Fall 11-2020

An Exploratory Study of General Aviation Visual to Instrument Meteorological Condition Contextual Factors

James Harry Hartman III
Embry-Riddle Aeronautical University

AN EXPLORATORY STUDY OF GENERAL AVIATION VISUAL TO INSTRUMENT METEOROLOGICAL CONDITION CONTEXTUAL FACTORS

By

James Harry Hartman, III

A Dissertation Submitted to the College of Aviation
in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy in Aviation

Embry-Riddle Aeronautical University
Daytona Beach, Florida
November 2020

AN EXPLORATORY STUDY OF GENERAL AVIATION VISUAL TO INSTRUMENT METEOROLOGICAL CONDITION CONTEXTUAL FACTORS

By

James Harry Hartman, III

This Dissertation was prepared under the direction of the candidate's Dissertation Committee Chair, Dr. Mark A. Friend, and has been approved by the members of the dissertation committee. It was submitted to the College of Aviation and was accepted in partial fulfillment of the requirements for the
Degree of
Doctor of Philosophy in Aviation

Mark A. Friend, Ed.D.
Committee Chair

Mike O'Toole, Ph.D.
Committee Member

Steven Hampton, Ed.D.
Associate Dean, School of Graduate Studies

Jennifer Thropp, Ph.D.
Committee Member

Alan J. Stolzer, Ph.D.
Dean, College of Aviation

Kevin Gildea, Ph.D.
Committee Member (External)

Lon D. Moeller, J.D.
Senior Vice President for Academic Affairs and Provost.

November 6, 2020

ABSTRACT

Researcher: James Harry Hartman, III

Title: **AN EXPLORATORY STUDY OF GENERAL AVIATION VISUAL TO INSTRUMENT METEOROLOGICAL CONDITION CONTEXTUAL FACTORS**

Institution: Embry-Riddle Aeronautical University

Degree: Doctor of Philosophy in Aviation

Year: 2020

The purpose of this dissertation was to bridge the existing literature gap of outdated contextual factor (CF) research through examination and determination of current General Aviation (GA) Title 14 Code of Federal Regulations (CFR) Part 91 visual flight rules (VFR)-into-instrument meteorological condition (IMC) contextual factors. Contextual factors are a multifaceted arrangement of pertinent events or occurrences contributing to pilot accidents in weather-related decision-making errors. A total of 46 contextual factors were identified and examined from the reviewed research literature. The study examined and determined the presence of the 46 contextual factors, frequencies, and manifestations in the GA VFR-into-IMC Aviation Accident Reports (AARs) archived in the National Transportation Safety Board (NTSB) online safety database. Significant relationships were identified among the contextual factors and pilot age, flight experience, weather, flight conditions, time of day, and certification level using point biserial and phi correlations. Contextual factor significant effects on the crash distance from departure and crash distance from the planned destination were revealed using multiple regression. A qualitative methodology was used on secondary data. Three subject matter experts (SMEs) for the main study analyzed a sample of 85 accidents for the presence of the 46 contextual factors. Raters then reported the presence of the contextual factors and provided opinions on how the contextual factors were manifested. Qualitative analysis revealed the presence of 37 out of 46 contextual factors. Highest frequency factors included number of passengers on board (CF29), accident time of day (CF1), crash distance from the planned destination (CF15), not filing of a flight plan (CF21), and underestimating risk (CF43). Raters described numerous manifestations of the contextual factors including 62% of the accident flights had passengers on board the aircraft (CF29). Quantitative analysis discovered several significantly weak to moderate relationships among pilot age, flight experience, weather, flight conditions, time of day, certification level, and the contextual factors. Several contextual factors had significant effects on the crash distance from departure and crash distance from the planned destination. Findings indicated the contextual factors were extensive in GA accidents. Additional research should focus on all flight domains, including further study of GA Part 91 VFR-into-IMC accidents. It is recommended the GA Part 91 pilot community be trained on the contextual factors assessed.

DEDICATION

The pursuit of my doctoral degree has taken seven years. This dissertation is dedicated to my wife Tiffany who inspired me to achieve this life goal. It was your support that made this achievement possible.

ACKNOWLEDGEMENTS

Many thanks to the four subject matter experts: Robert "Buck" Joslin, William ("Bill") Tuccio, Peter A. LeVoci, and Benjamin J. Goodheart and their respective collaboration. Your individual participation was vital in completing this dissertation.

Many thanks to Dissertation Chair Dr. Mark Friend and Dr. Dothang Truong. Your continued support was crucial to the completion of my study. I appreciate your willingness to work with me and the increased time and energy given to this research. I am grateful for your assistance in improving my writing abilities.

Many thanks to the dissertation committee members Dr. Mike O'Toole, Dr. Jennifer Thropp, and Dr. Kevin Gildea. I sincerely appreciate the writing and statistical support. I am grateful for each of you participating in my research.

Many thanks to Dr. Alan Stolzer and Dr. Steven Hampton for your expertise in guiding my completion of the doctoral degree. I have developed a strong interest in research as a result of your guidance.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

The purpose of this dissertation was to bridge the existing literature gap of outdated contextual factor (CF) research through examination and determination of current General Aviation (GA) Title 14 code of federal regulations (CFR) Part 91 (hereafter referred to as Part 91) visual flight rules (VFR)-into-instrument meteorological condition (IMC) contextual factors in the National Transportation Safety Board (NTSB) safety database. Contextual factors in Part 91, GA VFR-into-IMC accidents were determined and examined in the study. Identifying research-derived contextual factors from the perspective of the Subject Matter Expert (SME) pilot was the focus of the research. Approaching the identification of research-derived contextual factors from the expert point of view is important and has the main advantage of getting the pilot perspective over a more general point of view. A determination and examination of visual flight rules VFR-into-IMC, GA pilot-accident contextual factors in the single-pilot CFR Title 14 Part 91 environment was completed. Part 91 regulates the operation of small non-commercial aircraft within the United States (electronic code of federal regulations [e-CFR], 2018a). The most recent (27^{th}) Joseph T. Nall Report (2018) describes the most currently determined statistics on GA aviation accidents in 2015 and found VFR-into-IMC, or VFR-into-IMC events, caused 21 (20 fatal) weather accidents with a 95% fatality rate. The investigation of contextual factors influencing weather-related decision-making can assist researchers to change the GA flight system in order to increase safety. More research is needed to discover contextual factors contributing to GA Part 91 VFR-into-IMC accidents, including qualitative exploratory research using secondary data in the current study, so hazards can be mitigated, and the number of GA accidents can be reduced.

The GA Part 91 VFR-into-IMC accident type includes the John F. Kennedy, Jr. crash of a Piper Saratoga into the Atlantic Ocean after he developed spatial disorientation during a flight in marginal weather while acting as pilot-in-command (PIC) of a PA-32R-301, tail number N9253N, on July 16, 1999, to Martha's Vineyard in Massachusetts. A determination was made by the NTSB that the pilot was not proficient at flying the aircraft by reference to the instruments alone, was not instrument rated, and relied on visual references to fly the aircraft. On this night, there was no visible horizon due to the haze and dark night. The NTSB determined the probable cause of the accident to be spatial disorientation and failure to maintain control of the aircraft while descending over water on a dark night with haze (NTSB, 2000).

Contributory factors have been identified in Part 91, VFR-into-IMC accidents. The factors include initiating or continuing VFR-into-IMC, flight into clouds, controlled flight into terrain (CFIT), spatial disorientation, loss of aircraft control, unrecoverable, unusual flight attitude such as a spin, graveyard spiral, or inflight structural failure, and inadequate instrument flight training (Wilson & Sloan, 2003). Human error has also been identified as a factor in Part 91, VFR-into-IMC accidents (e.g., Gallo et al., 2015; Ison, 2014a). Studies have been conducted on human error to improve understanding of situational behavior (e.g., Hunter, Martinussen, Wiggins, & O'Hare, 2011; Ison, 2014b). Hunter et al. (2011) explained s*ituational behavior* assumes a person's behavior is influenced by an external influence from the environment or culture. The results can assist in mitigating the Part 91, VFR-into-IMC accident rate attributed to human error.

Contextual factors have been identified in Part 91, VFR-into-IMC accidents. The factors are generally defined as the degrees of challenge, uncertainty, predictability of outcome, time pressure, threat, emotionality, and situational understanding in classifying decisions (Boyes, & Potter, 2015). In the aviation domain, contextual factors are a multifaceted arrangement of pertinent events or occurrences contributing to pilot accidents in weather-related decision-making errors. The *context* term has been explained as "… contributes to General Aviation pilot errors in weather-related decision making … considered as a complex configuration of relevant events or phenomena that may be considered the domain within which the pilot makes the weather-related decision" (McCoy & Mickunas, 2000, p. 1). A total of 46 contextual factors have been identified in the reviewed literature on GA VFR-into-IMC accidents. The results of the studies showed more research is needed, including database research, to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding among context, pilot characteristics, policy violations, weather information assessment, perception of display information, training, accident analysis, and associated decision-making.

Significance of the Study

The Part 91, GA VFR-into-IMC events have been a part of accident and fatality statistics for over 50 years and identified as a continuing challenge by the most recent (27^{th}) Joseph T. Nall Report (Nall, 2018). Nall (2018) report findings describe the most currently determined statistics on GA aviation accidents in 2015 and found VFR-into-IMC, or VFR-into-IMC events, caused 21 (20 fatal) weather accidents with a 95% fatality rate. New approaches are needed to help reduce these statistics. The presence of research-identified, contextual factors in Part 91, GA VFR-into-IMC accidents was revealed and resulted in a greater understanding of how contextual factors affect both GA pilot decision-making in the cockpit and flight safety. Awareness of these contextual factors in the GA pilot community could help improve risk management in decision-making through implementation in scenario-based training. A knowledge of the contextual factors in GA pilot actions in the flight environment can improve the identification of hazardous behaviors and implementation of alteration techniques for the hazardous behaviors during ground and flight training.

Statement of the Problem

A very limited number of dated Part 91, GA studies have explored the contextual factors contributing to VFR-into-IMC accidents (Goh, & Wiegmann, 2001; Goh, & Wiegmann, 2002; McCoy & Mickunas, 2000; O'Hare, & Owen, 2002; Orasanu, & Martin, 1998; Orasanu, Martin, & Davison, 1998; Orasanu, Martin, & Davison, 2001; Wiegmann, & Goh, 2000; Wiegmann, Goh, & O'Hare, 2002). The studies have identified the presence of contextual factors occurring for this accident type, as well as the existence of unsafe pilot behaviors negatively affecting judgment and increasing the probability for error. The lack of a significant number of contextual studies for these types of events has created a knowledge gap contributing to a failure to resolve the problem of reducing or eliminating the occurrence of these events despite years of constant Federal Aviation Administration (FAA) and NTSB reported fatality statistics (Aviation Data & Stats, 2016; FAA, 2018b; NTSB, 2014; NTSB, 2015; NTSB 2016; NTSB, 2017c; NTSB, 2017d; NTSB 2017-2018; NTSB, 2018). The reporting of FAA and NTSB statistics may raise awareness of the existing VFR-into-IMC problem, but without some form of intervention, behavior change is unlikely. The identified studies emphasized the need for additional research, including database research, to improve understanding of how context contributes to GA pilot errors in weather-related decision-making through assessment of currently known contextual factors and identification of yet unknown contextual factors.

Purpose Statement

The study determined and examined contextual factors in Part 91, GA VFR-into-IMC accidents. A focus was placed on identifying research-derived contextual factors from the perspective of the Subject Matter Expert (SME) pilot. The scope of the study was from the SME pilot point of view. Approaching the identification of research-derived contextual factors from the expert point of view is important and has the main advantage of getting the pilot perspective over a more general point of view. The investigation of contextual factors influencing weather-related decision making can assist researchers to change the GA flight system in order to increase safety. More research is needed to discover contextual factors contributing to GA VFR-into-IMC accidents so hazards can be mitigated, and the number of GA accidents can be greatly reduced. The data analysis technique the researcher utilized included assessment of the relationships between the rater-identified contextual factors and factors including pilot age, flight experience, weather, flight conditions, time of day, and certification level. The qualitative analysis included a description of how each of the 46 contextual factors is manifested within pilot actions described in the NTSB online safety database sample of 85 GA Part 91, VFR-into-IMC AARs from the rater perspective. Descriptive statistics were used to report the rater-identified contextual factors and frequencies in the GA

VFR-into-IMC accidents archived in the NTSB safety database. These statistics were also used to report pilot age, flight experience, weather, flight conditions, time of day, and certification level for the identified sample. The quantitative analysis used point biserial and phi correlations to determine if there are statistically significant relationships between the previously mentioned 46 contextual factors and pilot age, flight experience, weather, flight conditions, time of day and certification level. The quantitative analysis also included multiple regression using dummy variables to determine if there are any significant effects from the 46 contextual factors on crash distance from departure and crash distance from the planned destination.

Research Questions

The contextual factors related to Part 91, GA pilot intentions and behavior resulting in VFR-into-IMC accidents were explored. The specific research questions for this exploratory study are as follows:

1. What contextual factors contribute to Part 91, GA pilot VFR-into-IMC accidents in the reviewed NTSB AARs?
2. What is the frequency of occurrence for the contextual factors in Part 91, GA pilot VFR into-IMC accidents in the reviewed NTSB AARs?
3. How are the contextual factors manifested in Part 91, GA pilot VFR-into-IMC accidents in the reviewed NTSB AARs?

Delimitations

Research-identified contextual factors exhibited during United States aviation accidents for Part 91, GA VFR-into-IMC operations were the focus of the current research. VFR-into-IMC transpires when GA pilots, flying in accordance with VFR, fly into IMC. VFR-into-IMC can be either intentional or unintentional. A list of 46 contextual factors was derived from an exhaustive literature search. The contextual factors chosen were identified by recognized experts in Part 91, GA pilot VFR into-IMC accidents. Specific search criteria were used to focus on only these types of accidents. The entire NTSB database was queried using specific coding identifying this accident type in the complete dataset. The specific codes used to filter out only these accidents included Code 401 for VFR encounter with IMC from 2008 to 2014 and Code 24015 for pre-2008 accidents for VFR encounter with IMC in the old NTSB coding schema. The factual reports from the NTSB to explore only Part 91, GA pilot-related accidents were utilized. All other accident groups were excluded from the analysis. This research utilized Part 91, GA VFR-into-IMC aviation accidents from this dataset occurring in the United States during a specific timeframe. The selected accidents were determined by NTSB investigators as being attributed to pilot error resulting in VFR-into-IMC accidents occurring during the 1991 to 2014 timeframe. This specific timeframe was selected as these reports were completed with NTSB investigator's final probable cause determinations given. The identified timeframe was selected because the NTSB began including investigator-determined probable causes in the AARs on January 1, 1991. The identified timeframe stopped at December 31, 2014, because the researcher was informed by NTSB personnel the investigative process can take five or more years. The accidents occurring from January 1, 2015, to the present may not be completed and may not yet include NTSB investigator's final probable cause determinations. Therefore, accidents occurring during this timeframe were not selected for use in the study.

Limitations and Assumptions

A limitation of the study was the 46 research-derived contextual factors were obtained from only a few out-of-date GA Part 91 studies assessing these factors contributing to VFR-into-IMC accidents (Goh, & Wiegmann, 2001; Goh, & Wiegmann, 2002; McCoy & Mickunas, 2000; O'Hare, & Owen, 2002; Orasanu, & Martin, 1998; Orasanu, Martin, & Davison, 1998; Orasanu, Martin, & Davison, 2001; Wiegmann, & Goh, 2000; Wiegmann, Goh, & O'Hare, 2002). The findings in the dated studies might overlap somewhat with the present research. It is possible the dated studies also looked for the presence of the identified contextual factors in a limited number of the same accidents selected for the study between 1998 and 2002, as the current research selected specific accidents between January 1, 1991, and December 31, 2014. However, it is not possible to determine if any of the same accidents were assessed in the 1998 and 2002 timeframe, as the specific datasets were not identified by the researchers in their respective journal articles.

The researcher assumed the reviewed research articles chosen to provide the 46 contextual factors were valid in their assessments since the studies were based on what these authors wrote, each recognized as an SME in the field. The researcher assumed the raters understood the contextual factors, and their backgrounds were representatives of those of the pilots involved in the AARs, validating their judgements. It was assumed the AAR narratives were accurate.

The contextual factors taken from the identified studies were assumed to be mutually exclusive. However, it is possible there was overlap considering these factors were taken from a relatively small set of research articles. Plan Continuation Error (PCE) could, for instance, overlap with Goal Conflicts. The problem was resolved by identifying the overlapping contextual factors and counting the overlap for each applicable factor. The raters were informed of this possibility and instructed the contextual factors could overlap and to identify all applicable factors in each AAR. No overlapping contextual factors were reported by the raters. It was also assumed the sample of 85 selected AARs was representative of the GA Part 91, VFR-into-IMC population of interest cases in the United States, as these cases were used to make some generalizations about this accident type.

The raters have many years of flight experience and associated knowledge related to adverse weather conditions, including VFR-into-IMC. This level of subject matter expertise could potentially be a limitation of the study and may bias the rater assessment of pilot decision-making behavior (expert versus novice), as it could be challenging for the rater to set aside expertise and assume the role of the deceased GA pilot. This situation could make it difficult for the raters to determine the applicability of the identified contextual factors in the 85 NTSB AAR sample. In order to minimize the potential of this type of SME bias affecting the validity of the results, multiple expert raters were used to identify the presence of the 46 contextual factors in the sample. The results for all expert raters were reviewed by the researcher to determine if the identification of contextual factors between the raters was reasonable. It was assumed the use of the provided 46 research-identified contextual factor definitions mitigated any bias resulting from prior exposures (familiarity) to the accident types. The researcher provided instruction, testing, and an inter-rater reliability assessment to reduce the potential for this bias.

Another assumption of the study was the choice made by the rater was not influenced by stress and/or anxiety, as would have likely been the case with the GA pilots in the AARs. The stress factor could account for some differences in the decisions between raters and the pilots in the AARs. The replication of the exact scenarios experienced by the deceased GA pilots for the raters was not possible and would be considered unethical research to expose the raters to the same stress and/or anxiety and would not be approved by the Institutional Review Board (IRB). The researcher was therefore reliant on the subject matter expertise of the raters.

The 23-year period selected between 1991 and 2014 for the study could create confounding variables related to changes in safety regulations and/or standards and technology. The use of the National Oceanic and Atmospheric Administration (NOAA) defined climate regions was used by the researcher to reduce the adverse effects of the outside influence of confounding variables on the phi and point biserial correlations (NOAA, 2018). The sample of 85 NTSB AARs for the main study was selected based on these NOAA defined climate regions. The stratification method was used to break down the data set into a manageable number of subsets, or strata, corresponding to the levels of the potential confounding variables among age, flight experience, weather, flight conditions, time of day, and certification level. A comparison was made of the overall cross-tabulations for the associations between exposures and outcomes. A 2 x 2 table for specific NOAA defined climate regions and percentage of VFR-into-IMC accidents was compared among stratum-specific age, flight experience, weather, flight conditions, time of day, and certification level cross-tabulations to determine whether these factors introduce confounder variables in the analysis. It was determined the stratum-specific associations did not deviate markedly from the overall association. Therefore, age, flight experience, weather, flight conditions, time of day, and certification level did not introduce confounder variables into the point biserial and phi correlation analyses.

Definitions of Terms

14 CFR Part 91	The regulations defining the operation of small non-commercial aircraft within the United States (FAA, 2018a).
Accident	"An occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage" (e-CFR, 2018a, p. 1).
aircraft_key	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents).

	Associated with events are date, location, weather, etc. Because an EVENT may involve multiple AIRCRAFT (as would be the case in collisions), the AIRCRAFT table is logically structured under the EVENTS table" (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with aircraft is the aircraft_key (aircraft key).
AKey	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc. Because an EVENT may involve multiple AIRCRAFT (as would be the case in collisions), the AIRCRAFT table is logically structured under the EVENTS table" (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with

	aircraft are the aircraft_key (aircraft key) and AKey (aircraft key).
Controlled Flight into Terrain	"An accident whereby an airworthy aircraft, under pilot control, inadvertently flies into terrain, an obstacle, or water" (FAA, 2016, p. G-2).
Change blindness	"… when human observers fail to perceive changes in their field of view, like when new objects appear in an image or when objects change color and/or shape. This phenomenon is particularly strong during multitasking situations, such as those experienced during single pilot operations" (Ahlstrom, et al., 2015, p. 1).
Contextual Factors	The degrees of challenge, uncertainty, predictability of outcome, time pressure, threat, emotionality, and situational understanding in classifying decisions (Boyes, & Potter, 2015).
DAWN	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation

	Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated events are light_cond (light condition) and DAWN (dawn).
DAYL	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated events are light_cond (light condition) and DAYL (daylight).
Distance to Diversion	The distance flown by the GA pilot until a specific point and time the weather began to deteriorate. ". . . pilots who frame diverting

	from the planned flight as a loss (e.g., loss of time, money, and effort) will tend to continue with the flight, whereas those who frame the diversion as a gain (e.g., in personal safety) will tend to divert" (Wiegmann, Goh, & O'Hare, 2002, p. 190).
DUSK	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated events are light_cond (light condition) and DUSK (dusk).
ev_date	"In the NTSB database, an event is classified as an accident or an incident. "Aircraft accident" means an occurrence associated with the operation of an aircraft which takes place between the time any

	person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. The NTSB defines "Incident" to mean an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations" (FAA, n.d.-a, p. 1). "At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Also associated with events is the ev_date (event date).
Event	"In the NTSB database, an event is classified as an accident or an incident. "Aircraft accident" means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention

	of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. The NTSB defines "Incident" to mean an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations” (FAA, n.d.-a, p. 1). “At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc.” (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1).
EventID	The EVENTID (event identification) is a “Unique identification for each event; each event is assigned a unique 14-character alphanumeric code in the database. This code, used in conjunction with other primary keys (if applicable), are used to reference all database records” (NTSB, n.d.-a, p. 1; NTSB, n.d.-b, p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-d, p. 1; NTSB, n.d.-e, p. 1).

Events_Sequence	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram “. . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database” (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). The Events Sequence is associated with ev_id (event identification), Aircraft_Key (aircraft key), Occurrence_No (occurrence number), Occurrence_Code (occurrence code), Occurrence_Description (occurrence description), phase_no (phase number), eventsoe_no (event operating experience number), Defining_ev (defining event), lchg_date (change date), and lchg_userid (change user identification).
ev_id	“Unique Identification for Each Event; Each event is assigned a unique 14-character alphanumeric code in the database. This code, used in conjunction with other primary keys (if applicable), are used to reference all database records” (NTSB, n.d.-a, p. 1;

	NTSB, n.d.-b, p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-d, p. 1; NTSB, n.d.-e, p. 1).
ev_state	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Events is also associated with ev_id (event identification) and ev_state (event state).
ev_type	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB,

	n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Events is also associated with ev_id (event identification) and ev_type (event type).
Experience	"A pilot's total flight hours, total solo hours, actual IFR hours, total VFR cross-country hours, and flight hours in the last 30 and 90 days" (Wiegmann, Goh, & O'Hare, 2002, p. 194).
far_part	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc. Because an EVENT may involve multiple AIRCRAFT (as would be the case in collisions), the AIRCRAFT table is logically structured under the EVENTS table" (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with

	aircraft is the far_part (Federal Aviation Regulation part).
FATL	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with injury are injury_level (injury level) and FATL (fatal).
Federal Aviation Administration	"An agency of the United States Department of Transportation with authority to regulate and oversee all aspects of civil aviation in the United States" (FAA, 2016, p. G-2).
General Aviation	"All flights other than military and scheduled airline flights, both private and commercial" (FAA, 2016, p. G-2).
Human behavior	"The product of factors that cause people to act in predictable ways" (FAA, 2016, p. G-3).
injury_level	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships

	among data elements in the NTSB Aviation Accident/Incident Database (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with injury is the injury_level (injury level).
Instrument Flight Rules	"Rules and regulations established by the Federal Aviation Administration to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals" (FAA, 2016, p. G-3).
Instrument Meteorological Conditions	The weather conditions given in relation to visibility, distance from clouds, and ceiling less than the minimums specified for visual meteorological conditions that require operations to be conducted under IFR (FAA, 2016, p. G-3).
light_cond	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation

	Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with events is light_cond (light condition).
NBRT	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with events are light_cond (light condition) and NBRT (bright night).
NDRK	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation

	Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc." (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with events are light_cond (light condition) and NDRK (dark night).
ntsb_no	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc. Because an EVENT may involve multiple AIRCRAFT (as would be the case in collisions), the AIRCRAFT table is logically structured under the EVENTS table" (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with

	events and aircraft is the ntsb_no (NTSB number).
Pilot error	"An accident in which an action or decision made by the pilot was the cause or a contributing factor that led to the accident" (FAA, 2016, p. G-4).
seq_of_events	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc. Because an EVENT may involve multiple AIRCRAFT (as would be the case in collisions), the AIRCRAFT table is logically structured under the EVENTS table" (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with events, aircraft, and occurrences is the seq_of_events (sequence of events).

Situational Awareness	"Knowledge of where the aircraft is in regard to location, air traffic control, weather, regulations, aircraft status, and other factors that may affect the flight" (FAA, 2016, p. G-4).
subj_code	The basic NTSB Aviation Accident Incident Database Architecture with Key Fields diagram ". . . shows the logical relationships among data elements in the NTSB Aviation Accident/Incident Database. At its highest level, the database is organized around EVENTS (i.e., accidents or incidents). Associated with events are date, location, weather, etc. Because an EVENT may involve multiple AIRCRAFT (as would be the case in collisions), the AIRCRAFT table is logically structured under the EVENTS table" (NTSB, n.d.-b., p. 1; NTSB, n.d.-c, p. 1; NTSB, n.d.-e, p. 1). Associated with the seq_of_events (sequence of events) is the subj_code (subject code).
Title 14 CFR	"Includes what was formerly known as the Federal Aviation Regulations governing the

	operation of aircraft, airways, and airmen" (FAA, 2016, p. G-5).
Visual Flight Rules	"Flight rules adopted by the FAA governing aircraft flight using visual references. VFR operations specify the amount of ceiling and visibility the pilot must have in order to operate according to these rules. When the weather conditions are such that the pilot cannot operate according to VFR, he or she must use instrument flight rules (IFR)" (FAA, 2016, p. G-5).
Visual Meteorological Conditions	Meteorological conditions expressed in terms of visibility, cloud distance, and ceiling meeting or exceeding the minimums specified for VFR (FAA, 2016, p. G-5).

List of Acronyms

AAR	Aviation Accident Report
AFSS	Automated Flight Service Station
AGL	Above ground level
AIRMET	Airmen's Meteorological Information
AMSL	Above mean sea level
ANOVA	Analysis of variance

AOG	Acts of God
ATC	Air Traffic Control
ATP	Air transport pilot
BFR	Biennial flight review
CAMI	Civil Aerospace Medical Institute
CFI	Certified flight instructor
CFIT	Controlled flight into terrain
CFR	Code of Federal Regulations
DOT	Department of Transportation
DUATS	Direct User Access Terminal Service
ERAU	Embry-Riddle Aeronautical University
FAA	Federal Aviation Administration
FBO	Fixed Base Operator
FSS	Flight service station
GA	General aviation
GMN	Gorman
GPS	Global Positioning System
GWIS	Graphical Weather Information System
HITS	Highway in the sky
HIWAS	Hazardous In-Flight Weather Advisory Service
HSV	High-speed videoendoscopic
IBM	International Business Machines
IFR	Instrument flight rules

IFV	In-flight volitional
IMC	Instrument meteorological conditions
IRB	Institutional Review Board
METAR	Meteorological Aerodrome Report
MIS	Meteorological Impact Statement
NEXRAD	Next-Generation Radar
NDM	Naturalistic decision-making
NOAA	National Oceanic and Atmospheric Administration
NTSB	National Transportation Safety Board
PABAK	Prevalence Adjusted Bias Adjusted Kappa
Part 91	14 CFR Part 91 General Operating and Flight Rules
PCE	Plan continuation error
PIC	Pilot in command
SA	Situational awareness
SBT	Situational based training
SPSS	Statistical Package for the Social Sciences
SVS	Synthetic Vision System
TAF	Terminal Aerodrome Forecast
VALI	Voice-Vibratory Assessment with Laryngeal Imaging
VFR	Visual flight rules
VIF	Variance inflation factor
VMC	Visual meteorological conditions
VOR	Very high frequency omni-directional range

WSA	Weather situational awareness

CHAPTER II

REVIEW OF THE RELEVANT LITERATURE

Continued flight from VFR-into-IMC has claimed the highest number of fatalities every year in GA accidents (Nall, 2018). According to the most recent Nall (2018) report, GA VFR-into-IMC events caused 21 (20 fatal) weather accidents in 2015. The statistics for 2015 also reported a 95% fatality rate for this accident type. Baron (2011) has also emphasized the greatest number of GA accidents with fatalities occurred because of VFR-into-IMC events. Despite these grim statistics, industry has been lacking in relevant, recent studies about this specific type of weather accident. Some factors believed to be contributory to VFR-into-IMC flights were discovered roughly two decades ago. There have been very few, if any, studies conducted after this time. VFR-into-IMC fatality statistics have remained steady. Orasanu and Martin (1998) and Orasanu, Martin, and Davison (2001) have stated Naturalistic Decision Making (NDM), or the context in which pilots make their decisions, must be better understood to learn how to reduce GA VFR-into-IMC accidents.

VFR-into-IMC occurs when GA pilots, flying in accordance with VFR, fly into IMC. VFR-into-IMC can be either intentional or unintentional. Accidents resulting from such occurrences have taken place after pilots fly under controlled flight into terrain (CFIT), or they have found themselves in unrecoverable low altitudes after experiencing spatial disorientation (Wilson & Sloan, 2003). Studies investigating the VFR-into-IMC phenomenon in GA Part 91, to this point, have focused on the pilot, the aircraft, and the flight environment. The intention of this research has been to gain better understanding of these contextual factors and accident type to potentially reduce related fatalities. The most recent research, while somewhat dated, has addressed the aforementioned areas. However, the results of these studies showed more research is needed, including database research, to understand the context of pilot actions resulting in VFR-into-IMC accidents. There are gaps in understanding of decision-making, pilot characteristics, policy violations, weather information assessment, training, and contextual factors in GA weather and non-weather accidents identified in the literature.

Decision-Making

Simulation has been used to investigate the influence of motivation and investment on the length of time pilots fly into degraded weather. A study conducted by Saxton (2008) examined the influence financial motivation and time investment had on the length of time a pilot would fly into degraded weather conditions. *Sunk cost* refers to the financial aspects of what might motivate pilots to take greater risks by continuing farther into adverse weather, when IMC was encountered later into a flight. Saxton's (2008) study found sunk cost to be a valid concept, as the participants of the study who were financially motivated did, in fact, continue longer into poor weather conditions than the participants who were not financially motivated and came upon hazardous weather earlier in the flight. Saxton (2008) recognized the results of the research were in support of both the situation assessment hypothesis and cognitive anchoring, suggesting the ways pilots process information before flight has an impact on decisions during flight. It might be argued this is congruent with an accelerating decision-making function, where a pilot making a decision is more willing to divert earlier in the flight and less likely as the flight progresses. The proposed accelerating decision-making function would be a decision-making process involving more than linear decision making where the GA pilot carries the decision through to the end without assessing circumstances as they arise, and less than adjusting decisions accordingly, in a way that helps to best achieve the desired goal, a process taking place in circular decision-making (Balog, 2013; Balog 2016).

Similar to sunk cost, based on a study by Wiegmann, Goh, and O'Hare (2002), it seems, generally speaking, when adverse weather is encountered later in flights, pilots are more likely to continue, as they might be more optimistic about the possibility of positive outcomes than they are when they encounter poor weather early in flights. The Wiegmann, Goh, and O'Hare (2002) study used simulation to expose different groups of pilots to adverse weather early and late into flights. The results were consistent with more optimism during poor weather encounters occurring later into flights, and less optimism when hazardous weather was present earlier in flights.

In addition to identifying contributory factors, simulation has also been used to improve pilot decision-making in IMC situations. Johnson and Wiegmann (2015) endeavored to allow pilots the opportunity to develop decision-making experience and improve their skills in navigating adverse weather conditions. The researchers used weather simulation to re-create historical weather events, helping pilots to find opportunities for better, weather-related training. The study used 16 VFR and 16 instrument-rated pilots in a simulation of a VFR cross-country flight in marginal weather and IMC. They found the only statistically significant difference was for the group of pilots who had previous experience with actual instrument weather were safer and more likely to use in-cockpit weather information during flight, allowing them to detect and avoid instrument weather.

Johnson, Wiegmann, and Wickens (2006) also used a simulation to study 12 pilots in a VFR cross-country flight with worsening weather. The pilots used either control/standard instruments, synthetic vision system (SVS), or SVS highway-in-the-sky (HITS)/electronic with a moving map display depicting weather. Somewhat contrary to the Johnson and Wiegmann (2015) research, the participants in the Johnson, Wiegmann and Wickens (2006) study, who were receiving in-cockpit weather information, did not avoid hazardous weather conditions. In fact, 60% of both SVS conditions breached the clouds and continued into conditions with zero visibility. The researchers noted there was head-down scanning, accounting for the fact the participants did not notice worsening weather conditions. The moving weather map did not seem to make a difference in pilot attentional tunneling (focusing disproportionate attention or time on one task or risk to the disadvantage of awareness of other risks). It might also be the case the pilots did not trust the timeliness of the weather information, as it was not from Hazardous In-Flight Weather Advisory Service (HIWAS) or Flight Watch.

Researchers have used simulation to test the ways new technology might enhance or diminish pilot decision-making and behavior. Ahlstrom, Ohneiser, and Caddigan (2016) assessed GA pilot use of portable weather applications. Participants were separated into a control group and an experimental group. The experimental group flew a simulated flight in VMC with a portable weather device, a receiver allowing in-flight access to subscribed weather products viewable on the device. It was found the weather device did improve situational awareness (SA), weather related decision-making in diverting or continuing to the planned destination, and distances in route deviation from the hazardous weather. Pilots in both groups still flew less than 20 statute miles from hazardous weather. However, those in the experimental group maintained greater distances than those in the control group. While newer technologies can improve cockpit performance, proper design can make the difference between helping and hindering pilots. Beringer and Ball (2004) used simulation to study the effects of Next-Generation Radar (NEXRAD) on pilot direct weather viewing, severity judgments, and willingness to continue VFR-into-IMC flight. The delay between the occurrence of the actual weather and when the radar image is displayed to the pilot in the cockpit can be misleading due to the lag in obtaining the current weather conditions. The researchers programmed heavy precipitation in the simulated flight, requiring participants to utilize the data and display of NEXRAD to make the decision to divert or continue. It was found pilots spent more time viewing the higher-resolution images, causing them to defer their decisions longer than the other groups in the study. The findings support the idea that higher-resolution images might encourage pilots to continue to fly in hazardous weather based on posttest NEXRAD image judgements. No potential countermeasures were discussed by the researchers. Fortunately, it was possible to conduct such a study in the safety of a simulated environment.

Linear versus circular decision-making. Pilots can potentially commit to one decision without reevaluation after actions have been implemented using linear decision making. Current decision-making theory identifies two processes: circular decision-making and linear decision-making. Circular decision-making is comprised of assessment, decision, and consolidation; consolidation being the point at which a person evaluates the direction of implementation to determine if the action is working to achieve the goal, and if not, corrections are made. Linear decision-making encompasses only assessment and decision. Once the decision is made, the action is implemented without reevaluation. If the decision was poor, the goal will not be met, and there is no opportunity to make corrections. Circular decision-making, then, is considered to be superior to linear decision-making, especially when stakes are high (Bell & Mauro, 2000).

In an aviation environment, the potential exists for the necessity of the use of linear, rather than circular, decision-making. Research has documented the tendency of the novice pilot to utilize linear decision-making and the expert pilot utilization of circular decision-making (Adams & Ericsson, 1992; Dogusoy-Taylan & Cagiltay, 2014; Schriver, Morrow, Wickens, & Talleur, 2008). During the point at which a pilot chooses to continue into questionable weather conditions, circumstances including invested time, money, and energy; passenger pressure; and *get-there-itis* may influence a pilot to continue, rather than divert. If the decision is made too late, there may not be time to reevaluate and make corrections. Once a pilot is flying in poor weather, if an emergency arises, depending on the time available to decide, the pilot might again be faced with only one option: to choose a direction and commit to it. Without time for consolidation/evaluation, if the linear decision made was not adequate, an accident or incident might result.

Decision-making and judgement. Simulation studies have been used to explore additional aspects of pilot decision-making regarding VFR-into-IMC events. Goh and Wiegmann (2001) used a cross-country simulation to determine if participants chose to continue or to divert from VFR-into-IMC, examining pilot situation assessment, risk perception, and motivation. Their study found the aspects distinguishing the two groups were a matter of accuracy of visibility estimates, appraisal of personal skill, judgment, and the frequency a given pilot was accustomed to participating in risky behavior. Pilots who overestimated personal abilities and inaccurately diagnosed visibility were more likely to continue into adverse weather.

Decision-making in flight does not begin the moment bad weather is encountered. Walmsley and Gilbey (2016) explained anchoring (information processed before flight affecting decision-making while in flight), adjustment, confirmation, and outcome could contribute to the development of cognitive biases. It was further clarified by the researcher, cognitive biases could potentially affect pilot weather-related decision-making in negative ways. The study used simulation to assess the possibility of anchoring, adjustment, confirmation, and outcome leading to cognitive biases, potentially negatively affecting pilot weather-related decision-making. The researchers conducted three separate studies and found pilot anchoring occurred. Specifically, researchers found in the first study the presence of anchoring and adjustment when weather reports were reviewed by the pilot before the flight and discovered this affected how weather cues were interpreted during the flight. In the second study, there was no evidence found pilots favored disconfirmatory evidence over confirmatory evidence in the case of environmental cues and confirmation when making the decision to continue the flight. In the third study, researchers discovered pilots more heavily weighted other pilots' decisions to continue into poor weather when their outcomes were successful than when they experienced negative outcomes. In this part of the study, researchers provided flight scenarios including current weather, area forecast, and outcome information from third-party flights to pilot study participants. Pilot participants in the negative outcome condition read a scenario ending where the pilot flew into a cloud resulting in aircraft loss of control and crashing with serious injuries. The pilot participants in the positive outcome condition read a scenario ending where the pilot landed safely at the intended destination. The pilot participants in the control group read the common information with no additional ending. The pilot participants were then asked to rate dimensions based on the scenarios they had read using a nine-point scale, including if the pilot study participants would conduct the same third-party flight given in the researcher-presented outcome scenarios. The researchers discovered pilots interpreted the decisions of pilots who flew into deteriorating weather conditions more favorably when the outcome was positive than when the outcome was negative. The researchers suggested using the three cognitive heuristics, anchoring and adjustment, confirmation, and outcome, may lead to pilots continuing the flight into deteriorating weather conditions when it would have been safer to divert to an alternate location or return to the departure point.

Flight simulation and pilot decision-making behavior. In order to learn more about pilot behavior, Wiegmann, Goh, and O'Hare (2002) conducted research into GA VFR-into-IMC accidents, focusing on flight time, distance, diversion, VFR-into-IMC, experience, and situation assessment contextual factors. The researchers identified VFR-into-IMC as a major safety hazard in GA. The study utilized a cross-country flight simulation to assess GA pilot decision-making to continue or divert from IMC during a VFR flight. GA pilots were given simulation scenarios to fly where they encountered IMC either early or later into the flight. The researchers documented the amount of time and distance GA pilots flew into the IMC weather before deciding to divert. The study findings identified pilots who encountered the deteriorating weather earlier in the flight flew longer into IMC before diverting and were more optimistic about the weather conditions. The GA pilots who encountered the IMC weather later in the flight flew shorter distances into IMC before diverting and were not optimistic about the weather conditions. It was discovered the time and distance GA pilots flew into the weather before deciding to divert were negatively correlated with previous flight experience. The findings of the study suggested VFR flight into IMC may be caused, in part, by poor situation assessment and experience rather than motivational judgment, encouraging risk-taking behavior as the GA pilot invests more time in the flight. More research is needed to improve understanding of pilot behavior and VFR-into-IMC accidents.

Decision error and cognition. According to Orasanu and Martin (1998), Orasanu, Martin, and Davidson (1998), and Orasanu, Martin, and Davison (2001), the focus of NDM is to become aware of the ways people, and in this case, pilots, use their domain knowledge in their decision-making processes. The authors have studied cognitive and contextual factors in aviation accidents using NDM, with the viewpoint decision error may be unavoidable as people with extensive domain knowledge apply their understanding while performing tasks. The researchers conducted their studies with the objective of reducing the frequency of GA accidents by gaining a better understanding of the factors leading up to the unfortunate outcomes. The study included a broad review of NTSB accidents. The results found several cognitive and contextual factors contributed to GA aviation accidents. These factors included (1) ambiguity, (2) underestimating risk, (3) goal conflicts, and (4) unanticipated consequences (Orasanu, & Martin, 1998; Orasanu, Martin, and Davidson (1998); Orasanu, Martin, & Davison, 2001).

NDM and contextual factors. The consideration of context, or NDM, can be used to understand pilots' actions when investigating accidents (FAA, 2008; Klein, 2008; Orasanu, Martin, & Davidson, 2001). The NDM framework developed as a way of assessing how people make decisions and perform cognitively complex functions in dynamic, real-world situations involving limited time, uncertainty, high stakes, team and organizational constraints, unstable conditions, and varying amounts of experience. In a general sense, NDM describes human intuition as based on large numbers of patterns gained through experience, resulting in different forms of implied knowledge. In retrospect, as O'Hare and Owen (2002) clarified, pilot contribution to cross-country VFR crashes cannot be explained by flight-time alone. There are other factors at play, ultimately comprising pilot circumstances, including but not limited to over-confidence, faulty risk-perception, lack of awareness, flight circumstances leading to risky decisions, decision-making, risk assessment, SA, proximity of the goal/planned destination, and time already invested in the flight/sunk cost. Orasanu, Martin, and Davidson (2001) used NDM to examine expertise and decision-making within context. The research topics identified in the applicable literature addressed areas related to the pilot, aircraft, and flight environment. Specifically, relevant studies to date have covered contextual factors related to decision errors, cognition, historical accident analysis, PCE, flight simulation, and pilot behavior. More research is needed to improve understanding of how NDM and context impact VFR-into-IMC accidents. The results of these studies showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding between context and decision-making on the following factors related to the length of time a pilot would fly into degraded weather conditions: (1) financial motivation, (2) time investment, (3) sunk cost, (4) situation assessment, (5) cognitive anchoring, (6) novice and expert use of linear versus circular decision-making, (7) when IMC weather is encountered during the flight, (8) use of in-cockpit weather information during flight, (9) moving weather map and attentional tunneling, (10) timeliness of weather information and perceived reputable source, (11) use of portable weather device/application and low versus higher-resolution weather image, (12) lag in obtaining the current weather conditions, (13) accuracy of visibility estimate, (14) appraisal of personal skill, judgment, comfort level participating in risky behavior, (15) anchoring (information processed before flight affecting decision-making while in flight), and (16) cognitive biases.

Pilot Characteristics

Studies utilizing simulation technology have addressed pilot factors likely contributing to VFR-into-IMC events. It was observed passengers are on board in more of these types of accidents than any other accidents in GA. Barron (2011) investigated how pressure from passengers might have contributed to pilots' decisions to continue into adverse weather conditions by using passenger social pressure in flight. The study used passenger social pressure in flight to convince pilots to continue or divert from hazardous weather. The study found the pilot participants tended to concede to the pressure of the passenger, whether they were positively or negatively motivated to continue into poor weather conditions. At the conclusion of the study, pilot participants were informed of the results. The participating pilots stated they were unaware of passenger influence on their decision-making. The study results found private pilots who were instrument rated were more likely to continue farther into IMC than their low time VFR, or high time commercial, and/or Air Transport Pilot (ATP) counterparts, a finding pertaining primarily to the pilot's ratings.

The Coyne, Baldwin, and Latrorella (2008) study used simulators to assess pilot ability to determine ceiling and visibility. It was found there was no difference between the abilities of instrument rated and non-instrument rated pilots to assess ceiling accuracy, but when it came to visibility, the non-instrument rated pilots were more accurate. However, all pilots assumed higher ceiling with better visibility. When comparing these two studies, it seems to be the case, while instrument rated pilots are more likely to continue into adverse weather, they are, according to Coyne, Baldwin, and Latrorella (2008), less proficient in accurately determining true visibility.

Studies investigating the demographics of GA pilots who encounter VFR-into-IMC events were limited. Bazargan and Guzhva (2011) explored whether pilot age and experience were factors in VFR-into-IMC occurrences. The results indicated male pilots over 60 years of age with more experience were more likely than other pilots to be involved in a fatal accident. There was no significant pilot gender difference for the likelihood of an accident attributed to pilot error. The explanation for this result was given by the researchers as "One plausible explanation for such a result could be older pilots typically are more experienced and fly more difficult flights, where a mistake or malfunction could have severe consequences" (Bazargan, & Guzhva, 2011, p. 967). Huster et al. (2014) completed a study on the medical risks of older pilots. These findings identified in-flight incapacitation of pilots occurring in 0.19-0.45 times/10(6) flight hours. The study results also identified professional pilots older than 60 years having an age-depending increase in incapacitation.

Training with simulators has been found to be useful when helping VFR pilots with anti-disorientation. Since spatial disorientation following VFR-into-IMC has been shown to be a frequent cause of accidents, Tropper, Kallus, and Boucsein (2009) evaluated pilot psychophysiological spatial orientation in a moving base simulator. Following pilot exposure and training in simulation, the study found the groups with anti-disorientation training performed better and experienced less psychological distress when carrying out complex maneuvers to recover from unusual attitudes.

Wiggins, Hunter, O'Hare, and Martinussen (2012) studied pilot characteristics of deliberate versus inadvertent-VFR-into-IMC events. For their study, the researchers recruited pilots who shared recollections of deliberate and inadvertent-VFR-into-IMC encounters. It was reported 145 of the 251 pilots entered IMC unintentionally during a VFR flight, and 93 had continued into IMC intentionally. Those pilots who were instrument-rated who also deliberately entered into hazardous weather were likely to have experienced similar conditions in the past, tolerated risk well, reported low anxiety during previous encounters, and believed the risks of VFR-into-IMC were low. More research is needed to improve understanding of pilot characteristics related to deliberate and inadvertent VFR-into-IMC. The results of these studies showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding between context and pilot characteristics on the following factors related to the length of time a pilot would fly into degraded weather conditions: (1) passenger social pressure, (2) ratings, (3) ceiling and visibility determination versus rating, (4) pilot gender, (5) pilot age, (6) pilot flight experience, (7) spatial disorientation, and (8) deliberate and inadvertent flight from VFR-into-IMC.

Policy Violations

Jackman's (2014) study investigated pilot policy violations to assess fatal VFR-into-IMC accidents in an ex post facto, quantitative analysis. Violations including flight plan, ratings, flight currency, and medical status were reviewed. The need for training, regulatory modifications, or enforcements was explored. Information between the years of 1998 and 2013 for NTSB GA VFR-into-IMC accident data was analyzed using binary logistic regression. The findings revealed flight plan violations and pilot medical status violations were not statistically significant predictors of fatality. It was discovered through the results of the binary logistic regression analysis, pilot ratings violations and pilot currency violations were statistically significant predictors of fatality (Pilot Ratings Violations, Wald statistic =13.824, SE = .050, df = 1, p = .000, OR = .832, 95% CI [.755, .917] and Pilot Currency violations, Wald statistic = 15.065, SE = .185, df = 1, OR = .488, p = .000, 95% CI [.339, .701]. The Jackman's (2014) study recommendations included not allowing non-instrument rated pilots to fly from VFR-into-IMC, and the restricting of instrument rated pilots with inadequate flight time to fly from VFR-into-IMC. The study indicated stronger policy enforcement is needed. However, there are difficulties in consistently and reliably detecting such violations. The results showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding among context, policy violations, and on the following factors related to the length of time a pilot would fly into degraded weather conditions: (1) flight plan, (2) ratings, (3) flight currency, (4) medical status, and (5) fatality prediction.

Weather Information Assessment

The most recent literature has found some similarities in the way weather displays might be affecting pilots' assessment of the current weather. Weather information assessment studies reviewed focused on GA pilot risk assessment and decision-making leading to VFR-into-IMC accidents. A study conducted by Ahlstrom et al. (2015) investigated weather display symbology and its effects on pilot behavior and decision-making. Twenty-four participants, who were instrument rated pilots, were instructed to avoid hazardous weather in a simulator. The researchers manipulated the weather displays, altering weather symbols and colors. It was found pilot behavior was affected by the variations in symbols and colors presented on the weather displays, specifically, these variations contributed to perceptual asymmetries affecting pilot behavior and decision-making. These pilot perceptual asymmetries in weather display symbols and colors could affect GA pilot behavior in the diversion to an alternate or continued VFR-into-IMC to the planned destination decision. It was suggested within the study development of automated cockpit applications, tracking hazardous weather and warning pilots of potential problems may help to mitigate the types of effects different displays might have upon pilot decision-making, leading pilots into hazardous terrain.

Similarly, Ahlstrom et al. (2015) studied effects of weather state-change notifications on GA pilots' behavior, cognitive engagement, and weather situation awareness. According to their results, the participants did not detect symbol changes very well when it came to Meteorological Terminal Aviation Routine Weather Report, or Meteorological Aerodrome Report (METAR) displays. This was attributed to the change blindness phenomenon. The change blindness phenomenon has been defined as "…

where human observers fail to perceive changes in their field of view, like when new objects appear in an image or when objects change color and/or shape. This phenomenon is particularly strong during multitasking situations, such as those experienced during single pilot operations" (Ahlstrom et al., 2015, p. 1). The pilots in the study also flew more closely to hazardous weather than what was suggested in the rules, indicating a possible effect of the symbol changes on pilot behavior and decision-making. Rather than the automation of weather alerts, it was recommended the optimization of visual symbols through weather state-change notifications be used to help pilots discriminate among them, reduce cognitive workload, and improve weather situational awareness (WSA).

At the time of their study, Coyne, Baldwin, and Latrorella (2005) mentioned VFR-into-IMC activity is responsible for over 10% of GA fatalities every year. The researchers also explored GA pilots' use of graphical METARS. Twenty-four participants were asked to use a graphical weather information system (GWIS) to make estimates regarding visibility and ceiling limits in different simulated weather conditions. It was found the GWIS influenced the judgments of the participants; pilots tended to overestimate weather conditions. Coyne, Baldwin, and Latrorella (2005) also explained, on average, pilots overestimated visibility when ceilings were higher, and overestimated ceilings when visibility was better. It was suggested by the researchers the interaction of ceiling and visibility shows pilots may be inappropriately assessing weather conditions. The researchers recommended disseminating information to help some pilots better understand VFR-into-IMC. A recommendation was also given for utilization of decision-making modeling of the interaction between ceiling and visibility and the design of

GWIS technology and GA pilot accurate weather assessment to improve understanding of this accident type.

