UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

RC-135V, T/N 64-14848

55TH WING

OFFUTT AIR FORCE BASE, NEBRASKA

LOCATION: OFFUTT AIR FORCE BASE, NEBRASKA

DATE OF ACCIDENT: 30 APRIL 2015

BOARD PRESIDENT:

LIEUTENANT COLONEL WILLIAM M. EVANS, JR.

Conducted IAW Air Force Instruction 51-503

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR COMBAT COMMAND
JOINT BASE LANGLEY-EUSTIS VA

OFFICE OF THE VICE COMMANDER
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AUG 0 3 2015

ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 30 April 2015 mishap, near Offutt Air Force Base, Nebraska, involving an RC-135, T/N 64-14848, assigned to the 343rd Reconnaissance Squadron, 55th Wing, Offutt Air Force Base, Nebraska, complies with applicable regulatory and statutory guidance; on that basis it is approved.

JERRY D. HARRIS, JR.
Major General, USAF
Vice Commander

EXECUTIVE SUMMARY
AIRCRAFT ACCIDENT INVESTIGATION

RC-135V, T/N 64-14848
OFFUTT AIR FORCE BASE, NEBRASKA
30 APRIL 2015

On 30 April 2015, at approximately 1825 local time (L), the mishap aircraft (MA), an RC-135V, Tail Number 64-14848, assigned to the 343rd Reconnaissance Squadron, 55th Wing, Offutt Air Force Base (AFB), Nebraska (NE), experienced a fire in the rear cabin during initial takeoff. The MA and its crew were conducting a routine training mission in support of an Air Force Special Operations Command exercise. The Mishap Crewmembers (MC) consisted of cockpit crew, electronic warfare officers, intelligence operators and in-flight maintenance technicians. The Mishap Pilot aborted the takeoff, and all 27 MC safely evacuated the MA. Four crewmembers received treatment for minor smoke inhalation.

Fire crews arrived at approximately 1829L and extinguished the flames. The fire burned a hole through the upper fuselage above the rear galley area of the MA, causing structural damage and damage to aircraft control and mission related systems. Repair cost to the MA is estimated at $62.4 million. There were no injuries to civilians or damage to private property.

The board president found by preponderance of the evidence that the cause of the mishap was a leak in the high-pressure oxygen system due to poor assembly of the system tubing at depot maintenance.

Failure by L3 Communications depot maintenance personnel to tighten a retaining nut connecting a metal oxygen tube to a junction fitting above the galley properly caused an oxygen leak. This leak created a highly flammable oxygen-rich environment that ignited. The resulting fire melted the retaining nut causing the tubing to become detached from the junction fitting, feeding more oxygen to the fire, increasing its size, and causing severe damage to the airframe, galley, and mission equipment onboard the aircraft.

SUMMARY OF FACTS AND STATEMENT OF OPINION
RC-135V, T/N 64-14848
OFFUTT AIR FORCE BASE, NEBRASKA

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ACRONYMS AND ABBREVIATIONS

1 Lt	First Lieutenant
25 AF	Twenty-Fifth Air Force
55 AMU	55th Aircraft Maintenance Unit
55 ISS	55th Intelligence Support Squadron
55 MXG	55th Maintenance Group
55 MXS	55th Maintenance Squadron
55 OG	55th Operations Group
55 WG	55th Wing
97 IS	97th Intelligence Squadron
343 RS	343rd Reconnaissance Group
ACC	Air Combat Command
AF	Air Force
AFB	Air Force Base
AFE	Air Flight Equipment
AFEM	Aircrew Flight Equipment Member
AFI	Air Force Instruction
AFSEC	Air Force Safety Center
AIB	Accident Investigation Board
ATC	Air Traffic Control
Capt	Captain
CMSgt	Chief Master Sergeant
Col	Colonel
CTR	Contractor
DoD	Department of Defense
ECS	Environmental Control System
EOS	Emergency Oxygen System
EPS	Emergency Power System
FL	Flight Lead
FLCS	Flight Control System
FPM	Feet Per Minute
FPS	Fire Protection System
FRC	Fault Reporting Codes
ft	Feet
IASE	Instructor Airborne Systems Engineer
IAW	In Accordance With
IP	Instructor Pilot
IMDS	Integrated Maintenance Data System
KIAS	Knots Indicated Airspeed
kts	Knots
L	Local Time
Lt Col	Lieutenant Colonel
MA	Mishap Aircraft
Maj	Major
MAJCOM	Major Command
MAMS	Mishap Airborne Mission Supervisor
MASE	Mishap Airborne Systems Engineer
MCO	Mishap Cryptologic Operator
MCP	Mishap Co-Pilot
MFF	Mishap Firefighter
MHFC	Mental Health Flight Commander
MM	Mishap Mechanic
MMX	Production Superintendent
MN	Mishap Navigator
MP	Mishap Pilot
MR	Mishap Raven
MSgt	Master Sergeant
MTC	Mishap Tactical Coordinator
OG	Operations Group
Ops Tempo	Operations Tempo
OSS	Operation Support Squadron
PA	Public Affairs
PHA	Physical Health Assessment
PR	Pre Flight
PSI	Pounds Per Square Inch
QA	Quality Assurance
QT	Quick Turn Inspection
SIB	Safety Investigation Board
SrA	Senior Airman
SSgt	Staff Sergeant
TCTO	Time Compliance Technical Order
T/N	Tail Number
T.O.	Technical Order
TPS	Technical Process Specification
TSgt	Technical Sergeant

The above list was compiled from the Summary of Facts, the Statement of Opinion, the Index of Tabs, and Witness Testimony (Tab V).

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 8 June 2015, Major General Jerry D. Harris, Jr., Vice Commander, Air Combat Command (ACC), appointed Lieutenant Colonel William M. Evans, Jr., to conduct an aircraft accident investigation of a mishap that occurred on 30 April 2015, involving an RC-135V aircraft, Tail Number (T/N) 64-14848, at Offutt Air Force Base (AFB), Nebraska (NE) (Tab Y-1). The aircraft accident investigation was conducted in accordance with Air Force Instruction (AFI) 51-503, *Aerospace and Ground Accident Investigations*, at Offutt AFB, NE, from 12 June 2015 through 30 June 2015. Also appointed to the board were a Legal Advisor (Major), a Pilot member (Capt), a Maintenance member (Technical Sergeant), and a Recorder (Technical Sergeant) (Tabs Y-1, Y-2).

b. Purpose

In accordance with AFI 51-503, *Aerospace and Ground Accident Investigations*, this accident investigation board conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force aerospace accident, prepare a publicly-releasable report, and obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action.

