U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

STATEMENT OF COMPLIANCE WITH THE FEDERAL AVIATION REGULATIONS

DATE: January 28, 2004

AIRCRAFT OR AIRCRAFT COMPONENT IDENTIFICATION

MAKE	MODEL NO.	TYPE (Airplane, Radio, Helicopter, etc.)	NAME OF APPLICANT
AMSAFE, Inc.	Version V23	Aviation Inflatable Restraint System	AMSAFE, Inc. Inflatable Restraints Division

LIST OF DATA

IDENTIFICATION	TITLE			
AMSAFE Document Number	REV	DATE	# PAGES	DOCUMENT TITLE
E508435	N/C	20-Jan-04	15 *	AMSAFE AVIATION INFLATABLE RESTRAINT (AAIR) SYSTEM SYSTEM DESCRIPTION

*15 pages including Page i, Page ii, Page iii, and Pages 1 through 12

FEDERAL AVIATION ADMINISTRATION
LOS ANGELES AREA AIRCRAFT CERTIFICATION OFFICE
Date Acknowledgement, Approval
Your Letter Ident E508435 Date 1/29/04
1/28/04
Data Reviewed.
Data Approved.
Date 2/9/04 Engineer
2/12/04

This approval indicates the data listed above demonstrates compliance only with the regulations specified by paragraph and subparagraph listed below as "APPLICABLE REQUIREMENTS". (Compliance to additional regulations not listed here may be required.) This form does not constitute FAA approval of all the data necessary for substantiation of compliance to necessary requirements for the entire STC.

PURPOSE OF DATA: To show compliance with the Federal Aviation Regulations in support of FAA STC Project No. ST10235LA-A.

APPLICABLE REQUIREMENTS *(List specific sections)*
14 CFR — Chapter I — Part 23: § 23.1301(a),(b); 23.1309(a)(1)(2),(b)(1)(2)(4),(e); 23.1541(a),(b); and Special Conditions 23-138-SC — Items 1, 3, 6, 10, & 12.

CERTIFICATION — Under authority vested by direction of the Administrator and in accordance with conditions and limitations of appointment under Part 183 of the Federal Aviation Regulations, data listed above and on attached sheets numbered — NONE — have been examined in accordance with established procedures and found to comply with applicable requirements of the Federal Aviation Regulations.

* (We) Therefore
- [x] Recommend approval of these data
- [ ] Approve these data

SIGNATURE(S) OF DESIGNATED ENGINEERING REPRESENTATIVE(S)	DESIGNATION NUMBER(S)	CLASSIFICATION(S)
Richard Oracheff	DERT-605417-NM	Certification Management, S/W Systems & Equip, & Flt. Test.
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AMSAFE AVIATION INFLATABLE RESTRAINT SYSTEM

SYSTEM DESCRIPTION

V23 - Three-Point Seatbelt Airbag Restraint with Dual Sensor EMA

Summary
This report provides the system description of the AMSAFE Aviation Inflatable Restraint (AAIR®) System, Version V23, using a Three-point Seatbelt Airbag Restraint with Dual Sensor EMA. This description defines all system components, their critical features, and their operation.

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Revision History

Rev	By	Approved	Date	Revision Summary
NC	KRK	RCL	RCL 1-20-09	Initial issue

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FIGURES

1.0 INTRODUCTION

This report provides the system description of the AMSAFE Aviation Inflatable Restraint (AAIR®) System, Version V23, using a Three-point Seatbelt Airbag Restraint with Dual Sensor EMA. This description defines all system components, their critical features, and their operation.

The AAIR V23 System is comprised of various core components. The core components are equivalent in design and manufacture for all aircraft using this generation product (referred to as AAIR System, Version V23, or AAIR V23 System) using a three-point restraint along with a dual sensor EMA. Certification data for the core components is common to all programs. These core items will be certified through dynamic testing (installation on seat test fixture) and vibration testing of the AAIR System. Refer to Paragraph 3.1 for further information on core components.

2.0 AIRWORTHINESS REQUIREMENTS

The AAIR System will be installed in aircraft to comply with the requirements of Special Condition 1 of the Proposed Special Conditions listed below. The applicable airworthiness requirements are:

14 CFR Part 23, up to Amdt 23-55	Federal Aviation Regulations
FAA AC 23.1309	Federal Aviation Administration Advisory Circular – Equipment, Systems, and Installations
RTCA-DO160D	Environmental Conditions and Test Procedures for Airborne Equipment
RTCA-DO183	Minimum Operational Performance Standards for Emergency Locator Transmitters
FAA TSO C114	FAA Technical Standard Order C114: Torso Restraint Systems
FAA Notice 23-03-01-SC, 17-Jul-03	Proposed Special Conditions

3.0 AAIR SYSTEM DEFINITION

The AAIR is a self-contained, modular restraint specifically designed to improve occupant protection from serious head injury during a survivable accident. The lapbelt is a three-point restraint system including the AAIR airbag attached to standard webbing, a webbing retractor, fixed anchor point, and buckle anchor point. This AAIR System is primarily located in the front two (pilot and copilot) aircraft seats, and can be used for passenger-only aircraft seating. It is completely independent with no interface to aircraft wiring.