The studies all found pilots' decision-making and behaviors were likely affected by visual displays. It is well documented in the aviation community the limitations of human perception, particularly visual sensory, are major contributors to human error. Since environments tend to remain in unchanging states, they might believe something not there has been seen, or something was not seen that was in plain sight. Humans may not be able to fully process sudden changes in what they are seeing (Sternberg & Sternberg, 2016). Visual displays are not always working to reduce human error in the cockpit. There are limitations to the current visual display technology. There may be a delay in reception of weather information from the source to the cockpit, combined with the weather depiction on the visual display may not be to the correct scale. This situation may lead the pilot to believe the weather is good along the selected flight path when in reality it is deteriorating, contributing to pilot continue to destination decision-making errors and a potential fatality. Coupled with linear decision-making, where pilots commit to one decision without reevaluation after actions have been implemented, industry still relies heavily upon visual displays, when pilots are making life and death decisions based on their ability to interpret the weather at any given time (Balog, 2013; Balog, 2016). The results of these studies showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding between context and weather information assessment and on the following factors related to the length of time a pilot would fly into degraded weather conditions: (1) weather display symbology and color and the perceptual asymmetry effects on pilot behavior and decision-making, (2) risk assessment, (3) decision making, (4) weather state-change notifications/symbol change detection on GA pilots' behavior, (5) cognitive engagement, (6) weather situation awareness, (7) change blindness, (8) ceiling and visibility determination, (9) use of graphical METARs, (10) delay in reception of weather information from the source to the cockpit, and (11) weather depiction on the visual display may not be to the correct scale.

Training

Nicolai et al. (2017) endeavored to discover accident trends and perceptions of deficiencies in training, by examining VFR-into-IMC accident reports between 2003 and 2012. The researchers also sought current information through a survey. The study found there remains a lack of proper training in the areas of weather and weather technology concepts. The authors argued it is difficult for pilots to improve their SA and decision-making because of this insufficient training. Whitehurst et al. (2017) conducted a study to identify causal factors and gaps in training leading to VFR-into-IMC aircraft accidents. A mixed methods approach with NTSB VFR-into-IMC accidents between 2003 and 2012 was used. A national survey was also disseminated to obtain data on pilot self-identified training deficiencies. The results reported SA is connected to decision-making.

A possibility for training to improve pilot decision-making, suggested by Nicolai et al. (2017), might be found in a study conducted by Wiggins and O'Hare (2003). The research utilized a computer-based training system for VFR pilots, and provided a cue-based training program, designed to teach pilots how to recognize deteriorating weather conditions while in flight. The cueing variables used in the study were associated with deteriorating weather conditions during flight and included darkening clouds, terrain clearance, cloud base, visibility, concentration, rain, cloud type, wind direction, and wind velocity. The training system helped pilots to practice skills necessary for recognizing and responding to declining weather cues in VFR-into-IMC conditions during flight. The study found self-reporting pilots were more likely to respond to weather cues following the training program. Performance-wise, it was evident cue-based training may improve the speed of pilot weather-related decision-making. In order to improve SA in training, Ball (2008) sought to understand why pilots fly too closely to hazardous weather. Using a graphical weather display and instructional training, the study found training improved pilots' ability to maintain safe distances from poor weather conditions. It might not be, necessarily, an ability to maintain safe distances, but rather, a conscious choice influenced by level of experience and quality of training. Sawyer and Shappell (2009) investigated the ways experience and training affect the weather identification accuracy, response bias, and visual scan paths of pilots. Their results found training did not improve decision accuracy, but it did indicate there was a shift in bias toward a decision to not continue into IMC.

Keller (2015) found VFR pilots who flew into IMC did so because they misperceived the severity of the weather and the associated risks. Pilots who turned, or diverted, did so because they became aware of the danger and sought to return to safety. Additionally, O'Hare and Smitheram (1995) found pilots who viewed risk from a gain standpoint were less likely to continue into IMC, and those who considered risk from a loss viewpoint were more likely to continue. The difficulty to train for accuracy found in the Sawyer and Shappell (2009) study might indicate it is also difficult to improve the accuracy of pilot risk assessment with training.

The Knecht, Ball, and Lenz (2010) study utilized video weather training, web-based preflight weather briefing, and pilot weather knowledge/flight behavior of local versus non-local pilots. Participants were given pre-tests and post-tests to measure knowledge acquisition because of the training. It was found both video trainings significantly improved pilot scores. However, both the online preflight weather briefing and the weather knowledge of local versus non-local pilots had no important differences, implying Civil Aerospace Medical Institute (CAMI) studies could be generalizable to the United Stated population of GA pilots. These studies emphasized the deficiency in adequate training for weather and weather technology concepts. This creates a difficult situation for pilots to acquire the needed knowledge, skills, and abilities during flight training and experience acquiring flight hours.

Historical GA adverse weather accident studies have utilized comprehensive statistics to help discover possible factors contributing to VFR-into-IMC events. Ison (2014a) used logistic regression to investigate potential pilot-related, and situational factors including accident time of day, terrain, receipt of weather briefing, communication with air traffic control, filing of a flight plan, pilot certification, pilot experience, and pilot age. It was found two factors were significant contributors to VFR-into-IMC accidents: terrain and weather briefing. Three significant relationships were also found: accident type and flight plans, terrain and pilot flight time, and terrain and flight plan. The study indicated a need for improvement in pilot training, including flying into mountainous areas and the proper interpretation of weather data.

The Ison (2014b) study found similar and additional information. The research concluded safety benefits could be achieved if lower-certification pilots completed situational-based training (SBT), received specific training prior to flying in mountainous terrain, and were provided with better weather briefing training including an emphasis on warnings and hazards. The results of these studies showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding among context, training, and on the following factors related to the length of time a pilot would fly into degraded weather conditions: (1) lack of proper training in the areas of weather and weather technology concepts, (2) situational awareness and weather-related decision-making, (3) cue-based training, (4) flight distance from poor weather conditions, (5) level of flight experience, (6) quality of training, (7) weather identification accuracy, (8) response bias, (9) visual scan paths, (10) decision accuracy, (11) perception of the severity of the weather and the associated risks, (12) gain versus loss risk perception, (13) risk assessment, (14) video, web-based preflight weather briefing, and weather knowledge, (15) accident time of day, (16) terrain, (17) receipt of weather briefing, (18) communication with air traffic control, (19) filing of a flight plan, (20) pilot certification, (21) pilot experience, (22) pilot age, (23) mountainous areas flight training, (24) proper interpretation of weather data, (25) situational-based training, and (26) weather briefing training including an emphasis on warnings and hazards.

Contextual Factors GA Weather/Non-Weather Accidents

O'Hare and Owen (2002) researched GA cross-country VFR crashes and contextual factors. The research involved the study of database historical archives of cross-country weather-related accidents in New Zealand from 1988 to 2000. A total of 1,308 records were retrieved for the time frame, and 77 accidents were identified as cross-country flights. A primary comparison found several contextual factors contributing to the accidents including the following:

Visibility. There was a marginally significant difference (F [1, 28] = 8.3, p = 0.07) in the estimated visibility at the time of the crash. The visibility was reported as 20 km for all the Acts of God (AOG) crashes and 5 to 20 km for In-Flight Volitional (IFV) crashes (seven IFV crashes occurred below 5 km visibility).

Altitude. There was a statistically significant difference in the height above sea level of the crash site for IFV crashes at a mean 2,970 feet above mean sea level (AMSL) and 150 feet AMSL for the AOG crashes (F [1,20] = 6.3, p = .02).

Pilot characteristics. The pilot mean age in IFV crashes was 37.8 years. The AOG pilots were 47 years of age. It was determined the difference of 9.2 years between the groups was statistically significant (F [1, 43] = 3.9, p = .05). The mean hours flown in the IFV group during the previous 90 days was determined to be 59.8 hours. It was also determined the AOG group flew a total of 31.9 hours. No statistically significant relationship was found for the flight hours of the two groups (F [1, 54] = 3.7, p = .06). Additionally, no statistically significant differences were found for any of the other pilot characteristics assessed in the study.

A second comparison of weather-related and non-weather-related crashes revealed weather-related crashes took place later into cross-country flights and closer to planned destinations than other types of GA accidents. Additionally, the second comparison found age and flight to be contextual, contributing factors to weather-related GA accidents. GA pilots who were involved in weather-related accidents tended to be younger and possessed more recent flight time than other pilots. The results showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC cross-country accidents, as there are gaps in understanding for contextual factors derived from accident analysis related to the length of time a pilot would fly into degraded weather conditions: (1) visibility, (2) altitude, (3) age, (4) hours flown, (5) time into cross-country flights and distance to planned destinations, and (6) flight.

Summary of GA Part 91 VFR-into-IMC Contextual Factors

The 46 contextual factors identified in the literature and used in the study are provided in Appendix D (Table D1). This table provides each of the 46 contextual factor names, descriptions, and sources for the factors identified in the research literature. The 46 contextual factors selected for the study were taken from a limited number of dated Part 91, GA studies exploring the contextual factors contributing to VFR-into-IMC accidents. These studies have identified the presence of contextual factors occurring for this accident type, as well as the existence of unsafe pilot behaviors negatively affecting judgment and increasing the probability for error.

Expert raters and inter-rater reliability

Inter-rater reliability studies, in fields such as medicine and the social sciences, have used models rated by experts with the guidance published by Cohen (1960) and

Fleiss (1971) to determine the degree of rater agreement for nominally scaled data (Gwet, 2008; Joslin, 2014; Oakleaf, 2009; Stemler, 2004). Applicable, statistical literature included research for rating categorical data using multiple raters, although no required number of raters was specified, and measuring inter-rater reliability using Fleiss' kappa. Inter-rater reliability has also been examined and determined with other measures including Cohen's kappa, Cohen's weighted kappa and the equivalent Intraclass Correlation Coefficient (ICC), and the particular inter-rater reliability measure chosen by the researcher depends on the number of raters and whether the data is nominal, ordinal, or continuous (Fleiss, 1971; Fleiss & Cohen, 1973; Joslin, 2014). The statistics kappa and weighted kappa apply only to Cohen's kappa measuring the extent two raters agree on rating a sample of subjects on a nominal scale, and Fleiss' kappa is a generalization of unweighted kappa measuring the degree three or more raters agree on rating a sample of subjects on a nominal scale (Fleiss, 1971). Cohen's kappa can only be used in assessing agreement for one rater against himself and two raters against each other, and the Fleiss' kappa measure is a variation of Cohen's kappa (Fleiss, 1971). Fleiss' kappa has been used in studies where any number of raters assign categorical ratings to a fixed number of items (Fleiss, 1971; Singendonk et al., 2016). Fleiss' kappa can only be used with binary or nominal scale ratings. Cohen's kappa has the same two raters rating a set of items and Fleiss' kappa allows a fixed number of raters to rate different items (Fleiss, 1971). Agreement among raters has been determined through a fixed number of raters assigning numerical ratings to several items. The kappa (κ) is a measure of the rating consistency among raters and specifies the amount of agreement beyond what is expected by chance

(Kiliç, 2015). The κ measure has been defined as the following in equation 1 (Fleiss, 1971):

$$\kappa = \frac{\bar{P} - \bar{P}_e}{1 - \bar{P}_e} \tag{1}$$

The denominator identifies the level of agreement achievable above chance. The numerator provides the level of agreement actually achieved above chance. If all raters are in total agreement, then the κ measure will be equal to one. If there is no agreement among raters, other than expected by chance, then the k measure will be less than or equal to zero. The specified number of raters, *n*, assign subjects, *N*, to a determined number of categories, *c*. The value of *P* (bar) is calculated by determining the sum of all data rows and then multiplying by one over the total number of rows for the entire spreadsheet. The value of P_e (bar) is calculated by determining the sum of each column, dividing by *N* multiplied by n assignments, then squaring and summing the result of each column. Fleiss' kappa (κ) can then be determined by completing the calculation using the equation given in equation 1.

The value of N is the total number of accidents. The value of n is the number of raters identifying the presence of the particular contextual factor from the 46 research identified contextual factors. The value of k is the 46 contextual factors used by the raters for identification of the presence of the individual contextual factors (1 through 46) in the 85 accident sample. The accidents are indexed by i = 1 to N, and the 46 contextual factors are indexed by j = 1 to k. The value n_{ij} represent the number of raters who assigned the i^{th} accident to the j^{th} contextual factor. The first step is to calculate p_j, the proportion of all accidents assigned by the raters to the j^{th} contextual factor. The second step is to calculate P_i, the extent the raters agree on the i^{th} accident. The second step involves determining the number of rater pairs who agree out of the total number of all possible rater pairs. The third step is to compute P (bar), the mean of the P_is, and P_e (bar) to calculate Fleiss' kappa (κ).

The four raters (pilot study) and three raters (main study) (*n*) assign 9 (pilot study) and 85 (main study) GA VFR-into-IMC accidents (N) to a total of 46 contextual factor categories (k). The 46 contextual factor categories (k) are presented in columns, and the GA VFR-into-IMC accidents are presented in rows. Each cell identifies the number of raters who assigned the particular accident (row) to the presence of a particular contextual factor (column) (i.e. 0, 1, 2, 3 or 4 in the pilot study or 0, 1, 2 or 3 in the main study). The example shown in Table 1 (not actual data) illustrates how the data is used to determine Fleiss' kappa for the main study using three raters (Fleiss, 1971; Gwet, 2014; Landis & Koch, 1977; Scott, 1955; Sim & Wright, 2005).

Table 1

Determination of Fleiss' Kappa

NTSB GA VFR-into-IMC Accident Number n_{ij}	Contextual Factor 1	…	…	…	Contextual Factor 46	P_i
A1 - ANC12FA009	3	…	…	…	2	P_{i1}
A2 - ANC12FA066	2	…	…	…	2	P_{i2}
A3 - ATL07FA038	0	…	…	…	3	P_{i3}
A4 - ATL03FA062	3	…	…	…	0	P_{i4}
A5 - ATL07FA081	1	…	…	…	3	P_{i5}
A6 - ATL91FA043	2	…	…	…	1	P_{i6}
…	…	…	…	…	…	…
A80 - SEA96FA021	3	…	…	…	1	P_{i80}
A81 - WPR10FA142	0	…	…	…	0	P_{i81}
A82 - WPR11FA147	1	…	…	…	2	P_{i82}
A83 - WPR11FA241	2	…	…	…	1	P_{i83}
A84 - WPR12FA031	3	…	…	…	3	P_{i84}
A85 - WPR14FA172	2	…	…	…	2	P_{i85}
Total	22	…	…	…	20	
P_j	P_{j1}	…	…	…	P_{j46}	

Note. Adapted from "The kappa statistic in reliability studies: Use, interpretation, and sample size requirements," by J. Sim and C.C. Wright, 2005, Journal of the American Physical Therapy Association, 85(3), 257-268.

The calculation to determine Fleiss' kappa (κ) uses the data in Table 1, including N = 85 (accidents), n = 3 (raters), and k = 46 (contextual factors), the sum of all cells, and the sum of P_i. The value of P_j is calculated using the number of total N accidents multiplied by the number of total raters. In the main study, the value of P_j is calculated to be 85 accidents multiplied by 3 raters = 255 total accident ratings made by the three raters to the j^{th} contextual factor. The values for P_j and P_i are then calculated. The value of P_j is determined for each column by calculating the sum of the column and then dividing by 255. The value of P_i is then determined for each row by dividing one by the sum of the column multiplied by the sum minus one then multiplying the value by the squared value of each rater rating in the row and then subtracting the total number of 3 raters. The value of P (bar) is then calculated by taking the sum of all P_i values and then dividing by 85, the total number of accidents in the main study sample. The P_e (bar) value is then calculated by taking the squared value of each P_j value and then calculating the sum of all values. Fleiss' kappa (κ) is then calculated by subtracting the P_e (bar) value from the P (bar) value and then dividing by the P_e (bar) value subtracted from one.

Landis and Koch (1977) developed a table to enable the interpretation of κ values (Table 2). The κ values are identified from -1.0 to +1.0. A κ value of -1.0 should be interpreted as the agreement between the raters was worse than expected by chance. A κ value of zero should be interpreted as the agreement between the raters was no better than by change. A κ value of 1.0 should be interpreted as the agreement between the raters was perfect (i.e. the raters all agreed the contextual factor was present in the accident). The table appears to be the most widely accepted for κ agreement.

Table 2

Generally accepted standards of agreement for kappa (κ)

Kappa (κ)	Interpretation
< 0	Poor agreement
0.01 – 0.20	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 1.00	Almost perfect agreement

Note. Adapted from "Measuring nominal scale agreement among many raters," by J. Fleiss, 1971, Psychological Bulletin, 76(5), 378-382.

The research literature has identified various κ values and the associated interpretation of acceptable levels of agreement. McCoul et al. (2012) used unweighted Fleiss' Kappa statistic (K_f) and the prevalence-adjusted bias-adjusted kappa (PABAK) to report interrater agreement of nasal endoscopy in patients with a prior history of endoscopic sinus surgery. Researchers reported interrater agreement values of excellent ($K_f = 0.886$), moderate ($K_f = 0.543$; $K_f = 0.443$; $K_f = 0.593$; $K_f = 0.429$), fair ($K_f = 0.314$; $K_f = 0.257$; $K_f = 0.229$), and poor ($K_f = 0.148$; $K_f = 0.126$). Smith et al. (2012) used the Fleiss' kappa test and PABAK for categoric data to report interrater reliability of endoscopic parameters following sinus surgery. The researchers also reported interrater agreement values of strong agreement (kappa = 0.499, prevalence index = 0.925; kappa = 0.364, prevalence index = 0.829). Green (1997) identified interrater agreement values for kappa statistics using multiple raters and categorical classifications of high agreement (kappa = greater than 0.75), low agreement (kappa = below 0.40), and fair to good level of agreement (kappa = 0.40 to 0.75). It has been explained kappa corrects for chance agreement and reports lower interrater agreement values where classification of agreement levels are opinions of the researchers and are therefore arbitrary (Landis & Koch, 1977). The Landis and Koch (1977) table was used to determine the κ values for the four raters (pilot study) and three raters (main study) as it appears to be the most widely accepted for κ agreement.

Percentage agreement and Fleiss' kappa for four (pilot study) and three (main study) raters was used to measure inter-rater consistency as the consensus in the reviewed research literature was a recommendation to use a minimum of two measures due to the advantages and disadvantages of the available measures. The percentage agreement is the simplest measure of inter-rater reliability but does not consider the agreement expected by chance alone and is strengthened by using measures indicating proportion of agreement beyond chance including Fleiss' kappa for multiple raters rating nominal data.

The use and reporting of the Fleiss' kappa statistic for the pilot and main studies is the only statistic needed if the totals from the four (pilot study) and three (main study) raters do not vary by large amounts. Falotico and Quatto (2015) emphasized the Fleiss' kappa statistic is a well-known index for assessing the reliability of agreement for raters used in the psychological and psychiatric fields. The study used IBM© SPSS™ software to determine Fleiss' kappa. It has been determined, through a review of the Sim & Wright (2005) research, if all the raters respond to the presence of a particular contextual factor, it is possible the Fleiss' kappa statistic could show a low level of interrater reliability despite a high observed agreement. In order to reduce bias, some researchers recommend using a prevalence-adjusted bias-adjusted kappa (PABAK) to adjust for prevalence and bias (Byrt, Bishop, & Carlin, 1993; Sim & Wright, 2005). The PABAK takes into consideration the prevalence index (PI), high chance rater agreement on presence of contextual factors leading to low Fleiss' kappa values/low chance rater agreement on presence of contextual factors leading to increased Fleiss' kappa values. The PABAK also considers the bias index (BI), large rater disagreement on presence of contextual factors leading to a higher Fleiss' kappa value/low rater disagreement on presence of contextual factors leading to lower Fleiss' kappa value. The PI and BI were used in the study to adjust the Fleiss' kappa interrater agreement statistic to account for the described potential biases by calculating average values and substituting the results for the actual values.

The use of more than two raters providing nominal ratings and measuring agreement with the Fleiss' kappa statistic has been identified in the reviewed research. Zapf et al. (2016) measured inter-rater reliability for nominal data using percentage agreement and Fleiss' kappa using a simulation study investigating the influence of four factors including number of observations, number of raters, number of categories, and the strength of agreement (low, moderate, and high). In order to show what was learned from the simulation study, the findings were applied to a case study consisting of 81 scenarios of histopathological assessment of patients with mamma carcinoma rated by four raters focusing on the interrater agreement. Researchers produced nominal data using the multinomial distribution with N subjects, n raters, and k categories due to utilization of the unweighted Fleiss' kappa being only appropriate for nominal data. The researchers identified, through observed agreement, considerable differences between the parameters investigated ranging from 10% (MIB-1 proliferation rate) to 96% (estrogen receptor group). The corresponding Fleiss' kappa values ranged from 0.20 (low rater agreement) to 0.74 (medium rater agreement). It was concluded, when considering nominal data with no missing values, the Fleiss' kappa is recommended for use in determining interrater reliability. Poburka, Patel, and Bless (2016) investigated the inter-judge and intra-judge reliability of raters using the Voice-Vibratory Assessment with Laryngeal Imaging (VALI) rating form developed for assessing video stroboscopy and high-speed videoendoscopic (HSV) recordings. Researchers used nine raters trained to use a data collection form for rating a sample of 66 voice disorders. The study assessed nominal data factors including glottal closure, vertical level, and free edge contour using percentage agreement and Fleiss' kappa. Nominal parameter results included correlations ranging from 0.18 to 0.35 for stroboscopy and from 0.13 to 0.33 for HSV and percentage of concordance ranged from 44% to 78% for stroboscopy and from 52% to 89% for HSV. It was concluded the rating form developed for the study incorporating visual-perceptual ratings of both stroboscopy and HSV can be used to make reliable visual-perceptual judgments related to features of vibratory motion from stroboscopy and HSV. McCoul et al. (2012) completed a study using 14 endoscopic nasal examinations recorded using digital video capture software. A total of five raters reviewed the inflammatory and anatomic video findings. The study compared the results between the K_f and the PABAK. The research specifically used the K_f and PABAK to report interrater agreement of nominal inflammatory and anatomic attributes examined in patients with a prior history of endoscopic sinus surgery. The study reported interrater agreement values of excellent (K_f = 0.886), moderate (K_f = 0.543; K_f = 0.443; K_f = 0.593; K_f = 0.429), fair (K_f = 0.314; K_f = 0.257; K_f = 0.229), and poor (K_f = 0.148; K_f = 0.126). It was concluded, due to the interrater agreement variability for the rater nominal inflammatory and anatomic attributes assessed in the study examined, additional standardization of nasal endoscopy interpretation could increase procedure reliability in clinical practice. Smith et al. (2012) completed a study on the interrater reliability of endoscopic parameters following sinus surgery. A total of 120 video-endoscopic evaluations for 20 subjects were rated by four sinus surgeons. The nominal categories used by the raters were related to adhesion formation and middle turbinate position. The researchers used Fleiss' kappa and PABAK to report interrater reliability of endoscopic parameters following sinus surgery. The results showed interrater values of strong agreement (kappa = 0.499, PABAK = 0.925; kappa = 0.364, PABAK = 0.829). It was concluded middle turbinate position and adhesions have acceptable reproducibility appropriate for evaluating endoscopic sinus surgery (ESS) postsurgical period outcomes.

Metric Reliability and Validity

The usefulness of any measure depends on the demonstrated benefit determined by valid metrics (Joslin, 2014). Zapf et al. (2016) explained validity is defined in terms of how well a study captures the interested measure, and high reliability means a measure is reproducible over time in changing settings and by different raters. The quality of a rater opinion can be measured using credibility, dependability, transferability, and confirmability testing (Lincoln & Guba, 1985; Velázquez, 2016). Similarly, the quality of a rater opinion on the presence of the 46 research identified contextual factors in the NTSB GA Part 91 VFR-into-IMC accident sample can be measured using these four tests. Credibility was achieved by using a recognized authoritative source of NTSB database descriptions of the accidents selected for the pilot and main study samples as well as using expert rater opinions for the presence of the 46 research-identified contextual factors (Appendix M). Dependability was achieved during communication between the raters when assessing the pilot study materials including the data collection form, contextual factor definitions, and NTSB database sample of AARs. Transferability was achieved by providing detailed descriptions of the research methodology and procedures so other researchers could complete studies using the information (Creswell, 2005; Velázquez, 2016). Confirmability was achieved through utilization of objective NTSB AAR data and rater data meaning agreement. All of the raters identified the presence of the 46 research-identified contextual factors from the same GA Part 91 VFR-into-IMC accident sample narratives selected from the NTSB AARs. The raters were provided drop down selections for the 46 research-identified contextual factors on the data collection form during the pilot study. During the pilot study, the raters communicated with each other and the researcher and identified discrepancies with the drop down menus of the factors to the researcher for correction before the main study was disseminated.

Summary

Continued flight from VFR-into-IMC accident statistics have consistently identified GA with the highest number of yearly fatalities. Historical research has focused on improved understanding and reducing the fatality causes and statistics for this pilot group and accident type. The review of relevant literature identified dated GA research concentrating on pilot characteristics, policy violations, weather information assessment, perception of display information, training, accident analysis, and associated decision-making. An assessment of the pertinent literature also identified dated GA contextual factor research focusing on decision errors, cognition, historical accident analysis, PCE, flight simulation, and pilot behavior. The dated studies identified knowledge gaps and the need for additional research, including database research, to improve understanding among context, pilot characteristics, policy violations, weather information assessment, perception of display information, training, accident analysis, and associated decision-making. The current research improved on deficiencies in previous research by utilizing four raters in the pilot study, and ultimately three raters in the main study due to one rater being unable to participate. These improvements were based on the most frequently used raters in the reviewed similar studies rating nominal/categorical data. Raters identified the presence and frequencies of the 46 reviewed research-identified contextual factors and manifestations of the contextual factors in recently completed GA VFR-into-IMC AARs archived in the NTSB online safety database. The researcher examined and determined the statistically significant relationships between the contextual factors present in the NTSB AARs and other factors including pilot age, flight experience, weather, flight conditions, time of day, and certification level using point biserial and phi correlations. Contextual factor effects were also examined and determined for the crash distance from departure and crash distance from planned destination using multiple regression. A review of the literature also specified precedents in research for utilizing multiple raters and measuring inter-rater reliability using Fleiss' kappa (κ).

CHAPTER III

METHODOLOGY

A total of four SME pilot raters (hereafter referred to as raters) were used in the pilot study and three raters in the main study. Four raters were originally chosen for the pilot and main studies based on the most frequently used number of raters identified in similar studies rating nominal/categorical data. The pilot study was completed by four raters. It was anticipated the same four raters would be used in the pilot and main studies in adherence to the recommendations given by Thabane et al. (2010) and van Teijlingen and Hundley (2001). However, three of the four raters ultimately completed the main study due to one rater being unable to participate. The guidance was given from the Committee Chair to complete the study reporting the four raters' data for the pilot study and three raters' data for the main study. Raters were used to standardize the classification of the 46 research-identified contextual factors during the pilot study and determine the presence of the factors in the sample of 85 NTSB AARs in the main study. The raters assessed pilot actions representative of the contextual factors and identified the presence of the contextual factors in the accident sample. The selected raters are experienced pilots (Appendix M). Results were reported from the aviation perspective. This standardized classification of the contextual factors reduced the possibility of misperception when studying contextual factors with similar definitions, as the findings could be used in the aviation industry for future investigations.

The NTSB archival AARs of GA Part 91 VFR-into-IMC accidents, and the associated final probable cause report data, were reviewed by four expert raters (pilot study) and three raters (main study). Although the raters may have been acquainted with the VFR-into-IMC accidents assessed, the focus was on identifying the presence, frequency, and manifestation of 46 research-identified contextual factors in these types of accidents. Definitions of the contextual factors and sources of these definitions were given to the four (pilot study) and three (main study) expert raters to review in completing the study. Raters were instructed to use the contextual factor definitions to aid them in their task. Therefore, any previous familiarity with these types of accidents would likely be mitigated. Definitions of 46 research-identified contextual factors were applied by the raters to determine if any of the factors were present in a sample of 85 accidents. The raters were instructed to indicate whether the factors were present for those factors with a yes/no outcome. Some of the factors did not have binary outcomes, including time of day, altitude, height of crash site, light condition, passengers on board, and terrain. Non-binary options for these factors were able to be selected by the raters. Where possible, contextual factors were converted to yes/no outcomes. The 'time of day' was converted to 'day' and 'night,' and 'passengers on board' converted to 'yes' and 'no' so these contextual factors could be incorporated into the previously described analyses. Frequencies among the altitude, height of crash site, terrain, 'time of day/light condition' and passengers on board/total number of passengers contextual factors where a yes/no conversion was not possible were reported separately from the point-biserial and phi correlations and multiple regression analyses. The first part of the study was completed, utilizing a qualitative approach with the raters, to identify the presence of these contextual factors, frequencies, and how the factors were manifest in the accident sample. Percentage agreement, PABAK, and Fleiss' kappa (κ) were used to determine inter-rater reliability for the raters. The second part of the study was accomplished utilizing a quantitative approach to examine the relationships between the contextual factors and the selected variables including pilot age, flight experience (total flight hours), weather (inclement/non-inclement), flight conditions (VMC/IMC), time of day (day/night), and certification level (instrument-rater/non-instrument rated). Quantitative analysis included the use of point biserial and phi correlations to determine if there was a statistically significant relationship between the contextual factors and pilot age, flight experience, weather, flight conditions, time of day, and certification level. A determination was made as to the specific contextual factors, if any, associated with what effects on Part 91 GA VFR-into-IMC pilot weather-related decision-making error. The researcher used the crash distance from departure and crash distance from planned destination as outcomes in the multiple regression analyses. The approach of using expert raters to identify accident contextual factors, frequencies, and manifestations is generalizable to other fields of study.

Research Approach

Qualitative research methods on secondary data were utilized to examine and determine the contextual factors present in GA Part 91 VFR-into-IMC accidents. The research assessed a sample of 85 NTSB United States aviation accidents from the population of 691 NTSB aviation accidents attributed to GA pilot error from 1991 to 2014. NTSB AARs were used to explore exclusively GA Part 91 VFR-into-IMC pilot-related accidents. Forty-six research-identified contextual factors were identified and correlated within the sample of 85 NTSB AARs to explore the relationships between the contextual factors and other factors involved in these events. The other factors involved in the VFR-into-IMC accidents included pilot age, flight experience, weather, flight conditions, time of day and certification level.

NTSB GA VFR-into-IMC AAR narratives were reviewed by four expert raters for the pilot study and three expert raters for the main study. All four raters are recognized flight instructor subject matter experts with GA VFR-into-IMC accidents (Appendix M). Raters identified the presence of 46 research-identified contextual factors in a pilot study sample of nine accidents and main study sample of 85 accidents. Expert opinions were provided by the raters about how the factors were manifested in the pilot study and main study accident samples. Research-identified contextual factor definitions were applied to each accident in the pilot study and main study by all raters (Table D1). The researcher reported the presence, frequency, and manifestation of the contextual factors in the sample of pilot and main study NTSB AARs as identified by the expert raters.

The selected four raters for the pilot study and three raters for the main study were samples representative of the experienced pilot population. Raters were selected based on precedent research conducting similar studies and using similar numbers of raters (Smith et al., 2012; Zapf et al., 2016). Criteria used to determine the qualifications for rater selection to participate in the study included GA flight instruction experience, flight experience level, and demographics. Selection criteria included the possession of the FAA Certified Flight Instructor (CFI) and ATP certificates. Raters were selected based on their respective possession of these qualifications. This flight instruction experience, combined with flight experience level, indicated the raters were proficient in VFR-into-IMC flight operations, as well as instructing GA pilots, and gave them an ideal background for being receptive to the 46 research-identified contextual factors connected to this accident type. It was assumed the rater training and instruction by the researcher provided adequate familiarization with the 46 research-identified contextual factors to be used in the study. All raters possessed significant flight time in GA and commercial aircraft as well as expert level knowledge related to VFR-into-IMC. The raters were recruited through professional affiliation.

Pilot Study. A pilot study, or feasibility study, was completed to establish data collection instrument validity and inter-rater reliability. The pilot study sample included nine NTSB AARs from fatal GA Part 91 VFR-into-IMC accidents. A sample size of nine was determined to be the minimum required sample size for inter-rater reliability as explained by Connelly (2008). The sample of nine NTSB AARs for the pilot study, as well as 85 separate NTSB AARs for the main study, were taken from the population of 691 accidents previously described (Appendix K; Table K1; Appendix L; Table L1).

The data from the pilot study were consolidated to compare the respective contextual factor selections for each of the four raters. This data was used to develop a table including descriptive statistics. The pilot study was used to check the provided instructions for understanding by the raters, confirm all four raters were able to view the NTSB AAR narratives through the provided hyperlinks, ensure the documentation was accessible, and evaluate the instruction form, data collection database file, procedures, and data analysis approach to determine if any modifications were needed. It was anticipated the same four raters would be used in the pilot and main studies in adherence to the recommendations given by Thabane et al. (2010) and van Teijlingen and Hundley (2001). However, one of the raters was able to complete the pilot study but not the main study. Guidance was given by the Committee Chair to complete the study reporting the four rater's data for the pilot study and three rater's data for the main study. A Human Subjects Protocol application was not submitted to the Embry-Riddle Aeronautical University (ERAU) Institutional Review Board (IRB) for study exemption since the research used existing secondary data from deceased individuals. A determination was made using the IRB Decision Tree #1 and Decision Tree #2 (Appendix A; Figure A1; Figure A2). The pilot study has been utilized in research to determine statistical significance and main study sample size (Thabane et al., 2010). Main study sample size was calculated to be 85 cases (Appendix I; Figure I1). The main study sample size of 85 out of a total of 691 VFR-into-IMC cases was determined using the percentage of VFR-into-IMC accidents occurring in each of the NOAA defined climate regions (NOAA, 2018; Figure 1; Figure 2). Guidance by Connelly (2008) established the pilot study sample should be at least 10% of the sample for the actual study. The pilot study sample size was calculated to be 8.5 or 9 cases.

The raters were emailed the instructions, contextual factor definitions and references, and Microsoft® Access™ database collection form (Table D1; Appendix B, Figure B1; Appendix F; Figure F1; Appendix J). Four raters then rated the nine VFR-into-IMC accidents one at a time. All raters were permitted to complete the ratings at a time and place of their respective choosing. Each rater completed the Microsoft® Access™ database collection form within two weeks and returned his respective ratings of the nine pilot study accidents via email to the researcher. Modifications were made to the main study Microsoft® Access™ database collection form from data received from the four raters in the pilot study (Appendix B; Figure B1; Appendix C; Figure C1). The pilot study was assessed to ensure the contextual factors were consistently rated and any discrepancies corrected. In some of the accidents, the raters were unsure of selecting a particular contextual factor due to confusion with some of the definitions, such as with Contextual Factor 23, Flight Plan Policy Violation, if filing IFR when required was part of the definition. The raters were referred to the detailed definitions of the contextual factors, including the sources of the definitions, and provided a copy of the definitions for reference in rating the 46 research-identified contextual factors in the pilot and main studies (Appendix D; Table D1).

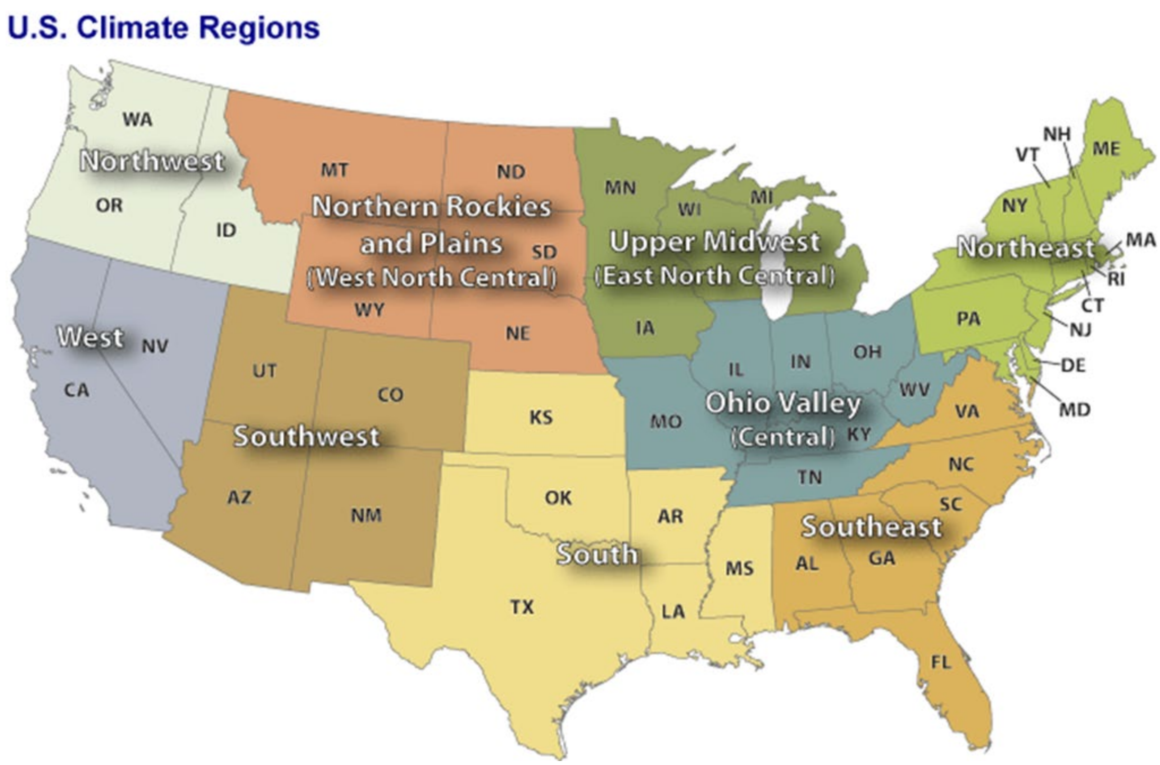


Figure 1. NOAA defined climate regions (NOAA, 2018). Adapted from the NOAA website (https://www.ncdc.noaa.gov/monitoring-references/maps/us-climate-regions.php)

Design and Procedures. A Human Subjects Protocol Application was not submitted to the ERAU IRB for approval as the researcher used existing secondary data from not living individuals. The ERAU IRB guidance provided in Decision Trees #1 and #2 was used by the researcher to determine use of existing secondary data does not constitute human subject research and does not require approval (Appendix A; Figure A1; Figure A2). Guidance from the decision trees was to proceed with the research. The raters were not required to complete an Informed Consent Form per guidance given to the researcher directly from the ERAU IRB.

The four raters (pilot study) and three raters (main study) were provided the instructions, contextual factor definitions and references, and Microsoft® Access™ database collection form (Table D1; Appendix B, Figure B1; Appendix C; Figure C1; Appendix F; Figure F1; Figure F2; Appendix J). The Microsoft® Access™ database collection form provided the raters with hyperlinks to the NTSB AARs. Raters reviewed the instructions, contextual factor definitions, and references. Individual GA VFR-into-IMC NTSB AARs were then reviewed by each rater one at a time. The 46 research-identified contextual factors were then reviewed one at a time by each rater to examine and determine if any of the contextual factors were present in the sample of NTSB AARs. Raters identified the presence of each contextual factor by selecting the appropriate option from the provided drop-down menu in the Microsoft® Access™ database collection form (Appendix B; Figure B1; Appendix C; Figure C1). Results for each accident were saved in the respective rater's Microsoft® Access™ database collection form for review by the researcher. Instructions in Appendix F were given to the three raters for the pilot study and four raters for the main study (Appendix F; Figure F1; Figure F2). The following instructions were also provided to each rater:

1. Each rater will receive an email including study completion instructions from the researcher, the GA VFR-into-IMC contextual factor definitions, the NTSB AARs for the accident sample, and a Microsoft© Access™ data collection form. The rater will review the GA VFR-into-IMC contextual factor definitions and then identify the presence of the contextual factors in the GA Part 91 VFR-into-IMC fatal accident sample and return the data collection form to the researcher when completed.
2. The rater will not reproduce or share any of the items and will return them to the researcher along with a completed rater Microsoft® Access™ database collection form.
3. The rater will identify the 46 literature-identified contextual factors independently using the provided definitions without discussion with any other person or reference to any other information.
4. The rater will not be expected to travel to any location but will require a personal computer with word processing (.doc and .docx) and the ability to view textual files.
5. The Main Study is provided in the attached Microsoft® Access™ database under the 'Main' table. Once you are in the program, click on the 'Main' table from the list of tables located on the left of the screen. The 'Main' table has 9 GA VFR-into-IMC fatal accidents selected from the NTSB Aviation Accident Database (pilot study). The 'Main' table has 85 GA VFR-into-IMC fatal accidents selected from the NTSB Aviation Accident Database (main study). The respective NTSB AAR numbers are given as well as hyperlinks to the NTSB

Aviation AARs that can be clicked when the pointing hand icon appears while hovering over the respective links. Once clicked, the respective NTSB final reports will open at this point for your review.

6. After reviewing the final reports and definition sheet for the 46 research-identified contextual factors, please identify the applicable contextual factors present for each of the 9 GA VFR-into-IMC accidents (pilot study)/85 GA VFR-into-IMC accidents (main study). This action can be accomplished by clicking the down arrow on the right side of each cell for each of the 46 contextual factors in moving from left to the right in the 'Main' table. If none of the drop-down list of options applies to the particular contextual factor, then select the NA (Not Applicable) option. If, in your opinion, there is not enough information provided in the NTSB factual report to identify a specific contextual factor, select the 'Not enough information provided to identify the contextual factor' in the drop-down options (select this option if there is a narrative to review and after reviewing, you feel there is not enough information to select a specific contextual factor). The NTSB report may lack a narrative to decide. If this is the case, select the 'Unknown' option in the drop down list (select this option if there is no narrative to review).

7. The hyperlink is provided for skyvector.com (https://skyvector.com/). This publicly available website includes United States sectional charts for rater determination of the accident site from the departure and destination points for DDLCF14 and DDLCF15.

8. Also, provide any comments in the rater comments cell related to how, in your opinion, the contextual factors were manifested considering the presence of the specific contextual factor(s) identified in the last cell of the Microsoft® Access™ 'Main' table.

9. These instructions should be completed for each of the 9 accidents (pilot study)/85 accidents (main study) one at a time.

Apparatus and materials. The researcher familiarized the raters with the 46 contextual factors identified in the reviewed research to correctly identify the presence of the factors in the accident sample through review of contextual factor definitions and reviewed literature sources (Table D1; Appendix J). Familiarization developed the rater's skill in recognizing the presence and manifestation of the contextual factors in GA Part 91 VFR-into-IMC flight scenarios in NTSB AARs. Raters were provided the instructions, contextual factor definitions and references, and Microsoft® Access™ database collection form including the sample of NTSB AARs to review (Table D1; Appendix B, Figure B1; Appendix C; Figure C1; Appendix F; Figure F1; Figure F2; Appendix J; Appendix K; Appendix L). An example of an NTSB GA VFR-into-IMC AAR from the NTSB database website is depicted in Appendix E (Figure E1; Figure E2).

Population/Sample

The source of the data for the study was the NTSB AARs and factual reports. These documents provided the information needed for the exploratory study of the 46 research-identified contextual factors contributing to GA Part 91 VFR-into-IMC accidents. NTSB AARs and factual reports between 1991 and 2014 were selected as these reports were completed with NTSB investigator's final probable cause determinations given. The identified timeframe was selected because the NTSB began including investigator-determined probable causes in the AARs on January 1, 1991. This timeframe stopped at December 31, 2014, because the researcher was informed by NTSB personnel it takes five or more years to complete an accident investigation. The NTSB AARs and factual accident reports were downloaded from the NTSB website (Appendix E; Figure E2). These reports were then analyzed by the raters for the presence of the 46 research-identified contextual factors.

The sample set used for the main study was comprised of 85 GA Part 91 VFR-into-IMC accidents involving the 46 research-identified contextual factors reported by the identified authors. This 85 accident sample set was representative of the GA Part 91 VFR-into-IMC accidents occurring in the United States, including Alaska, Guam, Hawaii, Puerto Rico, and the Virgin Islands (Figure 1; Figure 2). A minimum sample size of 85 was determined using stratified random sampling and taken from the population of 691 NTSB GA Part 91 VFR-into-IMC AARs and factual accident reports. The sample set was retrieved using NTSB filter codes 401 and 24015 specifically for this accident type from the NTSB database between January 1, 1991, and December 31, 2014 (Appendix E; Figure E1: Figure E2; NTSB, n.d.-d., p. 49). The sampling frame was all 691 NTSB GA Part 91 VFR-into-IMC accidents for this period, and relevant stratification was the specific GA Part 91 VFR-into-IMC accident type. All 691 GA Part 91 VFR-into-IMC accidents in the NTSB database were retrieved and identified with completed AARs and factual accident reports including final probable cause determinations. A consecutive number was assigned to each of the GA Part 91 VFR-into-IMC accidents occurring in the specific NOAA defined climate region stratum

(Figure 1). A proportionate stratification was calculated from the 691 accident cases. Systematic random sampling was used to select accidents directly from the sample frame. In order to ensure the number of accidents randomly selected for the sample from each NOAA defined climate region stratum was proportionate to the number of accidents in the population, the sample size was multiplied by the proportion of accidents occurring in each stratum (Figure 2). Therefore, the number of accidents required in the sample was calculated by multiplying the total number of GA Part 91 VFR-into-IMC accidents occurring in each NOAA defined climate region by the percentage of GA Part 91 VFR-into-IMC accidents occurring in each region (i.e., 34 Alaska GA Part 91 VFR-into-IMC accidents (AK total) x 0.049% GA Part 91 VFR-into-IMC accidents (AK proportion) = 1.66 or 2 accidents). A total of two accidents was randomly selected from the 34 total accidents occurring in Alaska. This process was followed to determine the sample set of 85 accidents randomly selected from each of the NOAA defined climate regions (Appendix I; Table I1). This sampling frame and method ensured the generalizability of the study as a United States representative sample of GA VFR-into-IMC accidents.

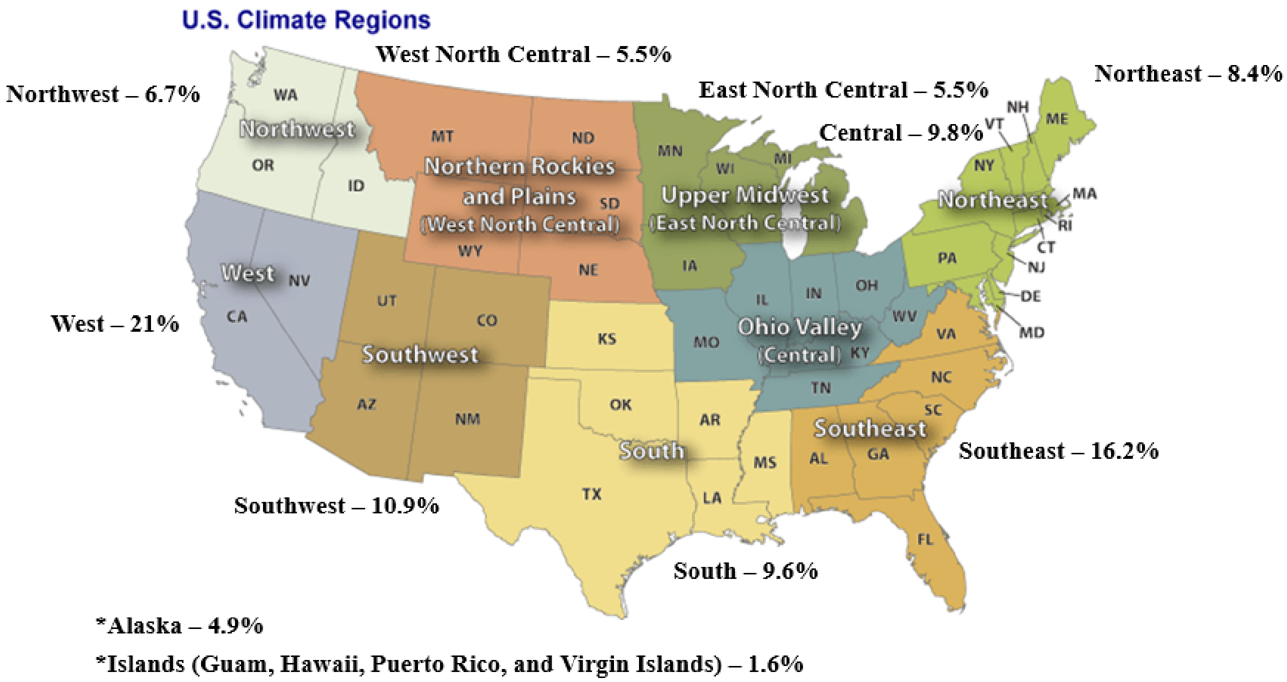


Figure 2. NOAA defined climate regions including percentage of accidents (NOAA, 2018). Adapted from the NOAA website (https://www.ncdc.noaa.gov/monitoring-references/maps/us-climate-regions.php).

Sources of the Data

The research data source was taken from the January 1, 1991, to December 31, 2014, population of completed NTSB United States AARs attributed to VFR-into-IMC pilot error where an investigator final probable cause ruling was established. The identified timeframe was selected because the NTSB began including investigator-determined probable causes in the AARs on January 1, 1991. This timeframe stopped at December 31, 2014, because the researcher was informed by NTSB personnel it takes five or more years to complete an accident investigation. Accidents occurring between January 1, 2015, and the present may not yet be completed and may not yet include NTSB investigator final probable cause determinations. Therefore, accidents occurring during this timeframe were not selected for use in the study. The number of qualifying reports meeting the GA Part 91 pilot entry into VFR-into-IMC criteria for the specified date range totaled 691. As this number of qualifying reports was abundant, the number of NTSB AAR reports used in the study was methodically narrowed down by selecting the 85 cases representative of all United States where the GA Part 91, VFR-into-IMC accident type occurred. NTSB AAR accident reports were used to explore exclusively GA Part 91, VFR-into-IMC accidents. Accident reports were downloaded from the NTSB Aviation Accident Database and Synopses online archives of AARs (Appendix E; Figure E1; Figure E2). These reports were analyzed by the raters to determine the presence and manifestation of the 46 research-identified contextual factors. The sample list creation involved the following seven steps:

1. The NTSB's complete aviation accident dataset was downloaded onto a computer as a Microsoft® Access™ file from the NTSB website at https://app.ntsb.gov/avdata/ (Appendix E; Figure E2). The file "avall.zip" (in the Access folder) contained all records for NTSB aviation investigations from 1982 to present, updated on the first day of each month.
2. After the *avall* database was downloaded, unzipped, and opened in Microsoft® Access™ , the following tables were identified:
    a. Events (one record per accident; contains accident date, fatalities, weather conditions, etc.)
    b. Aircraft (one record per accident aircraft; contains CFR part that aircraft was operated under)

c. Events_Sequence (one record per event in the accident sequence per aircraft for accidents occurring in 2008 or later as the NTSB changed its database structure and coding scheme during this timeframe)

3. A query was created in Microsoft® Access™ joining these tables on the ev_id and aircraft_key fields, which uniquely identified each accident and accident aircraft, respectively.

