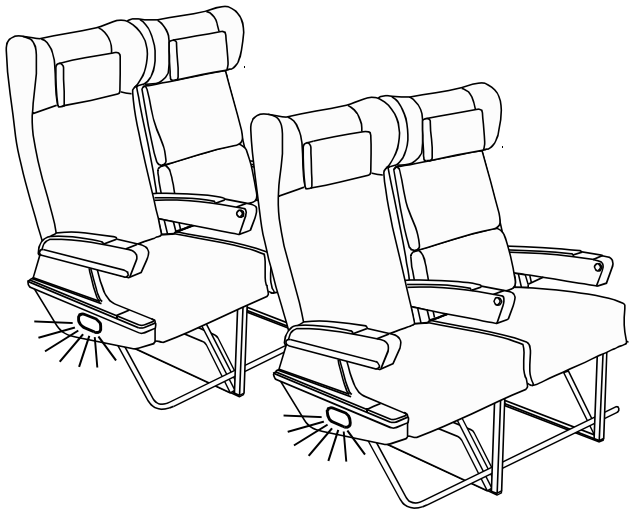
LSI Luminescent Systems Inc.

SYSTEM MAINTENANCE and INSTALLATION MANUAL

Seat Mounted LED (SLED)

Floor Proximity Emergency Escape Path Marking System (FPEEPMS)



LUMINESCENT SYSTEMS, Inc.
4 Lucent Drive
Lebanon, NH 03766
USA
Tel 603 643 7766
Fax 603 643 5947

V32890

33-50-18

Rev 0, Apr 30, 2003

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HIGHLIGHTS

This document represents the System Maintenance and Installation Manual for the LSI Seat Mounted LED Emergency Egress Lighting (SLED) System providing floor mounted Floor Proximity Escape Path Marking.

This System Maintenance and Installation Manual employs the philosophy that the system is composed of a number of Line Replaceable Units.

The System Maintenance and Installation Manual covers all items of the system.

This document is to be used in conjunction with the following documents:
33-50-19 IPC, Seat Mounted LED (SLED) FPEEPMS
33-50-20 IPC, LED Exit Markers
33-50-21 IPC, Exit Marker Overlays

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RECORD OF REVISIONS

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RECORD OF TEMPORARY REVISIONS

Rev. No.	Issue Date	Inserted		Rev. No.	Issue Date	Inserted	
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SERVICE BULLETIN LIST

Service Bulletin No.	Rev. No.	Issue Date	Inserted	
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DESCRIPTION & OPERATION

1. Introduction

As part of the Federal Aviation Administration's (FAA) continuing efforts to upgrade aircraft cabin safety and improve occupant survivability in aircraft accidents, the provisions of Part 25 of the Federal Aviation Regulation (FAR) requiring Floor Proximity Emergency Escape Path Marking (FPEEPM) were established. Guidelines were issued in FAA AC25.812-1A to include Seat Mounted LED FPEEPM (SLED).

2. SLED-FPEEPMS Design Concept

In order to meet requirements for ease of installation and maintain a level of high reliability for both airframe manufacturers and retrofitting airlines, LSI developed its Seat Mounted LED Floor Proximity Emergency Escape Path Marking System (SLED-FPEEPMS) with a number of very important goals in mind including:

- Capability of receiving damage and still remaining operational
- No fragile parts
- Very easy and straight forward installation
- Light weight

In addition, the system has to offer the following advantages to airlines:

- Short installation time
- Modularity, to allow easy re-configuration
- High durability
- Virtually no maintenance requirements from C-check to C-check
- Low cost of ownership
- Minimal delays

3. System Description

The topology of a Seat Mounted FPEEPMS system can take a variety of shapes depending on aircraft cabin configuration, seat type and preference. Systems can be certificated using either marker lights, floodlights or a combination of both. It is preferable to design a system using only one topology, however, due to a variety of possible reasons this may not always be possible.
Any system requires low level exit markers and all lights are to be mounted below 4 feet (1.20 m). Some aviation authorities also require a minimum mounting height for the exit markers.