The system is divided into the components listed below. These have means to be inspected or replaced as required for continued airworthiness. This design, verification, and certification testing have considered environmental conditions as specified in document RTCA DO-160D, as well as vibration robustness to RTCA DO-183.

3.1 AAIR SYSTEM OVERVIEW

The AAIR System contains the following core components corresponding to Figure 1.

Seatbelt Airbag Assembly (SAA)
Inflator Assembly
Electronics Module Assembly (EMA)
System Diagnostics Tool (not shown)

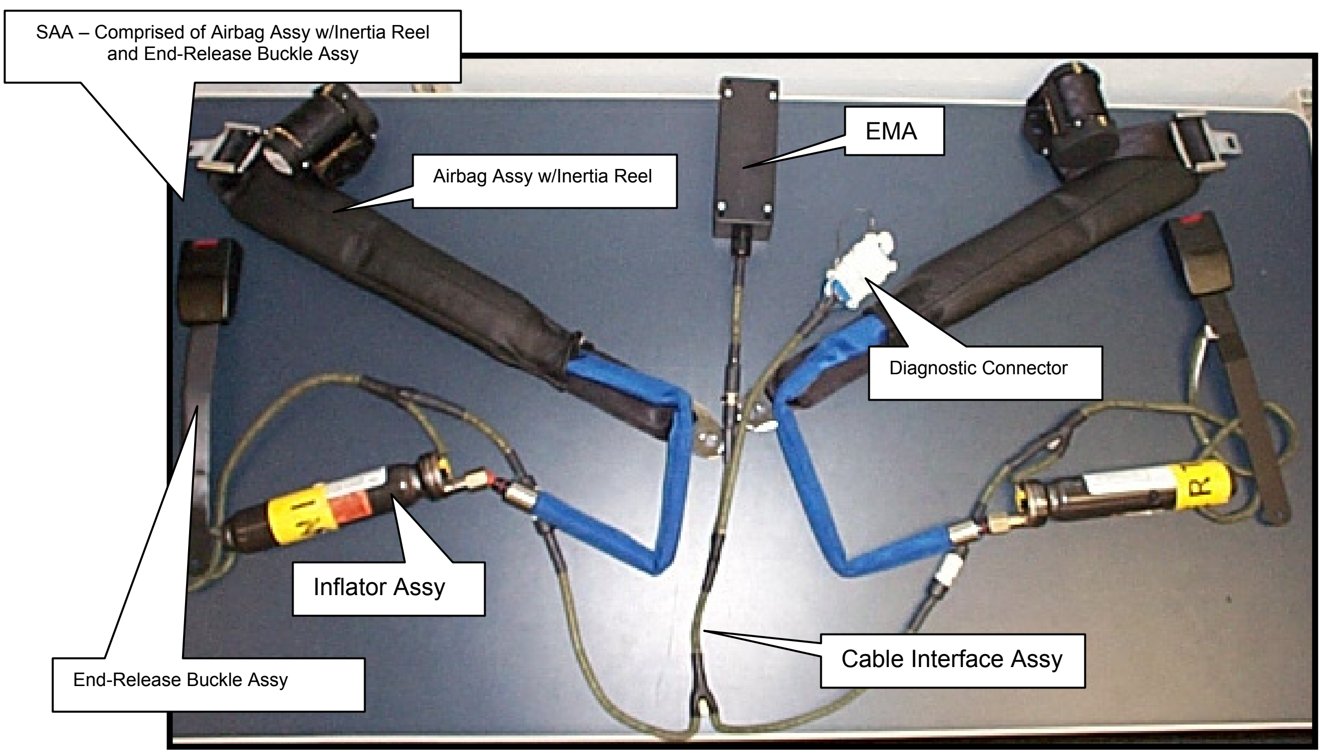

Figure 1 – AAIR V23 System Components – Two Seat Placement

3.2 SEATBELT AIRBAG ASSEMBLY AND BELT EXTENDER

The Seatbelt Airbag Assembly (SAA) is the basic lapbelt restraint and is certified to FAA TSO C114. The SAA consists of standard polyester webbing, the packed airbag assembly, a webbing retractor assembly, a fixed anchor point, and a buckle assembly anchor point. The AAIR SAA has the same basic configuration as conventional, three-point, non-inflatable lapbelts, but has the addition of an airbag, a gas delivery hose, and an activation circuit. The buckle is located at a fixed point and uses a push-button type release mechanism. The buckle assembly has a built-in activation system using a magnet and a reed switch. Buckling the lapbelt automatically activates the AAIR System. The lapbelt also includes stiffening device that mechanically resists buckling 180 degrees out of phase, i.e., twisting the belt. Any limitations and information necessary for safe operation of the AAIR are included in the AAIR SMM (Supplemental Maintenance Manual). Special instructions are not required for the passenger to use the device. Child seats are not allowed with pilot/copilot aircraft configurations of the AAIR V23 System. Reference Figures 2, 3, and 7 for seatbelt airbag features and end-release buckle assy features.

The AAIR SAA components and their special features are listed below and referenced in Figures 2 and 3:

- Standard polyester webbing with standard attachment anchors (ref. 2A).