4. The query was filtered for the following attributes:

a. Events.ev_type = ‘ACC’ (just accidents)

b. Aircraft.far_part (just Part 91 and Part 91K)

c. Events_Sequence.eventsoe_no = ‘401’ (The post-2008 accidents were retrieved using the Events_Sequence, and filtered for the eventsoe_no = ‘401’ (the NTSB code for VFR encounter with IMC in the post-2008 new coding schema)

5. The pre-2008 accidents were retrieved by repeating the above steps but using the seq_of_events table instead of Events_Sequence, and filtered for seq_of_events.subj_code = ‘24015’ (the NTSB code for VFR encounter with IMC in the pre-2008 old coding schema).

6. The specific Part 91, GA accident reports were then reviewed by searching for the desired report on the NTSB website (using the value in Events.ntsb_no) and going directly to the report with a Universal Resource Locator (URL) in the following format:

https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20080521X00707&AKey=1&RType=Final&IType=FA

a. Replaced the value after “EventID=” with Events.ev_id

b. Replaced the value after “AKey=” with Aircraft.aircraft_key

c. Replaced the value after “IType=” with the 6th and 7th characters of Events.ntsb_no

7. Any additionally available Part 91, GA VFR-into-IMC accident information was obtained through the NTSB accident docket system containing electronic copies of supporting materials for investigation reports such as photos, transcripts, and specialist reports. The public accident docket was accessed through the NTSB website at https://dms.ntsb.gov/pubdms/ and was searched using the Events.ntsb_no.

The data collected from the NTSB Aviation Accident Database and Synopses online AARs conformed to the following seven criteria:

1. United States GA Part 91 accidents attributed to VFR-into-IMC pilot decision error.
2. The accident involved the death of the pilot.
3. Accidents attributed to unknown causes were excluded from the study.
4. Only those Part 91 GA VFR-into-IMC accidents where the investigation was completed and accident cause determined were included in the analysis.
5. The GA Part 91, VFR-into-IMC accidents were sorted out of the entire list of all accidents in the NTSB database using the following codes:
   a. ev_date
      i. January 1, 1991 to December 31, 2014
   b. ev_type

i. ACC

1. Accident

c. eventsoe_no

i. 401

1. VFR encounter with IMC from 2008 to 2014 in the new post-2008 NTSB coding schema

d. subj_code

i. 24015

1. VFR encounter with IMC from 1991 to 2007 in the old pre-2008 NTSB coding schema

e. ntsb_no

i. NTSB accident number assigned to each case

f. far_part

i. 091

1. Part 91, GA

g. ev_state

i. The specific state in the United States where the accident type occurred

h. light_cond

i. DAYL

1. daylight

ii. DUSK

1. dusk

iii. NDRK

1. dark night

iv. NBRT

1. bright night

v. DAWN

1. dawn

i. injury_level

i. FATL

1. fatal

6. The total number of GA Part 91, VFR-into-IMC accidents retrieved from the entire NTSB database was 691 cases.
7. The final 85 cases were determined by selecting from the NOAA climate regions in defined United States geographic areas (Figure 1; Figure 2; Appendix I: Figure I1). Cases were selected for identified lighting conditions from the 691 GA Part 91, VFR-into-IMC accident occurrences. A total of 52 United States and territories had these qualifying NTSB VFR-into-IMC AARs, including Alaska, Guam, Puerto Rico, and the Virgin Islands.

Data Collection Device

Several data collection devices were used to complete the study. These devices included various forms the researcher and raters used to collect responses. The researcher provided the raters with documentation explaining the 46 research-identified contextual factor concepts. Raters became familiar with the 46 contextual factors through instruction provided by the researcher before the data was coded and analyzed

(Appendix J). The rater familiarization included review of the researcher-prepared list of definitions for the 46 research-identified contextual factors taken directly from the reviewed research articles (Appendix D; Table D1). Raters used the aforementioned researcher-prepared list of definitions document for the 46 research-identified contextual factors to aid in identifying the presence of the specific contextual factor(s) in the nine NTSB AARs for the pilot study and 85 NTSB AARs for the main study (Appendix K; Table K1; Appendix L; Table L1). The raters were evaluated by the researcher on their individual understanding of identifying the presence of the 46 research-identified contextual factors and manifestations of these factors during the pilot study (Appendix J). A Microsoft® Access™ database collection form was given to each of the raters (Appendix B; Figure B1; Appendix C; Figure C1). The Microsoft® Access™ database form was used by the researcher to collect the raters' identification of the presence of the 46 research-identified contextual factors and manifestation of the factors in the representative sample of 9 NTSB AARs for the pilot study and 85 NTSB AARs for the main study. Other factors related to the GA Part 91, VFR-into-IMC accidents were also evaluated by the researcher pertaining to the pilot and main study NTSB AARs including pilot age and flight experience, as well as weather, flight conditions, time of day, and certification level. The results were reported in tables.

At the conclusion of instruction and evaluation provided by the researcher, the main study representative sample of 85 NTSB AARs was assigned to each of the three raters so all three raters were able to independently analyze each accident (all three raters reviewed and rated all 85 AARs). The three raters were given a Microsoft® Access™ database collection form to record the presence of the 46 research-identified contextual factors and manifestations of the factors in the representative sample of 85 NTSB AARs (Appendix C; Figure C1). The researcher then entered the completed Microsoft® Access™ database collection form information from the raters into the International Business Machines (IBM®) Statistical Package for the Social Sciences (SPSS™) software for contextual factor analyses.

Instrument reliability. *Instrument reliability* is defined as the extent an instrument consistently measures what it is supposed to measure. The Microsoft® Access™ database collection form was filled out based on the rater examination and determination of the presence of the 46 research-identified contextual factors in the representative sample of 85 NTSB AARs. The layout of the data collection form contributed to the instrument reliability, as it guided each of the raters through the same data input process each time. Reliability of the instrument for the study was determined through a pilot study. The pilot study asked the raters to identify the presence of the 46 research-identified contextual factors and their opinion about how these factors were manifested in the accident sample.

The pilot study established whether or not an acceptable inter-rater agreement with percentage agreement and Fleiss' kappa (κ) was achieved. A standard score (Z-score) for Fleiss's kappa was also calculated and converted into a P-value. This P value indicated whether the agreement for the four raters was significantly better or not significantly better than would be expected by chance. The Z-score and P-value were reported (Table D2). The reliability of the data collection form for the main study was tested in the pilot study and established a percentage agreement of 86% and statistically significant ($p \leq .000$) inter-rater reliability (k = 0.519; PABAK = 0.422). As the pilot study Fleiss' kappa (κ) was in the moderate agreement range between 0.41 and 0.60 on the Fleiss (1971) scale of agreement, modifications were made to the main study Microsoft® Access™ database collection form based on rater feedback from the pilot study Microsoft® Access™ database collection form (Appendix B; Figure B1; Appendix C; Figure C1).

Instrument validity. Instrument validity is defined as the extent to which an instrument measures what it is supposed to measure. Raters completed the Microsoft® Access™ database collection form by applying the researcher instruction and demonstration to the main study representative sample of 85 Part 91, GA VFR-into-IMC accidents retrieved from the archived accidents in the NTSB database (Appendix C; Figure C1; Appendix L). The layout of the Microsoft® Access™ database collection form contributed to the instrument validity as it identified all of the 46 research-identified contextual factors and the respective NTSB AAR numbers identifying the representative sample of 85 Part 91, GA VFR-into-IMC accidents. This layout identified all information needed by the researcher from the three raters. An identical Microsoft® Access™ database collection form was given to all three raters as each rater evaluated all 85 Part 91, GA VFR-into-IMC accidents in the representative sample. Consistency in each of the three raters using the same Microsoft® Access™ database collection form increased the probability of collecting the correct data from each rater. This consistency increased the validity of the data collection form. The pilot study was completed to establish the Microsoft® Access™ database collection form instrument validity.

Treatment of the Data

The raters were selected using specific experience criteria. Each of the raters was selected for their possession of the FAA CFI and ATP certificates. These ratings indicated each rater's possession of the requisite VFR-into-IMC knowledge and flight experience needed to successfully complete the identification of the 46 research-identified contextual factors and manifestations of these factors in the representative sample of 85 NTSB AARs. The 46 contextual factors were derived from the established research literature. The three raters identified the presence and manifestations of these factors in a sample of 85 fatal Part 91 accidents for the main study.

The following instructions involving nine steps were given to the three raters for the main study:

1. The rater will not reproduce or share the information contained in the e-mailed rater package and will return all identified documentation, including the completed data collection form, to this researcher via e-mail at hartmaj7@my.erau.edu when completed.
2. The rater will complete the required actions for each NTSB AAR one at a time until all 85 NTSB AARs have been assessed. The rater will not begin the required actions for a new NTSB AAR until all actions are completed for the currently assessed NTSB AAR.
3. The rater will first read, one at a time, the narrative provided in the NTSB AAR, including the analysis, factual information, and probable cause and findings.

4. The rater will identify the presence of the 46 contextual factors taken from the reviewed literature in the sample of 85 NTSB AARs after reviewing all provided instructions and documentation and return to the researcher when completed via e-mail at hartmaj7@my.erau.edu.
5. The rater should only rate whether or not the 46 research-identified contextual factors are present in the currently assessed NTSB AAR.
6. The rater will identify the presence of the 46 research-identified contextual factors in the currently assessed NTSB AAR by recording the identified contextual factor(s) and manifestation(s) of these factors on the data collection form (Appendix C; Figure C1).
7. The rater will identify the 46 research-identified contextual factors in the representative sample of 85 NTSB AARs without discussion with anyone else or reference to any additional information other than provided in the rater package.
8. The rater will require a personal computer with word processing ability.
9. The rater will repeat steps one through nine for each of the representative sample of 85 NTSB AARs.

The following is a chronological order of the five steps that were taken:

1. The researcher provided the raters instruction on definitions of the 46 research-identified contextual factors taken directly from the respective reviewed research articles, examples of identification of the 46 research-identified contextual factors in NTSB AARs not used in the main study, and

showed the raters an example of how to complete the Microsoft® Access™ database collection form based on the example NTSB AARs.

2. The researcher provided the raters a testing session using an NTSB AAR not used in the main study. Each rater was required to demonstrate a minimum 80 percent proficiency in correctly identifying the applicable 46 research-identified contextual factors in the provided NTSB AAR. A total of 46 questions were asked corresponding to the presence or absence of the 46 contextual factors. Therefore, a total of 40 correct responses out of a total of 50, or 80% accuracy, were required for each rater. In the event a rater did not pass with the required accuracy, remediation and retesting sessions would have been conducted between the rater and researcher until a passing score had been achieved.
3. The three raters were first asked to read the narratives provided for each of the 85 NTSB AARs, including the analysis, factual information, and probable cause and findings.
4. The three raters were then asked to identify the 46 research-identified contextual factors and manifestations of the factors in each of the 85 NTSB AARs.
    a. The rater coding process included a complete review of the NTSB AAR for significant text identifying GA pilot errors where one or more of the 46 research-identified contextual factors applied. The NTSB AARs were independently coded and cross-checked by the researcher to ensure coding consistency between raters. This process

involved confirming with each rater their provided responses were accurate to ensure the data coding was correct.

b. The results for each accident were recorded on a Microsoft® Access™ database collection form (Appendix C; Figure C1).

5. The three raters determined which of the 46 research-identified contextual factors, if any, were present in the representative sample of 85 NTSB AARs. The researcher determined the contextual factor frequencies and the way these factors manifested reported by the raters from the Microsoft® Access™ database collection form drop down menu selections and comments. The researcher then entered the contextual factor data provided by the raters into the IBM® SPSS™ program. The IBM® SPSS™ program was used to generate the frequencies of the 46 research-identified contextual factors in the sample of 85 AARs reported by the raters. The researcher then reported the contextual factor presence, frequency, and rater reported manifestation of the contextual factor in the sample of 85 AARs.

The data collected from the three raters was coded as part of the process of converting the 46 research-identified contextual factors, pilot age, flight experience, weather, flight conditions, time of day, and certification level qualitative information into frequency of occurrence quantitative information that was analyzed by IBM® SPSS™. Treatment of the data included descriptive statistics establishing the frequency of each of the 46 research-identified contextual factors and contextual factors manifestations present in the representative sample of 85 NTSB AARs. Frequency data, along with the rater provided comments, was used by the researcher to determine how the 46 research-identified contextual factors were manifested in the representative sample of 85 NTSB AARs. Statistical analysis was performed using IBM® SPSS™ computer software. The Microsoft® Access™ database collection form containing the aforementioned qualitative data for each of the raters was transferred to a Microsoft® Excel™ spreadsheet. Raters' data was imported into IBM® SPSS™ from the Microsoft® Excel™ spreadsheet. A rater frequency table was generated in IBM® SPSS™ for the completed Microsoft® Access™ database collection form information submitted by each of the three raters for the presence of contextual factors, pilot age, flight experience, weather, flight conditions, time of day, and certification level in the representative sample of 85 NTSB AARs by running the frequencies procedure (Analyze > Descriptive Statistics > Frequencies). The IBM® SPSS™ frequencies were then reported in tables. The reported IBM® SPSS™ point biserial correlation, phi correlation, and multiple regression data utilizing dummy variables was then used by the researcher to examine and determine any significant relationships between the contextual factors and other factors in the representative sample of NTSB AARs. Contextual factor manifestation results were then reported in tables. The percentage agreement was manually calculated and reported. The Fleiss' kappa (κ) was computed with IBM® SPSS™. A computed Fleiss' kappa (κ) statistic for the agreement among the raters beyond what was expected by chance was reported. The Z-scores and P-values were also reported to identify the agreement among the raters beyond what was expected by chance. PABAK was calculated and reported to determine inter-rater reliability.

Descriptive statistics. The three raters determined which of the 46 research-identified contextual factors were present in the 85 NTSB AAR main study representative sample. Frequencies of the 46 research-determined contextual factors, pilot age, flight experience, weather, flight conditions, time of day, and certification level were determined and reported using the aforementioned IBM® SPSS™ frequency table procedure. The most prevalent research-identified contextual factors present in the representative sample of 85 NTSB AARs were also calculated. Contextual factor manifestations, determined by rater provided comments and contextual factor frequencies, were then determined. Overall percentage agreement between raters was calculated for pilot study and main study identification of the 46 research-determined contextual factors. The results were reported in tables.

Reliability testing. Inter-rater reliability for the categorical variables of the presence or absence of the 46 literature-identified, GA Part 91, VFR-into-IMC contextual factors was used to determine the consistency between the four raters (pilot study) and three raters (main study) by using overall percentage agreement and then by Fleiss' kappa statistic to calculate agreement beyond chance expectation (Fleiss, 1971; Gwet, 2014; Kiliç, 2015; Landis & Koch, 1977; Scott, 1955; Sim & Wright, 2005; Singendonk et al., 2016). In order to determine if the magnitude of Fleiss' kappa was influenced by prevalence of the presence for the 46 research-identified contextual factors in the sample of GA Part 91 VFR-into-IMC accidents and bias for the degree the raters disagreed on the proportion of accidents where the contextual factors were present or absent, the PABAK was calculated (Byrt, Bishop, & Carlin, 1993; Sim & Wright, 2005).

Qualitative data. The Microsoft® Access™ database collection form identified the 46 research-identified contextual factors for each GA Part 91, VFR-into-IMC accident (Appendix B; Figure B1; Appendix C; Figure C1). A drop down menu was provided for each contextual factor including all possible choices for the raters to select. The last column in the Microsoft® Access™ database collection form allowed the raters to provide their respective opinions of how contextual factors were manifested.

Quantitative data. Descriptive statistics were used to report pilot age, flight experience, weather, flight conditions, time of day, and certification level for the identified sample of NTSB AARs. Point biserial and phi correlations were calculated using IBM® SPSS™ software to identify statistically significant relationships between the contextual factors and pilot age, flight experience, weather, flight conditions, time of day, and certification level (Field, 2009). A Point-biserial correlation coefficient was used to examine the statistically significant relationships among the contextual factors, pilot age, and flight experience. A phi correlation coefficient was used to examine the statistically significant relationships among the contextual factors, certification level, weather, flight conditions, and time of day. A determination was made as to which of the contextual factors were associated with what effects for GA Part 91, VFR-into-IMC decision-making error. The multiple regression analyses using dummy variables determined which of the 46 research-identified contextual factors (independent variables) had any effect(s) on the crash distance from departure and crash distance to planned destination (dependent variables) in the multiple regression analyses.

CHAPTER IV

RESULTS

The research data source was taken from the January 1, 1991, to December 31, 2014, population of completed NTSB United States AARs attributed to VFR-into-IMC pilot error where an investigator final probable cause ruling was established. The number of qualifying reports meeting the GA Part 91 pilot entry into VFR-into-IMC criteria for the specified date range totaled 691. A proportionate stratification was calculated from the 691 accident cases. Systematic random sampling was used to select accidents directly from the sample frame. As this number of qualifying reports was abundant, the number of NTSB AAR and probable cause reports was methodically narrowed down by selecting the 85 cases representative of all United States where the GA Part 91, VFR-into-IMC accident type occurred. The selection of this representative sample ensured the generalizability of the study results. The percentage of accidents selected by NOAA defined climate region stratum and demographic information for the 85 selected cases are given in Appendices I and N, respectively.

The qualitative and quantitative data from the pilot study (nine accident sample) were put into a table to analyze the results. The table of pilot study qualitative and quantitative data from the four raters was used to generate a table of frequency and descriptive statistics. Modifications were made to the main study (85 accident sample) Microsoft® Access™ database collection form from the results obtained from the pilot study data. Qualitative and quantitative results obtained from the main study data generated by the three raters were used to create frequency and descriptive statistics tables for data analysis. Pilot and main study statistics and reliability testing were reviewed for agreement. The pilot and main study qualitative and quantitative data were analyzed to identify the presence and frequencies of the research-identified contextual factors in Part 91, GA pilot VFR-into-IMC accidents in the reviewed NTSB AARs. The relationships between the 46 research-identified contextual factors and age, flight experience, weather, flight conditions, time of day, and certification level as well as crash distance from departure and crash distance from planned destination were also explored.

Pilot Study

The percentage agreement, Fleiss' kappa (κ), and PABAK calculations were used to determine rater agreement between the four raters in the pilot study beyond what was expected by chance. This study used percentage agreement and Fleiss' kappa to measure inter-rater consistency, as the consensus in the reviewed research literature was a recommendation to use a minimum of two measures due to the advantages and disadvantages of the available measures. The percentage agreement is the simplest measure of inter-rater reliability but does not consider the agreement expected by chance alone and is strengthened by using measures indicating proportion of agreement beyond chance including Fleiss' kappa for multiple raters rating nominal data. Percentage agreement of 86% was manually calculated. An overall Fleiss' kappa (κ) for the pilot study was calculated using IBM® SPSS™ software and showed there was moderate agreement between the four raters, $\kappa = 0.50$ (95% CI, .46 to .54), $p < .01$ (Appendix D; Table D2). The individual Fleiss' kappa (κ) categories were also calculated using IBM® SPSS™ software (Appendix D; Table D3). The PABAK was also manually calculated (PABAK = 0.42). The calculated pilot study Fleiss' kappa, $\kappa = 0.50$ was between 0.41

and 0.60 for moderate agreement on the generally accepted standards of agreement for kappa (κ) shown in Table 2 (Fleiss, 1971).

The feedback from the raters gave the researcher insight into the reasons for the differences in identification of the presence of the contextual factors in the nine NTSB GA Part 91 VFR-into-IMC accidents selected for the pilot study. In some of the cases, there was minimal data provided in the NTSB AARs for the raters to make an informed decision as to the presence or absence of the 46 research-identified contextual factors. It was noted by the raters a more in-depth analysis reported by the NTSB investigators in the AARs would have likely revealed more contextual factors. The feedback from the raters obtained from the pilot study was used to modify the methodology including the main study Microsoft® Access™ database collection form.

The following modifications were made based on the pilot study feedback: (a) include a general definition of contextual factors at the beginning of the main study instructions; (b) add pilot study sample size selection information and reference into the dissertation methodology section; (c) add an "Unknown" option in the main study; (d) change meters to feet for the Contextual Factor 25: ‘Height of crash site’ category; (e) include installed weather equipment verbiage for Contextual Factor 45: ‘Use of in-cockpit weather information’ in the main study; (f) re-word last question to make it clearer the researcher is asking the raters to provide their opinions about how the identified contextual factors were manifested in each accident; (g) change times to 24-hour, and ‘seal’ level should be corrected in drop downs for altitude/elevation; (h) amend the CF23 to include verbiage to “file IFR to the maximum extent possible”; (i) change the altitudes to include all possible values and put in numerical order; (j) add an option in the drop down menu to include “not enough information provided to make a determination regarding contextual factor”; (k) include the hyperlink to skyvector.com (a publicly available website) for United States sectional charts so the raters can determine the accident site using the departure and destination points, as well as the latitude and longitude coordinates for the crash site location provided in the NTSB AARs in the main study instructions to raters document: https://skyvector.com/; (l) include only the final report for the main study to reduce the workload on the raters; (m) add an option in the drop down menu to include “Not Applicable, N.A.”.

The reliability of the data collection form for the main study was tested in the pilot study and established a percentage agreement of 86% and statistically significant ($p \leq .000$) inter-rater reliability (k = 0.50; PABAK = 0.42) as shown in Appendix D (Table D2; Table D3). As the pilot study Fleiss’ kappa (κ) was in the moderate agreement range between 0.41 and 0.60 on the Fleiss (1971) scale of agreement, modifications were made to the main study Microsoft® Access™ database collection form based on the described rater feedback from the pilot study Microsoft® Access™ database collection form (Appendix B; Figure B1; Appendix C; Figure C1). This process validated the Microsoft Access™ database collection form using the established guidance (Cohen, 1960; Fleiss, 1971; Gwet, 2014). The following results were from the data collected from the three raters for the main study.

Descriptive Statistics

The three raters determined the presence of specific contextual factors out of the 46 research-identified factors in the main accident sample of 85 NTSB AARs from fatal GA Part 91, VFR-into-IMC accidents (Appendix H; Table H1). Rater’s identification of the presence of the contextual factors in the 85 GA Part 91, VFR-into-IMC cases used in the main study were assessed for specific factors, frequencies of occurrence, and manifestations. Tables were developed to show the main study descriptive and frequency statistics (Table 3; Table 4; Table 5). Tables were also developed to show the specific contextual factors and frequencies (Appendix H; Table H1). The tables show the specific contextual factors and frequencies present in the 85 accidents used in the main study as identified by the three raters. The manifestations were reported separately in the analysis. The relationships between the 46 research-identified contextual factors and age, flight experience, weather, flight conditions, time of day, and certification level were explored.

The main study descriptive statistics were given in Table 3 and obtained from the SPSS™ analysis. Accident pilot ages ranged from 17 to 82 (M = 52.20, SD = 13.35). The pilot flight experience (total flight hours) ranged from 35 to 15,000 hours (M = 2,191.34, SD = 3,208.93). Number of passengers on board ranged from 0 to 5 (M = 1.01, SD = 1.06). Time of day when the accidents occurred ranged from 0100 to 2300 hours (M = 14.05, SD = 6.17).

Table 3
Accident Descriptive Statistics

Variable	Minimum	Maximum	Mean	Standard Deviation
Pilot Age	17	82	52.20	13.35
Pilot Flight Experience	35	15,000	2,191.34	3,208.93
Passengers	0	5	1.01	1.06
Time of Day (24 Hour)	1	23	14.05	6.17

Main study frequency statistics were provided in Table 4 and obtained from the SPSS™ analysis. Highest to lowest frequencies were identified. Flight conditions and inclement weather were identified with the highest frequencies of 97.6% occurrences in the main study. Non-instrument rated pilots had the second highest frequency of 62.4% occurrence in the 85 accident sample. Time of Day (Night) had the third highest frequency at 56.5% occurrence. The Time of Day Light Condition (Day) had the fourth highest frequency at 43.6% occurrence. Time of Day (Day) had the fifth highest frequency at 43.5% occurrence. The Time of Day Light Condition (Night) had the sixth highest frequency at 39.9% occurrence. Instrument-rated pilots had the seventh highest frequency at 37.6% occurrence. Time of Day Light Condition (Dusk) had the eighth highest frequency at 7.1% occurrence. Time of Day Light Condition (Dark) and (Dawn) had the nineth highest frequencies at 4.7% occurrence. Flight Conditions (VMC) and Weather (Non-Inclement) had the lowest frequencies at 2.4% occurrence.

Table 4

Accident Frequency Statistics

Variable	Percent
Flight Conditions (IMC)	97.6
Weather (Inclement)	97.6
Non-Instrument Rated Pilot	62.4
Time of Day (Night)	56.5
Time of Day (Light Condition) - Day	43.6
Time of Day (Day)	43.5
Time of Day (Light Condition) - Night	39.9
Instrument Rated Pilot	37.6
Time of Day (Light Condition) - Dusk	7.1
Time of Day (Light Condition) - Dark	4.7
Time of Day (Light Condition) - Dawn	4.7
Flight Conditions (VMC)	2.4
Weather (Non-Inclement)	2.4

Main study GA pilot crash distance descriptive statistics were provided in Table 5 and obtained from the SPSS™ analysis. Crash distance from departure to the midpoint of the planned route as a percentage of planned course completion, 0% to 50%, identified from the provided latitude and longitude of the crash site in the NTSB AARs ranged from 0% to 49% (M = 7.51, SD = 14.47). The crash distance from the midpoint to the planned destination of the planned route as a percentage of planned course completion, 51% to

100%, identified from the provided latitude and longitude of the crash site in the NTSB AARs, ranged from 51% to 99% (M = 82.53, SD = 15.46).

Table 5

Crash Distance Descriptive Statistics (Main Study)

Variable	Minimum	Maximum	Mean	Standard Deviation
Crash Distance from Departure (0% to 50%)	0	49	7.51	14.47
Crash Distance to Destination (51% to 100%)	51	99	82.53	15.46

Reliability Testing

The percentage agreement, Fleiss' kappa (κ), and PABAK calculations were used to determine rater agreement between the three raters in the main study beyond what was expected by chance. The percentage agreement of 57% was manually calculated. Overall Fleiss' kappa (κ) for the main study was calculated using IBM® SPSS™ software and showed there was fair agreement between raters, κ = 0.25 (95% CI, .24 to .25), $p < .01$ (Appendix D; Table D4). The individual Fleiss' kappa (κ) categories were calculated using IBM® SPSS™ software (Appendix D; Table D5). The PABAK was also manually calculated (PABAK = 0.50). The calculated main study overall Fleiss' kappa, κ = 0.25, was between 0.21 and 0.40 for fair agreement on the generally accepted standards of agreement for kappa (κ) shown in Table 2 (Fleiss, 1971). The fair agreement between the three raters for the overall main study Fleiss' kappa was a lower score on the scale of generally accepted standards of agreement. The overall Fleiss' kappa (κ) agreement was calculated for all ratings and six possible responses available for the 46 research-identified contextual factor questions answered by each rater for the 85 accident sample dataset. Although the overall Fleiss' kappa (κ) score was in the fair range of agreement κ = 0.25, the individual Fleiss' kappa (κ) score for the 1 response, indicating rater agreement for the presence of the contextual factor, was calculated to be κ = 0.51 and in the moderate range of agreement (Table 2). The individual Fleiss' kappa (κ) score for the 0 response, indicating rater agreement for the absence of the contextual factor, was calculated to be κ = 0.38 and was on the high end of the fair range of agreement (Table 2). The overall Fleiss' kappa (κ) score in the fair range of agreement κ = 0.25 was due to such reasons as inconsistency among the three raters in selecting the same response for the reason the contextual factor was not present, as there were several responses available to the raters for selection (i.e., Not Applicable, NA, Not enough information provided to identify the contextual factor, unknown, or providing no rating (blank) response). The response of 'Not enough information provided to identify the contextual factor' was inconsistently but repeatedly used by the three raters as a reason for being unable to identify the presence of the contextual factors in the accident sample dataset (Appendix D; Table D5). It is possible if the AARs and probable cause reports had contained more detailed information, a higher number of contextual factors could have been identified by the raters resulting in a higher overall Fleiss' kappa (κ) score.

Qualitative Data

The 46 research-identified contextual factors present in the main study sample of 85 accidents, as identified by the three raters, was sorted to identify the specific contextual factors and associated frequencies, from the results obtained from SPSS™ (Appendix H; Table H1). Three raters identified a total of 37 out of 46 research-identified contextual factors in the 85 accident sample used in the main study. The presence of the specific contextual factors identified by the raters is as follows:

1. Passengers on board (CF29) - 53 out of 85 accidents
2. Accident time of day (Day) (CF1) - 51 out of 85 accidents
3. Crash distance from planned destination (CF15) - 46 out of 85 accidents
4. Not filing a flight plan (CF21) - 42 out of 85 accidents
5. Underestimating risk (CF43) - 42 out of 85 accidents
6. IFR flight without clearance or ratings (CF26) - 41 out of 85 accidents
7. Crash distance from departure (CF14) - 39 out of 85 accidents
8. Situation assessment (CF39) - 35 out of 85 accidents
9. Accident time of day (Night) (CF1) - 34 out of 85 accidents
10. Crash distance from planned destination (CF15) - 29 out of 85 accidents
11. Goal conflicts (CF24) - 27 out of 85 accidents
12. Pilot briefer communication (CF33) - 25 out of 85 accidents
13. Medical status policy violation (CF28) - 23 out of 85 accidents
14. Receipt of weather briefing (CF36) - 22 out of 85 accidents
15. Mountainous terrain (CF42) - 22 out of 85 accidents
16. Adverse weather encountered late in the flight (CF3) - 22 out of 85 accidents

17. Plan continuation error (CF34) - 21 out of 85 accidents
18. Adverse weather encountered early in the flight (CF2) - 20 out of 85 accidents
19. Communication with air traffic control (CF12) - 18 out of 85 accidents
20. Time/distance flown into IMC before the accident occurred - less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6) - 17 out of 85 accidents
21. Height of crash site (0 to 999 feet mean sea level) (CF25) - 16 out of 85 accidents
22. Currency policy violation (CF16) - 15 out of 85 accidents
23. Decision to continue VFR-into-IMC to the planned destination (CF17) - 15 out of 85 accidents
24. Pilot briefer communication (not present) (CF33) - 14 out of 85 accidents
25. Scud running (CF37) – 13 out of 85 accidents
26. Filing a flight plan (CF21) - 12 out of 85 accidents
27. Ratings policy violation (CF35) - 12 out of 85 accidents
28. Self reported weather cues (CF38) - 12 out of 85 accidents
29. Source of weather information (good source) (CF41) - 12 out of 85 accidents
30. Adverse weather encountered early in the flight (CF2) - 11 out of 85 accidents
31. Communication with air traffic control (CF12) – 11 out of 85 accidents
32. Number of passengers on board (2) (CF29) – 9 out of 85 accidents
33. Receipt of weather briefing (CF36) – 9 out of 85 accidents
34. Medical status policy violation (CF28) – 7 out of 85 accidents
35. Ratings policy violation (CF35) – 7 out of 85 accidents

36. Ambiguity (CF5) – 6 out of 85 accidents
37. Time/distance flown into IMC before the accident occurred - greater than half the time and distance required to reach the destination before the accident occurred (CF6) – 6 out of 85 accidents
38. Flight into known icing conditions (CF22) – 5 out of 85 accidents
39. Decision to divert from VFR-into-IMC to an alternate destination (CF18) – 4 out of 85 accidents
40. Height of crash site 2,000 to 2,999 feet mean sea level (CF25) – 4 out of 85 accidents
41. Terrain (Hill) (CF42) – 4 out of 85 accidents
42. Unrecoverable low altitude (CF44) – 4 out of 85 accidents
43. Cruising altitude 0 to 999 feet mean sea level (CF4) – 3 out of 85 accidents
44. Cruising altitude 10,000 to 10,999 mean sea level (CF25) – 3 out of 85 accidents
45. Height of crash site 3,000 to 3,999 mean sea level (CF25) – 3 out of 85 accidents
46. Height of crash site 4,000 to 4,999 feet mean sea level (CF25) – 3 out of 85 accidents
47. Height of crash site 5,000 to 5,999 feet mean sea level (CF25) – 3 out of 85 accidents
48. Height of crash site 6,000 to 6,999 feet mean sea level (CF25) – 3 out of 85 accidents
49. Passengers on board (3) (CF29) – 3 out of 85 accidents

50. Permission seeking behaviors (CF32) - 3 out of 85 accidents
51. Social (CF40) - 3 out of 85 accidents
52. Cruising altitude 13,000 to 13,999 feet mean sea level (CF4) – 2 out of 85 accidents
53. Cruising altitude 6,000 to 6,999 feet mean sea level (CF4) – 2 out of 85 accidents
54. Cruising altitude 7,000 to 7,999 feet mean sea level (CF4) – 2 out of 85 accidents
55. Height of crash site 1,000 to 1,999 feet mean sea level (CF25) – 2 out of 85 accidents
56. Height of crash site 8,000 to 8,999 feet mean sea level (CF25) – 2 out of 85 accidents
57. Passengers on board (5) (CF29) – 2 out of 85 accidents
58. Organization (CF31) – 2 out of 85 accidents
59. Terrain (Ocean) (CF42) – 2 out of 85 accidents
60. Cruising altitude 11,000 to 11,999 feet mean sea level (CF4) – 1 out of 85 accidents
61. Cruising altitude 12,000 to 12,999 feet mean sea level (CF4) – 1 out of 85 accidents
62. Cruising altitude 14,000 to 14,999 feet mean sea level (CF4) – 1 out of 85 accidents
63. Cruising altitude 2,000 to 2,999 feet mean sea level (CF4) – 1 out of 85 accidents

64. Cruising altitude 4,000 to 4,999 feet mean sea level (CF4) – 1 out of 85 accidents
65. Cruising altitude 5,000 to 5,999 feet mean sea level (CF4) – 1 out of 85 accidents
66. Cruising altitude 9,000 to 9,999 feet mean sea level (CF4) – 1 out of 85 accidents
67. Amount of time/distance the GA pilot flew into the IMC weather before diverting (CF7) – 1 out of 85 accidents
68. Time/distance into IMC before diverting to an alternate - flight time and distance in IMC were less than or equal to half the time and distance to reach the destination before diverting (CF7) – 1 out of 85 accidents
69. Circular decision making (CF10) – 1 out of 85 accidents
70. Consequences not anticipated (CF13) – 1 out of 85 accidents
71. Height of crash site 10,000 to 10,999 feet mean sea level (CF25) – 1 out of 85 accidents
72. Height of crash site 7,000 to 7,999 feet mean sea level (CF25) – 1 out of 85 accidents
73. Obtaining an online preflight weather briefing (CF30) – 1 out of 85 accidents
74. Self reported weather cues (CF38) – 1 out of 85 accidents
75. Terrain (Forest) (CF42) – 1 out of 85 accidents
76. Unrecoverable low altitude (CF44) – 1 out of 85 accidents

The three raters provided their respective opinions about how the 46 research-identified contextual factors were manifested in the 85 accident sample. Comments provided by the raters for each accident were reviewed for their opinions on how the 46 contextual factors were manifested. Rater contextual factor manifestation results for the main study are as follows:

Accident time of day (CF1). Three raters identified the time of day when the 85 accidents occurred. There were a total of 70 accidents occurring during the day, and 15 accidents took place at night. The particular lighting conditions varied and included six accidents taking place at dusk, 37 during daylight conditions, 33 during night light conditions, five during dark light conditions, and four during dawn light conditions. Two accidents occurred at 0000, one at 0100, two at 0400, five at 0500, three at 0600, four at 0700, three at 0800, four at 0900, five at 1000, four at 1100, five at 1200, one at 1300, five at 1400, two at 1500, three at 1600, four at 1700, seven at 1800, ten at 1900, five at 2000, four at 2100, three at 2200, and three at 2300.

Adverse weather encountered early in flight (CF2). In a particular accident, the rater commented adverse weather existed, possibly the whole way. In another accident, the pilot filed IFR, then near the destination cancelled IFR and flew VFR-into-IMC back to the point of origin. A rater commented for a particular accident adverse weather was encountered before and after the mid flight point since the pilot was IMC from the departure point to the crash site which was a distance almost as great as that of the destination.

Adverse weather encountered late in flight (CF3). A rater commented for a particular accident adverse weather existed, possibly the whole way. In another accident the rater commented the pilot filed IFR, then near the destination, cancelled IFR and flew VFR into IMC back to point of origin. A rater commented for a particular accident adverse weather was encountered before and after the mid flight point since the pilot was IMC from the departure point to the crash site which was a distance almost as great as that of the destination.

Altitude (CF4). The cruising altitudes of the aircraft in the 85 accident sample included the following: (1) 0 - 999 feet mean sea level, (2) 1,300 - 1,399 feet mean sea level, (3) 5,000 - 5,999 feet mean sea level, (4) 6,000 - 6,999 feet mean sea level, (5) 7,000 - 7,999 feet mean sea level, (6) 9,000 - 9,999 feet mean sea level, (7) 10,000 - 10,999 feet mean sea level, (8) 11,000 - 11,999 feet mean sea level, (9) 12,000 - 12,999 feet mean sea level, and (10) 13,000 - 13,999 feet mean sea level.

Ambiguity (CF5). A rater commented for a particular accident ambiguity deterioration was gradual since the open VFR channel, as perceived by the pilot, may have been misleading. In a particular accident, the rater commented the radio call indicated cues were clear to the pilot. A rater commented for one of the accidents a discussion of cloud cycle with another pilot was not considered relevant by the pilot. A rater commented for one of the accidents cues were clear to the pilot as explained by the surviving rear seat passenger. In another accident, the rater commented a pilot stated the pilot-in-command descended to maintain contact with the ground. A rater commented for a particular accident ambiguity determination was based on the pilot reports to air traffic control. In another accident, the rater commented the cues were clear to the pilot, as the pilot-in-command advised air traffic control prior to frequency change the field was not in sight and he may need to call them again. A rater commented for one of the accidents the pilot could have seen cues and was trying to descend or did not see cues and thought he had enough holes to descend.

Amount time/distance GA pilot flew into IMC before accident occurred (CF6). A rater commented the plane was not in IMC conditions a long time. In another accident, the rater commented there was no way of knowing if the pilot was diverting to an alternate or just trying to get below clouds to continue the flight.

Amount time/distance GA pilot flew into IMC before diverting (CF7). A rater commented for a particular accident the plane was not in IMC conditions a long time. Another rater commented there was no way of knowing if the pilot was diverting to an alternate or just trying to get below clouds to continue the flight.

Attentional tunneling (CF8). One rater commented attentional tunneling was unknown. The rater made an additional comment a handheld global positioning system (GPS) was onboard but its use was unknown, and there was not enough information provided in the report. In another accident, one of the raters commented there was a moving map onboard; however, there was no information provided in the report on how it was used. One of the raters commented for a particular accident there was not enough information provided in the report, although the pilot had a handheld Garmin GPSMAP 196 onboard. Another rater commented for another accident a handheld GPS was found, but there was no way to know if the pilot became overly absorbed in its use.

Ceiling and visibility determination (CF9). A rater commented for a particular report the pilot overestimated the ceiling most likely due to rapid changes in ceiling and conditions of darkness. Another rater commented for a particular accident the pilot radio call at 1931 for weather at Lafayette to transition perhaps caused an overestimation for the destination ceiling and visibility. In another accident, the rater commented the pilot thought he could stay above and get below clouds. A rater commented for another accident the pilot overestimated ceiling; otherwise he would not have cruised at 7,500 becoming stuck on top. One rater commented for another accident the pilot may have flown VMC above a fog layer. In another accident, the rater commented the pilot overestimated clouds. One of the raters commented for a particular accident the pilot misinterpretation of ceiling and visibility led to getting caught above the clouds (ruling out intentional self-harm). A rater commented for one of the accidents the pilot thought he could get on top of clouds.

Circular decision-making (CF10). A rater commented for a particular accident no circular decision making was apparent, since no changes were made (no divert decision). In another accident, the rater commented circular decision making was apparent when the pilot changed the flight path to try and exit IMC. In another accident, the rater commented, although better decisions could have been made, the pilot used new information from the controller to update his plan, based on the level of risk he was willing to accept.

Cognitive anchoring (CF11). A rater commented cognitive anchoring was present due to the VFR channel and may have been misleading. In another accident, the rater commented there was not enough information to make a definite decision but since the weather was fine at the departure point, it is likely the pilot "anchored" this information and applied it to the destination. A rater commented for a particular accident, even though the weather was not formally checked, the pilot was likely aware of clear sky conditions and was misled with a rapidly changing ceiling in darkness. In another accident, a rater commented cognitive anchoring was attributable to the 1931 radio call. A rater commented for a particular accident since the earlier legs were trouble free, even with new information, the pilot thought it would hold. Another rater commented for one of the accidents cognitive anchoring was apparent since fog was moving into the area but had not yet arrived. In another accident, the rater commented there was no cognitive anchoring because the pilot was trying to pull information out of the second briefer to update his information. A rater commented for a particular accident cognitive anchoring was apparent as the pilot relied heavily on briefer information, suggesting VFR. In another accident, the rater commented cognitive anchoring was apparent when the pilot likely used his earlier experience on the inbound flight as a picture of the weather on the return, not checking weather for the return flight. A rater commented for another accident cognitive anchoring was apparent because the briefer said things would get better by 1000 and then he stated if the pilot waited until 1000 to depart then he could avoid the fog. A rater commented for another accident cognitive anchoring was apparent after addressing the radio failure, the pilot did not change his plan. In another accident the rater commented cognitive anchoring was apparent because the pilot left the departure point with marginal VFR. In another accident, the rater commented cognitive anchoring was possible due to the pilot latching on to the destination Terminal Aerodrome Forecast (TAF) and not giving as much consideration to the Airmen's Meteorological Information (AIRMET). A rater commented for a particular accident cognitive anchoring was apparent as the pilot was probably comfortable with the normal VMC of the area and used it to proceed; however, it is unclear why he navigated to Gorman (GMN) Very High Frequency Omni-Directional Range (VOR) which is near high terrain. In another accident, the rater commented cognitive anchoring was apparent due to predominantly VMC and the multiple crossings through the pass several times that day. A rater commented for another accident cognitive anchoring was apparent because the pilot, prior to the flight, indicated he would fly through the pass via route 95, and the plan was followed precisely until the crash. The rater made an additional comment the pilot likely had a belief this would avoid IMC. Another rater commented cognitive anchoring was apparent because the initial weather briefing, 11 hours prior, was acceptable for VFR flight. The rater made an additional comment the pilot never received an updated briefing, and it is likely the pilot maintained VFR flight to the destination was possible. A rater commented for a particular accident cognitive anchoring was apparent because the briefer and pilot concluded if he could get to the destination in about 45-50 minutes, the pilot could avoid the weather with the briefer, adding if he did need to get back to VFR he could head south. In another accident, the rater commented cognitive anchoring was apparent by continuing the flight and descending rather than turning around and finding an alternate. A rater commented for a particular accident cognitive anchoring was apparent as the pilot was told by another pilot at the destination he could see the stars and the runway lights. The rater made an additional comment, it appeared this convinced the pilot to make the flight rather than cancel or wait. In another accident, the rater commented the pilot imposed self-induced pressures to make flight. A rater commented for a particular accident cognitive anchoring was apparent due to nice weather on departure. In another accident, the rater commented cognitive anchoring was apparent as the weather at the departure point was acceptable; however, the pilot's wife called him to let him know she was encountering heavy fog, but he continued to the destination with no regard to the updated weather information. In another accident, the rater commented cognitive anchoring was apparent as the pilot must have been convinced the weather would improve at the destination.

Communication with air traffic control (CF12). A rater commented for a particular accident the pilot communicated with the automated flight service station (AFSS) but not air traffic control. A rater commented for one of the accidents the pilot communicated with air traffic control before the accident but then lost communication, although some communication relay was conducted. In another accident, the rater commented the pilot communicated with air traffic control, but the communication was very brief, and he did not respond to the assigned squawk and frequency change for transit through Memphis Class B airspace. In another accident, the rater commented the pilot was not in communication with Air Traffic Control (ATC). A rater commented for a particular accident the pilot was told services were terminated about nine minutes prior to the accident. In another accident, the rater commented the pilot was in communication with ATC prior to the accident but made the frequency change off of air traffic control before the actual accident.

Consequences not anticipated (CF13). A rater made a comment for one of the accidents the pilot was under stress because the left fuel cap was left off. In another accident, the rater commented the pilot was under stress and may or may not have considered IMC consequences. A rater commented for one of the accidents the pilot was under stress due to previous cancellations. A rater commented for one of the accidents the pilot was under stress due to a spinal condition and treatment. In another accident, the rater commented the pilot was under stress due to medications. A rater commented for another accident the underlying condition requiring the antihistamine likely stressed the pilot. In another accident, the rater commented the pilot was under stress due to the antihistamines in his system. A rater commented in one of the accidents the pilot was under stress due to his business work schedule. In another accident, the pilot was under stress due to a medical condition related to back pain. In another accident, the rater commented the pilot was under stress as he had a passenger onboard, and the purpose of the flight was to make an appointment, specifically soaring instruction. In another accident, the rater commented the pilot was under stress due to a medical condition. A rater commented for one of the accidents the pilot was under stress due to the weather environment. Another rater commented for a particular accident the pilot was under stress due to the long flight activity.

Crash distance from departure (CF14). The aircraft crash distances occurring between 0% and 50% of the planned route distance from the departure were calculated by the researcher based on the latitude and longitude coordinates provided by the NTSB investigators completing the AARs. The crash distances from the departure location to the midpoint as a percentage of the planned route of flight course completion included the following: (1) 0% (12 accidents), (2) 1% (3 accidents), (3) 2% (2 accidents), (4) 3% (1 accident), (5) 10% (2 accidents), (6) 11% (1 accident), (7) 13% (1 accident), (8) 18% (1 accident), (9) 19% (1 accident), (10) 20% (1 accident), (11) 23% (1 accident), (12) 24% (1 accident), (13) 25% (1 accident), (14) 29% (1 accident), (15) 33% (1 accident), (16) 35% (1 accident), (17) 41% (3 accidents), (18) 45% (1 accident), (19) 46% (1 accident), (20) 47% (1 accident), (21) 48% (1 accident), and (22) 49% (2 accidents).

Crash distance from planned destination (CF15). The aircraft crash distances occurring between 51% and 100% of the planned route distance from the planned destination were calculated by the researcher based on the latitude and longitude coordinates provided by the NTSB investigators completing the AARs. The crash distances from the midpoint to the planned destination as a percentage of the planned route of flight course completion included the following: (1) 51% (12 accidents), (2) 56% (1 accident), (3) 59% (1 accident), (4) 60% (1 accident), (5) 62% (1 accident), (6) 66% (1 accident), (7) 69% (1 accident), (8) 70% (2 accidents), (9) 71% (1 accident), (10) 73% (1 accident), (11) 74% (2 accidents), (12) 77% (3 accidents), (13) 84% (1 accident), (14) 86% (1 accident), (15) 89% (1 accident), (16) 90% (1 accident), (17) 94% (1 accident), (18) 95% (1 accident), (19) 96% (1 accident), (20) 97% (1 accident), (21) 98% (1 accident), and (22) 99% (9 accidents).

Currency policy violation (CF16). One of the raters commented the pilot's passenger carrying currency was exceeded. In another accident, the rater commented there was not enough information on night landing currency with passengers to determine if CF16 was present. A rater commented for a particular accident the pilot’s biennial flight review was expired. In another accident, the rater commented currency was assumed ok for night landings with passenger by assuming the reported night hours in the last 90 days included the three night takeoffs and landings. In another accident, the rater commented the currency policy was ok as 31 hours was obtained in the last 90 days and allowed for the three takeoffs and landings needed for passenger carry. A rater commented for a particular accident the student pilot took a passenger on the flight and was prohibited. One of the raters commented for a particular accident there was a currency policy violation because the last pilot logbook entry was greater than six months prior and would preclude 90 takeoffs and landings currency for passenger carrying. One of the raters commented for a particular accident the pilot was current due to pilot recent time, night passenger carrying currency was assumed, and the recent biennial flight review (BFR) was valid.

Decision to continue VFR-into-IMC to the planned destination (CF17). A rater commented for a particular accident the pilot overflew the destination field saying he saw lights, but the observation was not visual on the field. In another accident, the rater commented the pilot decided to continue VFR-into-IMC to the planned destination possibly due to communication with the controller. A rater made the comment for another accident the pilot decided to continue into IMC since the briefer said VFR was not recommended in the obscuration areas, but the pilot went anyway. In another accident, the rater commented the pilot decided not to divert based on descent and course.

Decision to divert from VFR-into-IMC to an alternate destination (CF18). A rater made the comment for a particular accident the pilot did not continue VFR-into-IMC because the report concluded the pilot turned to exit IMC. In another accident, the rater commented the pilot did not continue to the planned destination but tried to return to the point of origin. A rater made the comment for another accident, the pilot turned to the North and could have been disorientation or tried to divert to an alternate location. In another accident, the rater commented the pilot may have decided to divert based on the pilot statement to his wife and may have attempted to divert to the point of origin. In another accident, the rater commented the pilot decided to divert from IMC because the report concluded the pilot turned to exit IMC.

Delay in obtaining the current weather conditions (CF19). A rater made the comment for a particular accident, the pilot delayed obtaining the current weather conditions. In another accident, the rater commented the pilot did not get any weather information.

Descent below weather minimums (CF20). A rater commented for a particular accident, the pilot descended below weather minimums and encountered rising terrain. In another accident, the rater commented the pilot descended below VFR weather minimums, and likely IFR weather minimums, in an attempt to land at the desired airport.