2. ACCIDENT SUMMARY

On 30 April 2015, at approximately 1825 local time (L), the mishap aircraft (MA), an RC-135V, T/N 64-14848, assigned to the 343rd Reconnaissance Squadron (343 RS), 55th Wing (55 WG), Offutt AFB, NE, experienced a fire in the rear cabin during initial takeoff on Runway 12 at Offutt AFB, NE (Tabs N-2, CC-1, CC-2). The MA and its crew were conducting a routine training mission in support of an exercise in conjunction with Air Force Special Operations Command (Tab AA-1). The MA was traveling at approximately 45 knots when the Mishap Pilot (MP) successfully aborted takeoff. All 27 Mishap Crewmembers (MC) egressed the MA safely (Tab V-6.1). Four crewmembers received treatment for minor smoke inhalation (Tab V-6.1). The fire burned a sizable hole through the upper fuselage above the rear galley area of the MA and caused damage to aircraft structure, control systems and mission related systems (Tabs S-1.11, Z-1.4, Z-1.5, Z-1.7). Repair cost to the MA is estimated at $62.4 million (Tab P-3). There were no injuries to civilians or damage to private property (Tabs P1-P3).

3. BACKGROUND

The MA belonged to the 343 RS stationed at Offutt AFB, NE. The 343 RS is a squadron within the 55th Operations Group (55 OG). The 55 OG is, in turn, part of the 55 WG which is located at Offutt AFB, NE.

a. 55th Wing (55 WG)

The 55 WG is Air Combat Command's largest wing with a budget of more than $477 million annually, 49 aircraft, 32 squadrons and more than 7,000 employees. The wing conducts a global flying mission with worldwide reconnaissance and treaty verification tasked by our nation's highest levels as well as the National Airborne Operations Center. Additionally, it provides base support to more than 50 associate units, including U.S. Strategic Command, the Air Force Weather Agency and a military community of more than 57,000. The wing is comprised of six groups, five located at Offutt AFB, NE, and one at Davis-Monthan AFB, Arizona (Tab DD-1).

b. 55th Operations Group (55 OG)

The 55 OG is the largest and most diverse operations group in the Air Force, flying all variants of the RC-135, OC-135, WC-135 and E-4B aircraft. The group operates these aircraft around the clock in every geographic command in support of the 55th's global reconnaissance, contingency operations, treaty verification, National Command Authority support and command and control responsibilities. Permanent overseas operating locations include RAF Mildenhall, England, Souda Bay Naval Support Activity, Crete and Kadena Air Base (AB), Japan. The 55 OG is located at Offutt AFB, NE (Tab DD-2).

c. 343rd Reconnaissance Squadron (343 RS)

The mission of the 343rd Reconnaissance Squadron is to provide worldwide reconnaissance for national command authorities, Combatant Commands, the intelligence community, and war fighters. Flying the RC-135V/W Rivet Joint, the 343 RS provides near real-time on-scene intelligence collection, analysis and dissemination capabilities. The squadron supports worldwide missions of the Department of Defense to keep the United States aware of its potential adversaries (Tab DD-3).

d. RC-135V/W Rivet Joint

The RC-135V/W Rivet Joint reconnaissance aircraft supports theater and national level consumers with near real time on-scene intelligence collection, dissemination and analysis capabilities. The Rivet Joint is an extensively modified C-135 which contains an on-board sensor suite which allows the mission crew to detect, identify and geolocate signals throughout the electromagnetic spectrum. The mission crew can then forward gathered information in a variety of formats to a wide range of consumers via Rivet Joint's extensive

communications suite. The interior seats more than 30 people, including the cockpit crew, electronic warfare officers, intelligence operators and in-flight maintenance technicians. All Rivet Joint airframe and mission systems modifications are overseen by L-3 Communications (previously Raytheon), under the oversight of Air Force Materiel Command. (Tab DD-4).

e. L-3 Communications

L-3 Communications is a prime contractor in aerospace systems and national security solutions. L-3 is also a leading provider of a broad range of communication and electronic systems and products used on military and commercial platforms. L-3 Mission Integration Division is a world-class systems integration organization specializing in the complex ISR capabilities and equipment, aircraft modification and maintenance, command, control and communications, network-enabling technologies and full life-cycle systems support and sustainment (Tab DD-5).

4. SEQUENCE OF EVENTS

a. Mission

The mishap mission was planned and briefed to support an exercise in the southern continental United States (Tab AA-1). The MC, in conjunction with the exercise staff, planned an 8-hour mission that included air refueling and a mission orbit (Tab K-1.1). The 343 RS Commander and the squadron Operations Supervisor properly authorized the mission (Tab K-1.2).

b. Planning

The MC planned and conducted pre-mission briefings on the day prior to the mishap, in accordance with all applicable directives (Tabs AA-1, V-1.1, R-2.1). During the full-crew brief, the MC briefed expected and contingency mission scenarios (Tabs V-1.1, R-2.1). Additionally, the MC discussed general emergency procedures, takeoff emergencies, and egress procedures (Tabs V-1.1, R-2.1).

c. Preflight

On the day of the mission, the MC filed their flight plan and reviewed both weather and Notices to Airmen at the 343 RS prior to stepping to the aircraft (Tabs V-1.1, R-2.1, K-1, K-2). Takeoff emergencies were reviewed by the MC prior to engine start (Tabs V-1.1, R-2.1, K-1, K-2). As part of the preflight routine, the MC conducted an exterior and an interior inspection of the aircraft. These portions of the MC preflight were uneventful with two exceptions (Tabs V-1.1, R-2.1). The MC noted a minor issue with the lavatory located in the rear compartment (Tabs V-1.1, R-2.1). The MC also noted a malfunctioning starter valve on the inboard left engine, which was rectified using a manual starter valve operation (Tabs V-1.1, R-2.1). The total delay caused by these two issues was approximately 30 minutes (Tab V-6.1).

d. Summary of Accident

The MA taxied to Runway 12 without incident (Tabs V-1.1, R-2.1). The MC confirmed departure clearances and were cleared for takeoff at 18:24L (Tabs CC-2, N-2). The MP, sitting in the left seat, was planning to fly the takeoff with backup from the Mishap Co-Pilot (MCP) (Tabs V-1.1, R-2.1). The MP accomplished an engine check by increasing the engine throttles of the aircraft out of idle prior to releasing the brakes (Tabs V-1.1, R-2.1). The MP then released the brakes and passed control of the throttles to the MCP (Tabs V-1.1, R-2.1). The MCP then began to increase throttles to the planned takeoff setting which caused the aircraft to start moving down the runway (Tabs V-1.1, R-2.1). As the MA passed approximately 45 knots, multiple crewmembers in the rear compartment of the aircraft reported seeing a fire above the galley of the aircraft (Tabs R-6.1, R-8.1, R-12.1, V-2.1, V-3.1, V-4.1).

e. Impact

Not applicable.

f. Egress and Aircrew Flight Equipment (AFE)

All AFE was properly constructed, placed and inspected correctly (Tab H-4). After the radio call to the ATC tower reporting a fire, the aircraft was parked and cleared of all MC in approximately 4 minutes (Tabs CC-1, CC-2). The egress itself, from first person to the last person out of the aircraft, took approximately 2 minutes and 45 seconds (Tab CC-1). There were no egress related injuries. Four crewmembers received treatment for minor smoke inhalation (Tab V-6.1).

g. Search and Rescue (SAR)

Not applicable.