- Airbag sewn to webbing with approximately 30-liter airbag volume made of two fabric panels. The panels consist of a 315-denier nylon 6,6 substrate with an anti-flammability treatment (ref. 2B). The webbing also retracts within an Inertia Reel (ref. 2E) automatically maintaining tight fit of the seatbelt to an individual occupant's body shape.
- Cover with a tearable seam, which opens upon deployment. Cover is constructed of a durable material which protects the internal components from contamination and wear (ref. 2B).
- Gas delivery hose is tubular woven 1100-denier polyester with Kevlar-like filler and EPDM hose lining. The hose also contains a protective sleeve, which consists of a urethane-type treated, 1100-denier polyester fabric. The hose to inflation device connector is a threaded anodized aluminum fitting with a stainless steel ferrule. The gas hose construction provides resistance to wear and tear and provides safeguards preventing in-service tampering (ref. 2C).
- Activation circuit consists of a magnetically-activated reed switch and durable magnet mounted onto the end-release buckle assembly. The circuit conductors are strain-relieved, 20-gauge, copper-stranded cables with aerospace-specification connectors (ref. 2D).
- Igniter Connector connects the activation circuit to the inflation device's electrically activated igniter.

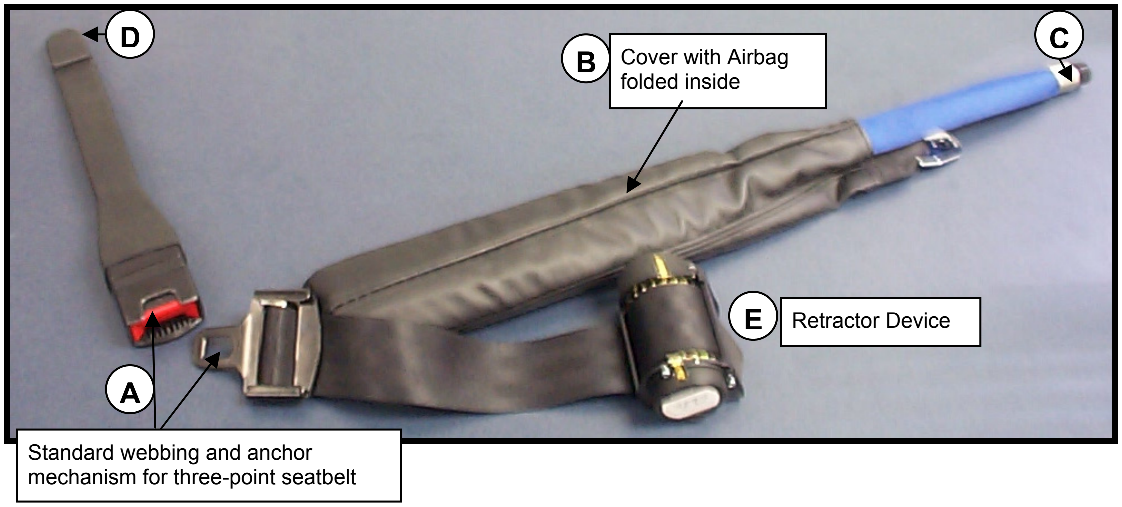

Figure 2 – Seatbelt Airbag Features

- Standard push-button type release mechanism (ref. 2A).
- The End-Release Buckle Assembly contains magnet and a reed switch to passively close activation circuit. (ref. 2A and 2D).

No belt extender is allowed with the AAIR V23 System.

The system does not contain sharp or hard surfaces that could cause injury to occupants during normal operation, during a crash, or in secondary impacts. The following design features remove hard points or sharp edges from interfacing with the occupant:

- Deployment gas ducted from behind-seat area removes inflation devices from occupant vicinity.
- The airbag, belt, and protective cover do not contain any hard points or sharp edges.