Filing of a flight plan (CF21). One of the raters made the comment for a particular accident, the pilot did not file a flight plan. In another accident, the rater commented the flight plan was input via computer but did not go through due to incomplete information input by the pilot. A rater made the comment for another accident, the pilot filed IFR, through a malformed request to air traffic control, but was not rated to do so. In another accident, the rater commented the pilot filed a flight plan, although the NTSB investigator completing the report incorrectly and indicated no on the form. In another accident, the rater commented it was possible an instrument rated pilot opted to not file IFR. A rater commented for a particular accident, the pilot filed IFR, then near the destination, cancelled the IFR flight plan and flew VFR-into-IMC back to the point of origin. In another accident, the rater commented the pilot received a weather briefing and filed via the Direct User Access Terminal Service (DUATS), but the report did not say that a briefing was obtained from DUATS. In another accident, the rater commented, the pilot filing IFR was technically true, but practically, if the pilot was trying to avoid icing, filing IFR was not a practical option. In another accident, the rater commented the IFR pilot in Class G airspace was not in violation of needing to file a flight plan. A rater commented for one of the accidents, the pilot should have filed IFR and flown IFR procedures.

Flight into known icing conditions (CF22). A rater made the comment for a particular accident, the pilot flew into forecast icing at night. In another accident, the rater commented, the pilot flew into icing conditions, since IMC was above the freezing level. Another rater commented in one of the accidents, the pilot flew into known icing based on the Meteorological Impact Statement (MIS).

Flight plan policy violation (CF23). A rater made the comment for one of the accidents, the pilot had a ratings policy violation, since he lied on his application. In another accident, the rater commented the flight plan policy was a key factor. Another rater commented on a particular accident, while the flight was conducted under Part 91 flight rules, the flight was operated by a Part 135 operator and is unlike most of the other accidents conducted as personal flights.

Goal conflicts (CF24). One of the raters commented in a particular accident, the pilot took a risk, since the co-owner advised him not to make the flight. In another accident, the rater commented it was not possible to determine if the pilot took a safety risk, as he thought he was getting good information. A rater made the comment in one of the accidents there was a goal conflict related to a 0930 appointment.

Height of crash site (CF25). The height of the crash sites were reported as the following: (1) 0 - 999 feet mean sea level, (2) 1,000 - 1,999 feet mean sea level, (3) 2,000 - 2,999 feet mean sea level, (4) 3,000 - 3,999 feet mean sea level, (5) 4,000 - 4,999 feet mean sea level, (6) 5,000 - 5,999 feet mean sea level, (7) 6,000 - 6,999 feet mean sea level, (8) 7,000 - 7,999 feet mean sea level, (9) 8,000 - 8,999 feet mean sea level, and (10) 10,000 - 10,999 feet mean sea level.

IFR flight without clearance or ratings (CF26). A rater made the comment for a particular accident, the pilot conducted the flight without clearance because the NTSB stated Class E airspace was the location for the accident.

Linear decision - making (CF27). One of the raters made the comment for a particular accident, the pilot exhibited linear decision making, since even though the forecast was for IFR along route of flight, the pilot waited for IMC to occur.

Medical status policy violation (CF28). One of the raters made the comment for a particular accident, the pilot's medical policy violation was severe since he lied on his medical application. In another accident, the rater commented the pilot was not in violation, but postmortem medical status was an interesting factor. A rater made the comment for one of the accidents, the pilot exhibited several medical status policy violations, as numerous impairing drugs seemed central and/or indicative of the pilot’s hazardous attitude. One of the raters commented for another accident, medical status policy violation was apparent due to the pilot’s use of antihistamine. In another accident, the rater made the comment, the pilot exhibited a medical policy violation due to drugs with a sedating side effect in his system. One of the raters made the comment for one of the accidents, the pilot exhibited a medical status violation due to an expired medical. In another accident, one of the raters made the comment a medical status violation was apparent since the coroner obtained the pilot’s medical data and the NTSB investigator provided the information in the AAR.

Number of passengers on board (CF29). A total of 32 out of the 85 accident sample occurred with no passengers on board the aircraft. A total of 36 accidents had one passenger on the aircraft. A total of 11 accidents had two passengers. A total of three accidents had three passengers on board the aircraft. A total of one accident had four passengers on board the aircraft. A total of two accidents had five passengers on board the aircraft.

Obtaining an on-line preflight weather briefing (CF30). One of the raters made the comment for a particular accident, the pilot was unable to get an online preflight weather briefing, though he tried. In another accident, the rater commented the pilot failed to get an online preflight weather briefing. One of the raters made the comment for a particular accident, the pilot obtained an online preflight weather briefing.

Organization (CF31). A rater made the comment for one of the accidents, the pilot was concerned about leaving the aircraft at the hospital and may have been a concern related to aircraft exposure to a storm. In another accident, the rater commented organizational conflict factored into an experienced pilot's decision to continue VFR-into-IMC. One of the raters made the comment for a particular accident, the organizational conflict affected the pilot's decision-making to conduct the flight.

Permission-seeking behaviors (CF32). One of the raters commented for a particular accident, the group flight contributed to permission seeking behavior. In another accident, the rater commented the pilot's permission-seeking also seemed at play, with multiple calls to the Flight Service Station (FSS); although, FSS never gave "permission" and advised against the flight, as did another IFR-rated pilot. In another accident, the rater commented the briefer aided the pilot's permission-seeking behavior.

Pilot-briefer communication (CF33). A rater commented in one of the accidents, the pilot-briefer communication was a factor. In another accident, the rater commented the co-owner advised the pilot about the weather. A rater made the comment in one of the accidents, the pilot-briefer communication may have contributed to pilot weather misdiagnosis by the briefer saying no adverse weather. In another accident, the rater commented the weather briefing for the accident segment was misleading and incomplete. A rater made the comment in one of the accidents, despite the adverse weather briefing, the pilot decided to conduct the flight.

Plan continuation error (PCE) (CF34). One of the raters made the comment for a particular accident, PCE was a factor contributing to the accident due to business plans discussed in the report. In another accident, the rater made the comment PCE behavior was assumed based on action and outcome. One of the raters made the comment for a particular accident, PCE was a possible contextual factor as the pilot seemed to go with his plan and ignore fog assuming he could punch through. In another accident, the rater commented PCE was likely, given the proximity to the airport. A rater made the comment in a particular accident, PCE was apparent based on the descent and flight course and affected the pilot's decision making. In another accident, the rater made the comment, the pilot exhibited poor decision-making skills combined with PCE to attempt the flight. One of the raters made the comment in a particular accident, PCE was likely because the pilot proceeded even with an airborne briefing in addition to a briefing during preflight. In another accident, the rater made the comment this was a preflight decision-making accident, not only for IMC but for thunderstorms. One of the raters made the comment in a particular accident, despite the weather briefing, the pilot conducted the flight anyway. In another accident, one of the raters made the comment PCE was a factor by the pilot continuing the flight and descending rather than turning around and finding an alternate. One of the raters made the comment for a particular accident, PCE led the pilot to underestimate the risk of conducting the flight. In another accident, the rater commented the pilot imposed self-induced pressures to complete the flight contributing to PCE.

Ratings policy violation (CF35). One of the raters made the comment the pilot filed IFR, through a malformed request to air traffic control, but was not rated to do so and was a key factor. In another accident, the rater made the comment a non-instrument rated pilot flying into IMC is a rating violation. One of the raters made the comment in a particular accident, the pilot was in violation of the ratings policy, as the pilot-in-command was a student pilot, because he was carrying passengers with no endorsement. In another accident, the rater commented there was a ratings policy violation since the pilot lied on his medical application. In another accident, the rater commented there was no instrument recency met. One of the raters commented for a particular accident, there was inadequate instructor supervision, as the instructor was obliged to provide better supervision to student pilot. In another accident, the rater commented the ratings policy violation was the primary contextual factor related to a student pilot with a passenger on a twice a week greater than 25 nm flight at night. One of the raters made the comment for a particular accident, many IMC flights were logged by the pilot without the proper rating. In another accident, the rater commented the pilot was not authorized to fly at night.

Receipt of weather briefing (CF36). One of the raters made the comment for a particular accident, the pilot did not receive a weather briefing. In another accident, the rater commented, given the resources at the field, the pilot likely obtained a weather briefing using electronic means at the Fixed Base Operator (FBO). One of the raters commented for a particular accident, the pilot did not receive a full weather briefing. In another accident, the rater commented the pilot received a weather briefing, but the weather briefing was incomplete and was not factored into the risk estimation. A rater made the comment in one of the accidents, the pilot did not receive a preflight weather briefing. In another accident, the rated commented the weather briefing for the accident segment was misleading and incomplete. One of the raters made the comment in a particular accident, the pilot received a weather briefing, presumably by DUATS. The rater made an additional comment the pilot filed via DUATS, but the report did not say a weather briefing was obtained from DUATS. In another accident, the rater commented despite the adverse weather briefing, the pilot decided to conduct the flight anyway. One of the raters commented in a particular accident, the pilot did receive a weather briefing, but it was not timely. In another accident, the rater commented the pilot did not get a weather brief from an FAA-approved source. The rater made an additional comment it is unknown if the pilot got a brief from another source.

Scud running (CF37). A rater made the comment in one of the accidents, it is assumed the pilot was scud running due to the 700 foot above ground level (AGL) cruise altitude. In another accident, the rater commented it is assumed the pilot was scud running due to the altitude prior to the accident. In another accident, the rater commented scud running was likely due to a transition, at some point, from 7,500 feet cruise altitude to 1,300 feet. One of the raters made the comment in a particular accident, the pilot was not scud running, as a witness said he was flying above the base of the clouds and was intentional IMC. In another accident, the rater commented scud running was assumed based on the aircraft altitude. One of the raters commented in a particular accident, the pilot was scud running based on a witness account. In another accident, the rater commented, the pilot was scud running based on weather and transit through controlled airspace. One of the raters commented in a particular accident, scud running was the primary cause of the accident.

Self-reported weather cues (CF38). One of the rater's commented in a particular accident, the squawked 7700 transponder code suggested the pilot recognized the deteriorating weather conditions but did not know how or what action to take to exit such conditions. In another accident, the rater commented the pilot recognized the self-reported weather cues, as the flight path near the crash site indicated he recognized the visibility. One of the raters commented in a particular accident, the pilot's inability to recognize self-reported weather cues led to getting caught above the clouds, ruling out intentional self-harm. In another accident, the rater commented the pilot was not able to recognize weather cues.

Situation assessment (CF39). One of the raters commented in a particular accident, the situation was underestimated by the pilot leading to inadvertent IMC. In another accident, the rater commented the pilot did assess the situation and return. One of the raters commented in a particular accident, the pilot misdiagnosed the situation using bad weather information. In another accident, the rater commented the pilot misdiagnosed the weather situation of fog forming, and night conditions contributed to the misdiagnosis. One of the raters made the comment in a particular accident, the pilot's poor decision-making let to poor situation assessment. In another accident, the pilot exhibited poor decision-making skills to attempt the flight. One of the raters commented in a particular accident, the accident was a preflight decision-making accident, not only for IMC but for thunderstorms. In another accident, the rater commented the pilot conducted a poor situation assessment, ruling out intentional self-harm. One of the raters made the comment in a particular accident, the pilot’s poor situation assessment led to getting caught above the clouds, ruling out intentional self-harm. In another accident, the rater commented the pilot misdiagnosed weather cues, and night was a factor including possible fatigue resulting from five flights, nine to ten hours of duty time, lack of risk assessment for positioning the flight, and lack of night vision goggles. One of the raters made the comment in a particular accident, the pilot imposed self-induced pressures to make the flight leading to poor situation assessment.

Social (CF40). One of the raters commented on a particular flight, the group flight contributed to permission seeking behavior. In another accident, social pressures were at play with business plans discussed in the report. One of the raters made the comment in a particular accident, social pressures factored into the experienced pilot's decision to continue VFR-into-IMC. In another accident, social pressure was apparent and based on the pressure to attend a meeting in Aspen. One of the raters made the comment in a particular accident, social pressures adversely affected the pilot's decision making. In another accident, the rater commented social pressure was apparent due to expectations at work, arriving by conducting a flight to different work locations. One of the raters made the comment in a particular accident, social pressures led to the pilot underestimating risk to conduct the flight.

Source of weather information (CF41). One of the raters commented for a particular flight, there was no record of a weather briefing. In another accident, the pilot selected a good source of weather information, but the weather information was not complete. One of the raters made the comment in a particular accident, the source of weather information provided to the pilot by the briefer was bad. In another accident, the rater commented the pilot should not have completed the long flight with only an outlook briefing, resulting in VFR-into-IMC and icing. One of the raters commented in a particular accident, the pilot did not update the weather information soon enough, resulting in his weather information being poor and leading to underestimating the risk in conducting the flight.

Terrain (CF42). The raters identified the physical characteristics of the land where the accidents occurred included the following: (1) marsh based on the chart; (2) mountains; (3) hills; (4) forest; and (5) swamp.

Underestimating risk (CF43). One of the raters commented, after the adverse weather briefing, the pilot filed VFR, indicating an underestimation of risk in conducting the flight. In another accident, the rater commented the pilot underestimated the risk in conducting the flight, given the time of day, night conditions, and mountainous terrain. One of the raters made the comment in a particular accident, the pilot exhibited poor decision-making in underestimating the risk in conducting the flight. In another accident, the rater commented the instructor-rated passenger presence and bad decision-making factors contributed to the pilot underestimating the risk in conducting the flight. One of the raters commented in a particular accident, the accident was a preflight decision-making accident, not only for IMC but for thunderstorms. In another accident, the rater commented the lighting conditions contributed to the accident. One of the raters commented in a particular accident, the pilot received a weather briefing, but it was incomplete and not factored into the risk estimation of flying in mountainous terrain. In another accident, the rater commented the weather briefing for the accident segment was misleading and incomplete, combined with an incomplete pilot risk assessment. One of the raters commented in a particular accident, the pilot was flying in night conditions. In another accident, the rater commented the NTSB report emphasized the pilot had next day work-related obligations. The rater made an additional comment stating these factors contributed to the pilot's bad decision-making, contributing to underestimating the risk in conducting the flight. The rater made another comment stating it is also possible an intentional self-harm act on the part of the pilot may have been a factor contributing to the accident. In another accident, the rater commented the pilot's underestimation of risk led to getting caught above the clouds. The rater made an additional comment stating it is also possible intentional self-harm may have also been a factor in the accident. In another accident, the rater commented the pilot underestimated the risk of clouds and thunderstorms. One of the raters made the comment in a particular accident, the pilot underestimated the risk of flying low to avoid IMC. In another accident, the rater commented social pressures led the pilot to underestimate risk in conducting the flight. One of the raters commented in a particular accident, the pilot imposed self-induced pressures on himself to make the flight, leading to an underestimation of risk resulting in the accident. In another accident, the rater commented an underestimation of risk by the pilot was a key factor resulting in the accident. One of the raters made the comment in a particular accident, it is possible the pilot did not recognize there was fog. In another accident, the rater commented the equipment failure, many unknowns, and probable cause faulting air traffic control could have contributed to the pilot's underestimation of risk in completing the flight. A rater made the comment in a particular accident, the pilot underestimated the risk in conducting the flight at night, considering the pilot’s lack of experience flying at night.

Unrecoverable low altitude (CF44). One rater made the comment in a particular accident, the pilot was flying VFR at low altitude. In another accident, the rater commented the rear seat passenger survived and provided an account of the accident. One of the raters commented in a particular accident, a pilot stated the accident pilot descended to maintain contact with the ground. The rater made an additional comment stating this also applies to scud running and unrecoverable low altitude. In another accident, the rater commented the pilot was scud running and at an unrecoverable low altitude, based on the pilot's transmission to air traffic control indicating he was trapped beneath the layer.

Use of in-cockpit weather information (CF45). No use of in-cockpit weather information contextual factor manifestations were reported by the raters.

Use of portable weather applications (CF46). One of the raters commented in a particular accident, a handheld GPS was onboard, but its use was unknown. In another accident, the rater commented the pilot had a handheld Garmin GPSMAP 196 onboard, but its use was unknown. One of the raters commented in a particular accident, a handheld GPS was found, but there was no way to know if the pilot became overly absorbed in its use.

Quantitative Data

A point-biserial correlation coefficient was used to examine the statistically significant relationships among the contextual factors, pilot age, and flight experience in the 85 accident main study sample of NTSB AARs. Results identified several statistically significant relationships among specific contextual factors, pilot age, and flight experience. Point-biserial results between the 46 contextual factors and pilot age are given in Table 6.

Table 6

Point-biserial Correlations Contextual Factors/Pilot age

Contextual Factor	Age
Accident time of day (Day) (CF1)	$r = -.377, p = .000$
Accident time of day (Night) (CF1)	$r = -.277, p = .000$
Adverse weather encountered before mid flight point reached (CF2)	$r = -.140, p = .025$
Adverse weather not encountered after mid flight point was reached (CF3)	$r = -.148, p = .018$
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	$r = -.139, p = .026$
The pilot did not exhibit circular decision-making (CF10)	$r = -.140, p = .026$

Table 6 continued

Point-biserial Correlations Contextual Factors/Pilot age

Contextual Factor	Age
The pilot exhibited cognitive anchoring (CF11)	$r = -.133, p = .034$
The aircraft crash site was closer to the departure location than the planned destination (CF14)	$r = -.158, p = .012$
The aircraft crash site was not closer to the departure location than the planned destination (CF14)	$r = .123, p = .050$
The aircraft crash site was closer to the planned destination than the departure location (CF15)	$r = .139, p = .026$
The pilot flew into known icing conditions (CF22)	$r = .164, p = .009$
The pilot did not experience an organizational conflict between productivity and safety (CF31)	$r = -.141, p = .025$
The pilot was in violation of FAA ratings policy (CF35)	$r = -.141, p = .024$
The pilot was not in violation of FAA ratings policy (CF35)	$r = .164, p = .009$
The pilot was able to recognize self-reported weather cues (CF38)	$r = .191, p = .002$
The pilot was not able to recognize self-reported weather cues (CF38)	$r = -.191, p = .002$
The pilot did not decide to obtain and use weather information through use of in-cockpit installed weather equipment information (CF45)	$r = -.277, p = .000$

Table 6 continued

Point-biserial Correlations Contextual Factors/Pilot age

Contextual Factor	Age
The pilot did not decide to use weather information obtained through portable weather smart phone applications (CF46)	$r = -.174$, $p = .005$

A point-biserial correlation coefficient was also used to examine the statistically significant relationships between the contextual factors and flight experience in the 85 accident main study sample of NTSB AARs. Results identified several statistically significant relationships between specific contextual factors and flight experience. Point-biserial results between the 46 contextual factors and flight experience are given in Table 7.

Table 7

Point-biserial Correlations Contextual Factors/Flight Experience

Contextual Factor	Flight Experience
The pilot did not communicate with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = .131$, $p = .037$

Table 7 continued

Point-biserial Correlations Contextual Factors/Flight Experience

Contextual Factor	Flight Experience
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = -.156, p = .012$
The pilot was not under stress and did anticipate the consequences of flying in IMC (CF13)	$r = .153, p = .015$
The pilot did not descend below weather minimums (CF20)	$r = -.149, p = .018$
The pilot flew into known icing conditions (CF22)	$r = .148, p = .018$
The pilot was not in violation of organizational flight plan policy - filing IFR when required (CF23)	$r = .209, p = .001$
The pilot did not exhibit linear decision-making (CF27)	$r = .200, p = .001$
The pilot did not exhibit permission-seeking behaviors (CF32)	$r = -.239, p = .000$
The pilot was in communication with a briefer (CF33)	$r = -.178, p = .004$
The pilot was in violation of FAA ratings policy (CF35)	$r = -.231, p = .000$
The pilot was not in violation of FAA ratings policy (CF35)	$r = -.231, p = .000$

A phi correlation coefficient was used to examine the statistically significant relationships among the contextual factors, certification level (instrument/non-instrument), weather (inclement/non-inclement), flight conditions (VMC/IMC) and time of day (day/night) in the 85 accident main study sample of NTSB AARs. Results identified statistically significant relationships between the contextual factors, and these identified other factors. Phi correlation results between the 46 contextual factors and the identified other factors are given in Tables 8, 9, 10, and 11.

Table 8

Phi Correlations Contextual Factors/Certification Level

Contextual Factor	Certification
Adverse weather encountered before mid flight point reached (CF2)	*r* = -.165, *p* = .007
Adverse weather not encountered before mid flight point reached (CF2)	*r* = -.126, *p* = .040
Adverse weather encountered after mid flight point was reached (CF3)	*r* = -.161, *p* = .009
Cues signaling problem clear to pilot (CF5)	*r* = -.126, *p* = .040
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	*r* = -.163, *p* = .008
The pilot overestimated ceiling and/or visibility weather conditions (CF9)	*r* = -.122, *p* = .048
The pilot did not communicate with air traffic control at the time of the VFR-into-IMC accident (CF12)	*r* = -.159, *p* = .010

Table 8 continued

Phi Correlations Contextual Factors/Certification Level

Contextual Factor	Certification
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident (CF12)	r = -.124, p = .044
The aircraft crash site was closer to the departure location than the planned destination (CF14)	r = -.160, p = .009
The aircraft crash site was not closer to the departure location than the planned destination (CF14)	r = -.164, p = .008
The aircraft crash site was closer to the planned destination than the departure location (CF15)	r = -.186, p = .002
The aircraft crash site was not closer to the planned destination than the departure location (CF15)	r = -.139, p = .024
The pilot was not in violation of the FAA flight time currency policy (CF16)	r = -.153, p = .013
The pilot decided to continue VFR-into-IMC to the planned destination (CF17)	r = -.156, p = .011
The pilot did not submit a flight plan to flight service (CF21)	r = .377, p = .000
The pilot took a safety risk to fly in IMC conditions to planned destination (CF24)	r = -.222, p = .000

Table 9

Phi Correlations Contextual Factors/Weather

Contextual Factor	Inclement Weather
Adverse weather encountered before mid flight point reached (CF2)	*r* = -.165, *p* = .007
Adverse weather not encountered before mid flight point reached (CF2)	*r* = -.126, *p* = .040
Adverse weather encountered after mid flight point was reached (CF3)	*r* = -.161, *p* = .009
The pilot was in violation of conducting an IFR flight without proper clearance or ratings (CF26)	*r* = .230, *p* = .000
The pilot was not in violation of FAA medical status policy (CF28)	*r* = -.293, *p* = .000
The pilot was in communication with a briefer (CF33)	*r* = -.143, *p* = .020
The pilot was not in communication with a briefer (CF33)	*r* = -.132, *p* = .032
The pilot exhibited Plan Continuation Error behavior (CF34)	*r* = -.306, *p* = .000
The pilot was in violation of FAA ratings policy (CF35)	*r* = -.150, *p* = .015
The pilot was not in violation of FAA ratings policy (CF35)	*r* = -.154, *p* = .012
The pilot did not receive a weather briefing (CF36)	*r* = -.122, *p* = .048

Table 9 continued

Phi Correlations Contextual Factors/Weather

Contextual Factor	Inclement Weather
The pilot received a weather briefing (CF36)	*r* = -.147, *p* = .017
The pilot was able to recognize self-reported weather cues (CF38)	*r* = -.136, *p* = .027
The pilot misdiagnosed the changes in or severity of the weather (CF39)	*r* = -.322, *p* = .000
The pilot underestimated the level of risk associated with cues that should have signaled a change in course of action (CF43)	*r* = -.332, *p* = .000

Table 10

Phi Correlations Contextual Factors/Flight Conditions

Contextual Factor	Flight Conditions
Adverse weather encountered before mid flight point reached (CF2)	*r* = -.165, *p* = .007
Adverse weather not encountered before mid flight point reached (CF2)	*r* = -.126, *p* = .040
Adverse weather encountered after mid flight point was reached (CF3)	*r* = -.161, *p* = .009

Table 10 continued

Phi Correlations Contextual Factors/Flight Conditions

Contextual Factor	Flight Conditions
Cues signaling problem clear to pilot (CF5)	*r* = -.126, *p* = .040
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	*r* = -.163, *p* = .008
The pilot overestimated ceiling and/or visibility weather conditions (CF9)	*r* = -.122, *p* = .048
The pilot did not communicate with air traffic control at the time of the VFR-into-IMC accident (CF12)	*r* = -.159, *p* = .010
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident (CF12)	*r* = -.124, *p* = .044
The aircraft crash site was closer to the departure location than the planned destination (CF14)	*r* = -.160, *p* = .009
The aircraft crash site was not closer to the departure location than the planned destination (CF14)	*r* = -.164, *p* = .008
The aircraft crash site was closer to the planned destination than the departure location (CF15)	*r* = -.186, *p* = .002
The aircraft crash site was not closer to the planned destination than the departure location (CF15)	*r* = -.139, *p* = .024

Table 10 continued

Phi Correlations Contextual Factors/Flight Conditions

Contextual Factor	Flight Conditions
The pilot was not in violation of the FAA flight time currency policy (CF16)	*r* = -.153, *p* = .013
The pilot decided to continue VFR-into-IMC to the planned destination (CF17)	*r* = -.156, *p* = .011
The pilot did not submit a flight plan to flight service (CF21)	*r* = -.322, *p* = .000
The pilot took a safety risk to fly in IMC conditions to planned destination (CF24)	*r* = -.332, *p* = .000

Table 11

Phi Correlations Contextual Factors/Time of Day

Contextual Factor	Time of Day
Adverse weather encountered before mid flight point reached (CF2)	*r* = .177, *p* = .004
Adverse weather not encountered before mid flight point reached (CF2)	*r* = -.146, *p* = .018
Adverse weather encountered after mid flight point was reached (CF3)	*r* = -.155, *p* = .012

Table 11 continued

Phi Correlations Contextual Factors/Time of Day

Contextual Factor	Time of Day
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	$r = .133$, $p = .030$
The aircraft crash site was closer to the departure location than the planned destination (CF14)	$r = .168$, $p = .006$
The aircraft crash site was closer to the planned destination than the departure location (CF15)	$r = -.130$, $p = .034$
The aircraft crash site was not closer to the planned destination than the departure location (CF15)	$r = .189$, $p = .002$

A multiple regression analysis was completed on the 85 NTSB GA Part 91, VFR-into-IMC accident sample to determine if any of the 46 contextual factors (independent/predictor variables) had any effects on the crash distance from the departure point to the midpoint of the planned route of flight (dependent/outcome variable). The 46 research-identified contextual factors were entered into the independent/predictor variable field and the crash distances from departure to the midpoint of the planned route of flight were entered into the dependent/outcome variable field of SPSS™ as a percentage from 0% to 50% of planned route completion, as determined by the provided latitude and longitude of the departure point to the crash site in the NTSB AARs (Table 12).

The six multiple regression assumptions were checked for each of the analyses completed by the researcher to ensure the correct data was reported. The relationship between the independent/predictor variables and dependent/outcome variable was assessed for linearity through review of scatterplots (Assumption 1). No multicollinearity in the data was determined by all variance inflation factor (VIF) scores below 10 and all tolerance scores above 0.2 (Assumption 2). Independent values of the residuals were determined through review of the Durbin-Watson statistic to ensure the number was close to the value of 2 (Assumption 3). Constant variance of the residuals was determined through a review of standardized residuals versus standardized predicted values showing no indication of funneling, suggesting the assumption of homoscedasticity had been accomplished (Assumption 4). Values of the residuals were determined to be normally distributed through review of the P-P plot for the model (Assumption 5). A check was made to ensure no influential cases were biasing the model as determined through review of Cook's Distance values being under 1, suggesting the individual cases were not unduly influencing the model (Assumption 6).

The multiple regression results were reviewed. A value of .609 for the multiple correlation coefficient, R, was observed and indicated a relatively strong level of prediction. The R Square coefficient of determination value is the proportion of variance in the dependent/outcome variable explained by the independent/predictor variables. The value of .371 indicated the independent/predictor variables explained 37.1% of the variability of the dependent/outcome variable (Table 12).

Table 12

Crash Distance from Departure Model Summary

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.609[a]	.371	.123	13.57626	1.013

a. Predictors: CF1, CF2, CF3, CF5, CF6, CF7, CF8, CF9, CF10, CF11, CF12, CF13, CF16, CF17, CF18, CF19, CF20, CF21, CF22, CF23, CF24, CF26, CF27, CF28, CF29, CF30, CF31, CF32, CF34, CF35, CF37, CF38, CF39, CF40, CF41, CF43, CF44, CF45

b. Dependent Variable: Crash Distance from Departure to Midpoint of Planned Route of Flight (0% to 50% of Planned Route Completion)

The F-ratio in the analysis of variance (ANOVA) table tests whether the overall regression model is a good fit for the data (Table 13). The table shows the independent/predictor variables statistically significantly predict the dependent/outcome variable, F (72, 182) = 1.494, $p < .017$. Therefore, the regression model is a good fit for the data. Statistical significance for each of the contextual factors (independent/predictor variables) was tested for whether the unstandardized or standardized coefficients were equal to zero in the population. It was determined the flight time and distance in IMC were less than or equal to half the time and distance required to reach the destination, p = .033 (CF7), the pilot submitted a flight plan to flight service, p = .040 (CF21), the pilot did not fly into known icing conditions, p = .027 (CF22), and the pilot was conducting scud running flight operations at the time of the accident, p = .054 (CF37) added statistically significantly to the prediction of the crash distance from departure to the midpoint of the planned route of flight (0 to 50 Percent), F(72, 182) = 1.494, $p < .017$, $R^2 = .371$.

Table 13

Crash Distance from Departure ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19822.441	72	275.312	1.494	.017[b]
	Residual	33545.300	182	184.315		
	Total	53367.741	254			

a. Dependent Variable: Crash Distance from Departure to Midpoint of Planned Route of Flight (0% to 50% of Planned Route Completion)
b. Predictors: CF1, CF2, CF3, CF5, CF6, CF7, CF8, CF9, CF10, CF11, CF12, CF13, CF16, CF17, CF18, CF19, CF20, CF21, CF22, CF23, CF24, CF26, CF27, CF28, CF29, CF30, CF31, CF32, CF34, CF35, CF37, CF38, CF39, CF40, CF41, CF43, CF44, CF45

A multiple regression analysis was also completed on the 85 NTSB GA Part 91, VFR-into-IMC accident sample to determine if any of the 46 contextual factors (independent/predictor variables) had any effects on the crash distance from the midpoint to the destination of the planned route of flight (dependent/outcome variable). The 46 research-identified contextual factors were entered into the independent/predictor variable field, and the crash distances from midpoint to destination of the planned route of flight were entered into the dependent/outcome variable field of SPSS™ as a percentage from 51% to 100% of planned route completion as determined by the provided latitude and longitude of the midpoint to the crash site in the NTSB AARs (Table 14).

Table 14

Crash Distance from Midpoint Model Summary

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.746[a]	.557	.382	32.73822	1.327

a. Predictors: CF1, CF2, CF3, CF5, CF6, CF7, CF8, CF9, CF10, CF11, CF12, CF13, CF16, CF17, CF18, CF19, CF20, CF21, CF22, CF23, CF24, CF26, CF27, CF28, CF29, CF30, CF31, CF32, CF34, CF35, CF37, CF38, CF39, CF40, CF41, CF43, CF44, CF45

b. Dependent Variable: Crash Distance from Midpoint to Destination of Planned Route of Flight (51% to 100% of the Planned Route Completion)

The multiple regression results were reviewed. A value of .746 for the multiple correlation coefficient, R, was observed and indicated a strong level of prediction. The R square coefficient of determination value is the proportion of variance in the dependent/outcome variable that can be explained by the independent/predictor variables. A value of .557 indicated the independent/predictor variables explained 55.7% of the variability of the dependent/outcome variable (Table 14). The F-ratio in the ANOVA table tests whether the overall regression model is a good fit for the data (Table 15). The table shows the independent/predictor variables statistically significantly predict the dependent variable, $F\ (72, 182) = 3.178$, $p < .01$. Therefore, the regression model is a good fit for the data. Statistical significance for each of the contextual factors (independent/predictor variables) was tested for whether the unstandardized or standardized coefficients were equal to zero in the population. It was determined the adverse weather encountered before mid flight point reached, $p = .009$ (CF2), adverse weather encountered after mid flight point was reached, $p = .000$ (CF3), the flight time and distance in IMC were greater than half the time and distance required to reach the destination before diverting, $p = .003$ (CF7), the pilot was not fixated on visually compelling head down displays, $p = .021$ (CF8), the pilot was under stress and did not anticipate the consequences of flying in IMC, $p = .017$ (CF13), the pilot decided not to continue VFR-into-IMC to the planned destination, $p = .018$ (CF17), the pilot decided to continue VFR-into-IMC to the planned destination, $p = .032$ (CF17), the pilot submitted a flight plan to flight service, $p = .002$ (CF21), the pilot flew into known icing conditions, $p = .027$ (CF22), the pilot exhibited linear decision-making, $p = .004$ (CF27), and the pilot did not exhibit permission-seeking behaviors, $p = .011$ (CF32), added statistically significantly to the prediction of the crash distance from the midpoint to the destination of the planned route of flight (51 to 100 Percent), $F(72, 182) = 3.178$, $p < .01$, $R^2 = .557$.

Table 15

Crash Distance from Midpoint ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	245217.019	72	3405.792	3.178	.000[b]
	Residual	195065.946	182	1071.791		
	Total	440282.965	254			

a. Dependent Variable: Crash Distance from Midpoint to Destination of Planned Route of Flight (51% to 100% of the Planned Route Completion)
b. Predictors: CF1, CF2, CF3, CF5, CF6, CF7, CF8, CF9, CF10, CF11, CF12, CF13, CF16, CF17, CF18, CF19, CF20, CF21, CF22, CF23, CF24, CF26, CF27, CF28, CF29, CF30, CF31, CF32, CF34, CF35, CF37, CF38, CF39, CF40, CF41, CF43, CF44, CF45

CHAPTER V

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The fair agreement inter-rater reliability Fleiss' kappa value of $\kappa = 0.25$ was determined for the main study rater agreement on the presence of the 46 research-identified contextual factors in the GA Part 91, VFR-into-IMC sample of 85 NTSB AARs. This fair agreement value was determined to be between 0.21 and 0.40 on the generally accepted standards of agreement (Fleiss, 1971). A percentage agreement of 57% percent was calculated between the three raters for the main study presence of the contextual factors. The Fleiss' kappa statistic was adjusted for prevalence and calculated to be a PABAK value of 0.50. Although the overall Fleiss' kappa (κ) score was in the fair range of agreement $\kappa = 0.25$, the individual Fleiss' kappa (κ) score for the 1 response, indicating rater agreement for the presence of the contextual factor, was calculated to be $\kappa = 0.51$ and in the moderate range of agreement (Table 2). The individual Fleiss' kappa (κ) score for the 0 response, indicating rater agreement for the absence of the contextual factor, was calculated to be $\kappa = 0.38$ and was on the high end of the fair range of agreement (Table 2). The overall Fleiss' kappa (κ) score in the fair range of agreement $\kappa = 0.25$ was due to such reasons as inconsistency in the raters selecting the same response for the reason the contextual factor was not present, as there were several responses available to the rater for selection (i.e., Not Applicable, N.A., Not enough information provided to identify the contextual factor, unknown, or providing no (blank) rating). The response of 'Not enough information provided to identify the contextual factor' was inconsistently but repeatedly used by the three raters as a reason for being unable to identify the presence of the contextual factors in the accident sample dataset (Appendix D; Table D5). It is possible if the AARs and probable cause reports had contained more detailed information, a higher number of contextual factors could have been identified by the raters resulting in a higher overall Fleiss' kappa (κ) score.

The study utilized expert raters to identify the presence and frequency of 46 research-identified contextual factors and manifestations from the pilot perspective in 85 GA VFR-into-IMC NTSB accident AARs. Rater-identified contextual factors were assessed with multiple regression analysis using dummy variables to determine any statistically significant effects from the 46 contextual factors on crash distance from departure to midpoint of the planned route (0% to 50% of planned course completion) and crash distance from midpoint to planned destination (51% to 100% of planned course completion). Relationships between the 46 contextual factors and pilot age and total flight experience were assessed for any statistically significant interactions using a point biserial correlation. The relationships between the 46 contextual factors and pilot certification level (instrument/non-instrument rated), weather (inclement/non-inclement), flight conditions (VMC/IMC), and time of day were assessed for any statistically significant interactions using a phi correlation.

Three raters identified the presence for 37 out of 46 (80%) of the research-identified contextual factors in the 85 accident sample used in the main study. The presence of the contextual factors was identified by the raters in the majority of the 85 GA Part 91, VFR-into-IMC NTSB accident sample. Identified contextual factors were assessed by comparing study findings with the research literature in reviewing the presence, frequency, and manifestation results from the raters, as well as findings from the correlation and multiple regression analyses.

The highest presence and frequencies of the top five rater-identified contextual factors in the sample of 85 GA Part 91, VFR-into-IMC NTSB AARs included the following: (1) number of passengers on board (CF29-62%), (2) accident time of day (Day) (CF1-60%), (3) crash distance from planned destination (CF15-54%), (4) not filing a flight plan (CF21-49%), and (5) underestimating risk (CF43-49%). Number of passengers on board the aircraft has been investigated by Barron (2011) in how pressure from passengers might have contributed to pilots' decisions to continue into adverse weather conditions by using passenger social pressure in flight. The study used passenger social pressure in flight to convince pilots to continue or divert from hazardous weather. It was found the pilot participants tended to concede to the pressure of the passenger, whether they were positively or negatively motivated to continue into poor weather conditions. At the conclusion of the study, pilot participants were informed of the results. The participating pilots stated they were unaware of passenger influence on their decision-making. Study results found private pilots who were instrument rated were more likely to continue farther into IMC than their low time VFR or high time commercial and/or ATP counterparts, a finding pertaining primarily to the pilot's ratings. In the current study, as the contextual factor number of passengers on board (CF29) was identified by the raters as the highest frequency factor present in the sample of 85 accidents, it could be the case the passengers were influencing the decision-making of the GA pilot to fly farther into IMC than he would if there were no passengers on board the aircraft, confirming the Barron (2011) findings.

The accident time of day has been investigated by Ison (2014a) and Ison (2014b). These studies used logistic regression to investigate potential pilot-related, and situational factors including accident time of day, terrain, receipt of weather briefing, communication with air traffic control, filing of a flight plan, pilot certification, pilot experience, and pilot age. No significant findings were identified pertaining to accident time of day. The results of these studies showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding among context, training, and on the factors related to the length of time a pilot would fly into degraded weather conditions including accident time of day. In the current study, the raters identified accident time of day (Day) as the second highest frequency (60%) contextual factor and accident time of day (Night) as the ninth highest frequency (40%) contextual factor. A total of 7.1% of the 85 accidents occurred during dusk light conditions, 4.7% occurred during dark light conditions, and 4.7% occurred during dawn light conditions. There was a spike in accidents occurring during the 1800- and 1900-time frame, accounting for the greater number of accidents taking place at night. Although the Ison (2014a) and Ison (2014b) studies did not provide any specific research findings on accident time of day (Day/Night), it could be the case the time of day (Day) when the accidents are occurring take place with the added lighting condition difficulties associated with dawn and dusk. It could also be the case the time of day (Night) when the accidents are occurring take place with the added lighting condition difficulties associated with darkness.

The crash distance from planned destination has been investigated by O'Hare and Owen (2002). Researchers have clarified, pilot contribution to cross-country VFR crashes cannot be explained by flight-time alone. There are other factors at play, ultimately comprising pilot circumstances, including but not limited to over-confidence, faulty risk-perception, lack of awareness, flight circumstances leading to risky decisions, decision-making, risk assessment, situational awareness, proximity of the goal/planned destination, and time already invested in the flight/sunk cost. A related research study has been conducted by Wiegmann, Goh, and O'Hare (2002) by assessing when adverse weather is encountered during the flight. It was discovered when adverse weather was encountered later in the flight, pilots were more likely to continue as they might be more optimistic about the possibility of positive outcomes than they were when they encounter poor weather early in a flight. The results were consistent with more optimism during poor weather encounters occurring later into flights, and less optimism when hazardous weather was present earlier in flights. A primary comparison found several contextual factors contributing to the accidents including a marginally significant difference (F [1, 28] = 8.3, $p = 0.07$) in the estimated visibility at the time of the crash. The visibility was reported as 20 km for all the AOG crashes and 5 to 20 km for IFV crashes (seven IFV crashes occurred below 5 km visibility). There was a statistically significant difference in the height above sea level of the crash site for IFV crashes at a mean 2,970 feet AMSL and 150 feet AMSL for the AOG crashes (F [1,20] = 6.3, $p = .02$). Pilot mean age in IFV crashes was 37.8 years. The AOG pilots were 47 years of age. It was determined the difference of 9.2 years between the groups was statistically significant (F [1, 43] = 3.9, $p = .05$). Mean hours flown in the IFV group during the previous 90 days was determined to be 59.8 hours. It was also determined the AOG group flew a total of 31.9 hours. No statistically significant relationship was found for the flight hours of the two groups (F [1, 54] = 3.7, $p = .06$). Additionally, no statistically significant differences were found for any of the other pilot characteristics assessed in the study. A second Wiegmann, Goh, and O'Hare (2002) comparison of weather-related and non-weather-related crashes revealed weather-related crashes took place later into cross-country flights and closer to planned destinations than other types of GA accidents. Additionally, the second comparison found age and flight to be contextual, contributing factors to weather-related GA accidents. The GA pilots who were involved in weather-related accidents tended to be younger and possessed more recent flight time than other pilots. Saxton (2008) found sunk cost to be a valid concept, as the participants of the study who were financially motivated did, in fact, continue longer into poor weather conditions than the participants who were not financially motivated and came upon hazardous weather earlier in the flight. The Ball (2008) research investigated why pilots fly too closely to hazardous weather. Researchers explained it might not be, necessarily, an ability to maintain safe distances, but rather, a conscious choice influenced by level of experience and quality of training. Ahlstrom, Ohneiser, and Caddigan (2016) found the use of a weather device did improve situational awareness, weather related decision-making in diverting or continuing to the planned destination, and distances in route deviation from the hazardous weather. In the current study, the findings of the Wiegmann, Goh, and O'Hare (2002) study are supported for time and distance the pilot flew into adverse weather. As the raters identified the contextual factor crash distance from the planned destination (CF15) with the third highest frequency (54%), crash distance from the departure (CF14) with the eighth highest frequency (46%), adverse weather encountered early in the flight (CF2) with the sixteenth highest frequency (24%), and adverse weather encountered late in the flight (CF3) also with the sixteenth highest frequency (24%), it could be the case the adverse weather encountered late in the flight could be influencing the GA pilot's decision to continue to the planned destination instead of diverting to an alternate location. However, since both CF2 and CF3 each have 20 accidents (24% of 85 accidents) identified by the raters with the respective contextual factors present for adverse weather encountered early and late in the flight, it cannot be stated for certain this is the case. In either case, the findings of the Wiegmann, Goh, and O'Hare (2002) research are confirmed for time and distances flown into adverse weather. It is possible any of the O'Hare and Owen (2002) identified pilot factors could be affecting pilot circumstances and be contributory factors resulting in the fatal accidents assessed in the current study. The Wiegmann, Goh, and O'Hare (2002) findings for visibility could not be assessed, as the current study did not study specific visibilities in the reviewed accidents. Identification of the heights of the crash sites by the raters varied, and not all crash site heights could be determined from the NTSB AARs. Heights of the crash sites identified by the raters included the following: (1) 0 - 999 feet mean sea level (16 out of 85 accidents), (2) 1,000 - 1,999 feet mean sea level (4 out of 85 accidents), (3) 2,000 - 2,999 feet mean sea level (3 out of 85 accidents), (4) 3,000 - 3,999 feet mean sea level (3 out of 85 accidents), (5) 4,000 - 4,999 feet mean sea level (3 out of 85 accidents), (6) 5,000 - 5,999 feet mean sea level (3 out of 85 accidents), (7) 6,000 - 6,999 feet mean sea level (2 out of 85 accidents), (8) 7,000 - 7,999 feet mean sea level (2 out of 85 accidents), (9) 8,000 - 8,999 feet mean sea level (1 out of 85 accidents), and (10) 10,000 - 10,999 feet mean sea level (1 out of 85 accidents). The current study findings for height of crash site differed from the Wiegmann, Goh, and O'Hare (2002) height above sea level of the crash site for IFV crashes at a mean 2,970 feet mean sea level and 150 feet mean sea level for the AOG crashes. As the current study determined the height of accident crash site in ranges based on drop down menu options selected by the raters, an exact comparison with the findings of Wiegmann, Goh, and O'Hare (2002) cannot be made. However, the most frequently identified height of crash site determined by the raters in the current study was 0 to 999 feet mean sea level (16 out of 85 accidents (19%) of accidents) in the range of 150 feet average mean sea level identified in the Wiegmann, Goh, and O'Hare (2002) study for the AOG crashes. There were only 3 out of 85 (4%) accidents in the range of 2,970 feet average mean sea level identified in the Wiegmann, Goh, and O'Hare (2002) study for IFV crashes. Current study findings for the mean age of pilots involved in the 85 accident sample was 52 years of age. The current study findings for mean pilot age were higher than the Wiegmann, Goh, and O'Hare (2002) study findings of pilot mean age in IFV crashes of 37.8 years and AOG pilots was 47 years of age. These current study findings disagree with the Wiegmann, Goh, and O'Hare (2002) research findings of GA pilots who were involved in weather-related accidents tended to be younger. A comparison with the Wiegmann, Goh, and O'Hare (2002) findings for pilot recent flight time could not be completed as the NTSB AARs did not identify the recency of reported pilot total flight hours. It could be the case the pilots in the current study were financially motivated to complete the flight and continued farther into IMC toward the destination than pilots who were not financially motivated diverting to an alternate location or attempting to return to the departure point confirming the Saxton (2008) study findings on sunk cost. It is also possible the pilots in the current study flew too closely to hazardous weather as a conscious choice influenced by level of experience and quality of training, supporting the Ball (2008) research. The findings of the Ahlstrom, Ohneiser, and Caddigan (2016) research could not be addressed from findings in the current study. Although the raters identified specific accidents where a weather device was discovered in the wreckage, the use of the device by the pilot during the flight could not be determined.

The pilot's failure to file a flight plan has been investigated by Jackman's (2014) study investigating pilot policy violations to assess fatal VFR-into-IMC accidents in an ex post facto, quantitative analysis. Violations including filing a flight plan were reviewed. A need for training, regulatory modifications, or enforcements was explored. Information between the years of 1998 and 2013 for NTSB GA VFR-into-IMC accident data was analyzed using binary logistic regression. Study findings revealed flight plan violations were not statistically significant predictors of fatality. Ison (2014a) used logistic regression to investigate potential pilot-related and situational factors including filing of a flight plan. Two significant relationships were found related to flight plans including accident type and flight plans and terrain and flight plan. The Ison (2014b) study found similar and additional information to the Ison (2014a) study. Results of these studies showed more research is needed to understand the context of pilot actions resulting in VFR-into-IMC accidents, as there are gaps in understanding among context, training, and on the additional factors related to the length of time a pilot would fly into degraded weather conditions including filing of a flight plan. In the current study, although the raters identified the contextual factor failure to file a flight plan (CF21) in 49% (fourth highest rater identified factor in the study) of the accidents in the 85 NTSB sample, it was not a significant contextual factor identified in the multiple regression analyses. The pilot's filing of a flight plan was identified as a statistically significant factor in both regression analyses for crash distance from the departure to the midpoint of the planned route of the flight (0% to 50% of the planned route completion), $p = .04$, and crash distance from the midpoint to the destination of the planned route of the flight (51% to 100% of the planned route completion), $p = .002$. Results of the current study did not refute or confirm the findings of the Jackman (2014) research discovery of flight plan violations were not statistically significant predictors of fatality only the filing of a flight plan was determined to be significant. A weak negative relationship was discovered in the current study as the pilot certification increased from the non-instrument to the instrument rating, the chance of the pilot not submitting a flight plan to flight service decreased (CF21) and was significant at the $p < .01$ level, $r = -.277$, $p = .000$. A weak negative relationship was also discovered in the current study as the flight conditions increased from VMC to IMC, the chance of the pilot not submitting a flight plan decreased (CF21) and was also significant at the $p < .01$ level, $r = -.277$, $p = .000$.

The underestimating of risk (CF43) has been assessed by Martin, Davison, and Orasanu (1998) in a study investigating errors in aviation decision-making. It was hypothesized by the researcher, errors are facilitated by underestimation of risk and failure to analyze the potential consequences of continuing with the initial plan as well as stressors may further contribute to these effects. In the current study, as the raters identified the contextual factor underestimation of risk (CF43) as the fifth highest (49%) in the study, it could be the case the GA pilots in the accidents could have failed to correctly estimate the level of risk and potential consequences of continuing the flight from VFR-into-IMC to the planned destination resulting in the fatal accidents. The related contextual factor, consequences not anticipated (CF13), defined as the pilot being under stress and not anticipating the consequences of flying in IMC, was identified as a significant contextual factor in the multiple regression analysis for crash distance from the midpoint to the destination of the planned route of the flight (51% to 100% of the planned route completion), $p = .017$, adding evidence to pilots failing to correctly estimate the level of risk and potential consequences of continuing the flight into IMC, confirming the findings of the Martin, Davison, and Orasanu (1998) research. A weak positive relationship was identified in the current study as the number of total flight hours increased, the chance of the pilot not being under stress and anticipating the consequences of flying in IMC increased (CF13) and was significant at the $p < .05$ level, r = .153, $p = .015$. A moderate negative relationship was identified in the current study as the weather increased from non-inclement to inclement weather, the chance of the pilot underestimating the level of risk associated with cues that should have signaled a chance in course of action decreased (CF43) and was significant at the $p < .01$ level, r = -.322, $p = .000$.

The raters provided their personal opinions on how the contextual factors were manifested in the sample of NTSB accident AARs. Manifestations provided by the raters for the top five contextual factors of (1) number of passengers on board (CF29-62%), (2) accident time of day (Day) (CF1-60%), (3) crash distance from planned destination (CF15-54%), (4) not filing a flight plan (CF21-49%), and (5) underestimating risk (CF43-49%) were assessed by the researcher. Raters identified the number of passengers on board the aircraft in the 85 NTSB accident sample. A total of 53 out of 85 aircraft, or 62% of the accident sample, had passengers on board the aircraft. The break down according to category of passenger number on board the aircraft and the associated percentages were identified as follows: 32 aircraft (0 passengers - 38%), 36 aircraft (1 passenger – 42%), 11 accidents (2 passengers – 13%), 3 accidents (3 passengers – 4%), 1 accident (4 passengers – 1%), and 2 accidents (5 passengers – 2%). As the majority of accidents had passengers on board the aircraft, it could be the case the pilots may have been influenced by the passengers in deciding to continue into IMC to the planned destination instead of diverting to an alternate location, supporting the Barron (2011) research.

