incomplete mental model	Sound (Sender) Sound (Receiver)
448	C	Establish contact with the message sender.	Level 1	- Memory Loss	Sound (Sender) Sound (Receiver)
449	C	Authenticate, if required.	Level 2	- Memory Loss - Data not available - Incorrect mental model	Sound (Sender) Sound (Receiver)
450	C	Establish contact with the message receiver.	Level 1	- Memory Loss	Sound (Sender) Sound (Receiver)
451	C, S	Configure the aircraft radios for radio relay.	Level 2	- Over-reliance on default values	Sound (Sender) Sound (Receiver)
465	T, A	Use visual search techniques.	Level 2	- Over-reliance on default values	Visual
468	C, T	Transmit tactical report.	Level 1	- Memory Loss	Sound (Sender) Sound (Receiver)
480	C	Announce if visual contact is lost with other aircraft.	Level 1	- Memory Loss	Sound (Sender) Sound (Receiver) Visual

APPENDIX F. FUNCTION TO FORM ANALYSIS

UID	Overarching Function	Task (HQDA 2017)	Phase V - Function to Form Diagram	
			SA System	Action System
14	N, C	Obtains specific air route coordinates, including the start point, release point, and other critical points along the route.	AN/ARC-231 via Headset/Helmet	Kneeboard/Tablet Radio Trigger Switch Headset/Helmet
15	O, C	Obtains mission line of departure (LD) time and designate a completion time.	AN/ARC-231 via Headset/Helmet	Kneeboard/Tablet Radio Trigger Switch Headset/Helmet
17	N	Conducts terrain analysis and determines the best route.	Kneeboard/Tablet	Kneeboard/Tablet
18	O, C, T	Updates the common operational picture, if equipped, providing current situational understanding by supplying timely and accurate information for intelligence preparation of the battlefield, risk management, and the planning process.	Kneeboard/Tablet	Intercommunications (ICS) Panel ICS/RADIO Trigger Switch Headset/Helmet
100	O, C, W	Deploys UAS and external reconnaissance assets prior to the LD, if available.	Kneeboard/Tablet Flight Management System (FMS) Blue Force Tracker (BFT) via Multi-Functional Display (MFD)	WX-500 Stormscope via Multi-Functional Display (MFD) Eyes Outside Unmanned Aerial Vehicle (UAV) & Controls
103	C	Perform Radio Communication Procedures	Intercommunications (ICS) Panel	Intercommunications (ICS) Panel Radio Trigger Switch Headset/Helmet
104	N	Perform Electronically Aided Navigation	Flight Management System (FMS) Multi-Functional Display (MFD)	Flight Management System (FMS)
105	A, N, S	Perform Fuel Management Procedures	Multi-Functional Display (MFD)	EICIS Display via Multi-Functional Display (MFD) Engine Fuel System Selector Lever (as needed)
110	C	Perform Digital Communications	Intercommunications (ICS) Panel	Intercommunications (ICS) Panel Radio Trigger Switch Headset/Helmet
115	C	Reports "set" to the commander, once subordinate leaders report they are set.	AN/ARC-231 via Headset/Helmet	ICS Trigger Switch Headset/Helmet
116	C, O	Coordinates movement with the supporting maneuver and air reconnaissance elements, as applicable.	Blue Force Tracker (BFT) via Multifunctional Display (MFD) AN/ARC-231 via Headset/Helmet Tablet / Kneeboard Multifunctional Display (MFD)	Radio Trigger Switch Headset/Helmet
117	C, O	Conducts coordination at contact points and coordinates lanes with adjacent units on flanks unless directed otherwise.	Blue Force Tracker (BFT) via Multifunctional Display (MFD) AN/ARC-231 via Headset/Helmet Tablet / Kneeboard Multifunctional Display (MFD)	Radio Trigger Switch Headset/Helmet
121	C, T	Incorporates real-time information from reconnaissance and security assets into the operation.	Blue Force Tracker (BFT) via Multifunctional Display (MFD) AN/ARC-231 via Headset/Helmet Tablet / Kneeboard	Radio Trigger Switch Headset/Helmet
122	C, O, T	Clears or conducts surveillance of assigned checkpoints and NAIs within the area of responsibility and reports to the section leader.	AN/ARC-231 via Headset/Helmet	Eyes Outside Radio Trigger Switch Headset/Helmet
130	C, O, T, S	Continuously monitoring the situation to collect relevant information.	Eyes Outside AN/ARC-231 via Headset/Helmet WX-500 Stormscope via Multi-Functional Display (MFD)	Intercommunications (ICS) Panel ICS/Radio Trigger Switch Headset/Helmet