3.3 INFLATOR ASSEMBLY

The Inflator Assembly is mounted behind each seat position and provides the gas source to inflate the airbag upon command from the EMA. The Inflator Assembly has adhesive labels with appropriate product and shipping information. The Inflator Assembly and its electrical connection are standard automotive components produced and used in high volume with extremely high reliability and safe operation. The Inflator Assembly contains special features for safety and tamper resistance. Reference Figures 3 and 4.

The Inflator Assembly components and their special features are listed below:

- The inflation device is a stored gas, single-stage, blow-down type using only non-heated inert helium gas to fill the airbag (ref. 3A).
- The inflation device uses a shielded, electrically activated igniter to burst a stainless steel membrane to release the gas to fill the airbag (ref. 3B). The igniter uses a self-shunting pin clip to automatically safe the Inflator Assembly when the igniter connector is removed.

- The inflation device is a cylindrical, extruded steel, pressure vessel with welded end caps and a welded membrane. Helium gas is contained at a nominal pressure of 6,250 psig. The low carbon alloy steel vessel and all manufacturing processes are specially developed and controlled for high reliability and long-life gas storage (less than 5% gas loss over 15 years). Design values and verification testing are conducted using industry recognized statistical methods. The factors of safety for the pressure vessel are 2.7 at the maximum expected operating pressure and 3.1 at ambient temperature. The Inflator Assembly meets DOT Class 9 and UN3268 requirements for compressed, non-flammable gas devices (ref. 3A).
- The inflation device and igniter have independent automatic gas release mechanisms that are temperature activated (~ +210°C) to protect from vessel fragmentation in the event of prolonged exposure to fire (not shown).
- The gas is released from the Inflator through a machined fitting assembly which is connected to the Inflator via a threaded attachment. It is connected to the gas hose by a threaded end on the fitting (ref. 3C).

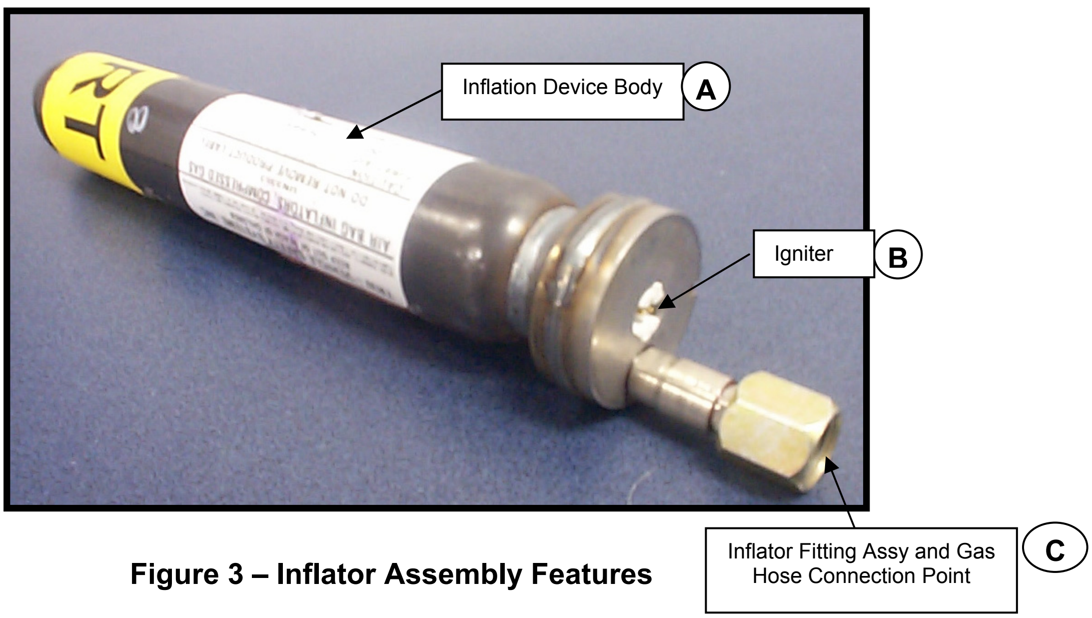

Figure 3 – Inflator Assembly Features

- The Inflator Assembly Igniter Connector (type FCI ABX-3) is attached to the SAA's activation circuit by a separate wire cable leg of the End-Release Buckle Assembly (ref. 4A).