Raters also provided their opinions on the manifestation of the contextual factor accident time of day (CF1-60%). There was a total of 34 accidents occurring during the day and 51 accidents took place at night. The particular lighting conditions varied and included six accidents taking place at dusk, 37 during daylight conditions, 33 during night light conditions, five during dark light conditions, and four during dawn light conditions. Two accidents occurred at 0000, one at 0100, two at 0400, five at 0500, three at 0600, four at 0700, three at 0800, four at 0900, five at 1000, four at 1100, five at 1200, one at 1300, five at 1400, two at 1500, three at 1600, four at 1700, seven at 1800, ten at 1900, five at 2000, four at 2100, three at 2200, and three at 2300. As previously described, there was a spike in accidents occurring during the 1800- and 1900-hour timeframe, increasing the number of accidents occurring at night over day accidents. The Ison (2014) and Ison (2014b) research indicated additional research is needed to improve understanding of how time of day affects the decision of pilots to fly in IMC. As the identified Ison (2014) and Ison (2014b) research could not be assessed for findings related to time of day and IMC flight, it could be the case the time of day (Day) when the accidents are occurring take place with the added lighting condition difficulties associated with dawn and dusk. It could also be the case, the time of day (Night) when the accidents are occurring take place with the added lighting condition difficulties associated with darkness. These lighting conditions could be contributing to the pilot's inability to see the ground resulting in an accident.

The raters also provided their opinions on the manifestation of the contextual factor crash distance from the planned destination (CF15-54%). The aircraft crash distances occurring between 51% and 100% of the planned route distance from the midpoint to the planned destination were also calculated by the researcher based on the latitude and longitude coordinates provided by the NTSB investigators completing the AARs. The crash distances from the midpoint to the planned destination as a percentage of the planned route of flight course completion included the following: (1) 51% (12 accidents), (2) 56% (1 accident), (3) 59% (1 accident), (4) 60% (1 accident), (5) 62% (1 accident), (6) 66% (1 accident), (7) 69% (1 accident), (8) 70% (2 accidents), (9) 71% (1 accident), (10) 73% (1 accident), (11) 74% (2 accidents), (12) 77% (3 accidents), (13) 84% (1 accident), (14) 86% (1 accident), (15) 89% (1 accident), (16) 90% (1 accident), (17) 94% (1 accident), (18) 95% (1 accident), (19) 96% (1 accident), (20) 97% (1 accident), (21) 98% (1 accident), and (22) 99% (9 accidents). The majority of accidents occurred between the midpoint to the planned destination and totaled 46 versus 39 occurring from the departure to the midpoint of the planned route of flight. As explained previously, as the raters identified the contextual factor crash distance from the planned destination (CF15) with the third highest frequency (54%), crash distance from the departure (CF14) with the eighth highest frequency (46%), adverse weather encountered early in the flight (CF2) with the sixteenth highest frequency (24%), and adverse weather encountered late in the flight (CF3) also with the sixteenth highest frequency (24%), it could be the case, supporting the Wiegmann, Goh, and O'Hare (2002) and Barron's (2011) research findings, the adverse weather encountered late in the flight and/or passenger pressure could be influencing the GA pilot's decision to continue to the planned destination instead of diverting to an alternate location. As the same percentage of accidents encountered adverse weather early and late in the flight (24%), a definite determination cannot be made.

The raters also provided their opinions on the manifestation of the contextual factor filing of a flight plan (CF21-49%). Manifestations included descriptions of GA pilots either filing or not filing a flight plan for various reasons. Reasons given by the raters for the GA pilots in the accident sample filing a flight plan included (1) the flight plan was input via computer but did not go through due to incomplete information input by the pilot, (2) the pilot filed a flight plan although the NTSB investigator completing the report incorrectly indicated no on the form, (3) the pilot filed IFR, then near the destination, cancelled the IFR flight plan and flew VFR-into-IMC back to point of origin, (4) the pilot filed IFR, through a malformed request to air traffic control, but was not rated to do so, (5) the pilot filed IFR was technically true, but, practically, if the pilot was trying to avoid icing filing IFR was not a practical option. The reasons given by the raters for the GA pilots not filing a flight plan included (1) it is possible an instrument rated pilot opted to not file IFR, an IFR pilot in Class G airspace was not in violation of needing to file a flight plan, and (2) the pilot should have filed IFR and flown IFR procedures. Reasons reported by the raters for the pilots filing and not filing a flight plan were reviewed by the researcher. The reasons reported by the raters for pilots filing a flight plan included (1) the pilot experienced errors in attempting to enter the flight plan, (2) NTSB investigators making mistakes in reporting pilots not filing flight plans when the pilots did file flight plans, (3) the pilots filing flight plans and then cancelling the flight plans for various reason, and (4) the pilots filing IFR flight plans when not qualified to file IFR flight plans. Reasons reported by the raters for pilots not filing flight plans included (1) the pilots felt filing flight plans was not necessary, and (2) the pilots did not file flight plans when they should have filed flight plans. These rater-identified manifestations for filing a flight plan could address the areas of future research needed as identified in the Ison (2014a) and Ison (2014b) studies.

The raters also provided their opinions on the manifestation of the contextual factor underestimating risk (CF43-49%). In the rater's opinions, the reasons the GA pilots underestimated the risk in conducting the flight included (1) after the adverse weather briefing, the pilot filed VFR indicating an underestimation of risk in conducting the flight, (2) the pilot underestimated the risk in conducting the flight given the time of day, night conditions, and mountainous terrain, (3) the pilot exhibited poor decision-making in underestimating the risk in conducting the flight, (4) the instructor-rated passenger presence and bad decision-making factors played into the pilot underestimating the risk in conducting the flight, (5) the accident was a preflight decision-making accident, not only for IMC but for thunderstorms, (6) the lighting conditions contributed to the accident, (7) the pilot received a weather briefing, but it was incomplete and not factored into the risk estimation of flying in mountainous terrain, (8) the weather brief for the accident segment was misleading and incomplete, combined with an incomplete pilot risk assessment, (9) the pilot was flying in night conditions, (10) the NTSB report emphasized the pilot had next day work-related obligations, (11) the pilot's bad decision-making, (12) a possible intentional self-harm act on the part of the pilot may have been a factor contributing to the accident, (13) the pilot's underestimation of risk led to getting caught above the clouds, (14) the pilot underestimated the risk of clouds and thunderstorms, (15) the pilot underestimated the risk of flying low to avoid IMC, (16) social pressures led the pilot to underestimate risk in conducting the flight, (17) the pilot imposed self-induced pressures on himself to make the flight leading to an underestimation of risk resulting in the accident, (18) it is possible the pilot did not recognize there was fog, (19) the equipment failure, many unknowns, and probable cause faulting air traffic control could have contributed to the pilot's underestimation of risk in completing the flight, (20) the pilot underestimated the risk in conducting the flight at night, considering the pilot's lack of night flying experience. Reasons reported by the raters for the pilots underestimating the risks in conducting the flights were reviewed by the researcher. These reasons included (1) poor decision-making, (2) time of day, (3) lighting conditions, (4) terrain, (5) social pressure, (6) incomplete weather briefing, (7) incomplete pilot risk assessment, (8) pilot intentional self-harm, (9) underestimation of risk for flight direction/location decision, (10) underestimation of risk for flying near adverse weather decision, (11) pilot self-imposed pressures, (12) equipment failure, (13) ATC failure, and (14) underestimation of night flying risk. Rater identified manifestations for the contextual factor underestimating risk (CF43) were found to be consistent with the Martin, Davison, and Orasanu (1998) study findings related to human error and judgement contributing to accidents. The researchers explained the problem centers on the pilot falling into the decision error type known as PCE to decide to continue with the original plan despite cues suggesting a change in course of action is required. Contextual factors contributing to PCE include organizational and socially induced conflicts and ambiguous dynamic conditions. Decision errors are facilitated by the pilot's underestimation of risk, failure to analyze the consequences of continuing with the initial plan, and stress. Pilots were using linear versus circular decision making under extremely stressful situations, supporting the Balog (2013) and Balog (2016) study findings where pilots commit to one decision without reevaluation after actions have been implemented. These findings are consistent with all 14 manifestation areas identified where pilots in the accident sample exhibited an underestimation of risk contributing to the fatal accidents. Current study findings also confirm the Keller (2015) research where VFR pilots who flew into IMC did so because they misperceived the severity of the weather and the associated risks versus pilots who turned, or diverted, did so because they became aware of the danger and sought to return to safety. It is possible the pilots in the current study misperceived the severity of the risk in attempting to continue the flight into IMC to the planned destination. The study also supports the O'Hare and Smitheram (1995) study finding pilots who viewed risk from a gain standpoint were less likely to continue into IMC, and those who considered risk from a loss viewpoint were more likely to continue. It is possible the pilots in the current study who chose to continue into IMC to the planned destination viewed risk from a loss perspective.

The GA pilot age and the 46 research-identified contextual factors were reviewed for significant relationships using the point biserial correlation. The analysis identified several statistically significant relationships between pilot age and the contextual factors.

A relationship between pilot age and the pilot flying into known icing conditions was significant at the $p < .05$ level, r = .164, $p = .009$ (CF22). As the age of the pilot increased, the chance of the pilot flying into known icing conditions would also increase. It was also found as the age of the pilot increased, the chance of being involved in more accidents during the day than at night decreased, $p < .01$, r = -.377, $p = .000$ (CF1). Statistically significant relationships between pilot age and the other contextual factors are as follows, as the age of the pilot increased (Table 16):

- the chance of being able to recognize self-reported weather cues increased, $p < .05$, r = .191, $p = .002$ (CF38)
- the chance of not being in violation of FAA ratings policy increased, $p < .05$, r = .164, $p = .009$ (CF35)
- the chance of being involved in fatal GA VFR-into-IMC accidents where the aircraft crash site was closer to the planned destination than the departure location increased, $p < .05$, r = .139, $p = .026$ (CF15)
- the chance of being involved in more accidents at night decreased, $p < .01$, r = -.277, $p = .000$ (CF1)
- the chance of not deciding to obtain and use weather information through use of in-cockpit installed weather equipment information decreased, $p < .01$, r = -.277, $p = .000$ (CF45)
- the chance of not being able to recognize self-reported weather cues decreased, $p < .05$, r = -.191, $p = .002$ (CF38)
- the chance of not deciding to use weather information obtained through portable weather smart phone applications decreased, $p < .05$, r = -.174,

$p = .005$ (CF46)

- the chance of being involved in fatal VFR-into-IMC accidents where the aircraft crash site was closer to the departure location than the planned destination decreased, $p < .05$, r = -.158, $p = .012$ (CF14)
- the chance of being involved in flight situations where adverse weather was not encountered after mid flight point was reached decreased, $p < .05$, r = -.148, $p = .018$ (CF3)
- the chance of being in violation of FAA ratings policy decreased, $p < .05$, r = -.141, $p = .024$ (CF35)
- the chance of being involved in flight situations where adverse weather was encountered before mid flight point reached decreased, $p < .05$, r = -.14, $p = .025$ (CF2)
- the chance of not experiencing an organizational conflict between productivity and safety decreased, $p < .05$, r = -.141, $p = .025$ (CF31)
- the chance of being involved in flight situations where less than or equal to half the time and distance was required to reach the destination before the accident occurred decreased, $p < .05$, r = -.139, $p = .026$ (CF6)
- the chance of not exhibiting circular decision-making decreased, $p < .05$, r = -.14, $p = .026$ (CF10)
- the chance of exhibiting cognitive anchoring decreased, $p < .05$, r = -.133, $p = .034$ (CF11)

- the chance of the aircraft crash site not being closer to the departure location than the planned destination increased, $p = .05$, r = .123, $p = .05$ (CF14)

Table 16

Point Biserial Correlations Between Contextual Factors and Pilot Age

Contextual Factor	Age
Accident time of day (Day) (CF1)	$r = -.377$, $p = .000$
Accident time of day (Night) (CF1)	$r = -.277$, $p = .000$
The pilot did not decide to obtain and use weather information through use of in-cockpit installed weather equipment information (CF45)	$r = -.277$, $p = .000$
The pilot was able to recognize self-reported weather cues (CF38)	$r = .191$, $p = .002$
The pilot was not able to recognize self-reported weather cues (CF38)	$r = -.191$, $p = .002$
The pilot did not decide to use weather information obtained through portable weather smart phone applications (CF46)	$r = -.174$, $p = .005$
The pilot flew into known icing conditions (CF22)	$r = .164$, $p = .009$
The pilot was not in violation of FAA ratings policy (CF35)	$r = .164$, $p = .009$

Table 16 continued

Point Biserial Correlations Between Contextual Factors and Pilot Age

Contextual Factor	Age
The aircraft crash site was closer to the departure location than the planned destination (CF14)	*r* = -.158, *p* = .012
Adverse weather not encountered after mid flight point was reached (CF3)	*r* = -.148, *p* = .018
The pilot was in violation of FAA ratings policy (CF35)	*r* = -.141, *p* = .024
Adverse weather encountered before mid flight point reached (CF2)	*r* = -.14, *p* = .025
The pilot did not experience an organizational conflict between productivity and safety (CF31)	*r* = -.141, *p* = .025
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	*r* = -.139, *p* = .026
The pilot did not exhibit circular decision-making (CF10)	*r* = -.14, *p* = .026
The aircraft crash site was closer to the planned destination than the departure location (CF15)	*r* = .139, *p* = .026
The pilot exhibited cognitive anchoring (CF11)	*r* = -.133 *p* = .034
The aircraft crash site was not closer to the departure location than the planned destination (CF14)	*r* = .123, *p* = .05

Point biserial correlation results between GA pilot age and the contextual factors show 18 significant correlations between age and the contextual factors. There were a total of five positive and 13 negative correlations identified between age and the contextual factors. The five significant positive correlations included the following:

- The chance of the pilot to recognize self-reported weather cues increased.
- The chance of the pilot flying into known icing conditions increased.
- The chance of the pilots not being in violation of the FAA ratings policy increased.
- The chance of the aircraft crash site being closer to the planned destination than the departure location increased.
- The chance of the aircraft crash site not being closer to the planned destination than the departure location increased.

There was a negative correlation between age and 13 of the contextual factors. As the age of the GA pilot increased, the chance of the accident occurring during the day decreased. Additionally, as the age of the GA pilot increased, the chance of the accident occurring at night decreased. The other significant negative correlations included the following:

- The chance of the pilot not deciding to obtain and use weather information through use of in-cockpit installed weather equipment information decreased.
- The chance of the pilot not using weather information obtained through portable weather smart phone applications decreased.

- The chance of the aircraft crash site being closer to the departure location than the planned destination decreased.
- The chance of weather not being encountered after mid flight point was reached decreased.
- The chance of the pilot being in violation of FAA ratings policy decreased.
- The chance of the weather being encountered before the mid flight point was reached decreased.
- The chance of the pilot not experiencing an organizational conflict between productivity and safety decreased.
- The chance of less than or equal to half the time and distance required to reach the destination before the accident occurred decreased.
- The chance of the pilot not exhibiting circular decision-making decreased.
- The chance of the pilot exhibiting cognitive anchoring decreased.
- The chance of the pilot not being able to recognize self-reported weather cues decreased.

These correlations relate to the identified research literature. The current research correlation findings between pilot age and the applicable contextual factors support the Saxton (2008) study findings on sunk cost. It is possible the pilots who flew longer distances and crashed closer to the destination were financially motivated. Correlation findings of the current study also confirm the study results of the Wiegmann, Goh, and O'Hare (2002) research. It could be the case when adverse weather was encountered later in the flight, the pilots were more likely to continue due to increased optimism about the possibility of a successful landing at the destination (positive outcome) than the pilots would have been had they encountered bad weather early in a flight. Johnson and Wiegmann (2015) and Ahlstrom, Ohneiser, and Caddigan (2016) study results cannot be addressed with the current study findings as it is unknown how the pilots used the in-cockpit installed weather equipment information or weather information obtained through portable weather smart phone applications or other devices. Walmsley and Gilbey (2016) study findings are also supported by the current results, as it is possible the pilots flew longer in IMC toward the destination because they interpreted the decisions of pilots who flew into deteriorating weather conditions toward the same destination more favorably as they landed at the same destination airport and perhaps heard their radio transmissions over the common traffic advisory frequency communicating a successful landing had been accomplished (positive outcome) as opposed to not being able to make the destination airport (negative outcome). In the research completed by Bazargan and Guzhva (2011) on the impact of gender, age, and experience of pilots on general aviation accidents, it was found older pilots have a higher probability of being involved in both fatal and non-fatal accidents. The statistically significant positive correlation findings between the identified contextual factors and older pilots support the Bazargan and Guzhva (2011) research for factors contributing to the higher probability of older pilots being involved in both fatal and non-fatal accidents.

Statistically significant relationships between GA pilot flight experience (total flight hours) and the specific research identified contextual factors were also determined using the point biserial correlation. A total of five positive and six negative significant correlations were identified. The relationship between total flight hours and the pilot not exhibiting permission-seeking behaviors was significant at the $p < .01$ level, r = -.239, p = .000 (CF32). As the number of total flight hours increased, the chance of the pilot not exhibiting permission-seeking behaviors decreased. It was also found as the pilot's total flight hours increased, the chance of not being in violation of organizational flight plan policy, filing IFR when required increased, $p < .05$, r = .209, p = .001 (C23). The other statistically significant relationships between GA pilot flight experience (total flight hours) and the specific research identified contextual factors are as follows, as the flight experience (total flight hours) increased (Table 17):

- the chance of not exhibiting linear decision-making increased, $p < .05$, r = .200, p = .001 (CF27)
- the chance of not being under stress and anticipating the consequences of flying in IMC increased, $p < .05$, r = .153, p = .015 (CF13)
- the chance of flying into known icing conditions increased, $p < .05$, r = .148, p = .018 (CF22)
- the chance of not communicating with air traffic control at the time of the VFR-into-IMC accident increased, $p < .05$, r = .131, p = .037 (CF12)
- the chance of the pilot being in violation of FAA ratings policy decreased, $p < .01$ level, r = -.231, p = .000 (CF35)
- the chance of the pilot not being in violation of FAA ratings policy decreased, $p < .01$, r = -.231, p = .000 (CF35)
- the chance of communication with a briefer decreased, $p < .01$, r = -.178, p = .004 (CF33)

- the chance of being in communication with air traffic control at the time of the VFR-into-IMC accident decreased, $p < .05$, r = -.156, $p = .012$ (CF12)
- the chance of descending below weather minimums decreased, $p < .05$, r = -.149, $p = .018$ (CF20)

Table 17

Point Biserial Correlations Between Contextual Factors and Experience

Contextual Factor	Experience
The pilot did not exhibit permission-seeking behaviors (CF32)	$r = -.239$, $p = .000$
The pilot was in violation of FAA ratings policy (CF35)	$r = -.231$, $p = .000$
The pilot was not in violation of FAA ratings policy (CF35)	$r = -.231$, $p = .000$
The pilot was not in violation of organizational flight plan policy - filing IFR when required (CF23)	$r = .209$, $p = .001$
The pilot did not exhibit linear decision-making (CF27)	$r = .200$, $p = .001$
The pilot was in communication with a briefer (CF33)	$r = -.178$, $p = .004$
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = -.156$, $p = .012$

Table 17 continued

Point Biserial Correlations Between Contextual Factors and Experience

Contextual Factor	Experience
The pilot was not under stress and did anticipate the consequences of flying in IMC (CF13)	$r = .153, p = .015$
The pilot did not descend below weather minimums (CF20)	$r = -.149, p = .018$
The pilot flew into known icing conditions (CF22)	$r = .148, p = .018$
The pilot did not communicate with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = .131, p = .037$

There were a total of five statistically significant positive correlations between experience (total flight hours) and the identified contextual factors. As the total flight hours increased, the chance of the pilot not being in violation of organizational flight plan policy, filing IFR when required increased. The other significant positive correlations included the following:

- The chance of the pilot not exhibiting linear decision-making increased.
- The chance of the pilot not being under stress and anticipating the consequences of flying in IMC increased.
- The chance of the pilot flying into known icing conditions increased.

- The chance of the pilot not communicating with air traffic control at the time of the VFR-into-IMC accident increased.

There were a total of six statistically significant negative correlations between experience (total flight hours) and the identified contextual factors. As the total flight hours increased, the chance of the pilot not exhibiting permission-seeking behaviors decreased. As the total flight hours increased, the chance of the pilot being in violation of FAA ratings policy decreased, the chance of the pilot not being in violation of FAA ratings policy decreased, the chance of the pilot being in communication with a briefer decreased, the chance of the pilot communicating with air traffic control at the time of the VFR-into-IMC accident decreased, and the chance of the pilot not descending below weather minimums decreased.

These positive and negative correlations relate to the identified research literature. Wiegmann, Goh, and O'Hare (2002) discovered the time and distance GA pilots flew into the weather before deciding to divert were negatively correlated with previous flight experience. Findings of the study suggested VFR flight into IMC may be caused, in part, by poor situation assessment and experience rather than motivational judgment, encouraging risk-taking behavior as the GA pilot invests more time in the flight. More research is needed to improve understanding of pilot behavior and VFR-into-IMC accidents. Current study findings support the Bazargan and Guzhva (2011) research exploring whether pilot age and experience were factors in VFR-into-IMC occurrences. Results indicated male pilots over 60 years of age with more experience were more likely than other pilots to be involved in a fatal accident. As the mean age of the pilots in the study were 57 years of age, including pilots as old as 82 years of age, it is possible the age of pilots over 60 with high flight hours and associated experience (total flight hours) was a factor contributing to the fatal accidents.

Statistically significant relationships between GA pilot certification (Instrument/Non-Instrument) and the specific research-identified contextual factors were determined using the phi correlation. A total of one significant positive and 15 significant negative correlations were identified. The relationship between certification (Instrument/Non-Instrument) and the pilot not submitting a flight plan to flight service (CF21) was significant at the $p < .01$ level, r = .377, $p = .000$. As the pilot certification from non-instrument to instrument-rating increased, the chance of the pilot not submitting a flight plan to flight service increased. It was also found as the pilot's certification from non-instrument to instrument-rating increased, the chance of the pilot taking a safety risk to fly in IMC conditions to the planned destination decreased, $p < .01$ level, r = -.222, $p = .000$ (CF24). The other statistically significant relationships between GA pilot certification (Instrument/Non-Instrument) and the specific research identified contextual factors are as follows, as the pilot certification increased from the non-instrument to the instrument rating (Table 18):

- the chance of the aircraft crash site being closer to the planned destination than the departure location decreased, $p < .05$ level, r = -.186, $p = .002$ (CF15)
- the chance of adverse weather being encountered before the mid flight point was reached decreased, $p < .05$ level, r = -.165, $p = .007$ (CF2)

- the chance of less than or equal to half the time and distance required to reach the destination before the accident occurred decreased, $p < .05$ level, r = -.163, $p = .008$ (CF6)
- the chance of the aircraft crash site not being closer to the departure location than the planned destination decreased, $p < .05$ level, r = -.164, $p = .008$ (CF14)
- the chance of adverse weather encountered after the mid flight point was reached decreased, $p < .05$ level, r = -.161, $p = .009$ (CF3)
- the chance of the aircraft crash site being closer to the departure location than the planned destination decreased, $p < .05$ level, r = -.16, $p = .009$ (CF14)
- the chance of the pilot not communicating with air traffic control at the time of the VFR-into-IMC accident decreased, $p < .05$ level, r = -.159, $p = .01$ (CF12)
- the chance of pilot deciding to continue VFR-into-IMC to the planned destination decreased, $p < .05$ level, r = -.156, $p = .011$ (CF17)
- the chance of the pilot not being in violation of the FAA flight time currency policy decreased, $p < .05$ level, r = -.153, $p = .013$ (CF16)
- the chance of the aircraft crash site not being closer to the planned destination than the departure location decreased, $p < .05$ level, r = -.139, $p = .024$ (CF15)
- the chance of the adverse weather not encountered before the mid flight point was reached decreased, $p < .05$ level, r = -.126, $p = .04$ (CF2)

- the chance of the cues signaling a problem being clear to pilot decreased, $p < .05$ level, r = -.126, p = .04 (CF5)
- the chance of the pilot communicating with air traffic control at the time of the VFR-into-IMC accident decreased, $p < .05$ level, r = -.124, p = .044 (CF12)
- the chance of the pilot overestimating the ceiling and/or visibility weather conditions decreased, $p < .05$ level, r = -.122, p = .048 (CF9)

Table 18

Phi Correlations Between Contextual Factors and Certification

Contextual Factor	Pilot Certification
The pilot did not submit a flight plan to flight service (CF21)	r = .377, p = .000
The pilot took a safety risk to fly in IMC conditions to planned destination (CF24)	r = -.222, p = .000
The aircraft crash site was closer to the planned destination than the departure location (CF15)	r = -.186, p = .002
Adverse weather encountered before mid flight point reached (CF2)	r = -.165, p = .007
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	r = -.163, p = .008

Table 18 continued

Phi Correlations Between Contextual Factors and Certification

Contextual Factor	Pilot Certification
The aircraft crash site was not closer to the departure location than the planned destination (CF14)	$r = -.164, p = .008$
Adverse weather encountered after mid flight point was reached (CF3)	$r = -.161, p = .009$
The aircraft crash site was closer to the departure location than the planned destination (CF14)	$r = -.16, p = .009$
The pilot did not communicate with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = -.159, p = .01$
The pilot decided to continue VFR-into-IMC to the planned destination (CF17)	$r = -.156, p = .011$
The pilot was not in violation of the FAA flight time currency policy (CF16)	$r = -.153, p = .013$
The aircraft crash site was not closer to the planned destination than the departure location (CF15)	$r = -.139, p = .024$
Adverse weather not encountered before mid flight point reached (CF2)	$r = -.126, p = .04$
Cues signaling problem clear to pilot (CF5)	$r = -.126, p = .04$

Table 18 continued

Phi Correlations Between Contextual Factors and Certification

Contextual Factor	Pilot Certification
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = -.124$, $p = .044$
The pilot overestimated ceiling and/or visibility weather conditions (CF9)	$r = -.122$, $p = .048$

There was a total of one significant positive and 15 significant negative correlations between certification (non-instrument verses instrument rating) and the identified contextual factors. As the pilot certification from non-instrument to instrument-rating increased, the chance of the pilot not submitting a flight plan to flight service increased. The other significant negative correlations included the following:

- The chance of the pilot taking a safety risk to fly in IMC conditions to the planned destination decreased.
- The chance of the aircraft crash site being closer to the planned destination than the departure location decreased.
- The chance of adverse weather being encountered before the mid flight point was reached decreased.
- The chance of less than or equal to half the time and distance required to reach the destination before the accident occurred decreased.

- The chance of the aircraft crash site not being closer to the departure location than the planned destination decreased.
- The chance of adverse weather being encountered after the mid flight point was reached decreased.
- The chance of the aircraft crash site being closer to the departure location than the planned destination decreased.
- The chance of the pilot not communicating with air traffic control at the time of the VFR-into-IMC accident decreased.
- The chance of the pilot deciding to continue VFR-into-IMC to the planned destination decreased.
- The chance of the pilot not being in violation of the FAA flight time currency policy decreased.
- The chance of the aircraft crash site not being closer to the planned destination than the departure location decreased.
- The chance of adverse weather not being encountered before the mid flight point was reached decreased.
- The chance of cues signaling a problem were clear to pilot decreased.
- The chance of the pilot not communicating with air traffic control at the time of the VFR-into-IMC accident decreased.
- The chance of the pilot overestimating the ceiling and/or visibility weather conditions decreased.

These positive and negative correlations relate to the identified research literature. Barron (2011) study results found private pilots who were instrument rated were more likely to continue farther into IMC than their low time VFR or high time commercial, and/or ATP counterparts, a finding pertaining primarily to the pilot's ratings. The current study findings confirmed the Baron (2011) research results, as it was discovered as the GA pilot certification increased from the non-instrument to the instrument rating, the chance of the aircraft crash site not being closer to the planned destination than the departure location decreased, $p < .05$ level, r = -.139, $p = .024$ (CF15). There were more instrument rated pilots identified in the current study crashing closer to the destination than the departure. Current study findings also support the Jackman's (2014) research pertaining to the discovery through the results of a binary logistic regression analysis pilot ratings violations and pilot currency violations were statistically significant predictors of fatality. The current study discovered as the certification of the GA pilot increased from the non-instrument to the instrument rating, the chance of the pilot not being in violation of the FAA flight time currency policy decreased, $p < .05$ level, r = -.153, $p = .013$ (CF16). Current study findings support the Coyne, Baldwin, and Latrorella (2008) results. While instrument rated pilots are more likely to continue into adverse weather, they are, according to Coyne, Baldwin, and Latrorella (2008), less proficient in accurately determining true visibility. Coyne, Baldwin, and Latrorella (2005) also explained, on average, pilots overestimated visibility when ceilings were higher, and overestimated ceilings when visibility was better. It was suggested by the researchers the interaction of ceiling and visibility shows pilots may be inappropriately assessing weather conditions. Findings of the current study disagree with the Baldwin and Latrorella (2005) study conclusions. A weak negative relationship was identified in the current study. It was determined as the GA pilot certification increased from the non-instrument to instrument rating, the chances of the pilot overestimating the ceiling and/or visibility weather conditions decreased (CF9) and was significant at the $p < .05$ level, r = -0.122, $p = 0.048$.

Statistically significant relationships between Weather (Inclement/Non-Inclement) and the specific research identified contextual factors were determined using the phi correlation. A total of one significant positive and 14 significant negative correlations were identified. The relationship between Weather (Inclement/Non-Inclement) and the pilot being in violation of conducting an IFR flight without proper clearance or ratings was significant at the $p < .01$ level, r = .230, $p = .000$ (CF26). As the weather increased from non-inclement to inclement, the chance of the pilot being in violation of conducting an IFR flight without proper clearance or ratings increased. It was also found as the weather increased from non-inclement to inclement, the chance of the pilot not being in violation of FAA medical status policy decreased, $p < .01$ level, r = -.293, $p = .000$ (CF28). The other statistically significant relationships between Weather (Inclement/Non-Inclement) and the specific research-identified contextual factors are as follows:

As the weather increased from non-inclement to inclement (Table 19):

- the chance of the pilot exhibiting PCE behavior decreased, $p < .01$ level, r = -.306, $p = .000$ (CF34)
- the chance of the pilot misdiagnosing the changes in or severity of the weather decreased, $p < .01$ level, r = -.322, $p = .000$ (CF39)

- the chance of the pilot underestimating the level of risk associated with cues that should have signaled a change in course of action decreased, $p < .01$ level, r = -.322, $p = .000$ (CF43)
- the chance of adverse weather encountered before the mid flight point was reached decreased, $p < .05$ level, r = -.165, $p = .007$ (CF2)
- the chance of adverse weather encountered after the mid flight point was reached decreased, $p < .05$ level, r = -.161, $p = .009$ (CF3)
- the chance of the pilot not being in violation of FAA ratings policy decreased, $p < .05$ level, r = -.154, $p = .012$ (CF35)
- the chance of the pilot being in violation of FAA ratings policy decreased, $p < .05$ level, r = -.150, $p = .015$ (CF35)
- the chance of the pilot receiving a weather briefing decreased, $p < .05$ level, r = -.147, $p = .017$ (CF36)
- the chance of the pilot being in communication with a briefer decreased, $p < .05$ level, r = -.143, $p = .02$ (CF33)
- the chance of the pilot being able to recognize self-reported weather cues decreased, $p < .05$ level, r = -.136, $p = .027$ (CF38)
- the chance of the pilot not being in communication with a briefer decreased, $p < .05$ level, r = -.132, $p = .032$ (CF33)
- the chance of adverse weather not encountered before the mid flight point was reached decreased, $p < .05$ level, r = -.126, $p = .04$ (CF2)
- the chance of the pilot not receiving a weather briefing decreased, $p < .05$ level, r = -.122, $p = .048$ (CF36)

Table 19

Phi Correlations Between Contextual Factors and Weather

Contextual Factor	Weather
The pilot was in violation of conducting an IFR flight without proper clearance or ratings (CF26)	r = .230, p = .000
The pilot was not in violation of FAA medical status policy (CF28)	r = -.293, p = .000
The pilot exhibited Plan Continuation Error (PCE) behavior (CF34)	r = -.306, p = .000
The pilot misdiagnosed the changes in or severity of the weather (CF39)	r = -.322, p = .000
The pilot underestimated the level of risk associated with cues that should have signaled a change in course of action (CF43)	r = -.322, p = .000
Adverse weather encountered before mid flight point reached (CF2)	r = -.165, p = .007
Adverse weather encountered after mid flight point was reached (CF3)	r = -.161, p = .009
The pilot was not in violation of FAA ratings policy (CF35)	r = -.154, p = .012
The pilot was in violation of FAA ratings policy (CF35)	r = -.150, p = .015
The pilot received a weather briefing (CF36)	r = -.147, p = .017

Table 19 continued

Phi Correlations Between Contextual Factors and Weather

Contextual Factor	Weather
The pilot was in communication with a briefer (CF33)	r = -.143, p = .02
The pilot was able to recognize self-reported weather cues (CF38)	r = -.136, p = .027
The pilot was not in communication with a briefer (CF33)	r = -.132, p = .032
Adverse weather not encountered before mid flight point reached (CF2)	r = -.126, p = .04
The pilot did not receive a weather briefing (CF36)	r = -.122, p = .048

There was a total of one positive significant and 14 negative significant correlations between weather (inclement/non-inclement) and the identified contextual factors. As the weather increased from non-inclement to inclement conditions, the chance of the pilot being in violation of conducting an IFR flight without proper clearance or ratings increased. The other significant negative correlations included the following:

- The chance of the pilot not being in violation of FAA medical status policy decreased.
- The chance of the pilot exhibiting PCE behavior decreased.

- The chance of the pilot misdiagnosing the changes in or severity of the weather decreased.
- The chance of the pilot underestimating the level of risk associated with cues that should have signaled a change in course of action decreased.
- The chance of adverse weather being encountered before the mid flight point was reached decreased.
- The chance of adverse weather being encountered after the mid flight point was reached decreased.
- The chance of the pilot not being in violation of FAA ratings policy decreased.
- The chance of the pilot being in violation of FAA ratings policy decreased.
- The chance of the pilot receiving a weather briefing decreased.
- The chance of the pilot being in communication with a briefer decreased.
- The chance of the pilot being able to recognize self-reported weather cues decreased.
- The chance of the pilot being in communication with a briefer decreased.
- The chance of adverse weather not being encountered before the mid flight point was reached decreased.
- The chance of the pilot not receiving a weather briefing decreased.

These positive and negative correlations relate to the identified research literature. Current research findings confirm the Jackman (2014) study results on FAA ratings and medical status violations. The findings revealed flight plan violations and pilot medical status violations were not statistically significant predictors of fatality. It was discovered through the results of the binary logistic regression analysis, pilot ratings violations were statistically significant predictors of fatality. It could be the case the pilots in the study flying while violating FAA ratings policy contributed to the fatal accidents. The current research findings also support the Saxton (2008) study conclusions on sunk cost. It is possible the pilots in the study took greater risks by continuing further into adverse weather when IMC was encountered later into a flight. It could also be the case as the pilots were not in communication with a briefer and did not receive a weather briefing these contextual factors contributed to the fatal accidents as well.

Statistically significant relationships between Flight Conditions (VMC/IMC) and the specific research identified contextual factors were determined using the phi correlation. A total of 16 significant negative correlations were identified. The relationship between Flight Conditions (VMC/IMC) and the pilot not submitting a flight plan to flight service was significant at the $p < .01$ level, r = -.322, $p = .000$ (CF21). As the flight conditions increased from VMC to IMC, the chance of the pilot not submitting a flight plan to flight service decreased. It was also found as the flight conditions increased from VMC to IMC, the chance of the pilot taking a safety risk to fly in IMC conditions to the planned destination decreased, $p < .01$ level, r = -.332, $p = .000$ (CF24). Other statistically significant relationships between Flight Conditions (VMC/IMC) and the specific research identified contextual factors are as follows, as the flight conditions increased from VMC to IMC (Table 20):

- the chance of the aircraft crash site being closer to the planned destination than the departure location decreased, $p < .05$ level, r = -.186, $p = .002$ (CF15)
- the chance of adverse weather encountered before the mid flight point was reached decreased, $p < .05$ level, r = -.165, $p = .007$ (CF2)
- the chance of less than or equal to half the time and distance required to reach the destination before the accident occurred decreased, $p < .05$ level, r = -.163, $p = .008$ (CF6)
- the chance of the aircraft crash site not being closer to the departure location than the planned destination decreased, $p < .05$ level, r = -.164, $p = .008$ (CF14)
- the chance of adverse weather encountered after the mid flight point was reached decreased, $p < .05$ level, r = -.161, $p = .009$ (CF3)
- the chance of the aircraft crash site being closer to the departure location than the planned destination decreased, $p < .05$ level, r = -.16, $p = .009$ (CF14)
- the chance of the pilot not communicating with air traffic control at the time of the VFR-into-IMC accident decreased, $p < .05$ level, r = -.159 $p = .01$ (CF12)
- the chance of the pilot deciding to continue VFR-into-IMC to the planned destination decreased, $p < .05$ level, r = -.156 $p = .011$ (CF17)
- the chance of the pilot not being in violation of the FAA flight time currency policy decreased, $p < .05$ level, r = -.153 $p = .013$ (CF16)

- the chance of the aircraft crash site not being closer to the planned destination than the departure location decreased, $p < .05$ level, r = -.139 $p = .024$ (CF15)
- the chance of adverse weather not encountered before mid flight point reached decreased, $p < .05$ level, r = -.126 $p = .04$ (CF2)
- the chance of cues signaling a problem were clear to the pilot decreased, $p < .05$ level, r = -.126 $p = .04$ (CF5)
- the chance of the pilot communicating with air traffic control at the time of the VFR-into-IMC accident decreased, $p < .05$ level, r = -.124 $p = .044$ (CF12)
- the chance of the pilot overestimating the ceiling and/or visibility weather conditions decreased, $p < .05$ level, r = -.122 $p = .048$ (CF9)

Table 20

Phi Correlations Between Contextual Factors and Flight Conditions

Contextual Factor	Flight Conditions
The pilot did not submit a flight plan to flight service (CF21)	$r = -.322$, $p = .000$
The pilot took a safety risk to fly in IMC conditions to planned destination (CF24)	$r = -.231$, $p = .000$

Table 20 continued

Phi Correlations Between Contextual Factors and Flight Conditions

Contextual Factor	Flight Conditions
The aircraft crash site was closer to the planned destination than the departure location (CF15)	$r = -.186, p = .002$
Adverse weather encountered before mid flight point reached (CF2)	$r = -.165, p = .007$
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	$r = -.163, p = .008$
The aircraft crash site was not closer to the departure location than the planned destination (CF14)	$r = -.164, p = .008$
Adverse weather encountered after mid flight point was reached (CF3)	$r = -.161, p = .009$
The aircraft crash site was closer to the departure location than the planned destination (CF14)	$r = -.16, p = .009$
The pilot did not communicate with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = -.159, p = .01$
The pilot decided to continue VFR-into-IMC to the planned destination (CF17)	$r = -.156, p = .011$
The pilot was not in violation of the FAA flight time currency policy (CF16)	$r = -.153, p = .013$

Table 20 continued

Phi Correlations Between Contextual Factors and Flight Conditions

Contextual Factor	Flight Conditions
The aircraft crash site was not closer to the planned destination than the departure location (CF15)	$r = -.139$, $p = .024$
Adverse weather not encountered before mid flight point reached (CF2)	$r = -.126$, $p = .004$
Cues signaling problem clear to pilot (CF5)	$r = -.126$, $p = .04$
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident (CF12)	$r = -.124$, $p = .044$
The pilot overestimated ceiling and/or visibility weather conditions (CF9)	$r = -.122$, $p = .048$

There were 16 statistically significant negative correlations between flight conditions (VMC/IMC) and the identified contextual factors. As the flight conditions increased from VMC to IMC, the chance of the pilot not submitting a flight plan to flight service decreased. These negative correlations also included the following:

- The chance of the pilot taking a safety risk to fly in IMC conditions to the planned destination decreased.
- The chance of the aircraft crash site being closer to the planned destination than the departure location decreased.

- The chance of adverse weather being encountered before the mid flight point was reached decreased.
- The chance of less than or equal to half the time and distance required to reach the destination before the accident occurred decreased.
- The chance of the aircraft crash site not being closer to the departure location than the planned destination decreased.
- The chance of adverse weather being encountered after the mid flight point was reached decreased.
- The chance of the aircraft crash site being closer to the departure location than the planned destination decreased.
- The chance of the pilot not communicating with air traffic control at the time of the VFR-into-IMC accident decreased.
- The chance of the pilot deciding to continue VFR-into-IMC to the planned destination decreased.
- The chance of the pilot not being in violation of the FAA flight time currency policy decreased.
- The chance of the aircraft crash site not being closer to the planned destination than the departure location decreased.
- The chance of adverse weather not being encountered before the mid flight point was reached decreased.
- The chance of the cues signaling a problem were clear to pilot decreased.
- The chance of the pilot communicating with air traffic control at the time of the VFR-into-IMC accident decreased.

- The chance of the pilot overestimating the ceiling and/or visibility weather conditions decreased.

These negative correlations relate to the identified research literature. The current study findings support the Wiegmann, Goh, and O'Hare (2002) conclusions on the amount of time and distance GA pilots flew into the IMC weather before deciding to divert. Study findings identified pilots who encountered the deteriorating weather earlier in the flight flew longer into IMC before diverting and were more optimistic about the weather conditions. The GA pilots who encountered the IMC weather later in the flight flew shorter distances into IMC before diverting and were not optimistic about the weather conditions. In the current study it was discovered as the weather increased from VMC to IMC, the crash sites and adverse weather occurred closer to the departure location slightly more often than the crash sites identified closer to the planned destination. It could be the case these pilots flew longer into IMC before attempting to divert to an alternate location and were more optimistic about the weather conditions. It is also possible as these pilots did not submit flight plans, were not in communication with air traffic control at the time of the accident, and violated FAA flight time currency policy, these contextual factors contributed to the fatal accidents as well.

Significant relationships between Accident Time of Day (Day/Night) and the specific research-identified contextual factors were determined using the phi correlation. A total of four significant positive and three significant negative correlations were identified. The relationship between Accident Time of Day (Day/Night) and the aircraft crash site not being closer to the planned destination than the departure location was significant at the $p < .05$ level, r = .189, $p = .002$ (CF15). As the time of day increased from Day to Night, the chance of the aircraft crash site not being closer to the planned destination than the departure location increased. It was also found as the time of day increased from Day to Night, the chance of adverse weather encountered before the mid flight point was reached increased, $p < .05$ level, r = .177, $p = .004$ (CF2). Other statistically significant relationships between Accident Time of Day (Day/Night) and the specific research-identified contextual factors are as follows, as the time of day increased from day to night (Table 21):

- the chance of the aircraft crash being closer to the departure location than the planned destination increased, $p < .05$ level, r = .168, $p = .006$ (CF14)
- the chance of adverse weather encountered after the mid flight point was reached decreased, $p < .05$ level, r = -.155, $p = .012$ (CF3)
- the chance of adverse weather not encountered before the mid flight point was reached decreased, $p < .05$ level, r = -.146, $p = .018$ (CF2)
- the chance of less than or equal to half the time and distance required to reach the destination before the accident occurred increased, $p < .05$ level, r = .133, $p = .03$ (CF6)
- the chance of the aircraft crash site being closer to the planned destination than the departure location decreased, $p < .05$ level, r = -.13, $p = .034$ (CF15)

Table 21

Phi Correlations Between Contextual Factors and Time of Day

Contextual Factor	Time of Day
The aircraft crash site was not closer to the planned destination than the departure location (CF15)	r = .189, p = .002
Adverse weather encountered before mid flight point reached (CF2)	r = .177, p = .004
The aircraft crash site was closer to the departure location than the planned destination (CF14)	r = .168, p = .006
Adverse weather encountered after mid flight point was reached (CF3)	r = -.155, p = .012
Adverse weather not encountered before mid flight point reached (CF2)	r = -.146, p = .018
Less than or equal to half the time and distance required to reach the destination before the accident occurred (CF6)	r = .133, p = .03
The aircraft crash site was closer to the planned destination than the departure location (CF15)	r = -.13, p = .034

There were four statistically significant positive correlations between the Accident Time of Day (Day/Night) and the identified contextual factors. As the time of day increased from day to night, the chance of the aircraft crash site not being closer to the planned destination than the departure location increased. Other significant positive correlations included the following:

- The chance of weather being encountered before the mid flight point was reached increased.
- The chance of the aircraft crash site being closer to the departure location than the planned destination increased.
- The chance of less than or equal to half the time and distance required to reach the destination before the accident occurred increased.

There were three statistically significant negative correlations between the Accident Time of Day (Day/Night) and the identified contextual factors. As the accident time of day increased from day to night, the chance of adverse weather being encountered after the mid flight point was reached decreased. The other statistically significant negative correlations included the following:

- The chance of adverse weather not encountered before the mid flight point was reached decreased.
- The chance of the aircraft crash site being closer to the planned destination than the departure location decreased.

These significant positive and negative correlations relate to the identified research literature. The current study findings support the Wiegmann, Goh, and O'Hare (2002) conclusions on the amount of time and distance GA pilots flew into the IMC weather before deciding to divert. Study findings identified pilots who encountered the deteriorating weather earlier in the flight flew longer into IMC before diverting and were more optimistic about the weather conditions. The GA pilots who encountered the IMC weather later in the flight flew shorter distances into IMC before diverting and were not optimistic about the weather conditions. In the current study, it was discovered as the Time of Day increased from Day to Night, the crash sites and adverse weather occurred closer to the departure locations than the planned destinations. It could be the case these pilots flew longer into IMC before attempting to divert to an alternate location and were more optimistic about the weather conditions.

Significant contextual factors identified included those factors revealed from the multiple regression analyses with the crash distance from departure to the midpoint of the planned route (0% to 50% of planned route completion). The results of the multiple regression analyses with the crash distance from departure to the midpoint of the planned route (0% to 50% of planned route completion) are the following:

- The flight time and distance in IMC were less than or equal to half the time and distance required to reach the destination, $p = .033$ (CF7).
- The pilot submitted a flight plan to flight service, $p = .040$ (CF21).
- The pilot did not fly into known icing conditions, $p = .027$ (CF22).
- The pilot was conducting scud running flight operations at the time of the accident, $p = .054$ (CF37).

The results added statistically significantly to the prediction of the crash distance from departure to the midpoint of the planned route of flight (0% to 50%), $F(72, 182) = 1.494$, $p < .017$, $R^2 = .371$. Current study results support the Saxton (2008) study findings on sunk cost to be a valid concept, as the participants of the study who were financially motivated did, in fact, continue longer into poor weather conditions than the participants who were not financially motivated and came upon hazardous weather earlier in the flight. It could be the case the pilots in the current study, having encountered IMC early in the flight, continued farther into IMC because they were financially motivated. The current study findings also support the Wiegmann, Goh, and O'Hare (2002) results identifying pilots who encountered the deteriorating weather earlier in the flight flew longer into IMC before diverting and were more optimistic about the weather conditions. It is possible the pilots in the current study, having encountered IMC early in the flight, flew greater distances into IMC and were optimistic about the weather conditions. Current study findings also support the Walmsley and Gilbey (2016) results of pilots interpreting the decisions of pilots who flew into deteriorating weather conditions more favorably when the outcome was positive than when the outcome was negative. It could be the case the pilots in the current study may have flown farther than they would have into IMC knowing other pilots had arrived successfully at the planned destination perhaps through hearing the radio transmissions of the pilots landing at the same destination. The findings of the current study are also consistent with the Ball (2008) results finding training improved pilots' ability to maintain safe distances from poor weather conditions. It is possible the pilots in the current study made a conscious choice to fly into IMC influenced by level of experience and quality of training.

The significant contextual factors identified from the multiple regression analyses also included those factors revealed with the crash distance from the midpoint of the planned route (51% to 100% of planned route completion) and include the following:

- The adverse weather was encountered before mid flight point reached, p = .009 (CF2).

- The adverse weather was encountered after the mid flight point was reached, *p* = .000 (CF3).
- The flight time and distance in IMC were greater than half the time and distance required to reach the destination before diverting, *p* = .003 (CF7).
- The pilot was not fixated on visually compelling head down displays, *p* = .021 (CF8).
- The pilot was under stress and did not anticipate the consequences of flying in IMC, *p* = .017 (CF13).
- The pilot decided not to continue VFR-into-IMC to the planned destination, *p* = .018 (CF17).
- The pilot decided to continue VFR-into-IMC to the planned destination, *p* = .032 (CF17).
- The pilot submitted a flight plan to flight service, *p* = .002 (CF21).
- The pilot flew into known icing conditions, *p* = .027 (CF22).
- The pilot exhibited linear decision-making, *p* = .004 (CF27).
- The pilot did not exhibit permission-seeking behaviors, *p* = .011 (CF32).

The findings added statistically significantly to the prediction of the crash distance from the midpoint to the destination of the planned route of flight (51% to 100%), $F(72, 182) = 3.178$, $p < .01$, $R^2 = .557$. Current study results support the Keller (2015) findings of VFR pilots who flew into IMC did so because they misperceived the severity of the weather and the associated risks and pilots who turned, or diverted, did so because they became aware of the danger and sought to return to safety. It could be the case in the current study the pilots who attempted to land at the destination in IMC and crashed may have misperceived the severity and risks of flying in adverse weather and those pilots diverting to an alternate did so because they became aware of the risks of flying in IMC and attempted to divert to an alternate or the departure point. The current study also supports the O'Hare and Smitheram (1995) research finding pilots who viewed risk from a gain standpoint were less likely to continue into IMC, and those who considered risk from a loss viewpoint were more likely to continue. It is possible the pilots in the current study who attempted to land at the destination viewed risk from a loss perspective and continued in IMC to the planned arrival point. It could also be the case the pilots in the current study who viewed risk from a gain perspective diverted to an alternate location or the departure point. The current study also agrees with the Wiegmann, Goh, and O'Hare (2002) research results; when adverse weather is encountered later in flight, pilots are more likely to continue as they might be more optimistic about the possibility of positive outcomes than they are when they encounter poor weather early in a flight. Results were consistent with more optimism during poor weather encounters occurring later into flights and less optimism when hazardous weather was present earlier in flights. It could be the case the pilots in the current study encountering IMC later in the flight were more likely to continue to the planned destination being more optimistic of the positive outcome of a successful landing at the arrival point. It is also possible the pilots in the current study encountering IMC earlier in the flight were more likely to divert to an alternate or attempt to return to the departure point being less optimistic with bad weather encountered early in the flight. The current study results also agree with the Ahlstrom, Ohneiser, and Caddigan (2016) findings documenting the tendency of the novice pilot to utilize linear decision-making and the expert pilot utilization of circular decision-making.