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

At the time of the mishap, the MA total airframe time was 39,422.9 hours (Tab D-2.2). A review of the active AFTO 781 forms and AFTO 781 historical records for the time period 90 days preceding the mishap revealed no discrepancies indicating any electrical or oxygen system anomalies existed on the MA (Tabs D-2.1 through D-2.4, U-4). The Integrated Maintenance Data System (IMDS) historical records for 90 days prior to the mishap were used to validate and confirm all form entries (Tabs U-4, BB-2). No open Time Compliance Technical Orders (TCTOs) restricted the MA from flying (Tab D-2.4). A review of the historical records showed all TCTOs had been accomplished in accordance with applicable guidance (Tab U-4). There were no TCTO compliance issues relevant to the mishap (Tabs D-2.4, U-4).

The MA flew a 5.7 hour mission earlier on the day of the mishap (Tab D-2.2). The flight crew noted three minor discrepancies that were unrelated to the mishap (Tab D-2.3). There were no maintenance discrepancies that would have prevented the MA from accomplishing its tasked mission on 30 April 2015 (Tabs D-2.2 through D-2.4). Historical records revealed only two repeat/recur maintenance discrepancies with the MA, neither of which were related to the mishap and both were corrected prior to the date of the mishap (Tab U-4).

b. Inspections

(1) Mishap Aircraft

Every 4 years, each RC-135 aircraft rotates through the depot facility for Programmed Depot Maintenance (PDM) (Tab BB-1). This process is an inspection and correction of defects requiring equipment and/or facilities not normally available at operating locations (Tab BB-1). The MA was delivered to Offutt AFB, NE, on 19 June 2014 after it had completed PDM (Tab U-1).

Isochronal inspections, also referred to as phase inspections, are regularly-scheduled maintenance inspections performed on Air Force aircraft (T.O. 1C-135-6WC-2). Isochronal inspections are conducted on RC-135 aircraft after a period of 24 months, 1,800 flying hours, or 1,000 landings, whichever comes first (T.O. 1C-135-6WC-2). The RC-135 also has a 900-hr inspection due every 900 hours or 12 months and a 60 day Hourly Post Flight (HPO) (T.O. 1C-135-6WC-1, T.O. 1C-135-6WC-7).

The last scheduled inspection accomplished on the MA was an HPO, which was accomplished on 23 March 2015 (Tab U-4.27). The next scheduled isochronal inspection was scheduled for 11 February 2016 (Tab D-2.4). The MA had approximately 287 days remaining before the next isochronal inspection due date (Tab D-2.4).

Prior to its first flight on 30 April 2015, maintenance personnel conducted a preflight (PR) inspection on the MA (Tab D-2.2). PR inspections are accomplished prior to the first flight of the flying period and are valid for 72 hours (T.O. 1C-135-6WC-1). The preflight was signed off at 2230L on 29 April 2015 and had another 52.5 hours of validity as of the scheduled take off time for the MA (Tab D-2.2, T.O. 1C-135-6WC-1). Additionally, between flights personnel performed a QT inspection at 1500L on the day of the mishap (Tab D-2.2). This type of inspection is used when the aircraft downtime will not exceed 12 hours (T.O. 1C-135-6WC-1). The inspection was valid at the time of the mishap (Tab D-2.2). The maintenance documentation confirmed all inspections were accomplished satisfactorily in accordance with applicable maintenance directives (Tab D-2.2).

c. Maintenance Procedures

A review of active and historical AFTO Form 781 series aircraft maintenance forms revealed no discrepancies indicating a deviation from established maintenance procedures on the MA (Tabs D-2.1 through D-2.4, U-4). A thorough review of the active AFTO 781 forms and AFTO 781 historical records for the time period 90 days preceding the mishap revealed only minor inconsequential documentation errors; no actual maintenance deviation was identified

(Tabs D-2.1 through 2.4, U-4, BB-2). The IMDS historical records for 90 days prior to the mishap were used to validate and confirm all form entries (Tabs U-4,BB-2).

Review of the AFTO 781 historical records revealed no oxygen system maintenance was accomplished or required in the area of the fire since the aircraft returned from PDM (Tab U-4). A 12-month hot gas purge of the oxygen system, which removes any residual moisture from the system, was complied with on 11 February 2015 (Tab U-4.37). Maintenance documentation indicates this task was accomplished satisfactorily in accordance with applicable maintenance directives (Tab U4.37).

During PDM, L-3 Communications inspects, cleans, and reinstalls the oxygen system using documents known as Technical Process Specifications (TPS) to complete assigned tasks (Tabs U-2, U-3). TPS3-100, *Installation of Oxygen Systems*, instructs the technician on proper alignment, initial torqueing, leak checking, and final torqueing of the oxygen system fittings (Tab U-2). According to L3 Communications' work order number 76596949, L3 Communications personnel completed these tasks on 21 August 2013 (Tab U-3).

d. Maintenance Personnel and Supervision

All preflight activities were normal and all personnel involved in the preflight and launch of the MA were qualified (Tabs T-1 through T-8, V-5.1, V-9.1). Maintenance supervisors were engaged in daily maintenance activities and were actively involved in the repair and launch of aircraft (Tab V-5.1). A thorough review of individual military training records on all personnel who performed maintenance on the MA indicated maintenance personnel were trained on all assigned tasks (Tabs T-1 through T-8).

e. Fuel, Hydraulic, and Oil Inspection Analyses

Fuel, oil, hydraulic fluid and liquid oxygen samples were taken from the MA after the mishap. The tests revealed no abnormalities with any of the aircraft fluids (Tabs D-5.1 through D-5.4).

f. Unscheduled Maintenance

A review of all aircraft maintenance activities on the MA for 90 days preceding the mishap revealed no discrepancies related to the mishap (Tabs D-2.1 through D-2.4, U-1). A review of IMDS and AFTO 781 maintenance records (90 days prior to the mishap) revealed two repeat/recur Pilot Reported Discrepancies (PRD), neither of which were related to the mishap (Tab U-4). All corrective actions were completed in accordance with applicable technical data (Tabs D2.1 through D2.4, U-4).