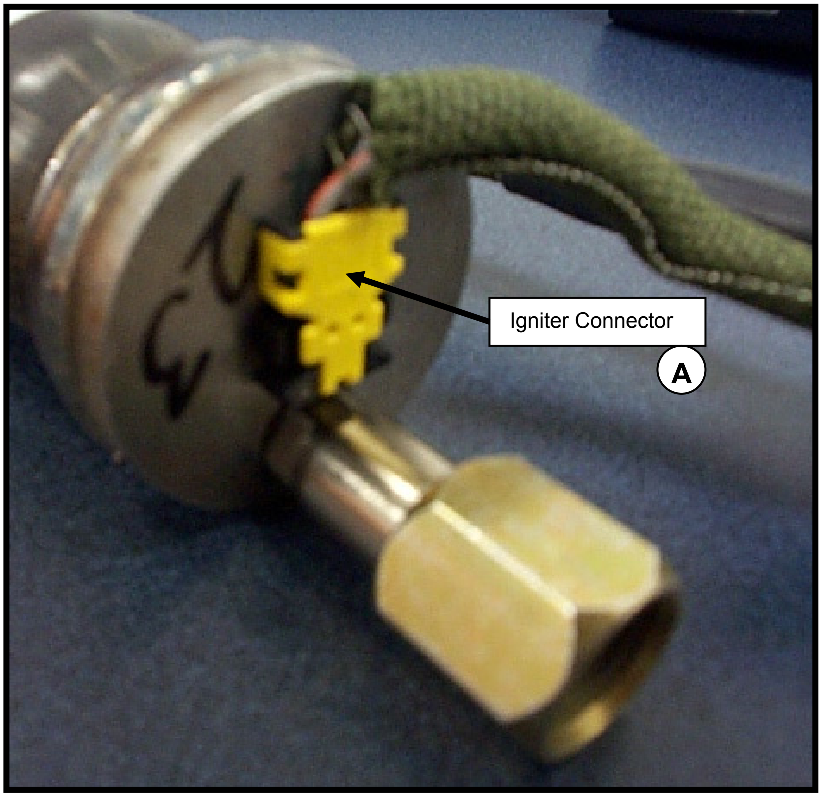

Figure 4 – Inflation Igniter Connector

3.4 ELECTRONICS MODULE ASSEMBLY

The Electronics Module Assembly (EMA) is a plastic box mounted to the aircraft structure on the floor. One EMA is mounted to aircraft floor for each pilot/copilot seat assembly. The EMA enclosure is designed to resist moisture and contamination and can withstand electrostatic discharge. The EMA contains crash sensors, electrical circuits, power, and connectors to service one pilot/copilot seat assembly. Reference Figures 5 and 6 for EMA and AAIR V23 System schematic, respectively.

The EMA components and their special features are listed below:

- The crash sensors are a spring-mass-damper type inertial switch used in high volume in automotive airbag sensor systems, but calibrated specifically for an aircraft's operating environment. Proper deployment of the AAIR requires it to deploy at a predetermined threshold. This threshold allows enough time for proper airbag fill, but will not allow inadvertent deployment during normal operations. Below the activation threshold, the AAIR System functions as a conventional seatbelt.
- Power is provided by two non-rechargeable, lithium cells with a fused thermal protection circuit. This arrangement precludes short circuits or other failures causing the batteries to release electrolyte or energy into the system in an uncontrolled manner. The system operates nominally at 7.2 VDC, and can maintain functional capability down to

approximately 7 VDC. The long-life, lithium/thionyl chloride battery system has stand-by capability of 10 years at room temperature.

- The electrical connectors have 20-gauge pins and a mistake proof, keyed interface.
- The "pigtail" cable consists of 20-gauge, copper-stranded insulated conductors with a woven protective wrap.

The EMA assembly has a total mass of approximately .85 pounds. The housing is fabricated from ABS plastic which is lightweight, durable, and rugged. The housing is made up of a body and a lid with the lid held to the body using four machine screws. The internal components consist of a printed circuit board (PCB) onto which are attached the sensors. The battery pack (complete with capacitors and fuse) is connected to the PCB.

Under an inertial load of 9g, the internal components could exert a maximum combined force of 5 lbs on the EMA housing, far below the rated capability of the housing or the fasteners including a factor of safety of 1.5. Under extremely severe circumstances, should the internal components of the EMA become detached, these components will be contained within the EMA housing.