Researchers explained when the pilot chooses to continue into questionable weather conditions, circumstances including invested time, money and energy, passenger pressure; and get-there-itis may influence a pilot to continue, rather than divert. It is possible the pilots in the current study making the decision to continue in IMC to the planned destination used linear decision making rather than circular decision making and could have been influenced by any of the identified factors contributing to the fatal accidents. The current study also supports the Goh and Wiegmann (2001) results identifying pilots who overestimated personal abilities and inaccurately diagnosed visibility were more likely to continue into adverse weather. It could be the case the pilots in the current study making the decision to continue into IMC to the planned destination were overconfident in their personal abilities and misjudged the decreasing visibility, thinking the visibility was higher when in fact it was lower, and continued into IMC to the destination, factors possibly contributing to the accident. Current study findings also support the Walmsley and Gilbey (2016) results of pilots interpreting the decisions of pilots who flew into deteriorating weather conditions more favorably when the outcome was positive than when the outcome was negative. It could be the case the pilots in the current study heard pilots on the radio arriving at the destination airport and making a successful landing (positive outcome) and decided to continue to the same destination airport in IMC to attempt a landing with deteriorating weather conditions based on the successful landing of other pilots in better weather conditions. The current study also supports the Coyne, Baldwin, and Latrorella (2005) findings on linear decision-making, where pilots commit to one decision without reevaluation after actions have been implemented. It is possible the pilots in the current study used linear rather than circular decision making and did not check decisions once they were made to see if another decision should be made based on updated information, contributing to the fatal accident. The current study also supports the Ball (2008) research findings for the reason pilots fly too closely to adverse weather being a conscious choice influenced by level of experience and quality of training. It could be the case the pilots in the current study made the conscious choice to fly too closely to adverse weather based on level of flight experience and quality of the training received. The current study also supports the Martin, Davison, and Orasanu (1998) research findings investigating errors in aviation decision-making. It was hypothesized by the researchers errors are facilitated by underestimation of risk and failure to analyze the potential consequences of continuing with the initial plan as well as stressors may further contribute to these effects. It could be the case the pilots in the current study were involved in the fatal aircraft crashes resulting partially from contributory factors related to bad decision-making, underestimation of risk, and stress.

Conclusions

The main study was able to answer the three research questions for the 46 research-identified contextual factors related to Part 91, GA pilot intentions and behavior resulting in VFR-into-IMC accidents. The first and second research questions were as follows:

1. What contextual factors contribute to Part 91, GA pilot VFR-into-IMC accidents in the reviewed NTSB AARs?

2. What is the frequency of occurrence for the contextual factors in Part 91, GA pilot VFR into-IMC accidents in the reviewed NTSB AARs?

The study's research questions one and two were able to be answered by the researcher. The 46 research-identified contextual factors present in the main study sample of 85 accidents, as identified by the three raters, were sorted to identify the specific contextual factors and associated frequencies from the results obtained from SPSS™ (Appendix H; Table H1). Three raters identified a total of 37 out of 46 research-identified contextual factors in the 85 accident sample used in the main study. Highest presence and frequencies of the top five rater identified contextual factors in the sample of 85 GA Part 91 VFR-into-IMC NTSB AARs included the following: (1) number of passengers on board (CF29-62%), (2) accident time of day (Day) (CF1-60%), (3) crash distance from planned destination (CF15-54%), (4) not filing a flight plan (CF21-49%), and (5) underestimating risk (CF43-49%).

The third research question was as follows:

3. How are the contextual factors manifested in Part 91, GA pilot VFR-into-IMC accidents in the sample of reviewed NTSB AARs?

The researcher was able to answer the third research question. Three raters provided their respective opinions about how the 46 research-identified contextual factors were manifested in the 85 accident sample. Highest frequency rater-identified contextual factor manifestations including the following:

The number of passengers on board the aircraft was identified by the raters in the 85 NTSB accident sample. A total of 53 out of 85 aircraft, or 62% of the accident sample, had passengers on board the aircraft. A break down according to category of passenger number on board the aircraft and the associated percentages were identified as follows: 32 aircraft (0 passengers - 38%), 36 aircraft (1 passenger – 42%), 11 accidents (2 passengers – 13%), 3 accidents (3 passengers – 4%), 1 accident (4 passengers – 1%), and 2 accidents (5 passengers – 2%).

Accident time of day was identified by the raters in the 85 NTSB accident sample. There was a total of 34 accidents occurring during the day and 51 accidents took place at night. Particular lighting conditions varied and included six accidents taking place at dusk, 37 during daylight conditions, 33 during night light conditions, five during dark light conditions, and four during dawn light conditions. Two accidents occurred at 0000, one at 0100, two at 0400, five at 0500, three at 0600, four at 0700, three at 0800, four at 0900, five at 1000, four at 1100, five at 1200, one at 1300, five at 1400, two at 1500, three at 1600, four at 1700, seven at 1800, ten at 1900, five at 2000, four at 2100, three at 2200, and three at 2300.

Crash distances from the midpoint to the planned destination were identified by the raters for the 85 NTSB accident sample. The crash distances from the midpoint to the planned destination as a percentage of the planned route of flight course completion included the following: (1) 51% (12 accidents), (2) 56% (1 accident), (3) 59% (1 accident), (4) 60% (1 accident), (5) 62% (1 accident), (6) 66% (1 accident), (7) 69% (1 accident), (8) 70% (2 accidents), (9) 71% (1 accident), (10) 73% (1 accident), (11) 74% (2 accidents), (12) 77% (3 accidents), (13) 84% (1 accident), (14) 86% (1 accident), (15) 89% (1 accident), (16) 90% (1 accident), (17) 94% (1 accident), (18) 95% (1 accident), (19) 96% (1 accident), (20) 97% (1 accident), (21) 98% (1 accident), and (22) 99% (9 accidents). A majority of accidents occurred between the midpoint to the planned destination and totaled 46 versus 39 occurring from the departure to the midpoint of the planned route of flight.

Reasons the pilots filed and did not file flight plans were identified by the raters in the 85 NTSB accident sample. The reasons reported by the raters for pilots filing a flight plan included the following: (1) the pilot experienced errors in attempting to enter the flight plan, (2) NTSB investigators making mistakes in reporting pilots not filing flight plans when the pilots did file flight plans, (3) the pilots filing flight plans and then cancelling the flight plans for various reasons, and (4) the pilots filing IFR flight plans when not qualified to file IFR flight plans. Reasons reported by the raters for pilots not filing flight plans included (1) the pilots felt filing flight plans was not necessary, and (2) the pilots did not file flight plans when they should have filed flight plans.

Reasons the pilots underestimated the risks in conducting the flights were identified by the raters in the 85 NTSB accident sample. The reasons reported by the raters for the pilots underestimating the risks in conducting the flights included the following: (1) poor decision-making, (2) time of day, (3) lighting conditions, (4) terrain, (5) social pressure, (6) incomplete weather briefing, (7) incomplete pilot risk assessment, (8) pilot intentional self-harm, (9) underestimation of risk for flight direction/location decision, (10) underestimation of risk for flying near adverse weather decision, (11) pilot self-imposed pressures, (12) equipment failure, (13) ATC failure, and (14) underestimation of night flying risk.

The main study identified and demonstrated a method of utilizing expert raters and historical archival fatal accident data and statistical analyses to identify significant contextual factors to mitigate incidents and accidents. Significance between the majority of contextual factors and pilot age, flight experience (total flight hours), pilot certification level (instrument/non-instrument), weather (inclement/non-inclement), flight conditions

(VMC/IMC), time of day (day/night), crash distance from departure, and crash distance from planned destination studied at the $p < .01$ and $p < .05$ levels were identified. A rater-identified possible NTSB archival database taxonomy suggestion of pilot intentional self-harm was also identified. Findings of the current study provided support/refuted the key discoveries of the Ahlstrom, Ohneiser, and Caddigan (2016), Baldwin and Latrorella (2005), Ball (2008), Balog (2013), Balog (2016), Barron (2011), Bazargan and Guzhva (2011), Coyne, Baldwin, and Latrorella (2008), Goh and Wiegmann (2001), Ison (2014a), Ison (2014b), Jackman (2014), Johnson and Wiegmann (2015), Keller (2015), Martin, Davison, and Orasanu (1998), O'Hare and Owen (2002), O'Hare and Smitheram (1995), Saxton (2008), Walmsley and Gilbey (2016), and Wiegmann, Goh, and O'Hare (2002) research. The application of the demonstrated methodology is generalizable to any other field and mode of transportation.

Recommendations

It is recommended archival studies be conducted for all flight domains using the identified methodology, including additional GA Part 91, VFR-into-IMC accident research. The studies should incorporate secondary data from the NTSB and other GA pilot historical databases. Populations and samples should be taken from a variety of geographical areas to support/refute the present study contextual factor and manifestation findings. These recommendations could increase the possibility of identifying other contextual factors and manifestations not revealed in the current study. Different groups of raters should be recruited to provide subject matter expertise for VFR-into-IMC accidents, such as professional flight instructors. Additional research should be conducted on the GA Part 91, VFR-into-IMC contextual factors and manifestations identified in the current study to increase knowledge and understanding of the reasons these factors and manifestations exist. Additional research should also be completed to improve understanding of the relationships among the contextual factors, manifestations, pilot age, flight experience (total flight hours), pilot certification level (instrument/non-instrument), weather (inclement/non-inclement), flight conditions (VMC/IMC) and time of day (day/night) identified in this study. The GA pilot community should be educated and trained on the relationships among the contextual factors, pilot age, flight experience, pilot certification level, weather, flight conditions, time of day, crash distance from departure, and crash distance from the planned destination as well as the manifestations revealed in this research.

REFERENCES

Adams, R. J., & Ericsson, K. A. (1992). *Introduction to cognitive processes of expert pilots.* Retrieved from https://apps.dtic.mil/dtic/tr/fulltext/u2/a254760.pdf

Ahlstrom, U. (2015). Weather display symbology affects pilot behavior and decision-making. *International Journal of Industrial Ergonomics, 50*, 73–96.

Ahlstrom, U., Caddigan, E., Schulz, K., Ohneiser, O., Bastholm, R., & Dworsky, M. (2015). *The effect of weather state-change notifications on general aviation pilots' behavior, cognitive engagement, and weather situation awareness (DOT/FAA/TC-15/64)*. Atlantic City International Airport, NJ: FAA William Hughes Technical Center.

Ahlstrom, U., Ohneiser, O., & Caddigan, E. (2016). Portable weather applications for general aviation pilots. *Human Factors: The Journal of Human Factors and Ergonomics Society, 58*(6), 864-885. doi: 10.1177/0018720816641783

Aviation Data & Stats. (2016, September 2). *2014 NTSB US Civil Aviation Accident Statistics.* Retrieved from https://www.ntsb.gov/investigations/data/Pages/AviationDataStats2014.aspx

Ball, J. (2008). *The impact of training on general aviation pilots' ability to make strategic weather-related decisions (DOT/FAA/AM-08/3)*. Oklahoma City, OK: Federal Aviation Administration.

Balog, C. R. C. (2013). *A descriptive instrumental collective case study of the cognitive processes employed by professional pilots-in-command (PICs) during extended, extreme in-flight emergencies* (Order No. 3559885). Available from ProQuest Dissertations & Theses Global. (1355174929). Retrieved from http://search.proquest.com.ezproxy.libproxy.db.erau.edu/docview/1355174929?accountid=27203

Balog, C. R. (2016). A validation of the efficacy of descriptive instrumental collective case study research methodology for examining pilot cognitive functioning. *International Journal of Aviation, Aeronautics, and Aerospace, 3*(4). https://doi.org/10.15394/ijaaa.2016.1094

Baron, J. (2011). *Pilot weather decision making and the influence of passenger pressure* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (3454896)

Bazargan, M., & Guzhva, V. S. (2011). Impact of gender, age, and experience of pilots on general aviation accidents. *Accident Analysis and Prevention, 43*, 962-970. doi:10.1016/j.aap.2010.11.023

Bell, B., & Mauro, R. (2000). Training in judgment and aeronautical decision-making. *Proceedings of the 19th Digital Avionics Systems Conference*, 2, 5.B.11- 5.B.18. Eugene, OR: University of Oregon Press.

Beringer, D., & Ball, J. (2004). *The effects of NEXRAD graphical data resolution and direct weather viewing on pilots' judgments of weather severity and their willingness to continue flight (DOT/FAA/AM-04/5)*. Oklahoma City, OK: Civil Aerospace Medical Institute, Federal Aviation Administration.

Boyes, M., & Potter, T. (2015). The application of recognition-primed decision theory to decisions made in an outdoor education context. *Australian Journal of Outdoor Education, 18*(1), 2-15.

Byrt, T., Bishop, J., & Carlin, J. (1993). Bias, prevalence, and kappa. *Journal of Clinical Epidemiology, 46*(5), 423-429.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*(1), 37-46.

Connelly, L. M. (2008). Pilot studies. *Medsurg Nursing, 17*(6), 411-2. Retrieved from http://ezproxy.libproxy.db.erau.edu/login?url=https://search-proquest-com.ezproxy.libproxy.db.erau.edu/docview/230525260?accountid=27203

Coyne, J. T., Baldwin, C. L., & Latrorella, K. A. (2005). Influence of graphical METARs on pilot's weather judgment. *Proceedings of the Human Factors and Ergonomics Society 49th Annual Meeting, 131–135*. Santa Monica, CA: Human Factors and Ergonomics Society.

Coyne, J. T., Baldwin, C. L., & Latrorella, K. A. (2008). Pilot weather assessment: Implications for visual flight rules flight into instrument meteorological conditions. *International Journal of Aviation Psychology, 18*(2), 153–166.

Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, New Jersey: Pearson Education, Inc.

Dogusoy-Taylan, B., & Cagiltay, K. (2014). Cognitive analysis of experts' and novices' concept mapping processes: An eye tracking study. *Computers in Human Behavior, 36*, 82-93. doi:10.1016/j.chb.2014.03.036

e-CFR. (2018a). *Title 14: Aeronautics and space. Part 91: General operating and flight rules.* Retrieved from https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=3efaad1b0a259d4e48f1150a34d1aa77&rgn=div5&view=text&node=14:2.0.1.3.10&idno=14#se14.2.91_11

FAA. (n.d.a). *Data dictionary for NTSB accident and incident system*. Retrieved from https://www.asias.faa.gov/apex/f?p=100:9:::NO::P9_REGION_VAR:1

FAA. (n.d.b). *NTSB system level business rules*. Retrieved from https://www.asias.faa.gov/apex/f?p=100:9:::NO::P9_REGION_VAR:2

FAA. (2008). *Aviation instructor's handbook.* Retrieved from https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/aviation_instructors_handbook/

FAA. (2016). *Risk management handbook-Change 1.* Washington, D.C.: Government Printing Office.

FAA. (2018a). *14 CFR 1 definitions and abbreviations.* Retrieved from https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=3efaad1b0a259d4e48f1150a34d1aa77&rgn=div5&view=text&node=14:2.0.1.3.10&idno=14

FAA. (2018b). *U.S. civil airmen statistics. Annual statistics – 2012 to 2017 active civil airmen statistics.* Retrieved from https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics

FAA. (2018c). *Pilot handbook of aeronautical knowledge. Aeronautical decision-making: Risk management process.* Retrieved from https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/04_phak_ch2.pdf

FAA. (2018d). *FAA flight planning information*. Retrieved from https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/air_traffic_services/flight_plan_filing/

Falotico, R., & Quatto, P. (2015). Fleiss' kappa statistic without paradoxes. *Quality & Quantity, 49*(2), 463-470. 10.1007/s11135-014-0003-1

Field, A. (2009). *Discovering statistics using SPSS* (Third ed.). Thousand Oaks, CA: Sage Publications.

Fleiss, J. (1971). Measuring nominal scale agreement among many raters. *Psychological Bulletin, 76*(5), 378-382.

Fleiss, J. L., & Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. *Educational and Psychological Measurement, 33*(3), 613–619. https://doi.org/10.1177/001316447303300309

Gallo, M. A., Alhallaf, H., Baran, S., Cremer, I., Finn, C., Maharaj, I., Ozyurek, A., Pecker, A., Reese, B., Tuncman, R., Turgut, T., & Uhuegho, K. O. (2015). Inadvertent VFR-into-IMC flights: A qualitative approach to describing GA pilots' first-hand experiences. *Collegiate Aviation Review, 33*(2), 27.

Goh, J., & Wiegmann, D. A. (2001). Visual flight rules flight into instrument meteorological conditions: An empirical investigation of the possible causes. *International Journal of Aviation Psychology, 11*(4), 359–379.

Goh, J., & Wiegmann, D. (2002). Human factors analysis of accidents involving visual flight rules flight into adverse weather. *Aviation, Space, and Environmental Medicine, 73*(8), 817.

Green, A. (1997). Kappa statistics for multiple raters using categorical classifications. *Proceedings of the 22nd Annual Conference of SAS Users Group.*

Gwet, K. L. (2008). Computing inter-rater reliability and its variance in the presence of high agreement. *British Journal of Mathematical and Statistical Psychology, 61(*1), 29-48. doi:10.1348/000711006X126600

Gwet, K. L. (2014). *Handbook of inter-rater reliability: The definitive guide to measuring the extent of agreement among raters* (Fourth ed.). Gaithersburg, MD: Advanced Analytics, LLC.

Hunter, D. R., Martinussen, M., Wiggins, M., & O'Hare, D. (2011). Situational and personal characteristics associated with adverse weather encounters by pilots. *Accident Analysis and Prevention, 43*(1), 176-186. doi:10.1016/j.aap.2010.08.007

Huster, K. M., Müller, A., Prohn, M. J., Nowak, D., & Herbig, B. (2014). Medical risks in older pilots: A systematic review on incapacitation and age. *International Archives of Occupational and Environmental Health, 87*(6), 567-578. doi:10.1007/s00420-013-0901-x

Ison, D. (2014a). Correlates of continued visual flight rules (VFR) into instrument meteorological conditions (IMC) general aviation accidents. *Journal of Aviation/Aerospace Education & Research, 24*(1), 1–26.

Ison, D. (2014b, March). Understanding VFR into IMC accidents: A study of situational and pilot factors. *Plane and Pilot, 50*(2). 60-62.

Jackman, B. (2014). *Policy violations predicting fatal general aviation accidents from visual flight rules to instrument meteorological conditions* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (3665796)

Johnson, C. M., & Wiegmann, D. A. (2015). VFR into IMC: Using simulation to improve weather-related decision-making. *The International Journal of Aviation Psychology, 25*(2), 63-76. doi:10.1080/10508414.2015.1026672

Johnson, N., Wiegmann, D., & Wickens, C. (2006). Effects of advanced cockpit displays on general aviation pilots' decision to continue visual flight rules flight into instrument meteorological conditions. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting, 30–34*. Santa Monica, CA: Human Factors and Ergonomics Society.

Joslin, R. (2014). *Validation of new technology using legacy metrics: Examination of Surf-IA alerting for runway incursion incidents* (Doctoral dissertation). Embry Riddle Aeronautical University, Daytona Beach, FL.

Keller, J. C. (2015). *Unexpected transition from VFR to IMC: An examination of training protocols to mitigate pilot gaps in knowledge and performance* (unpublished doctoral dissertation). Purdue University, West Lafayette, Indiana.

Kiliç, S. (2015). Kappa test. *Journal of Mood Disorders, 5*(3), 142. 10.5455/jmood.20150920115439

Klein, G. (2008). Naturalistic decision making. *Human Factors, 50*(3), 456–460. https://doi.org/10.1518/001872008X288385

Knecht, W., Ball, J., & Lenz, M. (2010). *Effects of video weather training products, web-based preflight weather briefing, and local versus nonlocal pilots on general aviation pilot weather knowledge and flight behavior, phase I*. Federal Aviation Administration, DOT/FAA/AM-10/1, Office of Aerospace Medicine, Washington, DC. Retrieved from http://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2010s/media/201001.pdf

Landis, J., & Koch, G. (1977). The measurement of observer agreement for categorical data coefficient of agreement for nominal scales. *Biometrics. 33*(1), 159-174.

Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic inquiry. Beverly Hills, CA: Sage.

Madhavan, P., & Wiegmann, D. A. (2005). Cognitive anchoring on self-generated decisions reduces operator reliance on automated diagnostic aids. *Human Factors, 47*(2), 332-431.

Martin, L., Davison, J., & Orasanu, J. (1998). *Errors in aviation decision making: Bad decisions or bad luck?* Retrieved from https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20020063485.pdf

McCoul, E. D., Smith, T. L., Mace, J. C., Anand, V. K., Senior, B. A., Hwang, P. H., Stankiewicz, J. A., & Tabaee, A. (2012). Interrater agreement of nasal endoscopy in patients with a prior history of endoscopic sinus surgery. *International Forum of Allergy & Rhinology, 2*(6), 453-459. doi:10.1002/alr.21058

McCoy, C. E., & Mickunas, A. (2000). The role of context and progressive commitment in plan continuation error. *Human Factors and Ergonomics Society Annual Meeting Proceedings, 44*(1), 26-29. doi: 10.1177/154193120004400108

Nall, J. T. (2018). *Joseph T. Nall report – General aviation accidents in 2015.* Retrieved from https://www.aopa.org/-/media/files/aopa/home/training-and-safety/nall-report/27thnallreport2018.pdf?la=en&hash=C52F88B38FD95CB7C0A43F3B587A12E2692A8502

Nicolai, D., Brown, L., Carney, T., Rantz, W. G., Major, W. L., Keller, J., Xie, A., Price, M., Duncan, J., Brown, L., Whitehurst, G., Dominic, N., & Beaudin-Seiler, B. M. (2017). VFR-into-IMC accident trends: Perceptions of deficiencies in training. *Journal of Aviation Technology and Engineering, 7*(1), 50-57. doi:10.7771/2159-6670.1153

NOAA. (2018). *U.S. climate regions.* Retrieved from https://www.ncdc.noaa.gov/monitoring-references/maps/us-climate-regions.php

NTSB. (n.d.a.). *Aviation data dictionary*. Retrieved from https://www.ntsb.gov/_layouts/ntsb.aviation/AviationDownloadDataDictionary.aspx

NTSB. (n.d.b.). *Legacy database coding*. Retrieved from https://app.ntsb.gov/avdata/eadmspub_legacy.pdf

NTSB. (n.d.c.). *Basic NTSB aviation accident incident database architecture with key fields.* Retrieved from https://app.ntsb.gov/avdata/admsrel.pdf

NTSB. (n.d.d.). *NTSB aviation coding manual.* Retrieved from https://app.ntsb.gov/avdata/codman.pdf

NTSB. (n.d.e.). *NTSB aviation data.* Retrieved from https://app.ntsb.gov/avdata/eadmspub.pdf

NTSB. (2000, July 6). *NTSB releases final report on investigation of crash of aircraft piloted by John F. Kennedy Jr.* [NTSB News Release]. Retrieved from https://www.ntsb.gov/news/press-releases/Pages/NTSB_NTSB_releases_final_report_on_investigation_of_crash_of_aircraft_piloted_by_John_F._Kennedy_Jr.aspx

NTSB. (2014). *NTSB most wanted list: Critical changes needed to reduce transportation accidents and save lives.* Washington, DC: Author. Retrieved from https://www.ntsb.gov/safety/mwl/Documents/MWL2014_broc_Web.pdf

NTSB. (2015). *NTSB most wanted list: Critical changes needed to reduce transportation accidents and save lives.* Washington, DC: Author. Retrieved from https://www.ntsb.gov/news/speeches/EWeener/Documents/weener_150128.pdf

NTSB. (2016). *NTSB most wanted list: Critical changes needed to reduce transportation accidents and save lives.* Washington, DC: Author. Retrieved from https://www.ntsb.gov/safety/mwl/Documents/MWL_2016_factsheet05.pdf

NTSB. (2017c). *Aviation accident & synopses. GA FAR Part 91 inadvertent IMC accident reports.* Retrieved from https://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx

NTSB. (2017d). *2013-2015 GA FAR Part 91 inadvertent-VFR-into-IMC accidents.* Retrieved from https://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx

NTSB. (2017-2018). *NTSB most wanted list: Critical changes needed to reduce transportation accidents and save lives.* Washington, DC: Author. Retrieved from https://www.ntsb.gov/safety/mwl/Documents/2017-18/MWL-Brochure2017-18.pdf

NTSB. (2018). *NTSB safety alerts.* Retrieved from https://www.ntsb.gov/safety/safety-alerts/Pages/default.aspx

Oakleaf, M. (2009). Using rubrics to assess information literacy: An examination of methodology and interrater reliability. *Journal of the American Society for Information Science and Technology, 60*(5), 969-983.

O'Hare, D., & Owen, D. (2002). Cross-country VFR crashes: Pilot and contextual factors. *Aviation, Space, and Environmental Medicine, 73*(4), 363.

O’Hare, D., & Smitheram, T. (1995). “Pressing on” into deteriorating conditions: An application of behavioral decision theory to pilot decision-making. *International Journal of Aviation Psychology, 5*(4), 351–370.

Orasanu, J., & Martin, L. (1998, April). *Errors in aviation decision-making: A factor in accidents and incidents*. Paper presented at HESSD 98, Working Conference on Human Error, Safety and Systems Development, Seattle, Washington.

Orasanu, J., Martin, L., & Davison, J. (1998, May). *Errors in aviation decision-making: bad decisions or bad luck?* Retrieved from https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20020063485.pdf

Orasanu, J., Martin, L., & Davidson, J. (2001). Cognitive and contextual factors in aviation accidents: Decision errors. In E. Salas & G. Klein (Eds.), *Linking expertise and naturalistic decision making*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Poburka, B. J., Patel, R. R., & Bless, D. M. (2016). Voice-vibratory assessment with laryngeal imaging (VALI) form: Reliability of rating stroboscopy and high-speed videoendoscopy. *Journal of Voice, 31*(4), 513.e1-513.e14. doi:10.1016/j.jvoice.2016.12.003

Sawyer, M. W., & Shappell, S. A. (2009). Eye tracking analysis of the effects of experience and training on pilots' ability to identify adverse weather conditions. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 53*(1), 46-50. 10.1177/154193120905300111

Saxton, B. (2008). *The influence of motivation and investment on the length of time pilots fly into degraded weather* (Master thesis). Retrieved from http://commons.erau.edu/db-theses/179/

Schriver, A. T., Morrow, D. G., Wickens, C. D., & Talleur, D. A. (2008). Expertise differences in attentional strategies related to pilot decision-making. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 50*(6), 864-878. doi:10.1518/001872008X374974

Scott, W. (1955). Reliability of content analysis: The case of nominal scale coding. *The Public Opinion Quarterly, 19*(3), 321-325. Retrieved from www.jstor.org/stable/2746450

Sim, J., & Wright, C. C. (2005). The kappa statistic in reliability studies: Use, interpretation, and sample size requirements. *Journal of the American Physical Therapy Association, 85(*3), 257-268.

Singendonk, M. M. J., Pullens, B., van Heteren, J. A. A., de Gier, H. H. W., Hoeve, H. L. J., König, A. M., van der Schroeff, M. P., Hoekstra, C., Veder, L. L., van der Pol, R. J., Benninga, M. A., & van Wijk, M. P. (2016). Reliability of the reflux finding score for infants in flexible versus rigid laryngoscopy. *International Journal of Pediatric Otorhinolaryngology, 86*, 37-42. 10.1016/j.ijporl.2016.04.017

Smith, T. L., Hwang, P. H., Murr, A. H., Lavigne, F., & Koreck, A. (2012). Interrater reliability of endoscopic parameters following sinus surgery. *The Laryngoscope, 122*(1), 230-236. doi:10.1002/lary.22440

Stemler, S. (2004). A comparison of consensus, consistency, and measurement approaches to estimating interrater reliability. *Practical Assessment, Research & Evaluation, 9*(4). Retrieved from http://PAREonline.net/getvn.asp?v=9&n=4

Sternberg, R., & Sternberg, K. (2016). *Cognitive psychology* (7th Ed.). Boston, MA: Cengage.

Thabane, L., Ma, J., Chu, R., Cheng, J., Ismaila, A., Rios, L, Robson, R., Thabane, M., Giangregorio, L., & Goldsmith, C. (2010). A tutorial on pilot studies: The what, why and how. *BMC medical research methodology, 10*(1), 1.

Tropper, K., Kallus, K. W., & Boucsein, W. (2009). Psychophysiological evaluation of an antidisorientation training for visual flight rules pilots in a moving base simulator. *The International Journal of Aviation Psychology, 19*(3), 270-286. doi:10.1080/10508410902983912

van Teijlingen, E., & Hundley, V. (2001). The importance of pilot studies. *Social research update,* 35, 1-4.

Velázquez, J. (2016). *Behavioral traps in flight crew-related 14 CFR part 121 airline accidents* (Doctoral Dissertation). Embry Riddle Aeronautical University, Daytona Beach, FL.

Walmsley, S., & Gilbey, A. (2016). Cognitive biases in visual pilots' Weather-Related decision-making. *Applied Cognitive Psychology, 30*(4), 532-543. doi:10.1002/acp.3225

Whitehurst, G. R., Beaudin-Seiler, B. M., Carney, T., Nicolai, D., Major, W. L., Xie, A., Duncan, J. (2017). VFR-into-IMC accident trends: Perceptions of deficiencies in training. *Journal of Aviation Technology and Engineering, 7*(1) doi:10.7771/2159-6670.1153

Wickens, C. D. (2005). Attentional tunneling and task management. *Proceedings of the 13th International Symposium on Aviation Psychology.* Columbus, OH: The Ohio State University.

Wiegmann, D., & Goh, J. (2000). *Visual Flight Rules (VFR) flight into adverse weather: An empirical investigation of factors affecting pilot decision-making*. Technical Report ARL-00-15/FAA-00-8.

Wiegmann, D. A., Goh, J., & O'Hare, D. (2002). The role of situation assessment and flight experience in pilots' decisions to continue visual flight rules into adverse weather. *Human Factors, 44*(2), 189–197.

Wiggins, M. W., Hunter, D. R., O'Hare, D., & Martinussen, M. (2012). Characteristics of pilots who report deliberate versus inadvertent visual flight into instrument meteorological conditions. *Safety Science, 50*(3), 472-477. 10.1016/j.ssci.2011.10.010

Wiggins, M., & O'Hare, D. (2003). Weatherwise: Evaluation of a cuebased training approach for the recognition of deteriorating weather conditions during flight. *Human Factors, 45*(2), 337–345.

Wilson, D. R., & Sloan, T. A. (2003). VFR flight into IMC: Reducing the hazard. *Journal of Aviation/Aerospace Education & Research, 13*(1). Retrieved from https://commons.erau.edu/jaaer/vol13/iss1/9

Zapf, A., Castell, S., Morawietz, L., & Karch, A. (2016). Measuring inter-rater reliability for nominal data – which coefficients and confidence intervals are appropriate? *BMC Medical Research Methodology, 16*(1), 1-10. 10.1186/s12874-016-0200-9

APPENDIX A

Permission to Conduct Research
IRB Decision Tree 1

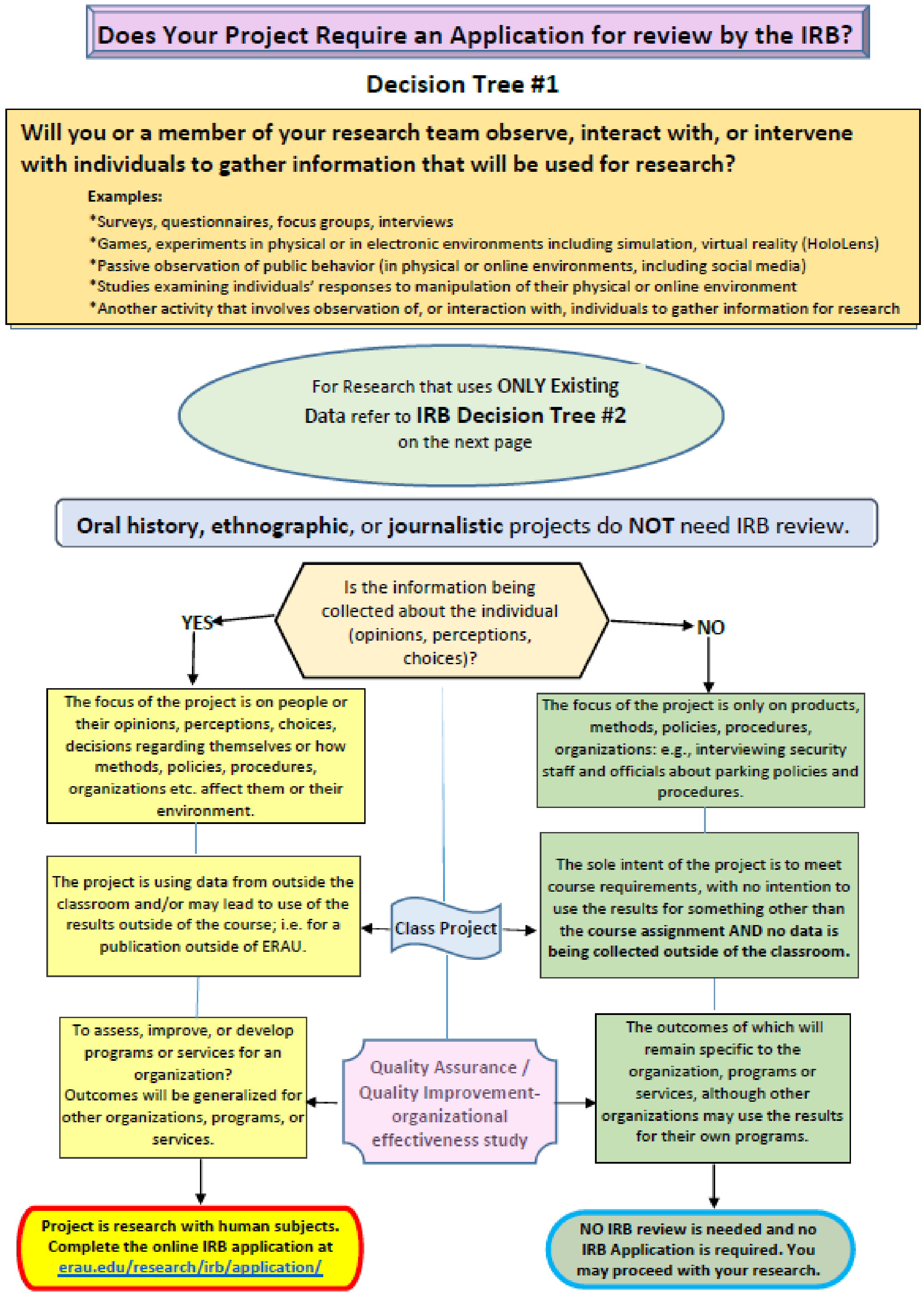


Figure A1. IRB decision tree 1. Adapted from the ERAU IRB website (https://erau.edu/-/media/files/university/research/irb-decision-tree-2020.pdf)

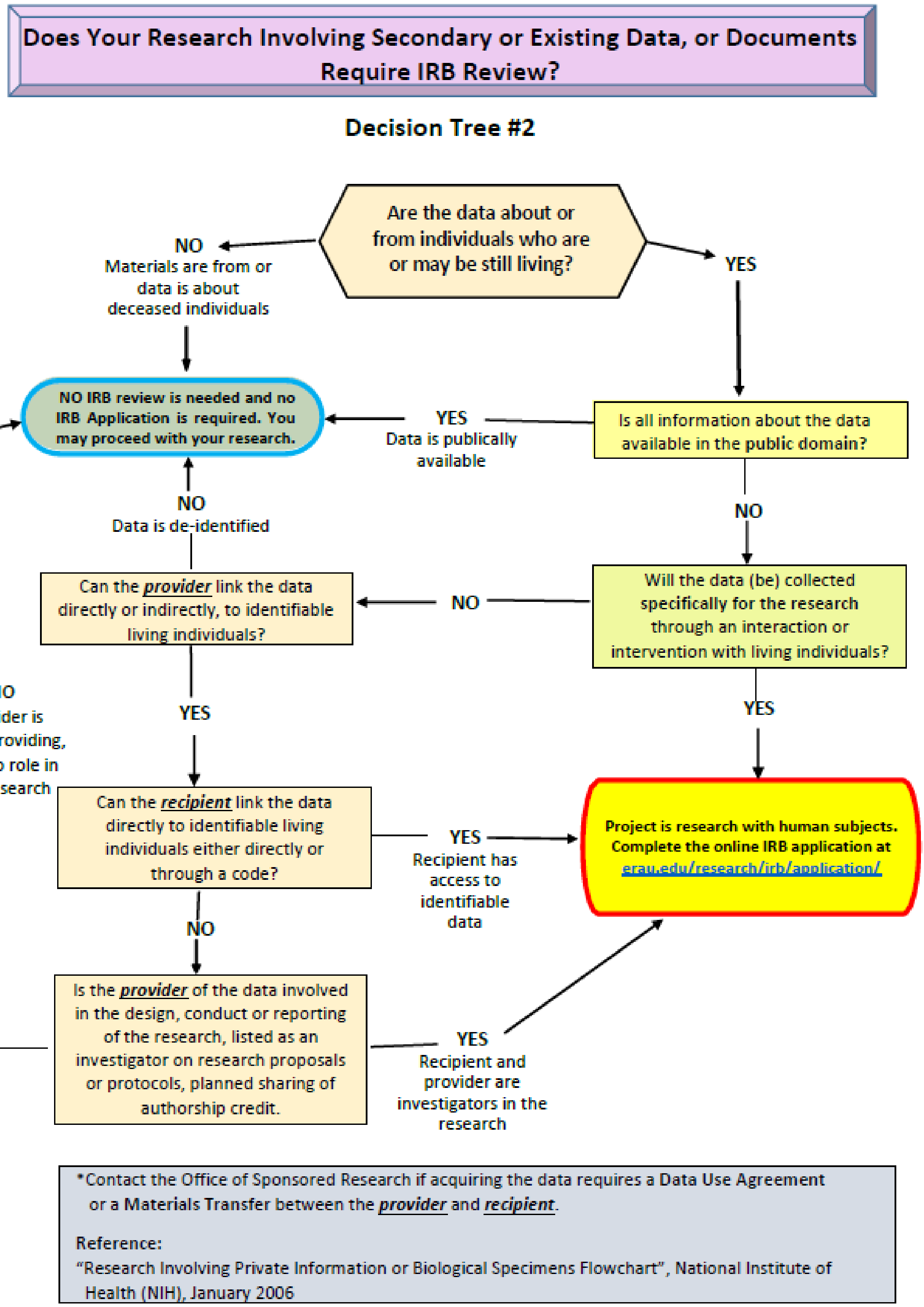


Figure A2. IRB decision tree 2. Adapted from the ERAU IRB website (https://erau.edu/-/media/files/university/research/irb-decision-tree-2020.pdf)

APPENDIX B
Pilot Study Data Collection Devices

Pilot Study Data Collection Form

Microsoft® Access™ Pilot Study Database Collection Form

ID	NTSB Report Number	NTSB Data Summary	NTSB Final Report
1	ANC91LA061	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
2	ANC91FA107	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
3	MIA00FA043	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
4	ATL01FA036	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
5	MIA08FA026	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
6	FTW03FA111	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
7	WPR12FA091	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
8	WPR15FA072	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen
9	LAX95LA001	https://app.ntsb.gov/pdfge	https://app.ntsb.gov/pdfgen

Contextual Factor 1

Accident time of day
00:00 - 00:59
01:00 - 01:59
02:00 - 02:59
03:00 - 03:59
04:00 - 04:59
05:00 - 05:59
06:00 - 06:59
07:00 - 07:59
08:00 - 08:59
09:00 - 09:59
10:00 - 10:59
11:00 - 11:59
12:00 - 12:59
13:00 - 13:59
14:00 - 14:59
15:00 - 15:59
16:00 - 16:59
17:00 - 17:59
18:00 - 18:59
19:00 - 19:59
20:00 - 20:59
21:00 - 21:59
22:00 - 22:59
23:00 - 23:59

Contextual Factor 2

Adverse weather encountered early in flight
Adverse weather encountered before mid flight point reached
Adverse weather not encountered before mid flight point reached

Contextual Factor 3

Adverse weather encountered late in flight
Adverse weather encountered after mid flight point was reached
Adverse weather not encountered after mid flight point was reached

Contextual Factor 4

Altitude
Cruising altitude 0 - 999 feet above mean sea level
Cruising altitude 1,000 - 1,999 feet above mean sea level
Cruising altitude 10,000 - 10,999 feet above mean sea level
Cruising altitude 11,000 - 11,999 feet above mean sea level
Cruising altitude 12,000 - 12,999 feet above mean sea level
Cruising altitude 13,000 - 13,999 feet above mean sea level
Cruising altitude 14,000 - 14,999 feet above mean sea level
Cruising altitude 15,000 - 15,999 feet above mean sea level
Cruising altitude 16,000 - 16,999 feet above mean sea level
Cruising altitude 17,000 - 17,999 feet above mean sea level
Cruising altitude 18,000 - 18,999 feet above mean sea level
Cruising altitude 19,000 - 19,999 feet above mean sea level
Cruising altitude 2,000 - 2,999 feet above mean sea level
Cruising altitude 20,000 - 20,999 feet above mean sea level
Cruising altitude 21,000 - 21,999 feet above mean sea level
Cruising altitude 22,000 - 22,999 feet above mean sea level
Cruising altitude 23,000 - 23,999 feet above mean sea level
Cruising altitude 24,000 - 24,999 feet above mean sea level
Cruising altitude 25,000 - 25,999 feet above mean sea level
Cruising altitude 26,000 - 26,999 feet above mean sea level
Cruising altitude 27,000 - 27,999 feet above mean sea level
Cruising altitude 28,000 - 28,999 feet above mean sea level
Cruising altitude 29,000 - 29,999 feet above mean sea level
Cruising altitude 3,000 - 3,999 feet above mean sea level
Cruising altitude 4,000 - 4,999 feet above mean sea level
Cruising altitude 5,000 - 5,999 feet above mean sea level
Cruising altitude 6,000 - 6,999 feet above mean sea level
Cruising altitude 7,000 - 7,999 feet above mean sea level
Cruising altitude 8,000 - 8,999 feet above mean sea level

Contextual Factor 5

Cues signaling problem not clear due gradually deteriorating Wx
Cues signaling problem not clear due gradually deteriorating Wx

Contextual Factor 6

Time/distance flown into IMC before accident occurred
less than or equal to half the time and distance required to reach the destination before the accident occurred
greater than half the time and distance required to reach the destination before the accident occurred

Contextual Factor 7

Amount of time/distance flown into IMC before diverting
flight time and distance in IMC were less than or equal to half the time and distance required to reach the destination before diverting
flight time and distance in IMC were greater than half the time and distance required to reach the destination before diverting

Contextual Factor 8

Attentional tunneling
The pilot was fixated on synthetic vision displays (attentional tunneling) and missed vital outside weather cues

Contextual Factor 9

Ceiling and visibility determination
The pilot overestimated ceiling and/or visibility weather conditions

Contextual Factor 10

Circular decision-making
The pilot exhibited circular decision-making

Contextual Factor 11

Cognitive Anchoring
The pilot exhibited cognitive anchoring

Contextual Factor 12

Communication with air traffic control
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident

Contextual Factor 13

Consequences not anticipated
The pilot was under stress and did not anticipate the consequences of flying in IMC

Contextual Factor 14

Crash distance from departure
The aircraft crash site was closer to the departure location than the planned destination

Contextual Factor 15

Crash distance from planned destination
The aircraft crash site was closer to the planned destination than the departure location

Contextual Factor 16

Currency policy violation
The pilot was in violation of the FAA flight time currency policy

Contextual Factor 17

Decision to continue VFR-into-IMC to the planned destination
The pilot decided to continue VFR-into-IMC to the planned destination

Contextual Factor 18

Decision to divert from VFR-into-IMC to an alternate destination
The pilot decided to divert from VFR-into-IMC to an alternate destination

Contextual Factor 19

Delay in obtaining the current weather conditions
The pilot delayed obtaining the current weather conditions

Contextual Factor 20

Descent below weather minimums
The pilot descended below weather minimums

Contextual Factor 21

Filing of a flight plan
The pilot submitted a flight plan to flight service

Contextual Factor 22

Flight into known icing conditions
The pilot flew into known icing conditions

Contextual Factor 23

Flight plan policy violation
The pilot was in violation of organizational flight plan policy

Contextual Factor 24

Goal conflicts
The pilot took a safety risk to fly in IMC conditions to planned destination

Contextual Factor 25

Height of crash site
The height of the crash site was 0 - 999 feet above mean sea level
The height of the crash site was 1,000 - 1,999 feet above mean sea level
The height of the crash site was 2,000 - 2,999 feet above mean sea level
The height of the crash site was 3,000 - 3,999 feet above mean sea level
The height of the crash site was 4,000 - 4,999 feet above mean sea level
The height of the crash site was 5,000 - 5,999 feet above mean sea level
The height of the crash site was 6,000 - 6,999 feet above mean sea level
The height of the crash site was 7,000 - 7,999 feet above mean sea level
The height of the crash site was 8,000 - 8,999 feet above mean sea level
The height of the crash site was 9,000 - 9,999 feet above mean sea level
The height of the crash site was 10,000 - 10,999 feet above mean sea level
The height of the crash site was 11,000 - 11,999 feet above mean sea level
The height of the crash site was 12,000 - 12,999 feet above mean sea level
The height of the crash site was 13,000 - 13,999 feet above mean sea level
The height of the crash site was 14,000 - 14,999 feet above mean sea level
The height of the crash site was 15,000 - 15,999 feet above mean sea level
The height of the crash site was 16,000 - 16,999 feet above mean sea level
The height of the crash site was 17,000 - 17,999 feet above mean sea level
The height of the crash site was 18,000 - 18,999 feet above mean sea level
The height of the crash site was 19,000 - 19,999 feet above mean sea level
The height of the crash site was 20,000 - 20,999 feet above mean sea level
The height of the crash site was 21,000 - 21,999 feet above mean sea level
The height of the crash site was 22,000 - 22,999 feet above mean sea level
The height of the crash site was 23,000 - 23,999 feet above mean sea level
The height of the crash site was 24,000 - 24,999 feet above mean sea level
The height of the crash site was 25,000 - 25,999 feet above mean sea level
The height of the crash site was 26,000 - 26,999 feet above mean sea level
The height of the crash site was 27,000 - 27,999 feet above mean sea level
The height of the crash site was 28,000 - 28,999 feet above mean sea level

Contextual Factor 26

IFR flight without clearance or ratings
The pilot was in violation of conducting an IFR flight without proper clearance or ratings

Contextual Factor 27

Linear decision- making
The pilot exhibited linear decision-making

Contextual Factor 28

Medical status policy violation

The pilot was in violation of FAA medical status policy

Contextual Factor 29

Number of passengers on board

The pilot had passengers on board the aircraft at the time of the crash

Contextual Factor 30

Obtaining an on-line preflight weather briefing

The pilot obtained an on-line preflight weather briefing

Contextual Factor 31

Organization

The pilot experienced an organizational conflict between productivity and safety

Contextual Factor 32

Permission-seeking behaviors

The pilot exhibited permission-seeking behaviors

Contextual Factor 33

Pilot-briefer communication

The pilot was in communication with a briefer

Contextual Factor 34

Plan Continuation Error (PCE)

The pilot exhibited Plan Continuation Error (PCE) behavior

Contextual Factor 35

Ratings policy violation

The pilot was in violation of FAA ratings policy

Contextual Factor 36

Receipt of weather briefing

The pilot received a weather briefing

Contextual Factor 37

Scud running

The pilot was conducting scud running flight operations at the time of the accident

Contextual Factor 38

Self-reported weather cues

The pilot was able to recognize self-reported weather cues

Contextual Factor 39

Situation Assessment
The pilot misdiagnosed the changes in or severity of the weather

Contextual Factor 40

Social
The pilot exhibited social pressure influences on decision making

Contextual Factor 41

Source of weather information
The pilot selected a good source of weather information
The pilot selected a bad source of weather information

Contextual Factor 42

Terrain
airport property
canyon
desert
field
forest
glacier
ground
high
hill
lake
low
marsh
mountain
oasis
ocean
residential
rising
river
swamp
tundra
water

Contextual Factor 43

Underestimating risk
The pilot underestimated the level of risk associated with cues that should have signaled a change in course of action

Contextual Factor 44

Unrecoverable low altitude

The pilot decided to fly VFR at low altitudes below the clouds where a recovery was not possible resulting in a collision with the terrain

Contextual Factor 45

Use of in-cockpit weather information

The pilot decided to obtain and use weather information through an installed cockpit weather system

Contextual Factor 46

Use of portable weather applications

The pilot decided to use weather information obtained through portable weather smart phone applications

Rater's Opinion of how contextual factors were manifest

How were contextual factors manifested given the pilot actions?

Figure B1. Microsoft® Access™ Pilot Study Data Collection Form.