4. System Design Philosophies

Due to the many aircraft cabin layouts and options that are possible and the variety of seat designs available in the market, there is usually not one single approach to floor proximity lighting that provides a solution to all situations found on board the aircraft.
A system using marker lights relies on the passenger’s direct viewing of the light for guidance towards a safe exit. The distance between two adjacent lights needs to be small enough in order to not lose the guidance cue.
A system using floodlights uses lights to illuminate the aisle and therefor clearly identify the escape path that passengers can follow.
As both approaches are valid and offer certain advantages over the other, the selection of either one or a combination of both are a compromise that depends largely on technical, operational, style & aesthetics and cabin product considerations.

The SLED-FPEEPMS lighting elements are available to mark the location of the aisle, and are typically mounted on the seat end bays, on the "monuments" (galley structure, lavatories, dividers, etc.) and near the exits (exit markers). They may have arrow markings if they are located in a dead end area of the cabin. The marker lights at an overwing emergency exit and at the end of the aisle (not all aviation authorities require the latter) emit red light. All versions are available as seat or monument mounted LED light assemblies.
The lights are powered from 6VDC provided by the Emergency Power Supply Units (EPSU) fitted to the aircraft.

A. Economy Class Considerations

The economy seat allows for both the marker and floodlight approach.

(1) A marker light is mounted on the seat's end bay in a location that is suitably protected, such as in or underneath a bumper. As economy seats are spaced at pitches below 40 inches, they only require one SLED light per seat.
Two SLED housing versions exist: one for surface mounting and one for recessed mounting. Choice of either type may depend on aesthetics requirements or the availability of suitable protection.

(2) Floodlights are of a larger size than marker lights. Contemporary economy seat designs allow for the floodlight to be hidden from view underneath the seat.

(3) With a marker system, it can be seen as an operational benefit that all seats are identical and fully interchangeable (only one part number needs to be stored).

(4) A floodlight system offers the advantage that it does not need to be installed on every seat row, which reduces installation cost. Floodlights are typically installed only once every seat or once every two seats, so that there are multiple part numbers. The seats are not interchangeable.

B. Business Class Considerations

(1) A marker light is mounted on the seat's end bay in a location that is suitably protected, such as in or underneath a bumper. As business seats are often spaced at pitches beyond 40 inches, they require two marker lights per seat that are mounted as far apart as possible.

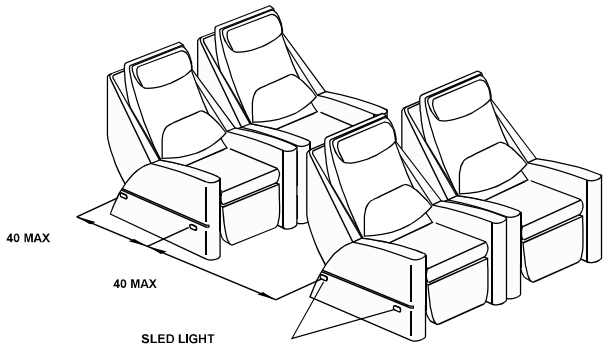

Figure 1: SLED Marker System on Business Class Seat

(2) The larger floodlights are usually obtrusive and require space to achieve the desired floodlighting pattern on the aisle floor.

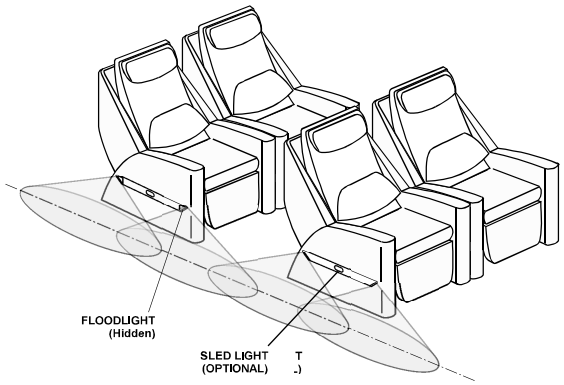

Figure 2: SLED Floodlight System on Business Class Seat

(3) Contemporary business seat designs do not always allow for the floodlight to be hidden from view underneath the seat and for appearance considerations from one seat row to the next, a floodlight system may interfere with the aesthetic appearance of the seat: the armrest/end bay extend all the way to the floor and does not have any provisions to hide the floodlight from view.

(4) As floodlights are available that illuminate a large area, such a system offers the advantage that it does not need to be installed on every seat row. Depending on seat pitch and mounting height, the floodlights can possibly be installed only once every other seat.