131	O	Evaluating progress toward attaining end state conditions, achieving objectives, and performing tasks, as necessary.	Blue Force Tracker (BFT) via Multifunctional Display (MFD) Tablet / Kneeboard	Blue Force Tracker (BFT) via Multifunctional Display (MFD) Tablet / Kneeboard ICS Trigger Switch Headset/Helmet
132	C, O	Directing adjustments to ensure that operations remain aligned with the higher headquarters commander's intent.	AN/ARC-231 via Headset/Helmet	ICS Trigger Switch Headset/Helmet
133	C, O	Receiving updates on the location and status of all subordinate elements to include attachments.	AN/ARC-231 via Headset/Helmet Blue Force Tracker (BFT) via Multifunctional Display (MFD)	ICS Trigger Switch Headset/Helmet

UID	Overarching Function	Task (HQDA 2017)	Phase V - Function to Form Diagram	
			SA System	Action System
135	C, O	The section receives logistics via a FARP and crew management dependent, reports ready to receive follow-on orders.	AN/ARC-231 via Headset/Helmet	Radio Trigger Switch Headset/Helmet
168	C, S	Verify planned performance values as required by environmental and aircraft configuration differences.	Multi-Functional Display (MFD) Kneeboard/Tablet	WX-500 Stormscope via Multi-Functional Display (MFD)
170	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff When operating within 3,000 pounds of MAX ALLOWABLE GWT OGE.	DD Form 365-4 (Form F) Operator's Manual	Operator's Manual Charts/Figures Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop
171	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff Increase of 1,000 feet pressure altitude from the PPC.	Altimeter	Operator's Manual Charts/Figures Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop
172	C, S	Update aircraft performance data when either of the following conditions apply with intent to land or takeoff Increase of 5 degrees Celsius from the PPC.	Performance Planning Card (PPC) via Flight Management System (FMS)	Operator's Manual Charts/Figures Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop
174	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Maximum torque available.	Operator's Manual Checklist	Operator's Manual Charts/Figures Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop
175	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Maximum allowable gross weight OGE.	DD Form 365-4 (Form F) Operator's Manual Checklist	Operator's Manual Charts/Figures Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop
176	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Torque required to hover at maximum gross weight OGE and IGE.	DD Form 365-4 (Form F) Operator's Manual Checklist	Operator's Manual Charts/Figures Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop
177	C, S	Update aircraft performance data using automated planning software or data found in the operator's and crewmembers CL for the following items Aircraft gross weight.	DD Form 365-4 (Form F) Operator's Manual Checklist	Operator's Manual Charts/Figures Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop
179	C, S, A	When not utilizing automated software determine values within following parameters Torque values ± 2 percent.	Operator's Manual Checklist	Kneeboard/Tablet
180	C, S, A	When not utilizing automated software determine values within following parameters Weight values ± 500 pounds.	DD Form 365-4 (Form F) Operator's Manual	Kneeboard/Tablet
181	C, S, A	Verify that CG and gross weight remain within aircraft limits for the duration of the flight IAW the aircraft current operator's manual.	Operator's Manual	Kneeboard/Tablet
182	C, S, A	Identify all mission or flight limitations imposed by weight or CG.	Operator's Manual	ICS Trigger Switch Headset/Helmet
184	C, O	Configure and operate the approved mission planning software.	Portable Flight Planning Software (PFPS) via Laptop	Flight Crew Information File (FCIF) Portable Flight Planning Software (PFPS) via Laptop