APPENDIX C
Main Study Data Collection Devices

Main Study Data Collection Form

ID	NTSB Report Number	NTSB Final Report
1	ANC12FA009	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20111130X92124&AKey=1&RType=HTML&IType=FA
2	ANC12FA066	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20120706X65939&AKey=1&RType=HTML&IType=FA
3	ATL07FA038	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070215X00196&AKey=1&RType=HTML&IType=FA
4	ATL03FA062	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030324X00372&AKey=1&RType=HTML&IType=FA
5	ATL07FA081	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070503X00507&AKey=1&RType=HTML&IType=FA
6	ATL91FA043	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X16260&AKey=1&RType=HTML&IType=FA
7	ATL92FA008	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X18232&AKey=1&RType=HTML&IType=FA
8	ATL92FA090	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X14367&AKey=1&RType=HTML&IType=FA
9	ATL92GA121	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X14765&AKey=1&RType=HTML&IType=GA
10	ATL99FA019	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X11359&AKey=1&RType=HTML&IType=FA
11	CEN09FA195	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20090309X20142&AKey=1&RType=HTML&IType=FA
12	CEN11FA240	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20110322X03800&AKey=1&RType=HTML&IType=FA
13	CEN14FA051	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20131112X30325&AKey=1&RType=HTML&IType=FA
14	CHI02FA193	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20020723X01184&AKey=1&RType=HTML&IType=FA
15	CHI03FA151	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030610X00829&AKey=1&RType=HTML&IType=FA
16	CHI04FA284	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041007X01595&AKey=1&RType=HTML&IType=FA
17	CHI92FA266	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X15642&AKey=1&RType=HTML&IType=FA
18	CHI93FA137	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X12082&AKey=1&RType=HTML&IType=FA
19	CHI96FA094	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X05225&AKey=1&RType=HTML&IType=FA
20	DEN05FA011	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041015X01641&AKey=1&RType=HTML&IType=FA
21	ERA09FA311	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20090601X31419&AKey=1&RType=HTML&IType=FA
22	ERA09FA537	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20090926X65328&AKey=1&RType=HTML&IType=FA
23	ERA10FA062	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20091114X32349&AKey=1&RType=HTML&IType=FA
24	ERA10MA188	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20100325X93604&AKey=1&RType=HTML&IType=MA

Microsoft® Access™ Main Study Database Collection Form (page 1 of 4)

ID	NTSB Report Number	NTSB Final Report
25	ERA12FA012	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20111006X03238&AKey=1&RType=HTML&IType=FA
26	ERA14FA377	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20140809X04729&AKey=1&RType=HTML&IType=FA
27	FTW03FA048	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20021202X05541&AKey=1&RType=HTML&IType=FA
28	FTW01FA171	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010801X01573&AKey=1&RType=HTML&IType=FA
29	FTW94FA036	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X13729&AKey=1&RType=HTML&IType=FA
30	FTW94FA165	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X01272&AKey=1&RType=HTML&IType=FA
31	FTW95FA402	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X04483&AKey=1&RType=HTML&IType=FA
32	FTW96FA368	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X06713&AKey=1&RType=HTML&IType=FA
33	FTW98FA121	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X09537&AKey=1&RType=HTML&IType=FA
34	IAD00LA021	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20498&AKey=1&RType=HTML&IType=LA
35	LAX00FA017	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X19975&AKey=1&RType=HTML&IType=FA
36	LAX00FA099	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20504&AKey=1&RType=HTML&IType=FA
37	LAX00FA354	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X22001&AKey=1&RType=HTML&IType=FA
38	LAX01FA023	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X22183&AKey=1&RType=HTML&IType=FA
39	LAX02FA019	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20011113X02226&AKey=1&RType=HTML&IType=FA
40	LAX03FA025	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20021122X05506&AKey=1&RType=HTML&IType=FA
41	LAX03FA282	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030904X01456&AKey=1&RType=HTML&IType=FA
42	LAX04FA061	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20031212X02024&AKey=1&RType=HTML&IType=FA
43	LAX04FA076	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040108X00032&AKey=1&RType=HTML&IType=FA
44	LAX04FA081	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040106X00022&AKey=1&RType=HTML&IType=FA
45	LAX04FA096	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040122X00094&AKey=1&RType=HTML&IType=FA
46	LAX04FA113	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040213X00192&AKey=1&RType=HTML&IType=FA
47	LAX04FA139	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040308X00291&AKey=1&RType=HTML&IType=FA
48	LAX05FA023	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041103X01749&AKey=1&RType=HTML&IType=FA

Microsoft® Access™ Main Study Database Collection Form (page 2 of 4)

ID	NTSB Report Number	NTSB Final Report
49	LAX05FA167	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20050610X00749&AKey=1&RType=HTML&IType=FA
50	LAX05FA184	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20050601X00700&AKey=1&RType=HTML&IType=FA
51	LAX05FA255	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20050806X01177&AKey=1&RType=HTML&IType=FA
52	LAX05LA014	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041103X01750&AKey=1&RType=HTML&IType=LA
53	LAX06FA148	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20060508X00526&AKey=1&RType=HTML&IType=FA
54	LAX07FA056	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20061220X01815&AKey=1&RType=HTML&IType=FA
55	LAX92LA105	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X14019&AKey=1&RType=HTML&IType=LA
56	LAX93FA045	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X15892&AKey=1&RType=HTML&IType=FA
57	LAX93FA246	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X12637&AKey=1&RType=HTML&IType=FA
58	LAX93LA244	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X12645&AKey=1&RType=HTML&IType=LA
59	LAX94FA271	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X01765&AKey=1&RType=HTML&IType=FA
60	LAX95LA060	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X02754&AKey=1&RType=HTML&IType=LA
61	LAX97FA334	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X08414&AKey=1&RType=HTML&IType=FA
62	LAX98FA199	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X10339&AKey=1&RType=HTML&IType=FA
63	LAX99FA020	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X11281&AKey=1&RType=HTML&IType=FA
64	MIA00FA029	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20135&AKey=1&RType=HTML&IType=FA
65	MIA03FA071	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030306X00294&AKey=1&RType=HTML&IType=FA
66	MIA05FA028	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041119X01845&AKey=1&RType=HTML&IType=FA
67	MIA99FA027	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X11471&AKey=1&RType=HTML&IType=FA
68	MIA91FA107	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X16650&AKey=1&RType=HTML&IType=FA
69	MIA95FA145	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X03765&AKey=1&RType=HTML&IType=FA
70	NYC01FA215	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010830X01829&AKey=1&RType=HTML&IType=FA
71	NYC01LA132	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010613X01175&AKey=1&RType=HTML&IType=LA
72	NYC04FA092	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040329X00383&AKey=1&RType=HTML&IType=FA

Microsoft® Access™ Main Study Database Collection Form (page 3 of 4)

ID	NTSB Report Number	NTSB Final Report
73	NYC07FA173	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070806X01113&AKey=1&RType=HTML&IType=FA
74	NYC08LA310	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20080922X01511&AKey=1&RType=HTML&IType=LA
75	NYC93FA012	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X15925&AKey=1&RType=HTML&IType=FA
76	NYC97FA004	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X06956&AKey=1&RType=HTML&IType=FA
77	SEA04FA154	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040810X01190&AKey=1&RType=HTML&IType=FA
78	SEA07LA040	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070115X00051&AKey=1&RType=HTML&IType=LA
79	SEA95FA209	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X04588&AKey=1&RType=HTML&IType=FA
80	SEA96FA021	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X04920&AKey=1&RType=HTML&IType=FA
81	WPR10FA142	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20100220X04837&AKey=1&RType=HTML&IType=FA
82	WPR11FA147	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20110227X34342&AKey=1&RType=HTML&IType=FA
83	WPR11FA241	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20110531X35220&AKey=1&RType=HTML&IType=FA
84	WPR12FA031	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20111109X93553&AKey=1&RType=HTML&IType=FA
85	WPR14FA172	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20140426X23435&AKey=1&RType=HTML&IType=FA

Microsoft® Access™ Main Study Database Collection Form (page 4 of 4)

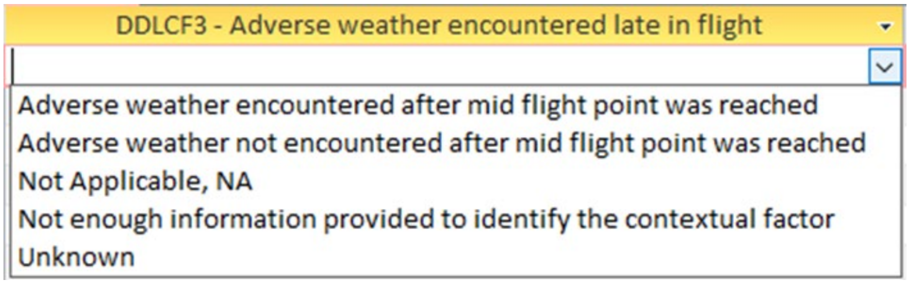
Contextual Factor 1

Accident time of day
00:00 - 00:59
01:00 - 01:59
02:00 - 02:59
03:00 - 03:59
04:00 - 04:59
05:00 - 05:59
06:00 - 06:59
07:00 - 07:59
08:00 - 08:59
09:00 - 09:59
10:00 - 10:59
11:00 - 11:59
12:00 - 12:59
13:00 - 13:59
14:00 - 14:59
15:00 - 15:59
16:00 - 16:59
17:00 - 17:59
18:00 - 18:59
19:00 - 19:59
20:00 - 20:59
21:00 - 21:59
22:00 - 22:59
23:00 - 23:59
Not enough information provided to identify the contextual factor
Unknown
Not Applicable, NA

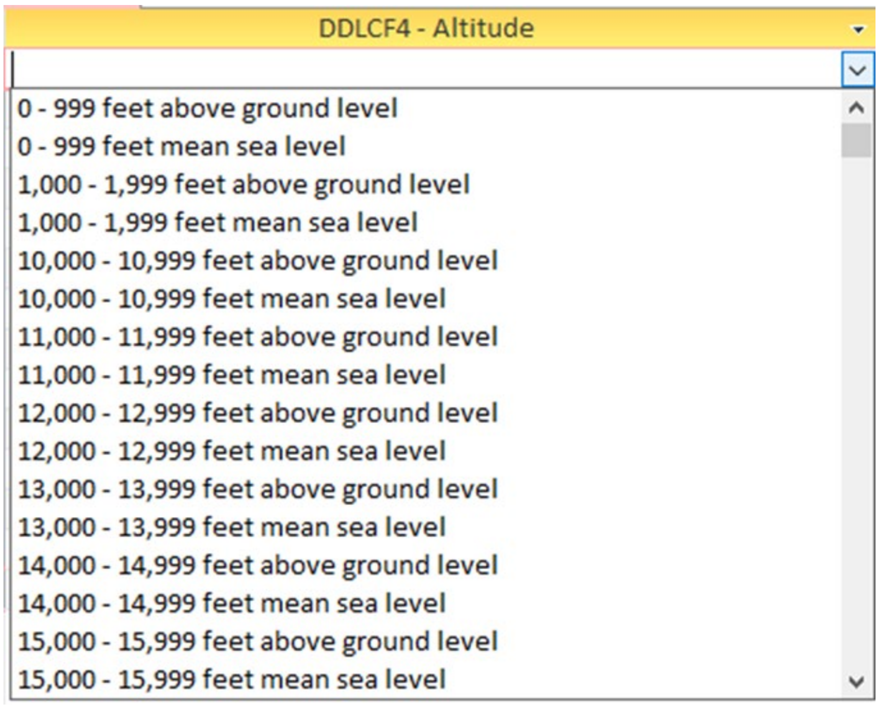
Contextual Factor 2

DDLCF2 - Adverse weather encountered early in flight
Adverse weather encountered before mid flight point reached
Adverse weather not encountered before mid flight point reached
Not Applicable, NA
Not enough information provided to identify the contextual factor
Unknown

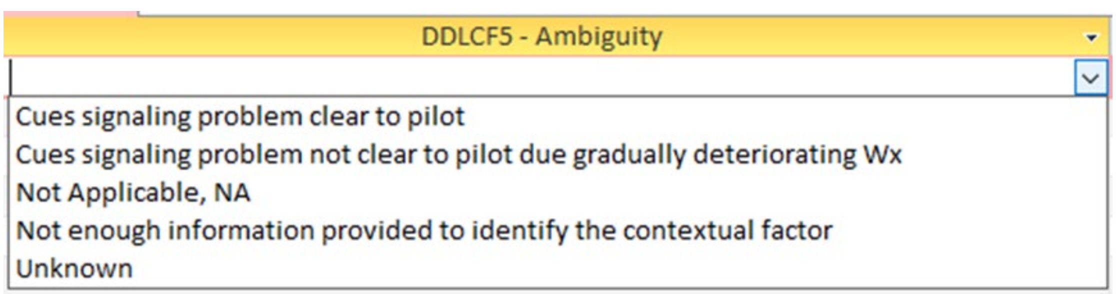
Contextual Factor 3



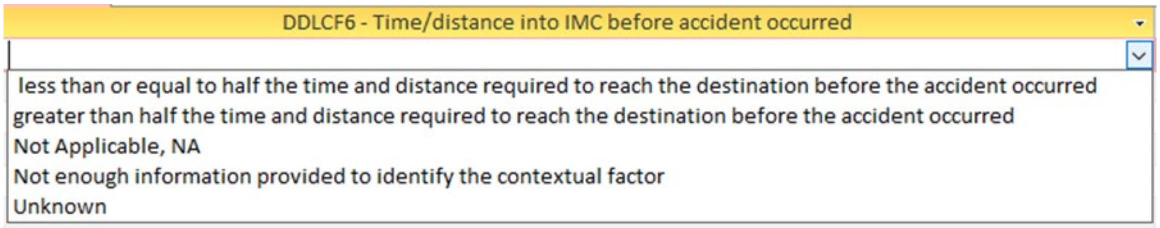
Contextual Factor 4



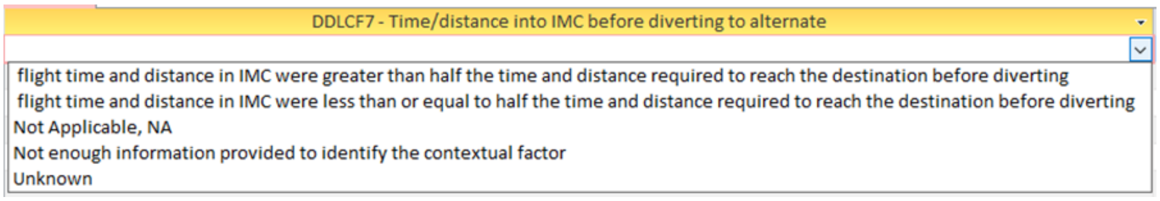
Contextual Factor 5



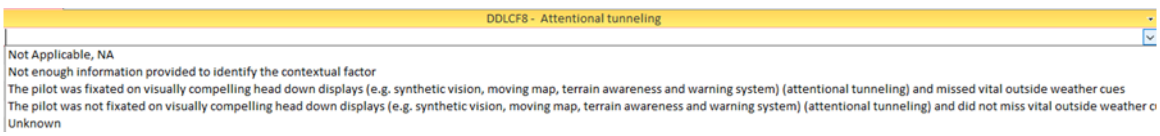
Contextual Factor 6



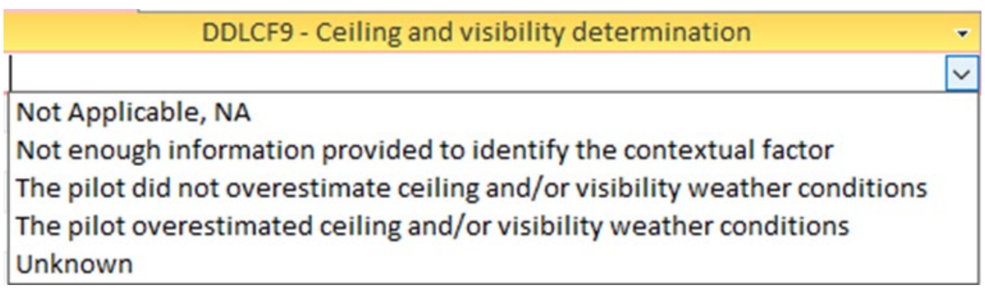
Contextual Factor 7



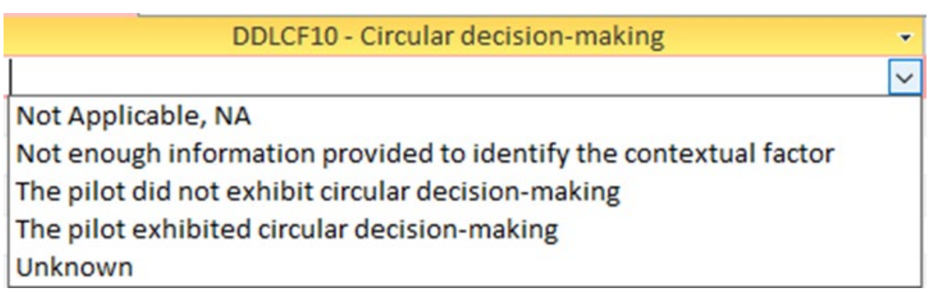
Contextual Factor 8



Contextual Factor 9



Contextual Factor 10



Contextual Factor 11

DDLCF11 - Cognitive Anchoring

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not exhibit cognitive anchoring
The pilot exhibited cognitive anchoring
Unknown

Contextual Factor 12

DDLCF12 - Communication with air traffic control

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not communicate with air traffic control at the time of the VFR-into-IMC accident
The pilot was communicating with air traffic control at the time of the VFR-into-IMC accident
Unknown

Contextual Factor 13

DDLCF13 - Consequences not anticipated

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was not under stress and did anticipate the consequences of flying in IMC
The pilot was under stress and did not anticipate the consequences of flying in IMC
Unknown

Contextual Factor 14

DDLCF14 - Crash distance from departure

Not enough information provided to identify the contextual factor
The aircraft crash site was closer to the departure location than the planned destination
The aircraft crash site was not closer to the departure location than the planned destination
Unknown

Contextual Factor 15

DDLCF15 - Crash distance from planned destination

Not enough information provided to identify the contextual factor
The aircraft crash site was closer to the planned destination than the departure location
The aircraft crash site was not closer to the planned destination than the departure location
Unknown

Contextual Factor 16

DDLCF16 - Currency policy violation

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was in violation of the FAA flight time currency policy
The pilot was not in violation of the FAA flight time currency policy
Unknown

Contextual Factor 17

DDLCF17 - Decision to continue into IMC to planned destination

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot decided not to continue VFR-into-IMC to the planned destination
The pilot decided to continue VFR-into-IMC to the planned destination
Unknown

Contextual Factor 18

DDLCF18 - Decision to divert from IMC to alternate destination

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot decided not to divert from VFR-into-IMC to an alternate destination
The pilot decided to divert from VFR-into-IMC to an alternate destination
Unknown

Contextual Factor 19

DDLCF19 - Delay in obtaining the current weather conditions

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot delayed obtaining the current weather conditions
The pilot did not delay obtaining the current weather conditions
Unknown

Contextual Factor 20

DDLCF20 - Descent below weather minimums

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot descended below weather minimums
The pilot did not descend below weather minimums
Unknown

Contextual Factor 21

DDLCF21 - Filing of a flight plan

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not submit a flight plan to flight service
The pilot submitted a flight plan to flight service
Unknown

Contextual Factor 22

DDLCF22 - Flight into known icing conditions

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not fly into known icing conditions
The pilot flew into known icing conditions
Unknown

Contextual Factor 23

DDLCF23 - Flight plan policy violation

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was in violation of organizational flight plan policy - not filing IFR when required
The pilot was not in violation of organizational flight plan policy - filing IFR when required
Unknown

Contextual Factor 24

DDLCF24 - Goal conflicts

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not take a safety risk to fly in IMC conditions to planned destination
The pilot took a safety risk to fly in IMC conditions to planned destination
Unknown

Contextual Factor 25

DDLCF25 - Height of crash site

0 - 999 feet mean sea level
1,000 - 1,999 feet mean sea level
10,000 - 10,999 feet mean sea level
11,000 - 11,999 feet mean sea level
12,000 - 12,999 feet mean sea level
13,000 - 13,999 feet mean sea level
14,000 - 14,999 feet mean sea level
15,000 - 15,999 feet mean sea level
16,000 - 16,999 feet mean sea level
17,000 - 17,999 feet mean sea level
18,000 - 18,999 feet mean sea level
19,000 - 19,999 feet mean sea level
2,000 - 2,999 feet mean sea level
20,000 - 20,999 feet mean sea level
21,000 - 21,999 feet mean sea level
22,000 - 22,999 feet mean sea level

Contextual Factor 26

DDLCF26 - IFR flight without clearance or ratings

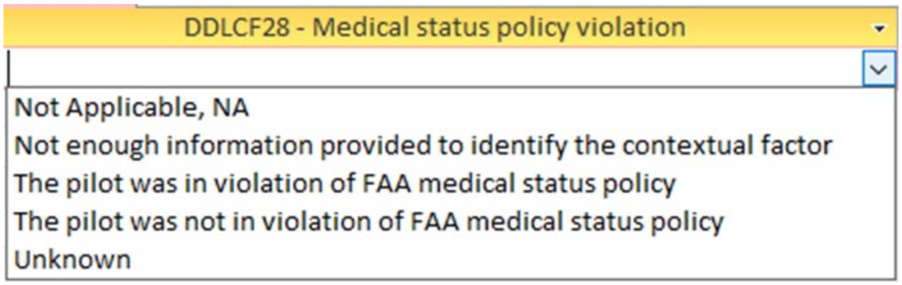
Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was in violation of conducting an IFR flight without proper clearance or ratings
The pilot was not in violation of conducting an IFR flight without proper clearance or ratings
Unknown

Contextual Factor 27

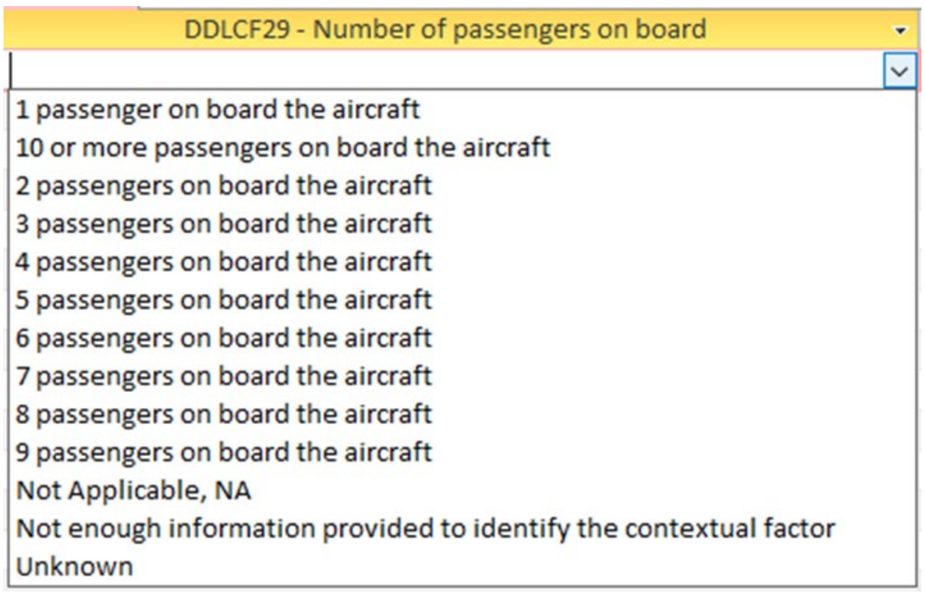
DDLCF27 - Linear decision- making

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not exhibit linear decision-making
The pilot exhibited linear decision-making
Unknown

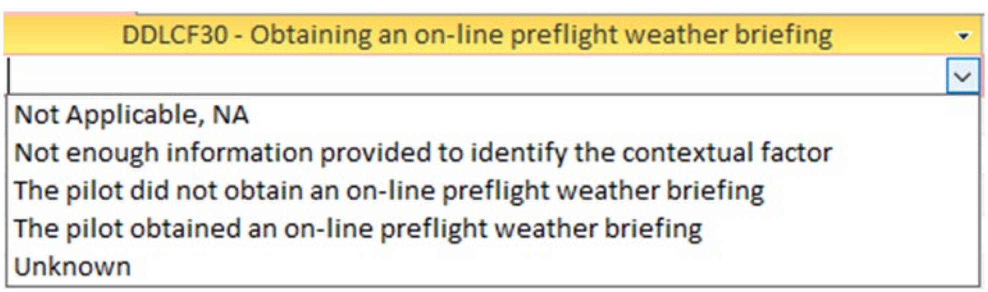
Contextual Factor 28



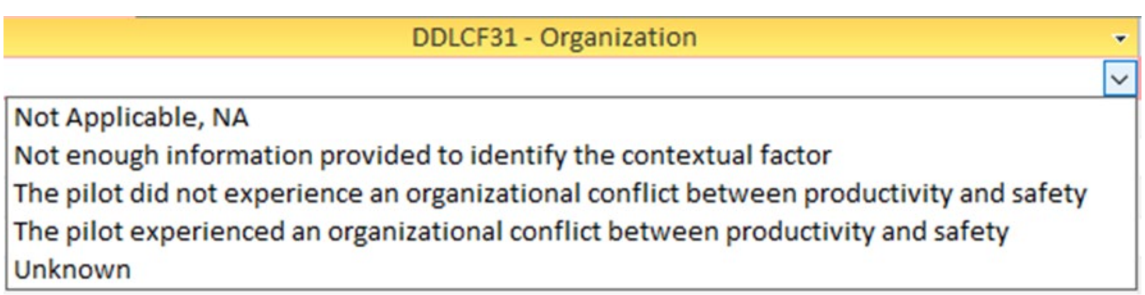
Contextual Factor 29



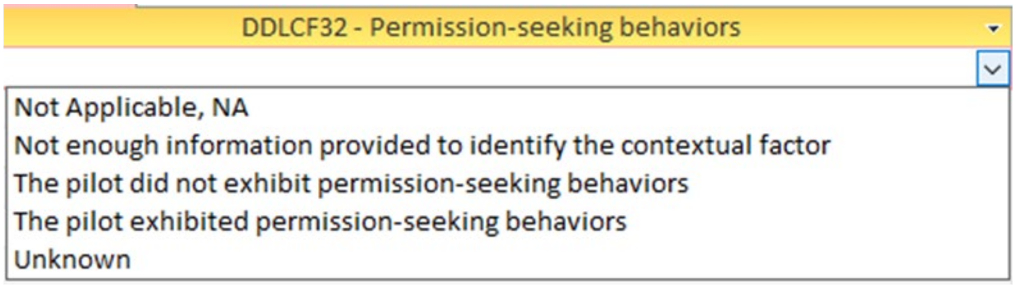
Contextual Factor 30



Contextual Factor 31

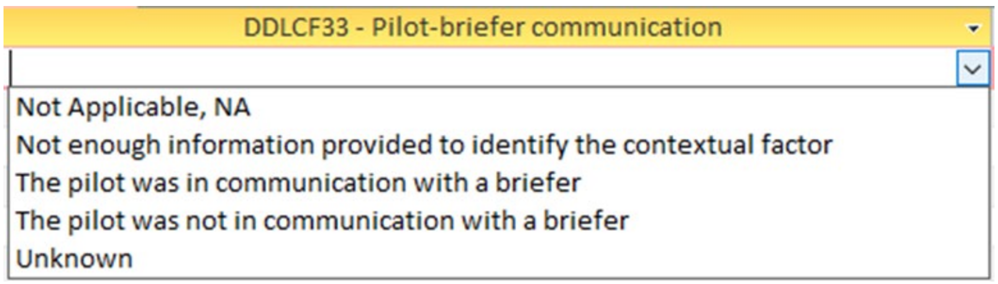


Contextual Factor 32


DDLCF32 - Permission-seeking behaviors

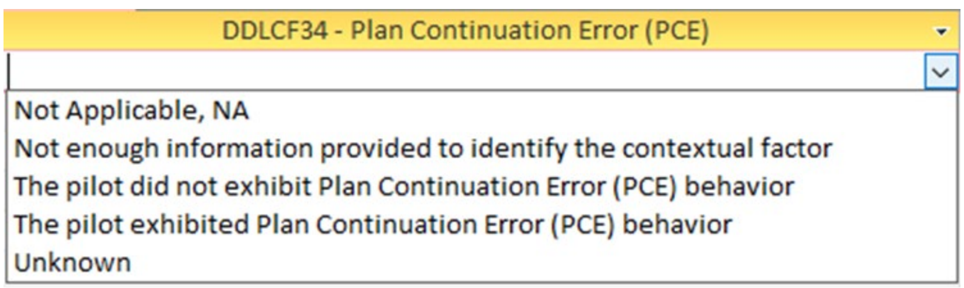
Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not exhibit permission-seeking behaviors
The pilot exhibited permission-seeking behaviors
Unknown

Contextual Factor 33


DDLCF33 - Pilot-briefer communication

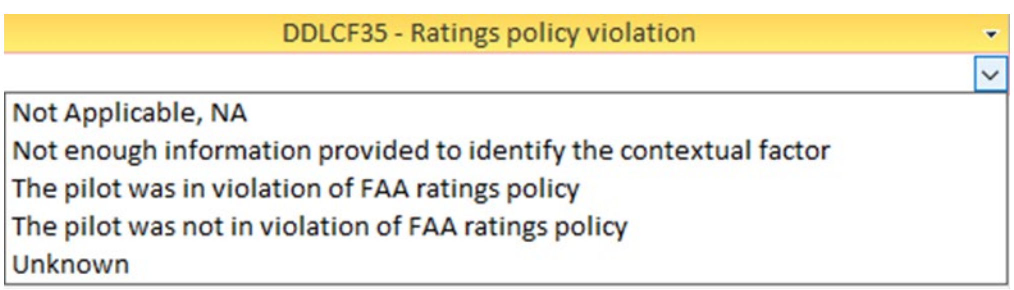
Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was in communication with a briefer
The pilot was not in communication with a briefer
Unknown

Contextual Factor 34


DDLCF34 - Plan Continuation Error (PCE)

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not exhibit Plan Continuation Error (PCE) behavior
The pilot exhibited Plan Continuation Error (PCE) behavior
Unknown

Contextual Factor 35


DDLCF35 - Ratings policy violation

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was in violation of FAA ratings policy
The pilot was not in violation of FAA ratings policy
Unknown

Contextual Factor 36

DDLCF36 - Receipt of weather briefing

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not receive a weather briefing
The pilot received a weather briefing
Unknown

Contextual Factor 37

DDLCF37 - Scud running

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was conducting scud running flight operations at the time of the accident
The pilot was not conducting scud running flight operations at the time of the accident
Unknown

Contextual Factor 38

DDLCF38 - Self-reported weather cues

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot was able to recognize self-reported weather cues
The pilot was not able to recognize self-reported weather cues
Unknown

Contextual Factor 39

DDLCF39 - Situation Assessment

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not misdiagnose the changes in or severity of the weather
The pilot misdiagnosed the changes in or severity of the weather
Unknown

Contextual Factor 40

DDLCF40 - Social

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not exhibit social pressure influences on decision making
The pilot exhibited social pressure influences on decision making
Unknown

Contextual Factor 41

DDLCF41 - Source of weather information
Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot selected a bad source of weather information
The pilot selected a good source of weather information
Unknown

Contextual Factor 42

Terrain
airport property
canyon
desert
field
forest
glacier
ground
high
hill
lake
low
marsh
mountain
Not Applicable, NA
Not enough information provided to identify the contextual factor
oasis
ocean
residential
rising
river
swamp
tundra
Unknown
water

Contextual Factor 43

DDLCF43 - Underestimating risk
Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot did not underestimate the level of risk associated with cues that should have signaled a change in course of action
The pilot underestimated the level of risk associated with cues that should have signaled a change in course of action
Unknown

Contextual Factor 44

DDLCF44 - Unrecoverable low altitude

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot decided to fly VFR at low altitudes below the clouds where a recovery was not possible resulting in a collision with the terrain
The pilot did not decide to fly VFR at low altitudes below the clouds where a recovery was not possible resulting in a collision with the terrain
Unknown

Contextual Factor 45

DDLCF45 - Use of in-cockpit weather information

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot decided to obtain and use weather information through use of in-cockpit installed weather equipment information
The pilot did not decide to obtain and use weather information through use of in-cockpit installed weather equipment information
Unknown

Contextual Factor 46

DDLCF46 - Use of portable weather applications

Not Applicable, NA
Not enough information provided to identify the contextual factor
The pilot decided to use weather information obtained through portable weather smart phone applications
The pilot did not decide to use weather information obtained through portable weather smart phone applications
Unknown

Rater's Opinion of how contextual factors were manifest

In your opinion how were the contextual factors manifested?

Figure C1. Main Study Data Collection Form.

APPENDIX D
Tables

Table D1

Forty-six Contextual Factor Sources

Contextual Factor Name	Description	Source
1. Accident time of day	The time of day when the accident occurred	Ison, 2014a; Ison, 2014b
2. Adverse weather encountered early in flight	The VFR-into-IMC weather was encountered by the pilot early in the flight path headed toward the planned destination	Wiegmann, & Goh, 2000; Wiegmann, Goh, and O'Hare, 2002
3. Adverse weather encountered late in flight	The VFR-into-IMC weather was encountered by the pilot late in the flight path headed toward the planned destination	Wiegmann, & Goh, 2000; Wiegmann, Goh, and O'Hare, 2002
4. Altitude	The cruising altitude of the aircraft above sea level	O'Hare & Owen, 2002
5. Ambiguity	"Cues that signal a problem are not always clear-cut. Conditions can deteriorate gradually, and the decision maker's situation	Martin, Davison, & Orasanu, 1998, p. 6

	assessment may not keep pace”	
6. Amount of time/distance GA pilot flew into IMC weather before the accident occurred	The flight time and distance the pilot flew from VFR-into-IMC before an accident occurred	Saxton, 2008
7. Amount of time/distance the GA pilot flew into the IMC weather before diverting	The flight time and distance the pilot flew from VFR-into-IMC before making the decision to divert to an alternate landing location	Wiegmann, Goh, & O'Hare, 2002
8. Attentional tunneling	“A concern with synthetic vision displays is the 3D immersed perspective of such displays can cause pilots to look extensively at the display at the expense of time spent sampling the outside world …. This attentional tunneling can have significant detrimental effects on pilots’ situation awareness, possibly causing them to miss vital weather cues only visible in the outside world”	Johnson, Wiegmann, & Wickens, 2006, p. 30; Wickens, 2005

9. Ceiling and visibility determination	"…. pilots allowed their estimates of ceiling and visibility to influence each other. That is, pilots tended to judge a ceiling to be higher than it actually was when it was paired with a high visibility. This interaction may play a significant role in pilots' decisions to continue into IMC …. Pilots generally overestimated weather conditions"	Coyne, Baldwin, & Latrorella, 2005, p. 153; Coyne, Baldwin & Latrorella, 2008, p. 1; FAA, 2016; McCoy & Mickunas, 2000
10. Circular decision-making	The circular decision- making process is part of aeronautical decision-making and includes identifying hazards, assessing risks, analyzing controls, making control decisions, using controls, and monitoring results. If changes are needed, hazards are repeatedly assessed as needed in a circular decision-making process	Bell & Mauro, 2000; FAA, 2018c, p. 2-4

11. Cognitive Anchoring	"…. how pilots assess the situation and utilize information obtained before making a decision can influence their decisions …. Any information the pilot gains prior to making a decision may bias his or her decision in favor of that information…. which has an effect on a person's ability to make decisions under uncertainty"	Madhavan & Wiegmann, 2005, pp. 44-45; Saxton, 2008, p. iii
12.Communication with air traffic control	"Pilots who were communicating with ATC at the time of the crash were less likely to be involved in a VFR-into-IMC accident …. seems to make sense as ATC could potentially assist the pilot get to VFR weather or away from hazardous terrain. Contrarily, non-VFR-into-IMC accidents are more likely to be in communication with ATC"	Ison, 2014a, p. 20

13. Consequences not anticipated	"If pilots are under stress, they may not do the required evaluations. Stress limits the decision maker's ability to project the situation into the future and mentally simulate the consequences of a course of action"	Martin, Davison, & Orasanu, 1998, p. 8; Orasanu, & Martin, 1998; Orasanu, Martin, & Davison, 1998; Orasanu, Martin, & Davison, 2001
14. Crash distance from departure	The aircraft crash site distance from the departure location	O'Hare & Owen, 2002
15. Crash distance from planned destination	The aircraft crash site distance from the destination location	O'Hare & Owen, 2002
16. Currency policy violation	"…. without flight time currency policy violations for flights from VFR to IMC. There were two categorical areas where violations manifested in this area. Both requirements are located in FAR 61.57 and pertained to the 90-day window for recent flight currency and IFR flight currency requirement to act	Jackman, 2014, pp. 78-79

	as pilot-in-command"	
17. Decision to continue VFR-into-IMC to the planned destination	The selection of the planned destination location by the pilot based on the pilot's perception of the location and severity of IMC weather along the flight path. The pilot in-flight decision to continue into IMC to the planned destination	Beringer & Ball, 2004; Wiegmann, Goh, & O'Hare, 2002
18. Decision to divert from VFR-into-IMC to an alternate destination	The selection of an alternate location by the pilot based on the pilot's perception of the location and severity of IMC weather along the flight path	Wiegmann, Goh, & O'Hare, 2002
19. Delay in obtaining the current weather conditions	"[Next-Generation Radar] NEXRAD data received in the cockpit are always time-delayed from the actual observation at least 6 to 7 minutes following the actual radar scan. This means that an image on a cockpit display may be as old as	Beringer & Ball, 2004, p. 1

	12 to 14 minutes before it is updated. This fact gives rise to the legitimate concern that pilots might be trying to make tactical decisions based upon "old" data. There is also the question of how much degradation is acceptable in the resolution of the data before pilots no longer feel that the displayed image is representative of the weather phenomena that they may be able to view directly through the windscreen	
20. Descent below weather minimums	The pilot intentional or unintentional descending flight below FAA-established ceiling and visibility weather minimums established for VFR/VMC pilots	McCoy & Mickunas, 2000, pp. 1-26
21. Filing of a flight plan	The pilot submission of a hardcopy or online	FAA, 2018d; Ison, 2014a; Ison, 2014b

	flight plan form to flight service	
22. Flight into known icing conditions	The pilot either intentional or unintentional flight into known icing conditions	McCoy & Mickunas, 2000
23. Flight plan policy violation	"…. general aviation flights from visual flight rules to instrument meteorological conditions for pilot flight plan policy violations"	Jackman, 2014, p. 63
24. Goal conflicts	"Pilots may be willing to take a risk with safety (a possible loss) to arrive on time (a sure benefit)"	Martin, Davison, & Orasanu, 1998; Orasanu, & Martin, 1998, p. 103; Orasanu, Martin, & Davison, 1998; Orasanu, Martin, & Davison, 2001
25. Height of crash site	Height above mean sea level of the crash site	O'Hare & Owen, 2002
26. IFR flight without clearance or ratings	The pilot decision to conduct a flight into instrument meteorological conditions without proper clearance, experience, and instrument rating	Jackman, 2014, pp. 14, 42, 131; McCoy & Mickunas, 2000
27. Linear decision-making	A thought process using a sequence of steps where a response to a step must be produced	Bell & Mauro, 2000

	before another step is taken	
28. Medical status policy violation	"The pilot violation of medical status policy by acting as PIC of a flight without the FAA required medical certificate (first class, second class, third class, student, sport pilot, expired, revoked, or no medical)"	Jackman, 2014, p. 123
29. Number of passengers on board	The number of passengers onboard the GA PIC flight	Martin, Davison, & Orasanu, 1998; Orasanu, & Martin, 1998; Orasanu, Martin, & Davison, 1998; Orasanu, Martin, & Davison, 2001
30. Obtaining an on-line preflight weather briefing	"…. proficiency using [on-line preflight weather briefing] to find desired kinds of information"	Knecht, Ball, & Lenz, 2010, p. 9
31. Organization	"An organization's emphasis on productivity may unwittingly set up goal conflicts with safety"	Martin, Davison, & Orasanu, 1998, p. 7; Orasanu, & Martin, 1998; Orasanu, Martin, & Davison, 1998; Orasanu, Martin, & Davison, 2001
32. Permission-seeking behaviors	The pilot seeking approval for a	McCoy & Mickunas, 2000

	desired action before deciding	
33. Pilot-briefer communication	"Pilots call flight service briefers …. these exchanges can also be viewed as a series of commitments building on one another in a form of plan continuation that occurs on the ground before a flight ever launches. Actions and words build on one another and make it increasingly difficult to change the path, to seek the open fields of alternative futures. The plan becomes more public while others assist in defining the acceptable outcomes. A flight service briefer can even become complicit in helping a pilot achieve a stated outcome and solidify a plan that needs to change. Rather than adapt to an alternative, together the pilot and briefer try to	McCoy & Mickunas, 2000, p. 29

	force the original plan to work with a context no longer the same”	
34. Plan Continuation Error	“…. Pressing on with the original plan in the face of cues that suggest a change would be warranted” Characteristics of PCE include pilot fixation on continuing to the planned destination despite deteriorating weather along the flight path.	Martin, Davison, & Orasanu, 1998, p. 9; McCoy & Mickunas, 2000
35. Ratings policy violation	“…. ratings, and hence experience has an impact on the predictability of Fatality Status, accidents from VFR to IMC. A pilot with a higher rating, specifically an instrument rating at a minimum, is 1.2 times less likely to have a fatal accident from VFR to IMC than a pilot that does not have an instrument rating”	Jackman, 2014, p. 142
36. Receipt of weather briefing	“… whether the pilot received a	Ison, 2014a, p. 11

	weather briefing or not”	
37. Scud running	A GA practice by VFR pilots lowering the flight altitude to evade clouds or IMC staying clear of weather to continue flying in VFR/VMC as opposed to IFR/IMC	Martin, Davison, & Orasanu, 1998; Orasanu, & Martin, 1998; Orasanu, Martin, & Davison, 1998; Orasanu, Martin, & Davison, 2001
38. Self-reported weather cues	The ability of the pilot to recognize and respond to the cues associated with deteriorating weather conditions during flight	Wiggins & O’Hare, 2003
39. Situation Assessment	“…. pilots risk pressing on into deteriorating weather because they do not fully realize they are doing so. In other words, pilots continue VFR flight into IMC when they misdiagnose the changes in or severity of the weather”	Goh & Wiegmann, 2001; Orasanu, & Martin, 1998; Orasanu, Martin, & Davison, 2001; Saxton, 2008; Wiegmann, Goh, & O'Hare, 2002, p. 191
40. Social	“Implied expectations among pilots may encourage risky	Barron, 2011; Martin, Davison, & Orasanu, 1998, p. 7; Orasanu, & Martin, 1998; Orasanu,

	behavior or may induce one to behave as if one is an expert, even in the face of ignorance. This may result in unwillingness to admit that one does not know something, is unfamiliar, is uncertain, is lost.”	Martin, & Davison, 2001
41. Source of weather information	The source of weather information chosen by the pilot for a particular flight	Balog, 2013; Balog 2016
42. Terrain	The physical characteristics of the land where the accident occurred, such as mountainous terrain	O'Hare & Owen, 2002
43. Underestimating risk	“In several accidents, the crew clearly was aware of cues that should have signaled a change in course of action, but appeared to underestimate the level of risk associated with them”	Martin, Davison, & Orasanu, 1998, p. 7
44. Unrecoverable low altitude	The decision made by the pilot to fly	Wilson & Sloan, 2003

	VFR at low altitudes below the clouds where a recovery is not possible resulting in a collision with the terrain	
45. Use of in-cockpit weather information	The pilot decision to obtain and use weather information through the cockpit instruments	Johnson, Wiegmann, & Wickens, 2006
46. Use of portable weather applications	The pilot decision to retrieve weather information through portable weather applications	Ahlstrom, Ohneiser, & Caddigan, 2016

Table D2

Pilot Study Overall Fleiss' Kappa

	Kappa	Asymptotic Standard Error	Z	P Value	Lower 95% Asymptotic CI Bound	Upper 95% Asymptotic CI Bound
Overall	.496	.021	23.633	.000	.455	.537

Table D3

Pilot Study Individual Categories for Fleiss' Kappa

Rating Category	Conditional Probability	Kappa	Asymptotic Standard Error	Z	P Value	Lower 95% Asymptotic CI Bound	Upper 95% Asymptotic CI Bound
0	.866	.496	.021	23.633	.000	.455	.537
1	.630	.496	.021	23.633	.000	.455	.537

0 = Rater identified the contextual factor as not present
1 = Rater identified the contextual factor as present

Table D4

Main Study Overall Fleiss' Kappa

	Kappa	Asymptotic Standard Error	Z	P Value	Lower 95% Asymptotic CI Bound	Upper 95% Asymptotic CI Bound
Overall	.245	.005	51.039	.000	.235	.254

Table D5

Main Study Individual Categories for Fleiss' Kappa

Rating Category	Conditional Probability	Kappa	Asymptotic Standard Error	Z	P Value	Lower 95% Asymptotic CI Bound	Upper 95% Asymptotic CI Bound
0	.485	.376	.009	39.954	.000	.358	.395
1	.659	.509	.009	54.075	.000	.491	.527
2	.199	.011	.009	1.148	.251	-.008	.029
3	.187	.142	.009	15.113	.000	.124	.161
4	.303	.096	.009	10.203	.000	.078	.114
5	.125	.080	.009	8.499	.000	.062	.098

0 = Rater identified the contextual factor as not present
1 = Rater identified the contextual factor as present
2 = Rater provided no rating (blank)
3 = Rater selected the 'not applicable, N.A.' response
4 = Rater selected the 'not enough information' response
5 = Rater selected the 'unknown' response

APPENDIX E
Figures

NTSB AAR report

National Transportation Safety Board
Aviation Accident Final Report

Location:	Chuathbaluk, AK	**Accident Number:**	ANC12FA009
Date & Time:	11/29/2011, 1925 AST	**Registration:**	N1673U
Aircraft:	CESSNA 207	**Aircraft Damage:**	Substantial
Defining Event:	VFR encounter with IMC	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General Aviation - Positioning		

Analysis

The pilot departed on a positioning flight during dark night, marginal visual meteorological conditions. A witness, who was waiting for the airplane at the destination airport, stated that shortly after the pilot-controlled airport lighting activated, a snow squall passed over the airport, greatly reducing the visibility. The accident airplane never arrived at its destination, and a search was initiated. The airplane's fragmented wreckage was discovered early the next morning in a wooded area, about 2 miles from its destination.

A review of archived automatic dependent surveillance-broadcast (ADS-B) data received from the accident airplane showed that the pilot departed, and the airplane climbed to about 700 feet above ground level. The airplane remained at about 700 feet for about 3 minutes, and then entered a shallow right-hand descending turn, until it impacted terrain.

On-site examination of the airplane and engine revealed no preaccident mechanical anomalies that would have precluded normal operation. The cockpit area was extensively fragmented, thus the validity of any postaccident cockpit and instrument findings was unreliable. Likewise, structural damage to the airframe precluded the determination of flight control continuity. A postaccident examination of the engine and recovered components did not disclose any evidence of a mechanical malfunction.

Given the witness account of worsening weather conditions at the airport just before the accident and the lack of mechanical anomalies with the airplane, it is likely that the accident pilot encountered heavy snow and instrument meteorological conditions while approaching the airport. It is also likely that the pilot became spatially disoriented during the unexpected weather encounter and subsequently collided with terrain.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:
The pilot's loss of situational awareness after an inadvertent encounter with instrument meteorological conditions, which resulted in an in-flight collision with tree-covered terrain.

Figure E1. National Transportation Board Aviation Accident Report example.

NTSB aviation accident database & synopses

Figure E2. NTSB Aviation Accident Database & Synopses website. Adapted from the NTSB website (https://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx)

APPENDIX F
Instructions to Raters

INSTRUCTIONS TO RATERS: PILOT STUDY

The pilot study is provided in the attached Microsoft® Access™ database under the 'Main' table. Once you are in the program, click on the 'Main' table from the list of tables located on the left of the screen. The 'Main' table has a total of nine General Aviation (GA) visual flight rules (VFR)-into-instrument meteorological condition (IMC) fatal accidents selected for testing in the pilot study and will not be used in the main study. The respective National Transportation Safety Board (NTSB) Aviation Accident Report (AAR) numbers are given as well as hyperlinks to the NTSB Aviation Accident Data Summary and Aviation Accident Final Reports that can be clicked when the pointing hand icon appears while hovering over the respective links. Once clicked, the respective NTSB data summary and final reports will open at this point for your review.

After reviewing the data summaries, final reports, and definition sheet for the 46 research literature-identified contextual factors, please identify the applicable contextual factors indicative of the pilots' actions for each of the nine GA VFR-into-IMC accidents in the pilot study. This action can be accomplished by clicking the down arrow on the right side of each cell for each of the 46 contextual factors in moving from left to the right in the 'Main' table. Also, provide any comments in the rater comments cell related to how the contextual factors were manifest considering the pilot actions indicative of the identified contextual factor(s) in the last cell of the Microsoft® Access™ 'Main' table.

These instructions should be completed for each of the nine accidents one at a time. The pilot study Microsoft® Access™ database 'Main' data collection table and Microsoft® Word™ contextual factor definitions document are provided as attachments to this email. Please take as much time as you need to complete the pilot study and return to my email when finished to hartmaj7@my.erau.edu.

The following files are included as attachments to this email for completion of the pilot study:

46_GA_VFR_IMC_Contextual_Factors_Definitions.docx
GA_VFR_IMC_Pilot_Study.accdb

*Note – If you are having difficulty downloading the attached files, you can also access them through the following hyperlinks:

https://www.dropbox.com/s/ebx1bdls6sxqmo5/46_GA_VFR_IMC_Contextual_Factors_Definitions.docx?dl=0

https://www.dropbox.com/s/x63669ip5kxj2t9/GA_VFR_IMC_Pilot_Study.accdb?dl=0

Please let me know if you have any questions. Thank you for your participation!

Jim

James H Hartman, III
Doctoral Candidate
Student ID: 1556911
3452 N Mayfair
Mesa, AZ 85213
480-540-6016
hartmaj7@my.erau.edu

Figure F1. Instructions to raters (pilot study).

INSTRUCTIONS TO RATERS: MAIN STUDY

Contextual factors have been generally defined as the degrees of challenge, uncertainty, predictability of outcome, time pressure, threat, emotionality, and situational understanding in classifying decisions (Boyes, & Potter, 2015). In the aviation domain, contextual factors are a multifaceted arrangement of pertinent events or occurrences contributing to pilot accidents in weather-related decision-making error. Specifically, the context term has been explained as "… contributing to General Aviation [GA] pilot errors in weather-related decision making … considered as a complex configuration of relevant events or phenomenon that may be considered the domain within which the pilot makes the weather-related decision" (McCoy & Mickunas, 2000, p. 1). As a subject matter expert (SME) rater, you will be identifying the applicable contextual factors indicative of the pilots' actions for each of 85 GA Visual Flight Rules (VFR)-into-Instrument Meteorological Conditions (IMC) selected accidents from the National Transportation Safety Board (NTSB) Aviation Accident Database in this main study.

The Main Study is provided in the attached Microsoft® Access™ database under the 'Main' table. Once you are in the program, click on the 'Main' table from the list of tables located on the left of the screen. The 'Main' table has 85 GA VFR-into-IMC fatal accidents selected from the NTSB Aviation Accident Database. The respective NTSB Aviation Accident Report (AAR) numbers are given as well as hyperlinks to the NTSB Aviation AARs that can be clicked when the pointing hand icon appears while hovering over the respective links. Once clicked, the respective NTSB final reports will open at this point for your review. After reviewing the final reports and definition sheet for the 46 research literature-identified contextual factors, please identify the applicable contextual factors indicative of the pilots' actions for each of the 85 GA VFR-into-IMC accidents. This action can be accomplished by clicking the down arrow on the right side of each cell for each of the 46 contextual factors in moving from left to the right in the 'Main' table.

If none of the drop-down list of options applies to the particular contextual factor, then select the NA (Not Applicable) option. If, in your opinion, there is not enough information provided in the NTSB factual report to identify a specific contextual factor, select the 'Not enough information provided to identify the contextual factor' in the drop-down options (select this option if there is a narrative to review and after reviewing, you feel there is not enough information to select a specific contextual factor). The NTSB report may lack a narrative to decide. If this is the case, select the 'Unknown' option in the drop down list (select this option if there is no narrative to review).

The hyperlink is provided for skyvector.com (https://skyvector.com/). This publicly available website includes sectional charts for the United States for rater determination of the accident site from the departure and destination points for DDLCF14 and DDLCF15. Also, provide any comments in the rater comments cell related to how, in your opinion, the contextual factors were manifest considering the pilot actions indicative of the identified contextual factor(s) in the last cell of the Microsoft® Access™ 'Main' table.