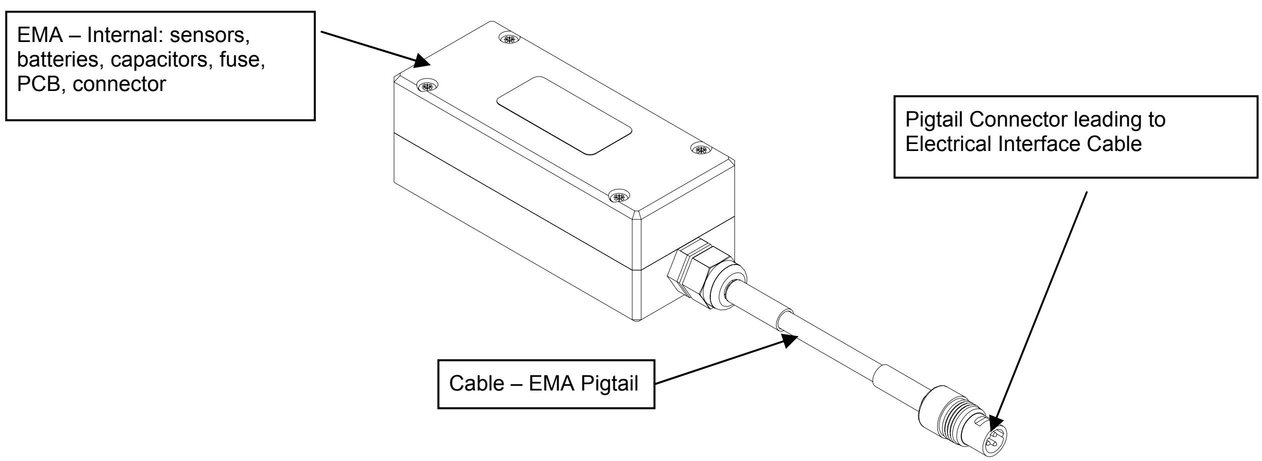

Figure 5 – EMA Assembly

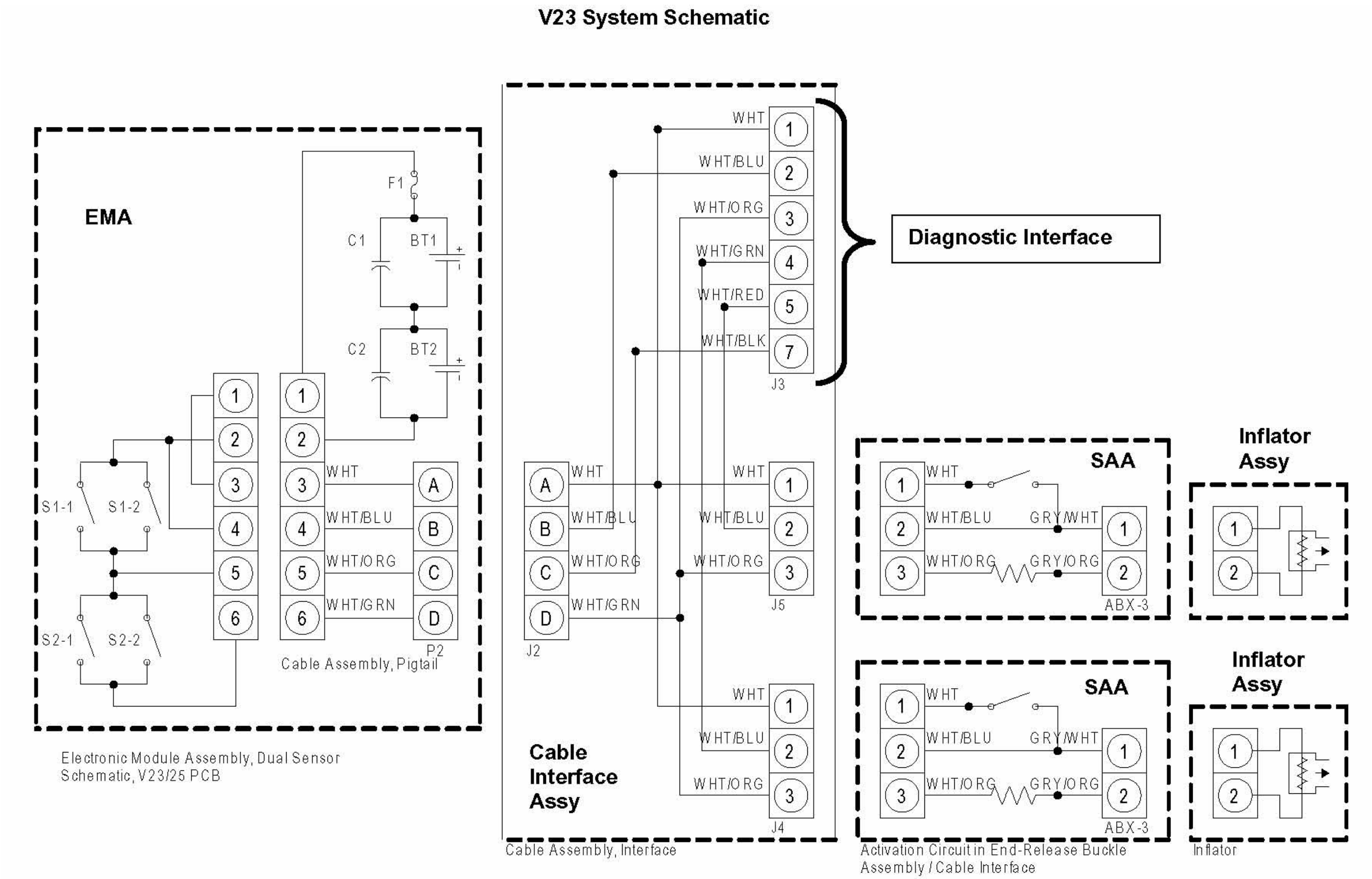

Figure 6 – AAIR V23 System Schematic

3.5 CABLE INTERFACE ASSEMBLY

The Cable Interface Assembly consists of a connector that interfaces to the EMA pigtail connector on one side and the SAA connector on the other. A Diagnostic Tool Connector leg branches from the EMA connection leg. This diagnostics connector mates with the connector on the System Diagnostic Tool to allow functional testing of the AAIR V23 System. This cable is independent and routed separately from all other aircraft wiring (ref. Figure 7).

The connectors have 20-gauge pins and a mistake proof, keyed interface. The cable is 20-gauge, copper-stranded insulated conductors with a woven protective wrap.

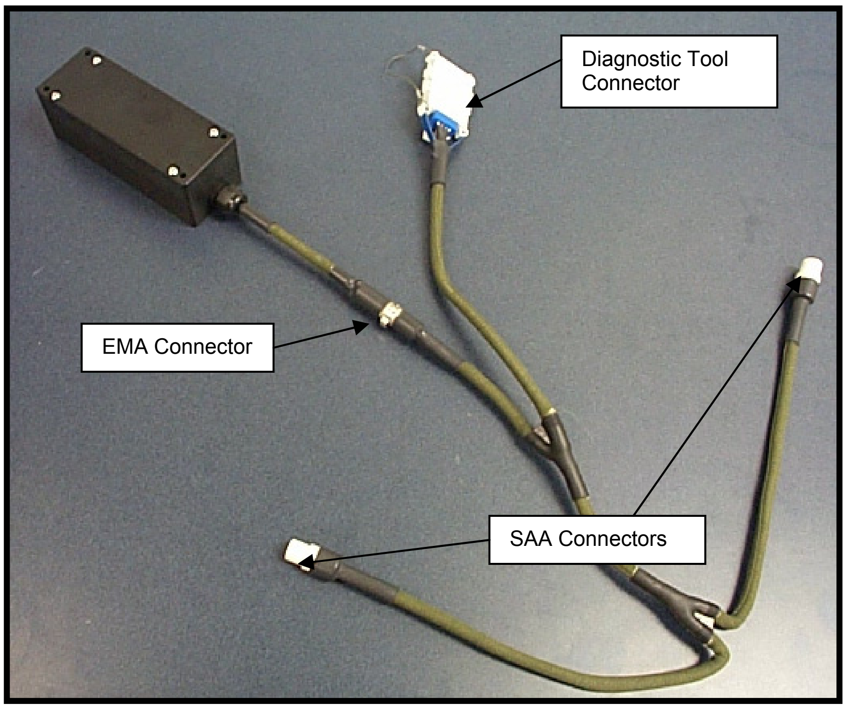

Figure 7 – EMA with Cable Interface Assembly

3.6 SYSTEM DIAGNOSTIC TOOL

A System Diagnostic Tool (SDT) is used to check the functional status of the AAIR. This small, portable, hand-held device has been designed for use by maintenance personnel at intervals predetermined by the AAIR System Safety Assessment, E508436. The SDT has a connector on the end of a short length of cable and a set of red/green/amber indicator lights. The connector plugs into the Diagnostic Tool Connector on the Electrical Interface Cable. The SDT provides readouts for proper and improper function for the seat position. The SDT has a built-in power supply that does not drain the AAIR battery. The SDT battery is replaceable by the user with a standard, commercially available, 9-volt battery. Figure 8 provides an illustration of the SDT.