185	C, O	Evaluate and enter all pertinent weather data, as appropriate.	Eyes Outside AN/ARC-231 via Headset/Helmet WX-500 Stormscope via Multi-Functional Display (MFD)	Kneeboard/Tablet
186	C, N, O	Select and enter appropriate primary and alternate routes.	AN/ARC-231 via Headset/Helmet	Flight Management System (FMS)
187	C, N, O	Select and enter appropriate tactical/terrain flight mission planning control features.	Portable Flight Planning Software (PFPS) via Laptop	Portable Flight Planning Software (PFPS) via Laptop
188	C, O	Select and enter appropriate communication data.	AN/ARC-231 via Headset/Helmet	AN/ARC-231 via Flight Management System (FMS)
189	C, O	Load mission data to data transfer device, if applicable.	Portable Flight Planning Software (PFPS) via Laptop	PCMCIA Card Flight Management System (FMS)
193	S	Ensure that the passengers/cargo is restrained.	Physical Equilibrium Intercommunication via Headset/Helmet	ICS Trigger Switch Headset/Helmet

UID	Overarching Function	Task (HQDA 2017)	Phase V - Function to Form Diagram	
			SA System	Action System
194	S, A	Ensure that floor loading limits are not exceeded.	Intercommunication via Headset/Helmet	DD Form 365-4 (Form F) Operator's Manual
211	C, N, S, T, A	Announce any unplanned drift or altitude changes, clear the aircraft, and immediately inform other crewmembers of all air traffic or obstacles that pose a threat to the aircraft.	Heads Up Display (HUD) Altimeter Multi-Functional Display (MFD)	ICS Trigger Switch Headset/Helmet
212	C, A	Announce when attention is focused inside the aircraft using a time limit that is appropriate for the conditions and announce when attention is focused back outside.	Any/All Internal Systems	ICS Trigger Switch Headset/Helmet
213	C, T	Maintain airspace surveillance in assigned scan sectors.	Multi-Functional Display (MFD)	Eyes Outside
214	A, S, C	Determine whether aircraft weight exceeds maximum gross weight.	DD Form 365-4 (Form F) Operator's Manual	Engine Fuel System Selector Lever (as needed)
215	A, S, C	Verify aircraft gross weight.	DD Form 365-4 (Form F) Operator's Manual	DD Form 365-4 (Form F) Operator's Manual
216	A, S, C	Determine sufficient power is available to perform the mission.	Performance Planning Card (PPC) via Flight Management System (FMS)	Operator's Manual Charts/Figures
218	C, S, A	Program, check, and operate aircraft avionics.	Operator's Manual	Checklist
219	C	Establish radio contact with the desired unit or air traffic control (ATC) facility. When communicating with ATC facilities, use correct radio communication procedures and phraseology IAW the DOD FUP and Department of Transportation/Federal Aviation Administration (DOT/FAA) 7110.65.	AN/ARC-231 via Headset/Helmet	Radio Trigger Switch Headset/Helmet
220	C	Operate intercommunication system.	Any/All Internal Systems Eyes Outside	ICS Trigger Switch Headset/Helmet
221	C, S	Perform two-way radio failure procedures IAW the DOD FUP or host-nation regulations.	AN/ARC-231 via Headset/Helmet	Flight Information Publication (FIP)
225	N	Operate the installed electronically aided navigational system IAW the current TM.	Embedded Global Positioning/Inertial Navigation (EGI) via Flight Management System (FMS)	Flight Management System (FMS) Multi-Functional Display (MFD)
226	N, O	Determine the position of the aircraft along the route of flight within 300 meters.	Flight Management System (FMS) Multi-Functional Display (MFD)	Embedded Global Positioning/Inertial Navigation (EGI) via Flight Management System (FMS)
227	N, S	M Configure the FD/DCP and MFD for desired processed data.	Flight Management System (FMS) Multi-Functional Display (MFD)	Flight Management System (FMS) Multi-Functional Display (MFD) PCMCIA Card (as needed)
229	S	Verify that the required amount of fuel is onboard at the time of takeoff.	EICAS Display via Multi-Functional Display (MFD) Tablet / Kneeboard	Tablet / Kneeboard