C. First Class Seats/Sleeper Beds

For first class seat pitches a floodlight system is the only practical solution to meet the regulations, with a combined floodlight/marking system can be specified when the economy/business area has a marking system (for consistency of appearance). For maximum recognition, the LED marker light continues the visual aspect of the marking system in business/economy, when the LED floodlight illuminates the aisle to provide the actual guidance.

For improved aesthetics, the floodlight can be hidden from view behind a bumper. The marker light is visible for direct viewing. Mounting height of the floodlights and spacing are very important design considerations, as is the suitable design of the bumper hiding the lights in order to avoid masking.

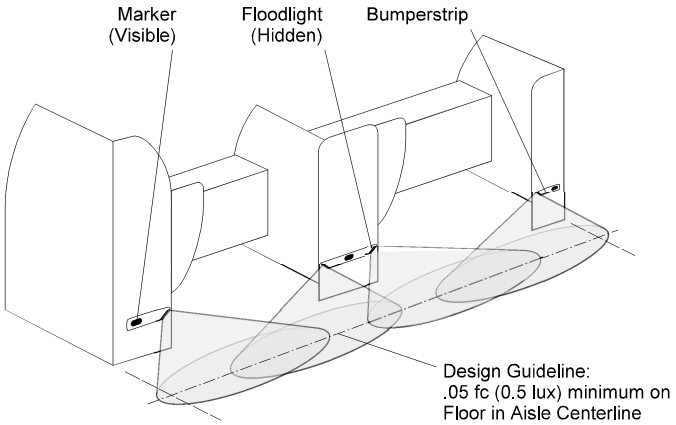

Figure 3: Combined Marker/Floodlight FPEEPMS in First Class Cabin

Although there is no guidance in the regulations about the light level that a floodlight system should achieve at floorlevel, nor about the requirement for the extra marker light, systems can and have been certificated using the requirement for FAR 25.812 overhead lighting as a design guideline as follows: when measured at floorlevel rather than at seat armrest height, the minimum illumination level shall be 0.05 fc or 0.5 lux in the center of the aisle.

D. Monument Marker Lights

The LED Monument Light have an adapted design for mounting on "monuments" (galley structures, class dividers, etc.) along aisles and in the cross-aisles. The location should be suitably protected by other monument features if possible.

As a design guideline, marker lights are not to be spaced more than 40 inches apart. In any other case, a floodlight is to be considered.

E. Monument Floodlights

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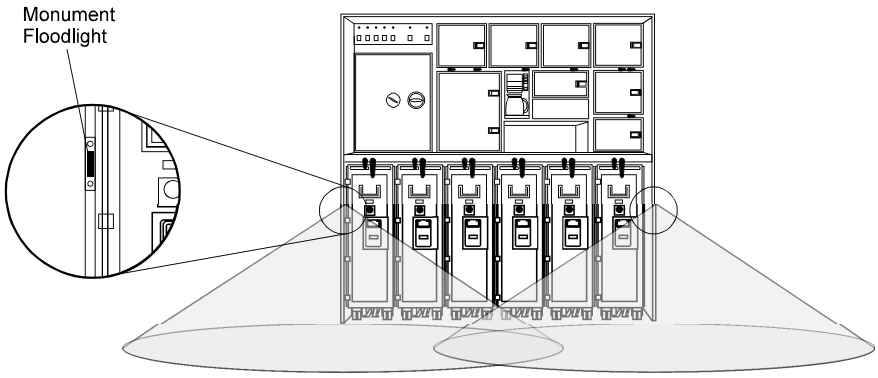

Figure 4: Example of Galley/Monument Floodlights

F. Exit Markers
The LED Exit markers consist of high output white LED's. They meet all airworthiness requirements with enhanced reliability.

G. Interconnecting Cables
In economy seats, the LED lights are wired into the seats using Interface Cables of the 7844 series in order to allow both the light and the entire seat to be separately servicable. Where there are two lights on a seat (business class and some first class), a Y-splitter Interface Cable 7911 is foreseen.
When the floodlight system is installed in first class, a "tripple Y" Interface Cable 8253 has been designed in case there are 3 lights on a single feature.
On the outboard side of the seat, the 7844, 7911 and 8253 interface cables are then connected to a Cable Harness of the 8008 series (with either one, two or three legs). The 8008 Cable Harness is connected to the bulkhead disconnect through which the system is connected to the aircraft wiring (standard Airbus cabin wiring for FPEEPMS). The 7844, 7911, 8253 and 8008 cables are already supplied to Airbus on other programs.