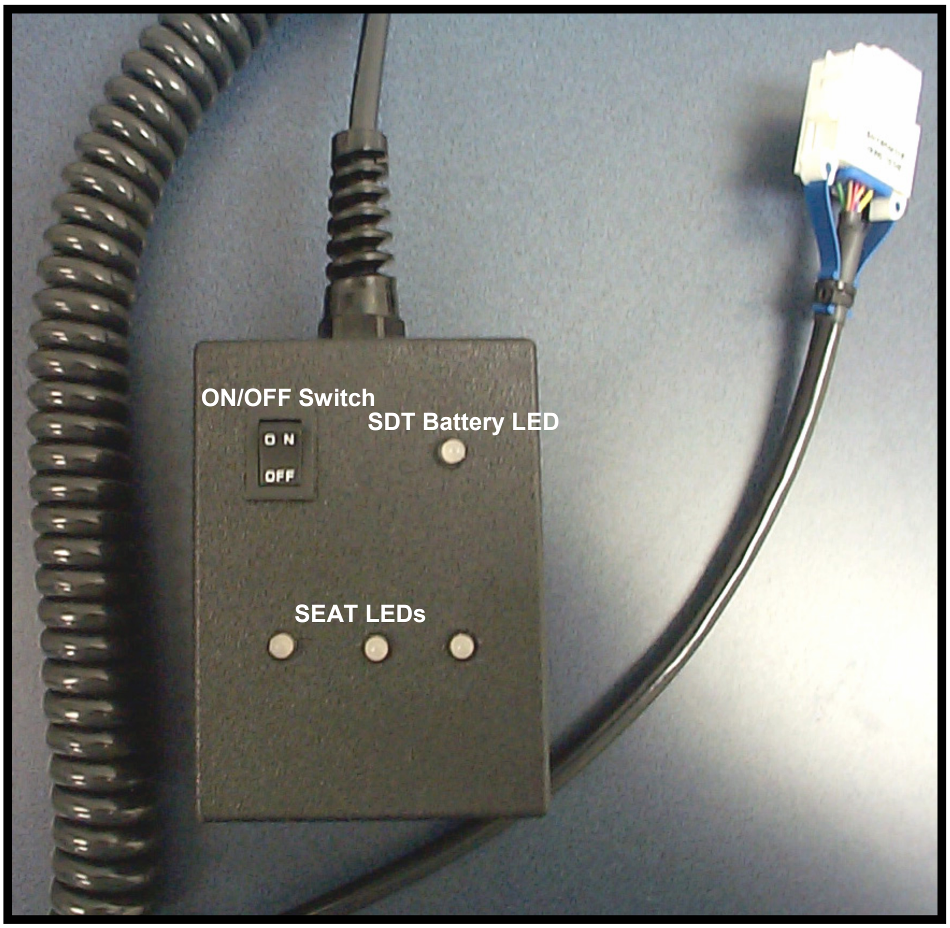

Figure 8 – V23 System Diagnostic Tool

4.0 AAIR V23 SYSTEM OPERATION

The AAIR V23 System requires no intervention during normal operation. The AAIR is active (able to deploy) upon buckling the seatbelt by the seat occupant and deactivated upon release of the same. The two functional states, active and inactive, both occur in the normal AAIR operational mode. The system has another non-functional, fundamental mode of operation, the diagnostic mode. This mode occurs when the SDT is connected and the system is undergoing a diagnostic test.

4.1 NORMAL OPERATION

The AAIR System is fully operational and considered “active” when properly installed and buckled. When buckled, the activation switch closes, completing its portion of the deployment circuit. This will allow the system to deploy upon closure of the sensor switch. When active, the AAIR is designed to protect the pilot/copilot occupants seated in the cockpit during emergency landing conditions. Proper deployment of the AAIR requires it to deploy at a predetermined deceleration level, known as the activation point. This is a point in the beginning of a crash that allows enough time for proper airbag fill. Impacts below the activation point will not cause deployment and the system functions as a conventional three-point seatbelt. Decelerations equal to or above the activation point will cause the EMA to sense the crash and initiate the firing sequence and deploy the system as previously described.

The inflated airbag acts as a cushion to decelerate the head and torso of the occupant. The kinetic energy of the seat occupant is dissipated on impact with the airbag. The airbag accommodates a range of occupant sizes, and the total time period for inflation and deflation of the airbag poses no hazard to egress.

The AAIR System operates within all aspects of the flight envelop environment.

4.2 DIAGNOSTICS OPERATION

The system diagnostic check is conducted at pre-determined intervals. This interval must be determined such that the resulting system reliability calculated from the System Safety Assessment (reference AMSAFE document E508436) meets regulatory requirements (FAA AC 23.1309).

Maintenance personnel perform the diagnostics check by using a hand-held SDT. First, the seatbelt is buckled to close the circuit and activate the system. Second, the protective cap covering the Diagnostics Tool Connector is removed. Third, the SDT is connected to the Diagnostics Tool Connector and the diagnostics check is performed. Indicators on the SDT provide system status for the seat position’s circuit.