These instructions should be completed for each of the 85 accidents one at a time. The main study Microsoft® Access™ database 'Main' data collection table and Microsoft® Word™ contextual factor definitions document are provided as attachments to this email. Please take as much time as you need to complete the main study and return to my email when finished at hartmaj7@my.erau.edu.

The following files are included as attachments to this email for completion of the Main Study:

46_GA_VFR_IMC_Contextual_Factors_Definitions.docx
GA_VFR_IMC_Main_Study_Sample_Correction3.accdb

Please let me know if you have any questions. Thank you for your participation!

*Note – If you are having difficulty downloading the attached files, you can also access them through the following hyperlinks:

https://www.dropbox.com/s/ebx1bdls6sxqmo5/46_GA_VFR_IMC_Contextual_Factors_Definitions.docx?dl=0

https://www.dropbox.com/s/x63669ip5kxj2t9/GA_VFR_IMC_Main_Study_Sample_Correction3.accdb?dl=0

References

Boyes, M., & Potter, T. (2015). The application of recognition-primed decision theory to decisions made in an outdoor education context. *Australian Journal of Outdoor Education, 18*(1), 2-15.

McCoy, C. E., & Mickunas, A. (2000). The role of context and progressive commitment in plan continuation error. *Human Factors and Ergonomics Society Annual Meeting Proceedings, 44*(1), 26-29. doi: 10.1177/154193120004400108

Jim

James H. Hartman, III
Doctoral Candidate
Student ID: 1556911
3452 N Mayfair
Mesa, AZ 85213
480-540-6016
hartmaj7@my.erau.edu

Figure F2. Instructions to raters (main study).

APPENDIX G

Pilot Study Rater Data

Table G1

Rater-identified Contextual Factors and Frequencies (Pilot Study)

Contextual Factor – Pilot Study	Total
CF1_Accident_time_of_day_Day	5
CF43_Underestimating_risk	5
CF14_Crash_distance_from_departure	5
CF6_Time_Distance_Flew_IMC_Accident_Less	5
CF29_Number_of_passengers_on_board	4
CF6_Time_Distance_Flew_IMC_Accident_Greater	4
CF15_Crash_distance_from_planned_destination	4
CF1_Accident_time_of_day_Night	4
CF2_Adverse_weather_encountered_early_in_flight	3
CF3_Adverse_weather_encountered_late_in_flight	3
CF34_Plan_Continuation_Error_PCE	3
CF21_Filing_of_a_flight_plan	2
CF26_IFR_flight_without_clearance_or_ratings	2
CF35_Ratings_policy_violation	2
CF44_Unrecoverable_low_altitude	2
CF9_Ceiling_visibility_determination	1
CF12_Communication_with_air_traffic_control	1
CF17_Decision_Continue_VFR_IMC_Planned_Destination	1
CF28_Medical_status_policy_violation	1
CF36_Receipt_of_weather_briefing	1
CF37_Scud_running	1
CF40_Social	1
CF42_Terrain_Type_Mountain	1
CF4_Altitude_Cruising	0
CF5_Ambiguity	0
CF7_Time_Distance_Flew_IMC_Divert	0
CF8_Attentional_tunneling	0
CF10_Circular_decision_making	0
CF11_Cognitive_Anchoring	0
CF13_Consequences_not_anticipated	0
CF16_Currency_policy_violation	0

CF18_Decision_Divert_VFR_IMC_Alternate_Destination	0
CF19_Delay_in_obtaining_the_current_weather_conditions	0
CF20_Descent_below_weather_minimums	0
CF22_Flight_into_known_icing_conditions	0
CF23_Flight_plan_policy_violation	0
CF24_Goal_conflicts	0
CF25_Height_of_crash_site	0
CF27_Linear_decision_making	0
CF30_Obtaining_an_on_line_preflight_weather_briefing	0
CF31_Organization	0
CF32_Permission_seeking_behaviors	0
CF33_Pilot_briefer_communication	0
CF38_Self_reported_weather_cues	0
CF39_Situation_Assessment	0
CF41_Source_of_weather_information_Good	0
CF41_Source_of_weather_information_Bad	0
CF45_Use_of_in_cockpit_weather_information	0
CF46_Use_of_portable_weather_applications	0

APPENDIX H

Main Study Rater Data

Table H1

Rater-identified Contextual Factors and Frequencies (Main Study)

Contextual Factor – Main Study	Total
CF29_Number_of_passengers_on_board_Yes	53
CF1_Accident_time_of_day_Day	51
CF15_Crash_distance_from_planned_destination_Yes	46
CF21_Filing_of_a_flight_plan_No	42
CF43_Underestimating_risk_Yes	42
CF26_IFR_flight_without_clearance_or_ratings_Yes	41
CF14_Crash_distance_from_departure_Yes	39
CF39_Situation_Assessment_Yes	35
CF1_Accident_time_of_day_Night	34
CF24_Goal_conflicts_Yes	27
CF33_Pilot_briefer_communication_Yes	25
CF28_Medical_status_policy_violation_No	23
CF36_Receipt_of_weather_briefing_Yes	22
CF42_Terrain_Type_Mountain	22
CF34_Plan_Continuation_Error_PCE_Yes	21
CF2_Adverse_weather_encountered_early_in_flight_Yes	20
CF3_Adverse_weather_encountered_late_in_flight_Yes	20
CF12_Communication_with_air_traffic_control_Yes	18
CF6_Time_Distance_Flew_IMC_Accident_Less	17
CF25_Height_of_crash_site_0 - 999 feet mean sea level	16
CF16_Currency_policy_violation_No	15
CF33_Pilot_briefer_communication_No	14
CF15_Crash_distance_from_planned_destination_No	12
CF17_Decision_Continue_VFR_IMC_Planned_Destination_Yes	12
CF21_Filing_of_a_flight_plan_Yes	12
CF35_Ratings_policy_violation_No	12
CF38_Self_reported_weather_cues_Yes	12
CF41_Source_of_weather_information_Good	12
CF2_Adverse_weather_encountered_early_in_flight_No	11
CF12_Communication_with_air_traffic_control_No	11
CF29_Number_of_passengers_on_board_2	11

CF36_Receipt_of_weather_briefing_No	9
CF28_Medical_status_policy_violation_Yes	7
CF35_Ratings_policy_violation_Yes	7
CF37_Scud_running_No	7
CF5_Ambiguity_Yes	6
CF6_Time_Distance_Flew_IMC_Accident_Greater	6
CF37_Scud_running_Yes	6
CF22_Flight_into_known_icing_conditions_Yes	5
CF18_Decision_Divert_VFR_IMC_Alternate_Destination_Yes	4
CF25_Height_of_crash_site_2,000 - 2,999 feet mean sea level	4
CF42_Terrain_Type_Hill	4
CF44_Unrecoverable_low_altitude_Yes	4
CF4_Altitude_Cruising_0 - 999 feet mean sea level	3
CF4_Altitude_Cruising_10,000 - 10,999 feet mean sea level	3
CF17_Decision_Continue_VFR_IMC_Planned_Destination_No	3
CF25_Height_of_crash_site_3,000 - 3,999 feet mean sea level	3
CF25_Height_of_crash_site_4,000 - 4,999 feet mean sea level	3
CF25_Height_of_crash_site_5,000 - 5,999 feet mean sea level	3
CF25_Height_of_crash_site_6,000 - 6,999 feet mean sea level	3
CF29_Number_of_passengers_on_board_3	3
CF32_Permission_seeking_behaviors_No	3
CF40_Social_Yes	3
CF3_Adverse_weather_encountered_late_in_flight_No	2
CF4_Altitude_Cruising_13,000 - 13,999 feet mean sea level	2
CF4_Altitude_Cruising_6,000 - 6,999 feet mean sea level	2
CF4_Altitude_Cruising_7,000 - 7,999 feet mean sea level	2
CF25_Height_of_crash_site_1,000 - 1,999 feet mean sea level	2
CF25_Height_of_crash_site_8,000 - 8,999 feet mean sea level	2
CF29_Number_of_passengers_on_board_5	2
CF31_Organization_Yes	2
CF42_Terrain_Type_Ocean	2
CF4_Altitude_Cruising_11,000 - 11,999 feet mean sea level	1
CF4_Altitude_Cruising_12,000 - 12,999 feet mean sea level	1
CF4_Altitude_Cruising_14,000 - 14,999 feet mean sea level	1
CF4_Altitude_Cruising_2,000 - 2,999 feet mean sea level	1
CF4_Altitude_Cruising_4,000 - 4,999 feet mean sea level	1
CF4_Altitude_Cruising_5,000 - 5,999 feet mean sea level	1
CF4_Altitude_Cruising_9,000 - 9,999 feet mean sea level	1
CF7_Time_Distance_Flew_IMC_Divert_Less	1

CF10_Circular_decision_making	1
CF13_Consequences_not_anticipated_Yes	1
CF25_Height_of_crash_site_10,000 - 10,999 feet mean sea level	1
CF25_Height_of_crash_site_7,000 - 7,999 feet mean sea level	1
CF30_Obtaining_an_on_line_preflight_weather_briefing_Yes	1
CF38_Self_reported_weather_cues_No	1
CF42_Terrain_Type_Forest	1
CF44_Unrecoverable_low_altitude_No	1
CF8_Attentional_tunneling	0
CF9_Ceiling_visibility_determination	0
CF11_Cognitive_Anchoring	0
CF19_Delay_in_obtaining_the_current_weather_conditions	0
CF20_Descent_below_weather_minimums	0
CF23_Flight_plan_policy_violation	0
CF27_Linear_decision_making	0
CF41_Source_of_weather_information_Bad	0
CF45_Use_of_in_cockpit_weather_information	0
CF46_Use_of_portable_weather_applications	0

APPENDIX I
Sample Size Selection

Table I1

Sample Size Selection

Climate Region	U.S. State/Territory VFR-into-IMC Occurrence	Number of VFR-into-IMC Accidents (Jan. 1, 1991-Dec. 31, 2014)	Number of VFR-into-IMC Accidents by NOAA Defined Climate Region	Percentage of accident occurrences by NOAA Defined Climate Region	Sample Selection by NOAA Defined Region % Split
Alaska	AK	34			
Total			34	4.9%	2.0
Central	IL	7			
Central	IN	3			
Central	KY	9			
Central	MO	7			
Central	OH	9			
Central	TN	26			
Central	WV	7			
Total			68	9.8%	7.00
East North Central	IA	7			
East North Central	MI	5			

East North Central	MN	13			
East North Central	WI	13			
Total			38	5.5%	2.00
Islands	GM	1			
Islands	HI	6			
Islands	PR	3			
Islands	VI	1			
Total			11	1.6%	1.00
Northeast	CT	5			
Northeast	MA	5			
Northeast	MD	9			
Northeast	ME	2			
Northeast	NH	3			
Northeast	NJ	6			
Northeast	NY	9			
Northeast	PA	16			
Northeast	RI	1			
Northeast	VT	2			
Total			58	8.4%	5.00
Northwest	ID	10			

Northwest	OR	16			
Northwest	WA	20			
Total			46	6.7%	3.00
South	KS	10			
South	LA	9			
South	MS	6			
South	OK	7			
South	AR	12			
South	TX	22			
Total			66	9.6%	6.00
Southeast	AL	17			
Southeast	FL	30			
Southeast	GA	18			
Southeast	NC	20			
Southeast	SC	7			
Southeast	VA	20			
Total			112	16.2%	18.00
Southwest	AZ	16			
Southwest	CO	31			
Southwest	NM	12			
Southwest	UT	16			
Total			75	10.9%	8.00

West	CA	134			
West	NV	11			
Total			145	21.0%	31.00
West North Central	MT	11			
West North Central	ND	5			
West North Central	NE	5			
West North Central	SD	5			
West North Central	WY	12			
Total			38	5.5%	2.00
Grand Total		691	691	100.0%	85.0

APPENDIX J

Rater Lesson on Contextual Factors

Objective(s): The objective of this lesson will be to familiarize the rater with the contextual factors identified in the peer-reviewed research. The lesson will develop the rater's skill in recognizing the presence of these contextual factors and manifestations in the sample of NTSB AARs.

Methods: Lecture, audio/visuals, and demonstration

Materials: Three NTSB GA VFR-into-IMC accident case studies

References: Instructions to raters, complete list of peer-reviewed research-identified contextual factors, data collection form

Presentation:

Topics:

1. Contextual Factors (Definitions and Descriptions) (Table 1)
2. Data collection form (See Appendix B and Appendix C)
3. Qualitative Approach for Analysis: using the data collection form
    a. Coding the presence of the contextual factors within the NTSB AARs will be completed by the raters such that the contextual factors will be used as a priori codes. The raters will use selective coding in that they will code systematically with respect to the contextual factors.
    b. The rater will record contextual factor manifestation thoughts and ideas as he reads the NTSB GA Part 91 VFR-into-IMC AARs using the data collection form comment cell.

c. The contextual factor presence coding and manifestation note taking completed by each rater will be cross-compared with the other raters.

4. A demonstration exercise example using the data collection form will be given by the researcher (Case Study 1)
    a. The contextual factors will be identified using the NTSB GA AAR using the Probable Cause Section.
    b. Any other contextual factors will also be identified using the full information in the NTSB GA AAR.

Practice: NTSB GA VFR-into-IMC Accident Case Study 2 (Accident to be determined)

Assessment:

1. A written assessment will be given covering the contextual factor concepts pertinent to the Part 91 GA flight environment.
2. Practical Test: Case Study 3 (Accident to be determined).
    a. coding (individually)
    b. note taking (individually)
    c. integrative sessions (collectively)

Completion Standards:

1. The raters demonstrate understanding of the peer-reviewed research-defined contextual factors by passing the written exam with an 80% minimum score. The researcher will review any incorrect responses to confirm the raters have complete understanding.

2. The raters demonstrate competence identifying the presence of the contextual factors and manifestations using NTSB GA VFR-into-IMC AARs.
3. The raters demonstrate competence using the data collection form.

APPENDIX K

NTSB GA VFR-into-IMC Accidents Sample (Pilot Study)

Table K1

NTSB GA VFR-into-IMC Accidents Sample (Pilot Study)

ID	NTSB Report Number	NTSB Data Summary	NTSB Final Report
1	ANC91LA061	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X16904&AKey=1&RType=Summary&IType=LA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X16904&AKey=1&RType=HTML&IType=LA
2	ANC91FA107	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X17402&AKey=1&RType=Summary&IType=FA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X17402&AKey=1&RType=HTML&IType=FA
3	MIA00FA043	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20276&AKey=1&RType=Summary&IType=FA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20276&AKey=1&RType=HTML&IType=FA
4	ATL01FA036	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010221X00474&AKey=1&RType=Summary&IType=FA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010221X00474&AKey=1&RType=HTML&IType=FA
5	MIA08FA026	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20071211X01926&AKey=1&RType=Summary&IType=FA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20071211X01926&AKey=1&RType=HTML&IType=FA
6	FTW03FA111	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030320X00357&AKey=1&RType=Summary&IType=FA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030320X00357&AKey=1&RType=HTML&IType=FA

7	WPR12FA091	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20120204X03117&AKey=1&RType=Summary&IType=FA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20120204X03117&AKey=1&RType=HTML&IType=FA
8	WPR15FA072	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20150101X15630&AKey=1&RType=Summary&IType=FA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20150101X15630&AKey=1&RType=HTML&IType=FA
9	LAX95LA001	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X02462&AKey=1&RType=Summary&IType=LA	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X02462&AKey=1&RType=HTML&IType=LA

APPENDIX L

NTSB GA VFR-into-IMC Accidents Sample (Main Study)

Table L1

NTSB GA VFR-into-IMC Accidents Sample (Main Study)

ID	NTSB Report Number	NTSB Final Report
1	ANC12FA009	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20111130X92124&AKey=1&RType=HTML&IType=FA
2	ANC12FA066	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20120706X65939&AKey=1&RType=HTML&IType=FA
3	ATL07FA038	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070215X00196&AKey=1&RType=HTML&IType=FA
4	ATL03FA062	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030324X00372&AKey=1&RType=HTML&IType=FA
5	ATL07FA081	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070503X00507&AKey=1&RType=HTML&IType=FA
6	ATL91FA043	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X16260&AKey=1&RType=HTML&IType=FA

7	ATL92FA008	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X18232&AKey=1&RType=HTML&IType=FA
8	ATL92FA090	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X14367&AKey=1&RType=HTML&IType=FA
9	ATL92GA121	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X14765&AKey=1&RType=HTML&IType=GA
10	ATL99FA019	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X11359&AKey=1&RType=HTML&IType=FA
11	CEN09FA195	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20090309X20142&AKey=1&RType=HTML&IType=FA
12	CEN11FA240	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20110322X03800&AKey=1&RType=HTML&IType=FA
13	CEN14FA051	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20131112X30325&AKey=1&RType=HTML&IType=FA
14	CHI02FA193	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20020723X01184&AKey=1&RType=HTML&IType=FA

15	CHI03FA151	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030610X00829&AKey=1&RType=HTML&IType=FA
16	CHI04FA284	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041007X01595&AKey=1&RType=HTML&IType=FA
17	CHI92FA266	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X15642&AKey=1&RType=HTML&IType=FA
18	CHI93FA137	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X12082&AKey=1&RType=HTML&IType=FA
19	CHI96FA094	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X05225&AKey=1&RType=HTML&IType=FA
20	DEN05FA011	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041015X01641&AKey=1&RType=HTML&IType=FA
21	ERA09FA311	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20090601X31419&AKey=1&RType=HTML&IType=FA
22	ERA09FA537	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20090926X65328&AKey=1&RType=HTML&IType=FA

23	ERA10FA062	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20091114X32349&AKey=1&RType=HTML&IType=FA
24	ERA10MA188	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20100325X93604&AKey=1&RType=HTML&IType=MA
25	ERA12FA012	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20111006X03238&AKey=1&RType=HTML&IType=FA
26	ERA14FA377	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20140809X04729&AKey=1&RType=HTML&IType=FA
27	FTW03FA048	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20021202X05541&AKey=1&RType=HTML&IType=FA
28	FTW01FA171	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010801X01573&AKey=1&RType=HTML&IType=FA
29	FTW94FA036	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X13729&AKey=1&RType=HTML&IType=FA
30	FTW94FA165	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X01272&AKey=1&RType=HTML&IType=FA

31	FTW95FA402	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X04483&AKey=1&RType=HTML&IType=FA
32	FTW96FA368	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X06713&AKey=1&RType=HTML&IType=FA
33	FTW98FA121	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X09537&AKey=1&RType=HTML&IType=FA
34	IAD00LA021	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20498&AKey=1&RType=HTML&IType=LA
35	LAX00FA017	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X19975&AKey=1&RType=HTML&IType=FA
36	LAX00FA099	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20504&AKey=1&RType=HTML&IType=FA
37	LAX00FA354	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X22001&AKey=1&RType=HTML&IType=FA
38	LAX01FA023	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X22183&AKey=1&RType=HTML&IType=FA

39	LAX02FA019	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20011113X02226&AKey=1&RType=HTML&IType=FA
40	LAX03FA025	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20021122X05506&AKey=1&RType=HTML&IType=FA
41	LAX03FA282	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030904X01456&AKey=1&RType=HTML&IType=FA
42	LAX04FA061	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20031212X02024&AKey=1&RType=HTML&IType=FA
43	LAX04FA076	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040108X00032&AKey=1&RType=HTML&IType=FA
44	LAX04FA081	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040106X00022&AKey=1&RType=HTML&IType=FA
45	LAX04FA096	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040122X00094&AKey=1&RType=HTML&IType=FA
46	LAX04FA113	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040213X00192&AKey=1&RType=HTML&IType=FA

47	LAX04FA139	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040308X00291&AKey=1&RType=HTML&IType=FA
48	LAX05FA023	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041103X01749&AKey=1&RType=HTML&IType=FA
49	LAX05FA167	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20050610X00749&AKey=1&RType=HTML&IType=FA
50	LAX05FA184	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20050601X00700&AKey=1&RType=HTML&IType=FA
51	LAX05FA255	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20050806X01177&AKey=1&RType=HTML&IType=FA
52	LAX05LA014	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041103X01750&AKey=1&RType=HTML&IType=LA
53	LAX06FA148	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20060508X00526&AKey=1&RType=HTML&IType=FA
54	LAX07FA056	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20061220X01815&AKey=1&RType=HTML&IType=FA

55	LAX92LA105	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X14019&AKey=1&RType=HTML&IType=LA
56	LAX93FA045	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X15892&AKey=1&RType=HTML&IType=FA
57	LAX93FA246	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X12637&AKey=1&RType=HTML&IType=FA
58	LAX93LA244	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X12645&AKey=1&RType=HTML&IType=LA
59	LAX94FA271	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X01765&AKey=1&RType=HTML&IType=FA
60	LAX95LA060	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001206X02754&AKey=1&RType=HTML&IType=LA
61	LAX97FA334	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X08414&AKey=1&RType=HTML&IType=FA
62	LAX98FA199	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X10339&AKey=1&RType=HTML&IType=FA

63	LAX99FA020	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X11281&AKey=1&RType=HTML&IType=FA
64	MIA00FA029	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X20135&AKey=1&RType=HTML&IType=FA
65	MIA03FA071	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20030306X00294&AKey=1&RType=HTML&IType=FA
66	MIA05FA028	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20041119X01845&AKey=1&RType=HTML&IType=FA
67	MIA99FA027	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X11471&AKey=1&RType=HTML&IType=FA
68	MIA91FA107	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001212X16650&AKey=1&RType=HTML&IType=FA
69	MIA95FA145	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X03765&AKey=1&RType=HTML&IType=FA
70	NYC01FA215	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010830X01829&AKey=1&RType=HTML&IType=FA

71	NYC01LA132	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20010613X01175&AKey=1&RType=HTML&IType=LA
72	NYC04FA092	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040329X00383&AKey=1&RType=HTML&IType=FA
73	NYC07FA173	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070806X01113&AKey=1&RType=HTML&IType=FA
74	NYC08LA310	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20080922X01511&AKey=1&RType=HTML&IType=LA
75	NYC93FA012	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001211X15925&AKey=1&RType=HTML&IType=FA
76	NYC97FA004	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001208X06956&AKey=1&RType=HTML&IType=FA
77	SEA04FA154	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20040810X01190&AKey=1&RType=HTML&IType=FA
78	SEA07LA040	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20070115X00051&AKey=1&RType=HTML&IType=LA

79	SEA95FA209	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X04588&AKey=1&RType=HTML&IType=FA
80	SEA96FA021	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20001207X04920&AKey=1&RType=HTML&IType=FA
81	WPR10FA142	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20100220X04837&AKey=1&RType=HTML&IType=FA
82	WPR11FA147	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20110227X34342&AKey=1&RType=HTML&IType=FA
83	WPR11FA241	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20110531X35220&AKey=1&RType=HTML&IType=FA
84	WPR12FA031	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20111109X93553&AKey=1&RType=HTML&IType=FA
85	WPR14FA172	https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20140426X23435&AKey=1&RType=HTML&IType=FA

APPENDIX M

Short Biographies of Raters

1. **Robert "Buck" Joslin** joined the FAA in 2005. Prior to being selected in 2010 as the CSTA-Flight Deck Technology Integration, he served as an FAA Flight Test pilot with the Atlanta Aircraft Certification Office and the Fort Worth Special Certification Office, involved in the certification of some of the latest flight deck systems. Robert Joslin has served on various national/international committees involved in developing regulations and certification standards for new technology with international experience living and working in aviation and aviation flight test centers worldwide, to include 3 years in Japan, and has over 60 published manuscripts in various aviation periodicals. He is an active FAA Flight Test Pilot and has over 9000 accident free flight hours in over 100 aircraft type and is qualified in AMEL, ASEL, AMES, ASES, Powered-Lift, Rotorcraft-Helicopter, Glider, and Remote Pilot with type ratings in the A-320, B-737, B-787, BE-200, BV-107, DA-2Easy, EMB-500, G-V, N-265, S-70, SA-227, and SK-61 as well CFI, CFII for Airplane and Rotorcraft, and is a qualified sUAS operator for the RQ-12A WASP and RQ-20A Puma, and has completed a MQ-1B Predator familiarization course.

Prior to joining the FAA in 2005, Dr. Joslin completed 30 years of military aviation service where he was a Colonel in the United States Marine Corps and a military experimental test pilot in jet, propeller, helicopter, and tilt-rotor aircraft at the Naval Air Test Centers in Patuxent River and China Lake, where he was involved in the early research and development of new flight deck technologies, many of which were subsequently adopted for civil use. He was the Commander of Defense Contract Management Agency-Bell Helicopter responsible for the initial production, acceptance, and delivery of the V-22 tilt-rotor aircraft. He also was a "Marine One" pilot for the President of the United States under the Bush Sr. administration, a 1994 NASA Astronaut Candidate finalist, an Assistant Professor of Aerodynamics and Aviation Safety at the Naval Postgraduate School, an Adjunct Assistant Professor with Embry-Riddle Aeronautical University, and is completely bilingual English-Spanish having been raised in Latin America.

Member, professional organizations, and societies:

•Associate Fellow - Society of Experimental Test Pilots (SETP)

•Full Member - International Society of Air Safety Investigators (ISASI)

•Member - Human Factors and Ergonomics Society (HFES)

•Fellow - Royal Aeronautical Society (FRAeS)

Industry and government awards:

•Contributor of the Year, Approach magazine

•Scribe of the Year, Rotor Review magazine

•Grampaw Pettibone award, National Naval Aviation Museum

•White House Aircraft Commander - Presidential Pilot

Academic achievement:

•Ph.D. in Aviation, Embry Riddle Aeronautical University

•Assistant Professor-College of Aviation, Embry-Riddle Aeronautical University

•Assistant Professor of Aerodynamics and Aviation Safety, Naval Postgraduate School

•Engineering Test Pilot, U.S. Naval Test Pilot School

•M.S. in Aeronautical Engineering, Naval Postgraduate School

•B.S. in Mechanical Engineering, University of Florida

2. **William ("Bill") Tuccio** was a regional airline pilot and has diverse experience in engineering, aviation, flight instruction, software engineering, accident investigation, and conversation analysis (CA). In 2010 he joined the first cohort of Embry-Riddle's PhD in Aviation program, earning his doctorate with a dissertation studying linguistics applied to pilot training. He currently is a part-time flight instructor and an investigator for the National Transportation Safety Board, working with recovery of electronics, including aviation cockpit voice recorders, and audio and video from aviation and rail. He has published numerous technical reports in support of accident investigations. His PhD in Aviation dissertation explored interventionist conversation analysis for pilot training.

After completing his dissertation, he co-authored a paper with his dissertation committee published in the Pragmatics of Professional Discourse issue of Pragmatics and Society (2016), "Interventionist Applied Conversation Analysis: Collaborative Transcription and Repair Based Learning (CTRBL) in Aviation." Continuing his interest in CA, he attended Elizabeth Stokoe's Conversation Analytic Role-play Method (CARM) affiliate workshop at Loughborough University, England, and then teamed up with Dr. Maurice Nevile to investigate using CARM to improve flight instructor effectiveness based upon voluntarily submitted video and audio recordings. Bill continues to independently pursue CA education through attendance at workshops. As a CARM affiliate, flight instructor, and FAASTeam Representative, Bill has delivered interactive CARM seminars to flight instructors.

Dr. Tuccio received his Bachelor of Science degree in Aeronautical Engineering from Rensselaer and his Master of Aviation Science degree from Embry-Riddle. Additional relevant publications include International Journal of Applied Aviation Studies (2011), Journal of Aviation Technology and Engineering (2012), Journal of Navigation (2012), Language and Social Interaction Working Group Annual Conference (2016), and Journal of Aviation/Aerospace Education & Research (2011, 2017).

3. **Peter A. LeVoci** is an Adjunct Professor of Mechanical Engineering at Columbia University where he teaches aerodynamics. In addition to having served in the U.S. Navy as an instructor pilot and operationally as an anti-submarine warfare pilot, he was also a naval test pilot conducting experimental flight testing on prototype V-22 tiltrotor aircraft. After naval service, he entered his current occupation as a civilian test pilot where he conducts engineering flight tests for the certification of transport airplanes and helicopters, as well as small airplanes for the Federal Aviation Administration. Dr. LeVoci received his BS in Aerospace Engineering from the United States Naval Academy in 1979, MS in Systems Analysis from the University of West Florida in 1983, and his PhD in Mechanical Engineering from Columbia University in 2004. He is also a 1988 graduate of the United States Naval Test Pilot School.

4. **Benjamin J. Goodheart** is an aviation professional with over 20 years of experience in the field. His diverse career began in aviation line service and has expanded to roles in aviation safety and loss control, training, and professional flying. He has worked in and with a variety of aviation organizations, including flight training organizations, business

and general aviation operators, and major airlines, and his varied experience affords him a wide variety of opportunities to practice within his passion. Benjamin is an active author and researcher focused on novel applications within aviation safety management and organizational climate and culture. He holds a Master of Science in Safety Science, and a Ph.D. from Embry Riddle Aeronautical University with a specialization in applied aviation safety. Dr. Goodheart is a Certified Safety Professional as well as an Airline Transport Pilot and Flight Instructor. Benjamin currently serves as the Managing Director of Versant, and international safety and risk advocacy firm, and he served as President of an aviation nonprofit organization, Mercy Wings Network through 2016. In 2014, Dr. Goodheart was named one of Aviation Week and Space Technology magazine's Top Forty under 40 in aviation worldwide.

APPENDIX N

Main Study Sample Demographic Information

sample_number	ev_date	ev_type	eventsoe_no	ntsb_no	far_part	ev_state	light_cond	injury_level	narr_cause
1	5/24/1991	ACC	24015	ANC91LA061	91	AK	DUSK	FATL	The pilot's decision to continue VFR into IMC conditions and failure to maintain proper altitude. Contributing to the accident was the low ceiling and visibility.
2	7/24/1991	ACC	24015	ANC91FA107	91	AK	DAYL	FATL	The pilot's loss of control in flight due to spatial disorientation while attempting to operate under

									visual flight rules while in instrument meteorological conditions. Contributing to the accident was the mountainous terrain.
3	12/8/1999	ACC	24015	MIA00FA04 3	91	AL	DUSK	FATL	The student pilot's decision to continue the visual flight rules flight into deteriorating visibility, and his failure to maintain altitude clearance with the terrain.
4	2/13/2001	ACC	24015	ATL01FA03 6	91	AL	NITE	FATL	The pilot continued visual flight into instrument weather conditions that resulted in the

									inflight collision with a riverbank. Factors were reduced visibility and dark night.
5	12/7/2007	ACC	24015	MIA08FA02 6	91	AL	NDRK	FATL	The flight instructor’s failure to maintain control of the airplane while attempting to conduct visual flight in reduced visibility conditions at night. Factors contributing to the accident include the flight instructor’s inadequate preflight planning.
6	3/15/2003	ACC	24015	FTW03FA11 1	91	AR	DAWN	FATL	The pilot's execution of VFR

									flight into IMC and his failure to maintain obstacle clearance. Fog conditions and the pilot's lack of an instrument rating are contributing factors.
7	2/4/2012	ACC	401	WPR12FA091	91	AZ	NITE	FATL	The pilot's encounter with low clouds/low visibility conditions during the initial climb, which resulted in spatial disorientation and loss of airplane control.
8	12/31/2014	ACC	401	WPR15FA072	91	AZ	DUSK	FATL	The pilot's continued visual flight into

									instrument meteorological conditions which resulted in an inflight collision with terrain. Contributing to the accident was the pilot’s inadequate preflight planning.
9	10/1/1994	ACC	24015	LAX95LA001	91	CA	NDRK	FATL	The non-instrument-rated pilot's failure to maintain aircraft control due to spatial disorientation after encountering instrument meteorological conditions after the pilot decided to takeoff in adverse

									weather conditions.
10	6/16/1998	ACC	24015	LAX98FA199	91	CA	DAWN	FATL	The non-instrument rated pilot's intentional VFR flight into instrument meteorological conditions. Factors were the low ceiling, drizzle, and fog.
11	10/15/1999	ACC	24015	LAX00FA017	91	CA	NDRK	FATL	The pilot's continued VFR flight into IMC. Contributing factors were the pilot's self induced pressure to depart the airport before the weather worsened and the airport closed, and

									the mountain obscurement and foggy weather conditions.
12	2/14/2000	ACC	24015	LAX00FA099	91	CA	DAYL	FATL	The pilot's attempted flight into known adverse weather after receiving hazardous weather advisories, which resulted in inadvertent flight into instrument meteorological conditions while attempting to maintain VFR conditions on top.
13	9/30/2000	ACC	24015	LAX00FA354	91	CA	NDRK	FATL	The pilot's failure to maintain clearance from terrain while

									turning to reverse course following inadvertent nighttime flight into instrument meteorological conditions. A factor in the accident was the pilot's lack of experience in nighttime operations.
14	10/23/2000	ACC	24015	LAX01FA023	91	CA	DAYL	FATL	The pilot's inadequate weather evaluation and attempted VFR flight into IMC, which resulted in the in-flight collision with mountainous terrain.

15	10/31/2001	ACC	24015	LAX02FA019	91	CA	NITE	FATL	The pilot's continued VFR flight into instrument meteorological conditions, which resulted in a collision with trees and terrain.
16	11/8/2002	ACC	24015	LAX03FA025	91	CA	NDRK	FATL	The pilot's continued VFR flight into instrument meteorological conditions and his subsequent failure to maintain clearance from power lines. A contributing factor was the pilot's impairment by medication.

17	8/25/2003	ACC	24015	LAX03FA28 2	91	CA	DAYL	FATL	The student pilot's spatial disorientation and inadvertent descent into the ocean while maneuvering to avoid inclement weather. Also causal was the flight instructor's inadequate supervision due to his improper approval of his student's preflight preparation.
18	12/7/2003	ACC	24015	LAX04FA06 1	91	CA	NITE	FATL	The pilot's inadequate in-flight planning/decision by which he conducted VFR flight into night

									instrument meteorological conditions. Mountainous terrain, dark night conditions and the pilot's failure to obtain a preflight weather briefing are contributing factors.
19	12/15/2003	ACC	24015	LAX04FA081	91	CA	NITE	FATL	The student pilot's intentional VFR flight into instrument meteorological conditions, and his failure to maintain aircraft control as a result of spatial disorientation.
20	12/23/2003	ACC	24015	LAX04FA076	91	CA	NDRK	FATL	The pilot's improper in-flight

									planning and decision to continue flight under visual flight rules into deteriorating weather conditions, which resulted in an inadvertent in-flight encounter with instrument meteorological conditions and a collision with ridgeline.
21	1/19/2004	ACC	24015	LAX04FA09 6	91	CA	NITE	FATL	The pilot's continued visual flight into instrument meteorological conditions and failure to maintain

									an adequate terrain/object clearance altitude. Also causal was the pilot's improper in-flight decision to return to the origin airport.
22	2/27/2004	ACC	24015	LAX04FA139	91	CA	DUSK	FATL	The pilot's continued visual flight into adverse weather conditions at night, which resulted in an in-flight collision with mountainous terrain. The pilot's failure to obtain preflight weather information for the route of flight was also causal.

23	11/13/2004	ACC	24015	LAX05FA034	91	CA	NDRK	FATL	The pilot's continued visual flight into instrument meteorological conditions leading to spatial disorientation and an in-flight loss of control.
24	5/20/2005	ACC	24015	LAX05FA184	91	CA	DAYL	FATL	The pilot's inadvertent encounter with instrument meteorological conditions and failure to maintain adequate terrain clearance, which resulted in controlled flight into the terrain. Contributing

									factors were the pilots' delayed decision to reverse course.
25	8/1/2005	ACC	24015	LAX05FA255	91	CA	NDRK	FATL	The pilot's continued flight into instrument meteorological conditions, and his failure to maintain clearance from the rising hilly terrain. Contributing factors were the pilot's inexperience regarding flying during the dark, nighttime condition.
26	4/23/2006	ACC	24015	LAX06FA148	91	CA	DAYL	FATL	The pilot's improper decision to continue VFR flight into

									instrument meteorological weather conditions, which resulted in controlled flight into mountainous terrain.
27	12/10/2006	ACC	24015	LAX07FA056	91	CA	NDRK	FATL	The pilot's inadvertent encounter with instrument meteorological conditions and subsequent failure to maintain terrain clearance. Contributing to the accident were the dark night conditions, fog, and mountainous terrain.

28	2/19/2010	ACC	401	WPR10FA14 2	91	CA	NITE	FATL	The pilot's continued flight into night instrument meteorological conditions during the landing approach, which resulted in an in-flight loss of aircraft control due to spatial disorientation.
29	9/24/1995	ACC	24015	FTW95FA40 2	91	CO	DUSK	FATL	VFR flight by the pilot into instrument meteorological conditions (IMC), and his failure to maintain sufficient altitude or clearance from mountainous

									terrain. Factors relating to the accident were: the light condition at dusk and the adverse weather conditions.
30	10/13/2004	ACC	24015	DEN05FA011	91	CO	DAWN	FATL	The pilot's failure to maintain clearance from terrain, and his inadequate planning and decision making resulting in VFR flight into IMC. Contributing factors include the pilot's self-induced pressure to arrive at his destination and the low ceiling.

31	3/24/1991	ACC	24015	MIA91FA107	91	FL	DAYL	FATL	The pilot in command continued VFR flight into IFR conditions resulting in an inflight loss of control and an inflight collision with the ground.
32	6/7/1995	ACC	24015	MIA95FA145	91	FL	NDRK	FATL	The pilot’s loss of aircraft control due to spatial disorientation after continuing the VFR flight into instrument meteorological conditions. Factors relating to the accident were: the existing weather

									conditions and dark night.
33	3/3/2003	ACC	24015	MIA03FA071	91	FL	NITE	FATL	The pilot's inadequate in-flight planning/decision by his continued VFR flight into instrument meteorological condition after receiving an in-flight weather advisory. Also causal was his failure to maintain aircraft control.
34	3/15/2003	ACC	24015	ATL03FA062	91	GA	NDRK	FATL	The pilot continued visual flight into instrument meteorological conditions, and his

									failure to maintain altitude/terrain clearance.
35	4/26/2007	ACC	24015	ATL07FA08 1	91	GA	DAYL	FATL	The pilot's improper decision to continue visual flight rules flight into instrument meteorological conditions, with a low cloud ceiling, over mountainous terrain.
36	8/9/2014	ACC	401	ERA14FA37 7	91	GA	NITE	FATL	The non-instrument-rated pilot's inadequate preflight weather planning and his improper decision to attempt a visual flight rules flight in night instrument metrological

									conditions, which resulted in subsequent collision with terrain.
37	1/31/2004	ACC	24015	LAX04FA113	91	HI	NITE	FATL	The pilot's disregard for an in-flight weather advisory, his likely encounter with marginal VFR or IMC weather conditions, his decision to continue flight into those conditions, and failure to maintain an adequate terrain clearance altitude.
38	11/18/1995	ACC	24015	SEA96FA021	91	ID	DAYL	FATL	Improper planning/decision by the pilot, his

									resultant VFR flight into instrument meteorological conditions (IMC), and his failure to maintain altitude and clearance from mountainous terrain. Factors relating to the accident were: the adverse weather conditions.
39	2/18/1996	ACC	24015	CHI96FA094	91	IL	NDRK	FATL	VFR flight by the pilot into instrument meteorological conditions (IMC), and subsequent loss of aircraft control, probably due to spatial

									disorientation of the pilot. Factors relating to the accident were: darkness and reduced visibility due to the weather.
40	4/14/1993	ACC	24015	CHI93FA137	91	IN	NDRK	FATL	The pilot in command’s failure to maintain aircraft control. Factors were fog and drizzle, and the pilot in command’s continuing VFR flight into IMC conditions.
41	9/5/1992	ACC	24015	CHI92FA266	91	KS	NDRK	FATL	The pilot in command’s (CFI) failure to maintain the airplane.
42	3/21/2004	ACC	24015	NYC04FA092	91	KY	NITE	FATL	The pilot's improper decision

									to continue VFR flight into IMC conditions and his failure to maintain terrain clearance, which resulted in controlled flight into terrain. Factors were night, snow, and a low ceiling.
43	9/1/1996	ACC	24015	FTW96FA368	91	LA	NDRK	FATL	VFR flight into instrument meteorological conditions (VMC), and failure of the pilot (PIC) to maintain control of the airplane after becoming spatially disorientation. Factors relating to the accident were

									darkness and the adverse weather condition.
44	1/15/2001	ACC	24015	NYC01LA132	91	MA	NITE	FATL	The pilot's improper decision to takeoff and attempt VFR flight in IMC conditions.
45	9/9/2008	ACC	401	NYC08LA310	91	MD	DUSK	FATL	The pilot's inadequate preflight weather evaluation which resulted in an attempted landing in fog and subsequent impact with terrain.
46	9/27/2004	ACC	24015	CHI04FA284	91	MN	NDRK	FATL	The pilot's inadequate weather evaluation that resulted flight into night instrument meteorological

									conditions and a subsequent loss of aircraft control. Factors to the accident were the pilot's lack of recent night experience and the low cloud ceiling.
47	7/18/2002	ACC	24015	CHI02FA193	91	MO	DAYL	FATL	The inadequate preflight planning/preparation, the flight into instrument meteorological conditions, and lack of instrument certification by the pilot. Contributing factors were fog/clouds and the pilot's nondisclosure of

									his physical condition.
48	11/14/2004	ACC	24015	MIA05FA028	91	MS	DAYL	FATL	The pilot's inadvertent flight into instrument meteorological conditions and his in-flight loss of control, resulting in overstress of the airframe and subsequent structural failure.
49	9/7/1995	ACC	24015	SEA95FA209	91	MT	DAYL	FATL	Clearance from the ground was not maintained while attempting a VFR flight into IMC weather conditions. A factor to the accident was fog.

50	1/27/1991	ACC	24015	ATL91FA043	91	NC	DUSK	FATL	The inadvertent flight into instrument meteorological conditions in mountainous terrain by the non-instrument rated pilot.
51	10/16/1991	ACC	24015	ATL92FA008	91	NC	DAYL	FATL	The inadvertent flight from visual flight rules flight conditions into instrument flight rules flight conditions by the non-instrument rated pilot, and his subsequent failure to maintain control of the aircraft.
52	4/25/1992	ACC	24015	ATL92FA090	91	NC	NDRK	FATL	The pilot's failure to adequately

									evaluate the weather information and his continued flight into instrument meteorological conditions, which resulted in a collision with high terrain. A factor was the dark night.
53	11/14/2009	ACC	401	ERA10FA062	91	NJ	DAYL	FATL	The non-instrument-rated pilot's decision to depart into known instrument meteorological conditions, which resulted in his spatial disorientation and overcontrol of the airplane and the

									subsequent in-flight structural failure.
54	2/5/1998	ACC	24015	FTW98FA121	91	NM	DUSK	FATL	The pilot attempting VFR flight into instrument meteorological conditions and his lack of an instrument rating. Factors were weather conditions that included mountain wave activity conducive to turbulence, and clouds obscuring the mountainous terrain.
55	3/9/2009	ACC	401	CEN09FA195	91	NM	NITE	FATL	The pilot's continued visual flight into

									instrument meteorological conditions. Contributing to the accident were the pilot's recent usage of alcohol and his subsequent impairment.
56	1/28/1992	ACC	24015	LAX92LA105	91	NV	DAYL	FATL	The pilot’s delay in reversing direction, his continued flight into instrument meteorological conditions, his failure to maintain adequate airspeed and inadvertent stall while maneuvering to reverse direction.
57	10/29/1992	ACC	24015	LAX93FA045	91	NV	DAYL	FATL	The pilot’s decision to attempt

									VFR flight into instrument meteorological conditions, which included mountain obscurement and sever mixed icing, and his failure to maintain control of the aircraft due to a probable aerodynamic stall.
58	6/4/1993	ACC	24015	LAX93FA246	91	NV	DAYL	FATL	The pilot's continuation of VFR flight into instrument meteorological conditions. Factors which contributed to the accident were: the adverse weather conditions and

									mountainous terrain.
59	6/6/1993	ACC	24015	LAX93LA24 4	91	NV	DAYL	FATL	The pilot disregarding the advice that visual flight rules were not recommended; the pilot's inadequate weather evaluation along his route of flight; the pilot attempting flight into known adverse weather conditions; the pilot's loss of aircraft control.
60	5/18/1994	ACC	24015	FTW94FA16 5	91	NV	DAYL	FATL	The pilot's continued flight into instrument meteorological conditions (IMC),

									and his failure to maintain altitude (or clearance) from mountainous terrain. Factors related to the accident were: the adverse weather conditions and high mountainous/hilly terrain.
61	12/24/1994	ACC	24015	LAX95LA060	91	NV	DAYL	FATL	The pilot's intentional continued flight into instrument meteorological conditions in mountainous terrain.
62	7/23/1997	ACC	24015	LAX97FA334	91	NV	DAYL	FATL	The pilot's attempted visual flight into

									instrument meteorological conditions which resulted in his spatial disorientation and a loss of airplane control. A contributing factor was his overconfidence in his personal ability.
63	10/29/1998	ACC	24015	LAX99FA020	91	NV	DAYL	FATL	The non-instrument rated pilot's failure to maintain control of the airplane during an attempted flight into adverse weather which resulted in inadvertent VFR

									flight into instrument meteorological conditions.
64	10/23/2004	ACC	24015	LAX05LA014	91	NV	DAYL	FATL	The pilot's likely inadvertent entry into instrument meteorological conditions created by the rapidly changing cloud conditions that resulted in his spatial disorientation and exceeding the glider's ultimate design loads while in a spiral dive.
65	5/12/2005	ACC	24015	LAX05FA167	91	NV	DAYL	FATL	The pilot's continued VFR cruise flight into instrument

										meteorological conditions in mountainous terrain, and his failure to maintain clearance from terrain. A contributing factor was mountain obscuration and clouds.
66	5/28/2011	ACC	401	WPR11FA24 1	91	NV	DAYL	FATL	The pilot's continued visual flight rules flight into instrument meteorological conditions, which resulted in a controlled collision with terrain.
67	7/24/2007	ACC	24015	NYC07FA17 3	91	NY	NITE	FATL	The pilot's inadequate in flight decision and

									failure to maintain aircraft control during cruise flight. Contributing to the accident were inadequate preflight planning, dark night, and poor weather conditions.
68	8/24/2001	ACC	24015	NYC01FA215	91	OH	DAWN	FATL	The pilot's improper decision to attempt a visual landing under instrument meteorological conditions and his failure to maintain adequate altitude/clearance, which resulted in an in-flight

									collision with trees. A factor in this accident was the ground fog.
69	11/17/1993	ACC	24015	FTW94FA036	91	OK	NBRT	FATL	The pilot in command's continued VFR fight into IMC. A factor was fog.
70	12/30/2006	ACC	24015	SEA07LA040	91	OR	DAYL	FATL	The loss of engine power during maneuvering flight due to carburetor icing, and inadvertent flight into instrument meteorological conditions. Factors were the ambient weather conditions conducive to

									carburetor icing and fog.
71	10/8/1996	ACC	24015	NYC97FA00 4	91	PA	NDRK	FATL	Continued VFR flight by the pilot into instrument meteorological conditions, and his failure to maintain altitude and/or clearance from high terrain. Factors relating to the accident were: darkness, low ceiling, fog, and high (mountainous) terrain.
72	6/7/1992	ACC	24015	ATL92GA12 1	91	SC	NDRK	FATL	The pilot's inadvertent flight into IMC, which resulted in an in-flight collision

									with trees. Factors were the obscured sky and foggy weather conditions, and the night lighting conditions at the time of the accident.
73	11/16/1998	ACC	24015	ATL99FA019	91	SC	DAYL	FATL	The pilot continued VFR flight into IMC conditions and lost control of the airplane due to spatial disorientation. Factors were foggy weather conditions and self-induced stress.
74	9/25/2009	ACC	401	ERA09FA537	91	SC	NDRK	FATL	The pilot's decision to

									continue the visual flight rules flight into an area of instrument meteorological conditions, which resulted in the pilot’s spatial disorientation and a loss of control of the helicopter.
75	3/25/2010	ACC	401	ERA10MA188	91	TN	NITE	FATL	The pilot’s decision to attempt the flight into approaching adverse weather, resulting in an encounter with a thunderstorm with localized instrument meteorological conditions, heavy

									rain, and severe turbulence that led to a loss of control.
76	11/12/2013	ACC	401	CEN14FA051	91	TX	DAYL	FATL	The non-instrument-rated private pilot's decision to continue a visual flight rules flight into instrument meteorological conditions, which resulted in the loss of airplane control. Contributing to the accident was the pilot’s failure to obtain a weather briefing.
77	11/24/2002	ACC	24015	FTW03FA048	91	UT	DUSK	FATL	The pilot's inadequate inflight planning/decision to continue flight

									from visual to instrument meteorological conditions, which resulted in his failure to maintain clearance from terrain while in cruise flight. A low ceiling, obscuration, and mountainous terrain were contributing factors.
78	2/26/2011	ACC	401	WPR11FA147	91	UT	DAYL	FATL	The pilot's loss of control of the airplane due to spatial disorientation after inadvertently entering instrument meteorological

									conditions. Contributing to the accident were the pilot's inadequate preflight preparation, and his enroute decision-making.
79	10/8/1992	ACC	24015	NYC93FA01 2	91	VA	NDRK	FATL	The improper decision by the non-instrument-rated pilot to continue VFR flight into known instrument meteorological conditions resulting in spatial disorientation and loss of control of the airplane.
80	2/11/2000	ACC	24015	IAD00LA02 1	91	VA	DAYL	FATL	The pilot's continued flight

									from visual flight rules into instrument meteorological conditions.
81	5/29/2009	ACC	401	ERA09FA311	91	VA	DAYL	FATL	The pilot's continued visual flight into instrument meteorological conditions, which resulted in controlled flight into terrain.
82	8/3/2004	ACC	24015	SEA04FA154	91	WA	NDRK	FATL	The pilot's VFR flight into IMC and his failure to maintain clearance from trees. Trees, mountainous terrain, dark night conditions, clouds and VFR flight

									into IMC were factors.
83	6/7/2003	ACC	24015	CHI03FA151	91	WI	NITE	FATL	The pilot failed to maintain control of the airplane after encountering instrument meteorological conditions during takeoff. Factors associated with the accident were the low ceiling, fog, and lack of instrument rating.
84	3/20/2011	ACC	401	CEN11FA24 0	91	WI	DAYL	FATL	The student pilot's inadequate preflight planning and his decision to continue the flight into instrument meteorological conditions, which

									resulted in a subsequent loss of airplane control.
85	10/2/2011	ACC	401	ERA12FA012	91	WV	NDRK	FATL	The non-instrument rated pilot's improper decision to continue visual flight into instrument meteorological conditions, which resulted in spatial disorientation and subsequent in-flight collision with mountainous terrain.