5. MEL requirements
Every light is to be operational.

6. SLED-FPEEPMS System Operation
The LED lights and low level exit markers are powerd by the 6 VDC emergency battery system fitted to every aircraft. They operate under the same control laws as the emergency lighting.

7. SLED-FPEEPMS Layout
A. General
The SLED-FPEEPMS system follows the regulations called for in 14 CFR 25.812. Guidance is provided in FAA Advisory Circular 25.812-1A, Floor Proximity Emergency Escape Path Marking Systems.
B. Aircraft Configuration
Individual installations are dependent of the aircraft cabin configuration and seating arrangement.

8. SLED-FPEEPMS Layout Description

A. Emergency Exits

(1) Regulations: FAR 25.812(e)(2)

(2) Each emergency exit should be marked with an exit marker located below 4 ft (1.2 m). To meet CAA regulations, the exit marker should be mounted at least 1.5 ft (0.45 m) above the floor.

B. Aisle and Galley/Lavatory Lighting

(1) Regulations: FAR/JAR 25.812(e)(1) and (2), CAA AWN 56 §2.2 and §2.7.2.

(2) FAA requires overlay arrows to indicate that there are no exits to be found in the direction opposite to the arrows (typically in dead ends).

TESTING AND FAULT ISOLATION

1. General

The SLED system is by nature very modular in design which facilitates system installation and troubleshooting.
Problems with the SLED system will be evidenced either by failure of one or more of the lights or exit markers to illuminate, or failure of some or all of the lights or exit markers to turn off when the system is disarmed/switched to "OFF".

System faults readily appear during a system check where all lights and exit markers are supposed to be illuminated fully after the system has been switched to "ON" and non-illuminated after the system has been switched to "OFF".
If this is not the case, proceed under 2. and take action according to the observation of the system.

For testing and fault isolation of the emergency power supplies, refer to the respective Component Maintenance Manual.

2. System Testing and Fault Isolation

A. Definitions.

The following definitions are used for parts of the SLED-FPEEPMS system in this paragraph:

(1) LED lamps:
Refers to exit markers, monument lights, flood lights and seat lights of the aisle lighting that use LED lighting technology.

(2) Section:
Refers to that part of the system which is powered by an emergency power supply.

(3) Power supply unit (PSU):
Refers to the emergency power supply fitted to the aircraft.

B. Preparing the FPEEPMS System for Trouble Shooting.

Cycle the system through an ARM-DISARM ("ARM"/"OFF") test cycle before starting any system level troubleshooting. Cycling the system precludes starting off from an unknown state.

C. Troubleshooting the FPEEPMS System

The troubleshooting charts provide a schematic way to locate and subsequently solve faults/errors that could occur. They can be used for Line Maintenance Repair.
As the SLED-FPEEPMS system can be installed in a variety of ways, the troubleshooting charts that follow are generic.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
A. LED Lights will not light		
(1) All FPEEPM sections fail (complete system failure)	(a) Aircraft wiring failure	Check aircraft wiring.
	(b) PSU failure	Proceed to C.
(2) One or more FPEEPM sections fail completely	(a) PSU failure	Proceed to C. If not defective, proceed to (2)(b).
	(b) Broken aircraft wiring from PSU to FPEEPM section	Check for 6 VDC at A/C harness connectors. If defective, repair/replace; If not, proceed to 2 (c).
	(c) Cable assembly failure	Check for 6 VDC at connector of cable assembly. If defective, replace cable lead assembly; If not, proceed to (2)(d).
	(d) LED light(s) failure	Replace LED Light(s).
(3) One or more LED lights do not light in a FPEEPM section	(a) LED light not fully plugged into cable assembly	Check LED light connector mating. If not mating, plug lamp fully; If mating, proceed to (3)(b).
	(b) Cable assembly failure	Check connectors of non-illuminated lights for 6 VDC. If defective, replace cable assembly; If not, proceed to (3)(c) or (4).
	(c) LED light(s) failure	Replace LED light(s).
(4) LED Light(s) lit but not bright enough	(a) Insulation failure in aircraft wiring from PSU to FPEEPM section	Check wiring. If defective, locate insulation failure and repair/replace defective component(s); If not, proceed to (4)(b)
	(b) LED Light failure	Replace LED light(s).