6. AIRFRAME SYSTEMS

a. Structures and Systems

Damage to the MA was photographed immediately following the mishap (Tabs S-1.1 through S-1.5). The aircraft sustained substantial structural damage, including fire damage to several vertical and lengthwise structural components to the fuselage known as frames and stringers.

The fire also burned a sizable hole through the aircraft skin (Tabs S-1.11, Z-1.4, Z-1.5, Z-1.7).

Figure 1. Damage to Fuselage (Tabs S-1.11, Z-1.4, Z-1.5, Z-1.7)

The mishap rendered a number of aircraft systems inoperable (Tab S-1.9). The MA sustained substantial damage to the oxygen system and electrical input to the rudder power control unit. An antenna located at the site of the hole in the fuselage was also damaged (Tabs S-1.2, S-1.9 through S-1.11). Portions of the crew rest area in the rear compartment and the entire aircraft galley were severely damaged (Tab S-1.3). See Figures 2 and 3. Additionally, the fire caused substantial damage to a number of aircraft mission systems (Tabs S-1.3, S-1.11).

Figure 2. Undamaged Galley Area, RC-135V/W (Tab Z-1.10)

Figure 3. Galley Area of T/N 64-14848 (Tab S-1.9)

b. Evaluation and Analysis

(1) Oxygen System: Overview

The Air Force Research Laboratory/Materials Integrity Branch (AFRL/RXSA) provided on-site and laboratory analysis of portions of the onboard oxygen system located in the galley area of the rear compartment of the MA (Tab J-6). Members of the team collected oxygen system

components and certain wiring harnesses from the galley area in order to conduct a further detailed laboratory analysis (Tab J-6).

Figure 4 shows components of the oxygen system superimposed on an image of the MA. Figure 4 also has a numbering system for the junctions (also called joints or fittings) that will be used for reference in this report (Tab J-26). Prior to the mishap, Junction #5 was connected to Junction #11 via flex hose (Tab J-31).

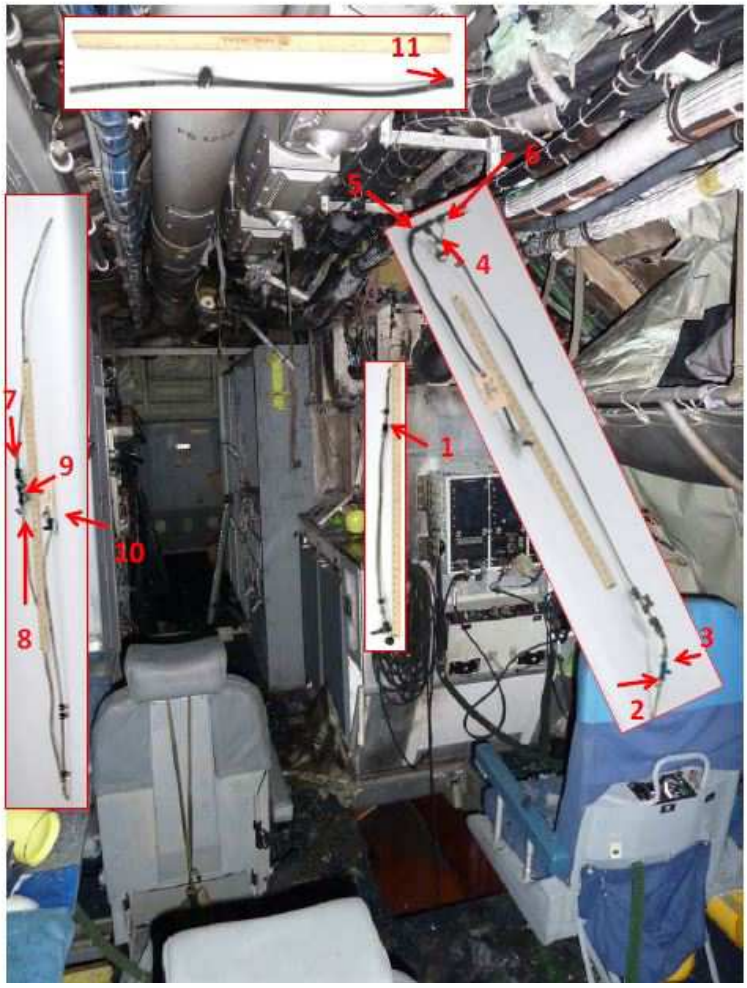

Figure 4. Oxygen System Tubing (Tab J-26).

Fittings used in the oxygen system are shown in Figure 5. The T-shaped fittings may be replaced by elbow-shaped fittings as needed (Tab J-29). These fittings are commonly referred to as "AN" fittings because each fitting has a specification that begins with "AN" (Tabs J-8, J-28). These fittings consist of four components; a male threaded end, a female nut (referred to as a B-nut), a sleeve, and a flared tube. A schematic of the system shown in Figure 5 indicates that contact between the inside of the flared tube and the male fitting cone constitutes the sealing surface of the fitting (Tab J-28). The B-nut itself does not provide sealing force to the fitting (Tab J-28). When properly tightened, the B-nut and sleeve provide clamping force to the sealing surface between the flared tube and the male fitting cone (Tab J-28).