230	C, N, O, S, A	Initiate an alternate course of action if the actual fuel consumption varies from the planned value and the flight cannot be completed without the planned use of the required reserve.	EICAS Display via Multi-Functional Display (MFD) Tablet / Kneeboard	ICS/RADIO Trigger Switch Headset/Helmet
231	S, A	Balance/manage fuel tank levels to maintain aircraft within CG limits.	DD Form 365-4 (Form F) Operator's Manual EICAS Display via Multi-Functional Display (MFD)	EICAS Display via Multi-Functional Display (MFD) Engine Fuel System Selector Lever (as needed)
233	C, S	Initiate an in-flight fuel consumption check within 10 minutes of leveling off or within 10 minutes of entering into the mission profile.	EICAS Display via Multi-Functional Display (MFD) Digital Clock	Tablet / Kneeboard
234	S	Within 15 to 30 minutes after taking the initial readings, compute the fuel consumption rate ± 50 pounds per hour and complete the fuel consumption check.	EICAS Display via Multi-Functional Display (MFD) Digital Clock	Tablet / Kneeboard
235	S	Monitor the remaining fuel quantity and the continuing rate of consumption.	EICAS Display via Multi-Functional Display (MFD)	EICAS Display via Multi-Functional Display (MFD)

UID	Overarching Function	Task (HQDA 2017)	Phase V - Function to Form Diagram	
			SA System	Action System
240	O, N, T, A	Perform map, photo, or visual reconnaissance.	Tablet / Kneeboard Eyes Outside	Tablet / Kneeboard Eyes Outside
241	O, N, T	Determine that the LZ, PZ, or holding area is suitable for operations and provide accurate and detailed information to supported unit (if applicable).	Multi-Functional Display (MFD) Tablet / Kneeboard Eyes Outside	Eyes Outside Radio Trigger Switch Headset/Helmet
242	A, N, S	(For power critical landings), Establish altitude, airspeed, and flight path for conducting a high reconnaissance commensurate with terrain and environmental conditions.	WX-500 Stormscope via Multi-Functional Display (MFD) Eyes Outside	Eyes Outside Operator's Manual Charts/Figures ICS Trigger Switch Headset/Helmet
243	A, N, O	Determine approximate wind direction and velocity at touchdown point and identify other pertinent wind characteristics in proximity to LZ.	WX-500 Stormscope via Multi-Functional Display (MFD) Eyes Outside AN/ARC-231 via Headset/Helmet	WX-500 Stormscope via Multi-Functional Display (MFD) Eyes Outside Radio Trigger Switch Headset/Helmet
244	O, T, A	Assess the LZ size, axis, surface conditions, and obstacles.	Tablet / Kneeboard Eyes Outside	Eyes Outside Operator's Manual Charts/Figures
245	O, C, N	Plan ingress and egress routes to include escape routes required above and below ETL.	Tablet / Kneeboard Eyes Outside	Eyes Outside Operator's Manual Charts/Figures
246	C, N, A	Confirm the winds and tentative plan formulated in the high reconnaissance by performing a thorough low reconnaissance.	Tablet / Kneeboard Eyes Outside	Eyes Outside Operator's Manual Charts/Figures
247	N, C	Select a suitable landing area (analyze suitability, barriers, wind, approach path, touchdown point, and takeoff direction).	Tablet / Kneeboard Eyes Outside	Eyes Outside Operator's Manual Charts/Figures
248	S	Ensure that sufficient power exists for the type of approach/landing desired.	Eyes Outside	Operator's Manual Charts/Figures ICS Trigger Switch Headset/Helmet
254	A, S	Monitor wind conditions using cockpit indicators (CI).	Multi-Functional Display (MFD)	Multi-Functional Display (MFD)
255	A, C, S	Determine wind direction and velocity at the landing point.	Multi-Functional Display (MFD) AN/ARC-231 via Headset/Helmet	Multi-Functional Display (MFD) Tablet / Kneeboard Radio Trigger Switch Headset/Helmet
268	S	Verify that the required amount of fuel is onboard at the time of each takeoff.	EICAS Display via Multi-Functional Display (MFD)	EICAS Display via Multi-Functional Display (MFD) Tablet / Kneeboard
269	C, N, O, S, A	Initiate an alternate course of action if the actual fuel consumption varies from the planned value and the flight cannot be completed with the required reserve.	EICAS Display via Multi-Functional Display (MFD)	EICAS Display via Multi-Functional Display (MFD) Tablet / Kneeboard ICS Trigger Switch Headset/Helmet