Table 101: SLED System Troubleshooting

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
B. LED lights will not go out		
(1) All FPEEPM sections stay on or comes on after DISARM command has been sent	(a) Aircraft wiring failure	Check for PSU receiving correct DISARM signal. Repair/replace aircraft wiring.
(2) One or more FPEEPM sections stay on or come on after DISARM command has been sent	(a) Aircraft wiring failure	Check for PSU receiving correct DISARM signal. If yes, proceed to (b). If not, repair/replace aircraft wiring.
	(b) PSU failure	Proceed to C.
C. PSU failure		
(1) PSU non-operative	(a) Broken wiring	Return PSU to shop for testing. If defective, replace PSU. Investigate reason.
	(b) Battery discharged	Return PSU to shop for testing. If defective, replace battery. Investigate reason.
	(c) Broken logic: electronic circuit failure (output voltage out of tolerance)	Return PSU to shop for testing. If defective, replace PSU. Investigate reason.
(2) PSU not working in accordance with logic provisions	(a) PSU defective.	Return PSU to shop for testing. If defective, replace PSU. Return defective PSU to manufacturer for analysis.

Table 102: SLED System Troubleshooting (Continued)

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AUTOMATIC TEST REQUIREMENTS

1. General
   Not applicable.

   Automatic test requirements do not apply to the LSI SLED-FPEEPMS system.

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DISASSEMBLY

1. General
   The SLED-FPEEPMS system components are Line Replaceable Units (LRU), which cannot be disassembled.

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CLEANING

1. General

Cleaning of the SLED-FPEEPMS system is straightforward and industry accepted practices should be used. This section highlights the special care that needs to be taken with respect to fragile parts and the materials used during cleaning.

CAUTION: DO NOT USE HARSH CLEANING COMPOUND OR SOLVENTS AS THEY MAY FOG THE POLYCARBONATE LENSES OR LEAD TO CRYSTALLIZATION AND STRESS CRACKING OF THE POLYCARBONATE COMPONENTS (SEE TABLE103).

CAUTION: DO NOT USE HIGHLY ALKALINE SOLUTIONS AS THESE MAY CAUSE THE POLYCARBONATE COMPONENTS TO DEGRADE.

2. Clean Polycarbonate SLED Components

NOTE: Lens of Exit Marker can be replaced when damaged.

Clean these parts with a mild soap solution, applying with a slightly damp, clean, soft lint-free cloth every A-check or at intervals of 30 days or sooner. Avoid excess moisture.
Refer to Table 103 for compatibility.

3. Ultrasonic Cleaning

CAUTION: PROLONGED OR UNCONTROLLED EXPOSURE OF THE ASSEMBLIES TO ULTRASONICS CAN RESULT IN DAMAGE TO, OR DESTRUCTION.

Exposure of the assemblies to ultrasonic cleaning is not recommended.

CHEMICAL CLASS	EFFECT
ACIDS (Mineral)	No effect under most conditions of concentration and temperature. Generally compatible.
ALKALIS	Acceptable at low concentration and temperature. Higher concentrations and temperatures result in etching and attack, evidenced by decomposition.
ALIPHATIC HYDROCARBONS	Generally compatible.
AMINES	Avoid the use of this material. Surface crystallization and chemical attack.
AROMATIC HYDROCARBONS	Avoid the use of this material. Partial solvents and severe stress cracking agents.
DETERGENTS and CLEANERS	Mild soap solutions are compatible. Strong alkaline materials should be avoided.
ESTERS	Avoid the use of this material. Causes severe crystallization. Partial solvents.
GREASES and OILS	Pure petroleum types generally compatible. Many additives used with them are not. Thus, materials containing additives should be tested.
HALOGENATED HYDROCARBONS	Solvents. Avoid the use of this material.
KETONES	Avoid the use of this material. Causes severe crystallization and stress cracking. Partial solvents.
SILICONE OILS and GREASES	Generally compatible up to 85°C (185°F). Fluids should be tested, as some contain aromatic hydrocarbons.