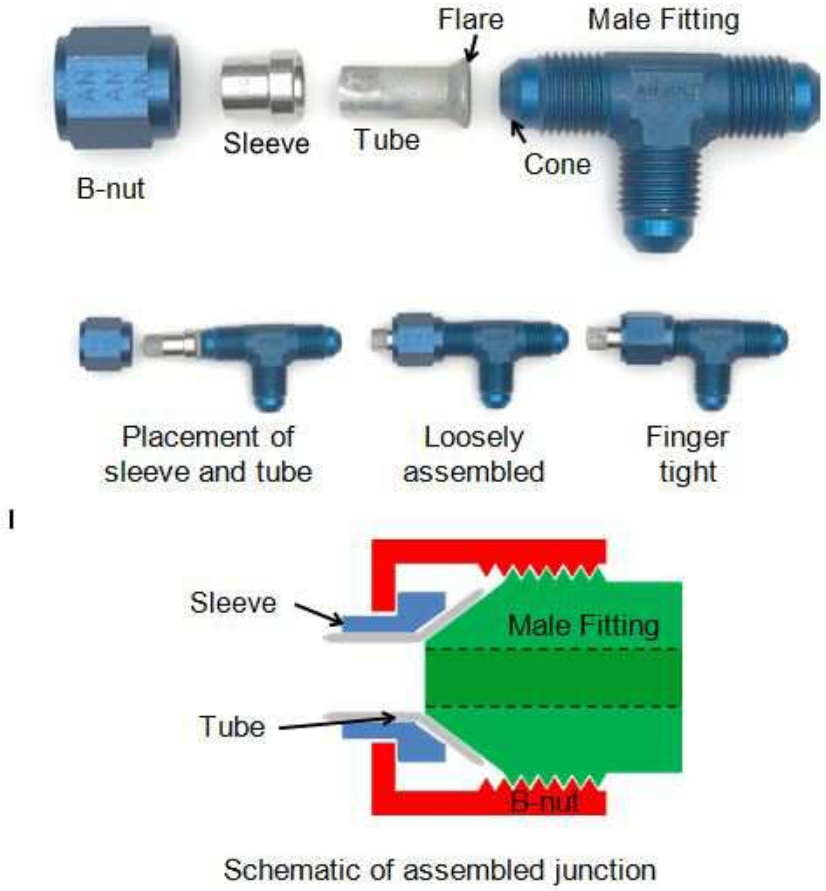

Figure 5. Oxygen System Fittings (Tab J-28).

Tightening (or torqueing) "AN" fittings to the proper specification requires initial torqueing, leak checking and final torqueing (Tab U-2.15). Initial torqueing is a two-step process which involves hand tightening the B-nut (in accordance with the schematic in Figure 5) to ensure proper alignment and a firm seal between the male cone fitting and the flared tube, and then torqueing the B-nut using a torque wrench to an initial minimum torque value (Tabs U-2.15, V-11.1). The initial minimum torque value for 5/16 inch aluminum tubing used in the MA is 100 inch-pounds (in-lbs) (Tabs U-2.16, J-9, J-30). Leak checking involves pressurizing the oxygen system to operational specifications while examining all fittings and connections using a leak test compound (Tab U-2.17). Final torqueing is required if any leaks occur and involves increasing the torque value as necessary to stop the leak, up to a maximum specified torque value (Tab U-2.15). The maximum torque value for 5/16 inch aluminum tubing used in the MA is 125 in-lbs (Tabs U-2.16, J-9, J-30). Replacement or repair is necessary if leakage cannot be stopped at the maximum torque value (Tab U-2.15).

(2) Oxygen System: Inspection and Testing

Inspection of the fittings removed from the MA revealed that the B-nuts at Junction #4, Junction #5 and Junction #11 were all finger tight (Tab J-9). Inspection of the oxygen system tubing also

revealed there was no B-nut on the other side of Junction #11 (Tab J-8). A fragment of the missing B-nut was discovered in the debris (Tab J-8). Analysis of the fragment indicated that the B-nut had melted (Tabs J-8, J-29). There was no evidence that the B-nut had forcibly passed over either the sleeve or the flared end of the corresponding tube (Tab J-8).

Figure 6 shows the male threaded end of the elbow fitting where the B-nut at Junction #11 should have been located (on the right side of the elbow) (Tab J-29). Upon disassembly of the fitting, difference in colors of the threads between the protected side (left) of the elbow fitting and the missing B-nut side (right) indicate that the left side was exposed to some combustion products (such as soot), but not as much as the missing B-nut side (Tab J-29).

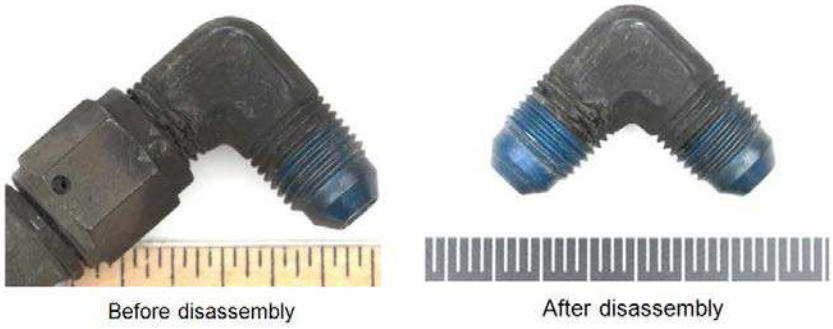

Figure 6. Elbow Fitting (Tab J-29).

Further examination of the tubing system showed the inner liner of the flex hose between Junction #11 and Junction #5 was destroyed (Tab J-8). See Figure 7. Light passing through the flex hose indicates the inner tubing is completely destroyed near Junction #5 (Tab J-31). Images of the flex hose near Junction #11 shows rumpling deformation on the inner tube, indicating exposure to heat (Tab J-31).

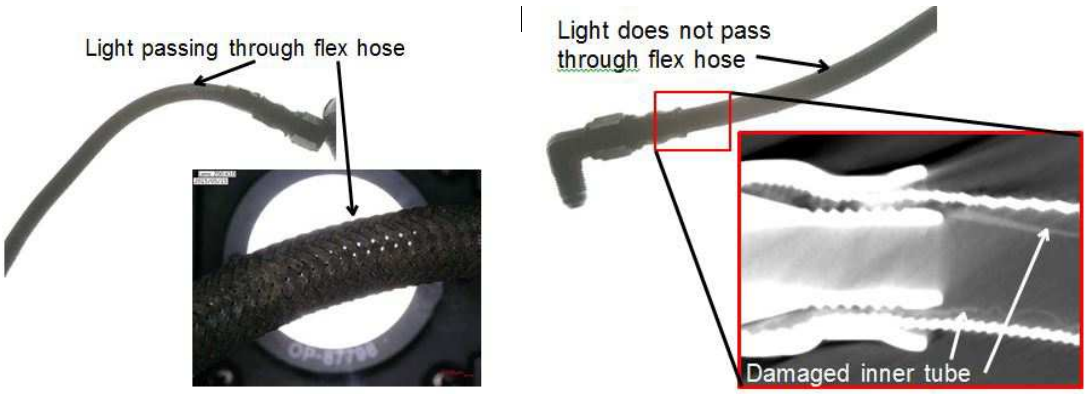

Figure 7. Flex Hose Between Junction #5 (Left) and Junction #11 (Right) (Tab J-31).