271	S	Verify that the aircraft will remain within weight and CG limitations for the duration of the flight.	DD Form 365-4 (Form F) Operator's Manual EICAS Display via Multi-Functional Display (MFD)	DD Form 365-4 (Form F) Operator's Manual EICAS Display via Multi-Functional Display (MFD)
272	S, A	Recognize and respond to ERFs malfunctions.	Extended Range Fuel System (ERFS)	Operator's Manual ICS Trigger Switch Headset/Helmet

UID	Overarching Function	Task (HQDA 2017)	Phase V - Function to Form Diagram	
			SA System	Action System
273	C, S, A	Perform or describe appropriate emergency procedures IAW the aircraft current operator's manual/CL.	HH-60 Emergency Indicator Lights & Sounds	Operator's Manual Checklist ICS/Radio Trigger Switch Headset/Helmet
278	A, S, C	Conduct the Emergency Response Method (fly, alert, diagnose, execute, communicate-fly [FADEC-F]) upon recognition of an emergency	HH-60 Emergency Indicator Lights & Sounds	Operator's Manual Checklist ICS/Radio Trigger Switch Headset/Helmet
280	S, C	Identify the emergency condition or system malfunction.	HH-60 Emergency Indicator Lights & Sounds	Operator's Manual Checklist ICS/Radio Trigger Switch Headset/Helmet
281	A, C	Conduct the emergency procedure.	HH-60 Emergency Indicator Lights & Sounds	Operator's Manual Checklist ICS/Radio Trigger Switch Headset/Helmet
290	S, C	Transmit, receive, review, and delete messages and mission information as required.	Blue Force Tracker (BFT) via Multifunctional Display (MFD)	Operator's Manual Multifunction Slew Control ICS Trigger Switch Headset/Helmet
291	N, S	Tune and identify appropriate navigational aids (NAVAIDs).	Flight Management System (FMS) Multi-Functional Display (MFD)	Flight Management System (FMS) ICS Trigger Switch Headset/Helmet
296	S, N	Configure the HSI/VSI mode select panels and CIS to obtain the desired navigational data and commands.	AN/ARC-231 via Headset/Helmet	Flight Management System (FMS) Multi-Functional Display (MFD) Operator's Manual
299	N, S	Program the FMS for the desired flight plan.	Tablet / Kneeboard Portable Flight Planning Software (PFPS) via Laptop	Flight Management System (FMS)
300	N, S	Select the desired display on the MFD.	Multi-Functional Display (MFD)	Multi-Functional Display (MFD) ICS Trigger Switch Headset/Helmet
301	N, S	Select the appropriate modes on the FD/DCP.	Intercommunication via Headset/Helmet	Multi-Functional Display (MFD)
305	C, S	Time and track holding pattern legs.	AN/ARC-231 via Headset/Helmet Flight Information Publication (FUP)	Tablet / Kneeboard ICS Trigger Switch Headset/Helmet
306	C	Send the appropriate report to ATC IAW DOD FLIP.	Flight Information Publication (FUP)	Radio Trigger Switch Headset/Helmet
321	A, S	Analyze aircraft attitude.	Altimeter	Tablet / Kneeboard
335	C, A, N	Contact ATC, as required. Comply with ATC instructions, local regulations, and SOP.	Eyes Outside	Radio Trigger Switch Headset/Helmet
341	N, S	Operate bezel keys on the MFD to select desired map (TAC/ND) configuration and orientation.	Multi-Functional Display (MFD)	Multi-Functional Display (MFD)
342	N, S, O	Operate the multifunction slew controller (MFSC) or the collective cursor slew controller to gain desired information and to manipulate desired mission data on the digital map display.	Multi-Functional Display (MFD)	Multifunction Slew Controller
360	C, S	Test and operate aircraft avionics and voice security equipment IAW the aircraft current operator's manual.	Operator's Manual	Intercommunications (ICS) Panel Radio Trigger Switch Headset/Helmet
362	C	Maintain radio discipline.	Intercommunications (ICS) Panel	Intercommunications (ICS) Panel ICS/Radio Trigger Switch Headset/Helmet
365	C, S, O, T	Operate Mark XII identification, friend or foe (IFF) system.	Transponder Control Screen via Flight Management System (FMS)	Transponder Control Screen via Flight Management System (FMS)