Table 103: General Chemical Resistance of Polycarbonate Resins

CHECK

1. General

Checking the SLED-FPEEPMS system consists of both individual parts inspection as well as inspection on the system level.

2. Installation

Upon installation of the SLED lights an overall systems check must be performed:
The SLED-FPEEPMS system check can be accomplished by:

(1) Switching the FPEEPMS lights on.
(2) Visually inspect the LED lights to ensure that they are all emitting light.
(3) Depending on MEL requirements, any failed lights must be changed and the replacement retested.

See applicable aircraft manuals and checklist.

3. Regular Check Interval

The SLED-FPEEPMS system check can be accomplished by:

(1) Switching the FPEEPMS lights on.
(2) Visually inspect the LED lights to ensure that they are all producing adequate light to find the exits.
(3) Depending on MEL requirements, any failed lights must be changed and the replacement retested.

See applicable aircraft manuals and checklist.

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REPAIR

1. General
   The SLED-FPEEPMS system components are Line Replaceable Units (LRU), which are not line or shop repairable.

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ASSEMBLY AND INSTALLATION

1. General

The SLED-FPEEPMS system is a custom installed system within all aircraft types. The components can be fitted together to form a complete emergency lighting system. Due to the variation that exists in the available seats and monuments and their construction, in combination with the multitude of aircraft layouts, the installation sequence of the SLED-FPEEPMS system will vary and a basic installation sequency is non-existent.

2. Storage

A. SLED Lights

SLED Lights storage parameters:

(1) dark area

(2) < 20% Relative Humidity

(3) 21.0°C ± 3.0°C (70°F ± 5.0°F)

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FITS AND CLEARANCES

1. General

The fits and clearances data of the SLED components can be found in the Illustrated Parts Catalogs (IPC 33-50-19).

The IPC references the weight, installation related dimensions and other characteristics of each component.
The weight data may be desired in order to obtain total system weight as installed in an aircraft, whereas the dimensions of each of component are necessary to determine the correct location of the aisle lighting components to meet regulations.

2. In-service Wear

None of the parts experience any wear under normal service conditions.

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SPECIAL TOOLS, FIXTURES AND EQUIPMENT

1. General
   Only common hand tools and standard workshop equipment are required for fitting or removing the SLED-FPEEPMS system.

2. Tool List
   No special tools are required.

3. Fixtures List
   No special fixtures are required.

4. Equipment List
   No special equipment is required.

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APPENDIX A: AOG PROCEDURES

1. Requirement

The ATA Airline Suppliers Guide requires that "suppliers make every effort to ship AIRCRAFT ON GROUND (AOG) material within 4 hours of request and to ship other critical material within 24 hours. For these purposes, suppliers will need to operate 24 hours a day, 7 days a week".

2. General Approach

A. LSI has established a 24 hour telephone number to take any AOG call, or other emergency after office hours.

LSI AOG PHONE NUMBER: +1 802 295 0408

The operator will take:
(1) callers name
(2) airline name
(3) telephone number
(4) any message that the caller wishes to leave.

The operator will then pass the message to the appropriate individual within LSI. It will be the responsibility of this individual to:
(1) call the airline back
(2) get all pertinent information (see list below)
(3) take the necessary AOG action required to get the necessary parts shipped.

B. LSI requires the following information from the caller for prompt and correct action:
(1) callers name
(2) airline name
(3) telephone number
(4) date and time of call
(5) part number(s)
(6) material quantity
(7) aircraft type
(8) purchase order number
(9) ship to address
(10) bill to address
(11) special instructions.

C. AOG Shipment.
(1) Federal Express (Fedex) is the best method of shipping from Lebanon, New Hampshire. Fedex:
  (a) leaves Lebanon with packages received before 6:15 p.m.
  (b) ships late packages the following evening
  (c) provides no service out of either Lebanon, NH or Boston, MA on Sundays or holidays.
(2) Local airlines offer counter to counter service which interconnect to major carriers. This service is available daily from Lebanon, NH at an extra service fee. Last drop off time at FedEx in Lebanon, NH is 6.15 pm.
(3) Please specify clearly which shipping method is preferred.

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