Examination of the flared ends of the tubes for each fitting indicated they all had a circular contact impression from the sleeve, through the tube coating to the base metal, except the flare at Junction #11 (also referred to as Tube #11) (Tabs J-10, J-35). See Figure 8. While the torque value at Junction #11 could not be measured due to the melted B-nut, the lack of a contact scar on Tube #11 indicates it had the lowest torque value of all the fittings examined (Tabs J-10, J-12, J-

35) .

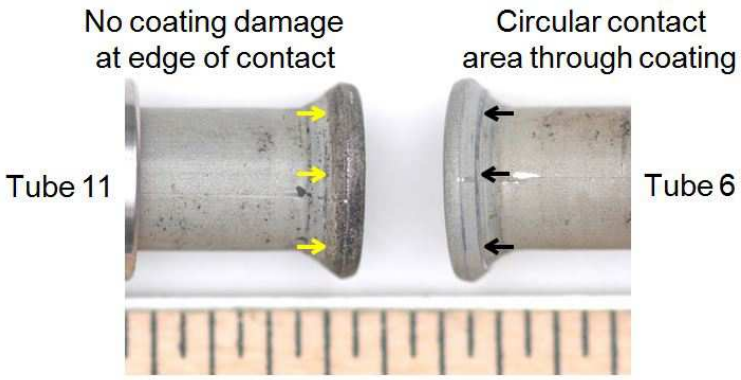

Figure 8. Flared Tube Ends (Tab J-35).

Additionally, the sleeve located at Junction #11 had significant pitting (i.e, tiny holes or "pits") on one side (Tab J-10). The pitting on this sleeve indicates the damage was directional, since it was present on one side and not the other (Tab J-10). Pitting was also found more frequently on one side of the corresponding Tube #11, just past the area the sleeve covered (Tabs J-10, J-38). No pitting damage was found beneath the sleeve (Tab J-10). The damaged B-nut fragment also had localized melting, which is consistent with damage on one side of the tube, starting at the shoulder of the B-nut (Tab J-11). Physical evidence indicates the area of high heat was localized, causing damage predominantly to one side of the sleeve and Tube #11 (Tabs J-11, J-35). The location of Tube #11 prior to removal from the MA is shown in Figure 9 (Tabs J-26, S-1.9, Z-1.1 through 1.3).

Figure 11. Location of Tube #11 Prior to Removal (Tabs J-26, S-1.9, Z-1.1 through 1.3).

AFRL/RXSA also pressure tested the oxygen system in segments using compressed nitrogen at

normal operating pressures up to 300 pounds per square inch (PSI) in conjunction with a foaming leak detectant (Tab J-9). In order to test each fitting, the damaged flex hose (between Junction #5 and Junction #11) was replaced using the flex hose connected to Junction #1 (which was undamaged in the fire), after Junction #1 had been pressure tested (Tab J-9).

As stated above, Junction #4, Junction #5 and Junction #11 were found to be finger tight during initial inspection, therefore these fittings were pressure tested finger tight (Tab J-9). In the case of Junction #11, the missing B-nut (from the other side of the elbow joint) was replaced with the B-nut from Junction #2 and tested finger tight (Tab J-9).

The oxygen system leaked at 20 PSI from Junction #4 and Junction #11 (Tab J-9). The B-nut at Junction #4 was then tightened 1/10th of a turn, but still leaked at 50 PSI (Tab J-9). Except for Junction #4 and Junction #11, all other areas of the tubing system held 300 PSI with no leaks detected (Tab J-9).

Following pressure testing, the tubing system was disassembled and the individual components examined (Tab J-9). The torque required to loosen each nut is known as breakaway torque (Tab J-9). Laboratory testing and analysis indicated that tightening torque was approximately 40 in-lbs higher than breakaway torque (Tab J-9). Therefore, adding 40 in-lbs to the measured breakaway torque values for each B-nut will indicate their approximate tightening torque values (Tab J-9). See Figure 9.

Nut Number	Breakaway Torque, in-lbs	Estimated Tightening Torque, in-lbs
1	150	190
2	40	80
3	20	60
4	50	90
5	30	70
6	30	70
7	50	90
8	60	100
9	40	80
10	130	170

Figure 9. Measured and Estimated Torque Values (Tabs J-9 and J-39).

Figure 9 indicates that only Junction #8 meets the minimum/maximum torque requirements of 100/125 in-lbs (Tabs J-9, J-39). Additionally, only Junctions #1 and #10 had breakaway torques over 100 in-lbs (Tabs J-9, J-39). As stated above, all fittings except Junctions #4 and #11 held 300 PSI prior to disassembly, notwithstanding the low estimated tightening torque values noted in Figure 5 (Tab J-9). The lack of leaking on B-nuts with very low torque values indicates that the difference between a leaking and non-leaking fitting is very small (Tab J-12). The laboratory experiments indicated that a slight rotation of the fitting can cause a large change in the leaking pressure (Tab J-12).

AFRL/RXSA also determined that the T-shaped fitting connecting Junctions #4, #5 and #6 (4/5/6 fitting) lacked required letter markings and appeared to have a parting line and a rough surface (Tab J-10). See Figure 10. Parting lines and rough surfaces are both typical of a casting, whereas a machined or forged part is required by the specifications (Tab J-10). The 4/5/6 fitting also showed uneven wear patterns, nicks, gouges, and large areas of exposed metal which would also be cause for rejection of the fitting (Tab J-10). AFRL/RXSA determined that fittings similar to the 4/5/6 fitting were last manufactured in 2003 (Tabs J-10, J-34).

Figure 10. T-Shaped Fittings. Red circle indicates a correct marking (Tab J-34).

(3) Wiring and Electrical

Visual inspection of the damaged aircraft showed the fire damage was intense and well-focused in a specific area of the rear compartment near the galley (Tab J-6). The interior area with the most severe wire damage coincided with a large hole in the fuselage (Tab J-6). Electrical system components in the direct proximity of the fire-damaged region were severely compromised (Tab J-6). Portions of cables and wiring harnesses in this area completely lacked insulation and showed signs of having partially melted (Tab J-6). AFRL/RXSA removed portions of cables and wiring harnesses for further analysis (Tab J-6).

The galley contained two refrigerators, microwave oven, convection oven, lighting, and receptacles for up to four separate beverage jugs, along with the galley control panel (Tabs J-6, J-17). The electrical connections immediately behind the galley control panel were blackened due to smoke, but showed no evidence of arcing or insulation failure (Tab J-7). The wires associated with the beverage jugs were heavily damaged, but only in the region directly under the hole in the fuselage (Tab J-7). The wires associated with the microwave and convection ovens were blackened due to smoke, but showed no evidence of arcing or insulation failure (Tabs J-7, J-23). The beverage jugs and light switches were all found in the off position (Tabs J-7, J-17).