367	C	To save time, minimize confusion, and ensure completeness, report information in an established format. Assemble the report in the correct format and transmit it to the appropriate agency. Standard formats may be found in the SOI or other sources.	Standard Operating Instruction (SOI)	Tablet / Kneeboard Radio Trigger Switch Headset/Helmet

UID	Overarching Function	Task (HQDA 2017)	Phase V - Function to Form Diagram	
			SA System	Action System
368	N	During NOE flight (surface to 25 feet above highest obstacle [AHO]), know the en route location within 200 meters.	Flight Management System (FMS) Multi-Functional Display (MFD)	Tablet / Kneeboard ICS Trigger Switch Headset/Helmet
369	N	During contour flight (25 to 80 feet AHO) or low-level flight (80 to 200 AHO), know the en route location within 500 meters.	Flight Management System (FMS) Multi-Functional Display (MFD)	Tablet / Kneeboard ICS Trigger Switch Headset/Helmet
370	N	Locate each objective within 100 meters.	Flight Management System (FMS) Multi-Functional Display (MFD)	Tablet / Kneeboard ICS Trigger Switch Headset/Helmet
379	S, T	Evaluate any damage to aircraft.	Eyes Outside	Eyes Outside
380	A, C, N, S, T	Recommend or execute a course of action.	Eyes Outside	ICS Trigger Switch Headset/Helmet
382	C	Transmit tactical report IAW signal operating instructions (SOI), unit SOP, and or mission briefing.	Standard Operating Instruction (SOI)	Tablet / Kneeboard Radio Trigger Switch Headset/Helmet
385	N	Determine Hoisting location.	AN/ARC-231 via Headset/Helmet	Eyes Outside Tablet / Kneeboard
386	S, A	Determine appropriate Hoisting Method (Static or Dynamic).	AN/ARC-231 via Headset/Helmet	ICS Trigger Switch Headset/Helmet
387	C, S, A	Perform Hoist Operations IAW the Army Aviation Rescue Hoist SOP.	AN/ARC-231 via Headset/Helmet	ICS Trigger Switch Headset/Helmet
388	C	Utilize crew coordination terminology IAW the Army Aviation Rescue Hoist SOP and chapter 8 of this ATM.	AN/ARC-231 via Headset/Helmet	ICS Trigger Switch Headset/Helmet
389	C, S, A	Respond to Rescue Hoist Emergencies (if necessary).	AN/ARC-231 via Headset/Helmet Army Aviation Rescue Hoist SOP	ICS Trigger Switch Headset/Helmet
396	C, S	Confirm aircraft is at appropriate hover height location.	Multi-Functional Display (MFD)	Tablet / Kneeboard Operator's Manual Charts/Figures
397	C, S	Monitor Hoist operations IAW the Army Aviation Rescue Hoist SOP.	Intercommunication via Headset/Helmet Eyes Outside Rescue Hoist SOP	Intercommunication via Headset/Helmet Eyes Outside Rescue Hoist SOP
410	C	Conduct a thorough crew and passenger safety briefing.	Intercommunication via Headset/Helmet	ICS Trigger Switch Headset/Helmet
433	A, C	Ensure maximum airspeed with caving ladder deployed is 80 KIAS with personnel attached to the ladder and no faster than a brisk walk with no personnel attached.	Air Speed Indicator via Multi-Functional Display (MFD) Eyes Outside	Eyes Outside ICS Trigger Switch Headset/Helmet
443	C	Conduct a thorough crew and passenger briefing.	Intercommunication via Headset/Helmet	ICS Trigger Switch Headset/Helmet
447	C	Identify and tune the appropriate frequency.	AN/ARC-231 via Flight Management System (FMS) Flight Information Publication (FIP)	Flight Management System (FMS)
448	C	Establish contact with the message sender.	Intercommunications (ICS) Panel	Radio Trigger Switch Headset/Helmet
449	C	Authenticate, if required.	AN/ARC-231 via Headset/Helmet Authentication Documents	Authentication Documents Radio Trigger Switch Headset/Helmet
450	C	Establish contact with the message receiver.	AN/ARC-231 via Headset/Helmet	Radio Trigger Switch Headset/Helmet
451	C, S	Configure the aircraft radios for radio relay.	AN/ARC-231 via Flight Management System (FMS)	Flight Management System (FMS)
465	T, A	Use visual search techniques.	Eyes Outside	Eyes Outside
468	C, T	Transmit tactical report.	Standard Operating Instruction (SOI)	Tablet / Kneeboard Radio Trigger Switch Headset/Helmet
480	C	Announce if visual contact is lost with other aircraft.	Eyes Outside	Radio Trigger Switch Headset/Helmet

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