AFRL/RXSA examined two wire harnesses supplying power to the microwave and convection ovens within the galley (Tabs J-7, J-23). Both harnesses exhibited little damage; insulation was intact and only displayed slight discoloration in areas that would have been exposed to the fire as it was burning (Tabs J-7, J-23). A 3-foot section of coaxial cable removed from the MA was also analyzed (Tabs J-7, J-24). The outer shield and visible inner conductor displayed no visual evidence of electrical arcing (Tabs J-7, J-24).

AFRL/RXSA also examined an 8-foot section of a wire harness that runs along the roof of the fuselage above the galley (Tab J-7). Overall, the harness showed exposure to a wide temperature range, with each end showing little to no heat damage, and the middle showing severe damage (Tabs J-7, J-18). Testing of the wires indicated exposure to temperatures greater than 450° Celsius for an extended period (Tabs J-7, J-18, J-19). Numerous wires had molten copper ends (Tabs J-7, J-19). Cross-sectioned samples of these ends contained voids (i.e., tiny holes), which are indicators of electrical arcing, as well as a structured grain pattern or morphology, which occurs from extended exposure to a high temperature environment (Tabs J-7, J-19). An analysis of the relatively undamaged ends of the 8-foot wire harness indicated no evidence of arcing, continuous overcurrent, or degradation to the insulation (Tab J-7). Although evidence of electrical arcs was present within the large wire bundle, many electrical lines were powered for some period after the fire occurred (Tabs J-7, J-13). It is likely that the highly localized flame removed the insulation from the wires very quickly, while power was still feeding the wires, and the wires in the bundle were then able to freely arc to each other (Tab J-13).

7. WEATHER

a. Forecast Weather

Weather at Offutt AFB, NE, was forecast for winds from 150 degrees (out of the southeast) at 06 knots, with few clouds at 25,000 feet (Tab F-1). Temperature was forecast to be +23 degrees Celsius with 7 miles visibility (Tab F-1).

b. Observed Weather

Reported weather at the time of the mishap was winds from 120 degrees (out of the southeast) at 05 knots with clear skies, a temperature of +22 degrees Celsius and visibility of 10 miles (Tab F-2). The ATC tower at Offutt AFB, NE, passed current runway winds to the MC as calm (Tab N-2).

c. Space Environment

Not applicable.

d. Operations

Weather was well within operational limits. There is no evidence to suggest that weather was a factor in this mishap.

8. CREW QUALIFICATIONS

a. Mishap Crew

The MC was current and qualified for this mission (Tabs G-1.1 through G-1.12, G-2.1 through G-2.12). A review of the 30/60/90 day look-back, flight evaluation folders, and training records for all members of the MC revealed no deficiencies related to the mishap (Tabs G-1.1 through G-1.12, G-2.1 through G-2.12).

The MP was a qualified Aircraft Commander (Tab G-1.1). The mishap flight was to be his first sortie as Aircraft Commander following an initial qualification checkride on 2 April 2015 (Tab G-1.1). He had a total of 1108.7 hours, with 834.6 hours in the RC-135V/W (Tab G-1.1.2).

His recent flight time was as follows on the day of the mishap (Tab G-1.1.3):

	Hours	Sorties
Last 30 Days	5.5	1
Last 60 Days	42.9	7
Last 90 Days	42.9	7

The MCP was a qualified and experienced Mission Copilot (Tab G-1.2). He had a total of 902.3 hours, with 660.3 hours in the RC-135V/W (Tab G-1.2.2).

His recent flight time was as follows on the day of the mishap (Tab G-1.2.3):

	Hours	Sorties
Last 30 Days	0	0
Last 60 Days	33.4	5
Last 90 Days	43.2	7

The MN was a qualified and experienced Mission Navigator (Tab G-1.3). He had a total of 1918.1 hours, with 1845.5 hours in the RC-135V/W (Tab G-1.3.2).

His recent flight time was as follows on the day of the mishap (Tab G-1.3.3):

	Hours	Sorties
Last 30 Days	11.5	3
Last 60 Days	16.7	4
Last 90 Days	16.7	4

The MTC was a qualified and experienced Instructor and Evaluator Electronic Warfare Officer (Tab G-1.5). He had a total of 2036.6 hours, with 1994.0 hours in the RC-135V/W and 259.2 hours as an Instructor (Tab G-1.5.2).

His recent flight time was as follows on the day of the mishap (Tab G-1.5.3):

	Hours	Sorties
Last 30 Days	0	0
Last 60 Days	0	0
Last 90 Days	7.5	1

The MAMS was a qualified and experienced Instructor and Evaluator Airborne Mission Supervisor. He had a total of 2100.7 hours, all in the RC-135V/W, with 120.8 hours as an Instructor (Tab G-1.7.2).

His recent flight time was as follows on the day of the mishap (Tab G-1.7.3):

	Hours	Sorties
Last 30 Days	6.8	1
Last 60 Days	35.1	5
Last 90 Days	59.9	9

9. MEDICAL

a. Qualifications

At the time of the mishap, the MC was fully medically qualified for flight duty without medical restrictions or waivers (Tab AA-2).

b. Health

The medical records for the MC, as well as their 72-hour histories were reviewed (Tabs R-1 through R-12). Medical records revealed all individuals were in good health and had no recent performance-limiting illnesses prior to the mishap. All members of the MC had current physical health assessments (Tab AA-3). No relevant medical information was noted in the medical records. Four crewmembers were treated for minor injuries related to smoke inhalation. None of these individuals required further treatment after initial treatment on the day of the mishap (Tab AA-3).

c. Pathology

Not applicable.

d. Lifestyle

There is no evidence to suggest lifestyle factors were a factor in the mishap.

e. Crew Rest and Crew Duty Time

Air Force Instructions require flight crew to have proper crew rest, as defined in AFI 11-202, Volume 3, *General Flight Rules*, 07 November 2014, prior to performing in-flight duties. Crew rest is compulsory for aircrew members prior to performing any duties involving aircraft

operations and is a minimum of 12 non-duty hours before the Flight Duty Period begins. Crew rest is free time and includes time for meals, transportation, and rest. This time must include an opportunity for at least 8 hours of uninterrupted sleep. Crew rest period cannot begin until after the completion of official duties.

A review of the duty cycles of the MC leading up to the mishap indicated they all had adequate crew rest (Tabs G-1.1 through G-1.12, R-1 through R-12). The MC was near the beginning of their 16-hour duty day when this incident occurred (Tab V-6.1).

10. OPERATIONS AND SUPERVISION

a. Operations

None of the MC reported an elevated operations tempo (i.e. more than ten flights per month) leading up to the mishap or that operations tempo was negatively affecting their ability to accomplish the mission (Tabs G-1.1 through G-1.12, R-1 through R-12).

There is no evidence to suggest that operations tempo was a factor in this mishap.

b. Supervision

The 343 RS reviewed and approved the mishap sortie (Tabs K-1.3, AA-1).

There is no evidence to suggest that 343 RS supervision was a factor in this mishap.

11. HUMAN FACTORS

a. Introduction

AFI 91-204, *Safety Investigations and Reports*, 24 September 2008, Attachment 5, contains the Department of Defense Human Factors Analysis and Classification System, which lists potential human factors that can play a role in any mishap. Human factors consider how people's tools, tasks and working environment systematically influence human performance.

b. Applicable Factors

There is no evidence that human factors contributed to this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) Air Force Instruction 11-202, Volume 3, *General Flight Rules*, 7 November 2014
(2) Air Force Instruction 11-2RC-135, Volume 3, *RC/OC/WC/TC-135 Operations Procedures*, 22 April 2010
(3) Air Force Instruction 21-101, *Aircraft and Equipment Maintenance Management*, 21 May 2015

(4) Air Force Instruction 51-503, *Aerospace and Ground Accident Investigations*, 14 April 2015
(5) Air Force Instruction 91-204, *Safety Investigations and Reports*, 12 February 2014

NOTICE: All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: http://www.e-publishing.af.mil.

b. Other Directives and Publications Relevant to the Mishap

(1) T.O. 00-25-4, *Depot Maintenance of Aerospace Vehicles and Training Equipment*, 15 January 2012
(2) T.O. 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures*, 15 June 2013
(3) TPS3-100, *Installation of Oxygen Systems* (L-3 Communications), 22 May 2014

The following T.O.s are not publically available and are subject to the Arms Export Control Act of 1976.

(4) T.O. 1C-135-6WC-1, *Preflight/Postflight/Hourly Post-Flight Inspection Workcards*, 9 January 2015
(5) T.O. 1C-135-6WC-2, *Periodic Inspection Workcards*, 15 June 2015
(6) T.O. 1C-135-6WC-7, *Hourly Inspection Workcards*, 15 June 2015

c. Known or Suspected Deviations from Directives or Publications

Evidence indicates that L-3 Communications maintenance personnel deviated from TPS3-100, *Installation of Oxygen Systems*, dated 22 May 2014, by failing to tighten the B-nuts located at Junction #4, Junction #5 and Junction #11 properly as required by paragraphs 3.5 through 3.5.2 and Table II of that publication (Tab U-2).

13. ADDITIONAL AREAS OF CONCERN

Not applicable.

30 June 2015

WILLIAM M. EVANS, Jr, Lt Col, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

RC-135V, T/N 64-14848
OFFUTT AIR FORCE BASE, NEBRASKA
30 APRIL 2015

Under 10 U.S.C. § 2254(d) the opinion of the accident investigator as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report, if any, may not be considered as evidence in any civil or criminal proceeding arising from the accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

1. OPINION SUMMARY

On 30 April 2015, at approximately 1825 local time (L), the mishap aircraft (MA), an RC-135V, Tail Number 64-14848, assigned to the 343rd Reconnaissance Squadron, 55th Wing, Offutt Air Force Base (AFB), Nebraska (NE), experienced a fire in the rear cabin during initial takeoff. The MA and its crew were conducting a routine training mission in support of an Air Force Special Operations Command exercise. The Mishap Crewmembers (MC) consisted of cockpit crew, electronic warfare officers, intelligence operators and in-flight maintenance technicians. The Mishap Pilot (MP) aborted the takeoff, and all 27 MC safely evacuated the MA. Four crewmembers received treatment for minor smoke inhalation.

Fire crews arrived at approximately 1829L and extinguished the flames. The fire burned hole through the upper fuselage above the rear galley area of the MA, causing structural damage and damage to aircraft control and mission related systems. Repair cost to the MA is estimated at $62.4 million. There were no injuries to civilians or damage to private property.

I find by preponderance of the evidence that the cause of the mishap was a leak in the high-pressure oxygen system due to poor assembling of the system tubing at depot maintenance.

Failure by L-3 Communications depot maintenance personnel to tighten a retaining nut connecting a metal oxygen tube to a junction fitting above the galley properly caused an oxygen leak. This created a highly flammable oxygen-rich environment that ignited. The resulting fire melted the retaining nut causing the tubing to become detached from the junction fitting, feeding more oxygen to the fire, increasing its size, and causing severe damage to the airframe, galley, and mission equipment onboard the aircraft.

I developed my opinion by analyzing factual data from witness testimony and information provided by subject matter experts to include technical reviews, engineering and laboratory testing, and analysis of post-mishap aircraft components.

2. CAUSE

The cause of the mishap was the failure of depot maintenance personnel to assemble the oxygen system properly, specifically the high-pressure oxygen hose connection above the galley of the MA. The improper assembly of tubing system caused an oxygen leak. This leak created a highly flammable oxygen-rich environment that ignited.

The lack of a contact scar on the flared tube end of the connection above the galley and the improper torque values on other undamaged high-pressure oxygen system tubing connections in the MA, as tested by the Air Force Research Laboratory/Materials Integrity Branch, support the conclusion that the B-nut on the connection above the galley was torqued insufficiently. The work order indicates that the oxygen hose and oxygen tube assemblies were installed at programmed depot maintenance. There is no evidence that would indicate that any disassembly, reassembly, or adjustments were made to the high-pressure oxygen system tubing at the location of the fire after the mishap aircraft was delivered from programmed depot maintenance.

In addition, I found no evidence that the MC caused, could have prevented, or substantially contributed to the damage to the MA.

3. CONCLUSION

I find by preponderance of the evidence that the cause of the mishap was a leak in the high-pressure oxygen system due to poor assembling of the system tubing at depot maintenance.

Failure by depot maintenance personnel to tighten a retaining nut connecting a metal oxygen tube to a junction fitting above the galley properly caused an oxygen leak. This leak created a highly flammable oxygen-rich environment that ignited. The resulting fire melted the retaining nut causing the tubing to become detached from the junction fitting, feeding more oxygen to the fire, increasing its size, and causing severe damage to the airframe, galley, and mission equipment onboard the aircraft.

30 June 2015

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President, Accident Investigation Board

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