United States of America
Department of Transportation -- Federal Aviation Administration

Supplemental Type Certificate

Number **ST00405LA-D**

This certificate issued to

PATS Aircraft, LLC.
21652 Nanticoke Avenue
Georgetown, DE 19947

certifies that the change in the type design for the following product with the limitations and conditions therefor as specified hereon meets the airworthiness requirements of Part 25 *of the* Federal Aviation *Regulations.*

Original Product -- Type Certificate Number: A16WE

Make: Boeing

Model: 737-700 IGW, 737-700C Series

Description of Type Design Change: Installation of Provisions for Smoke Detection and Fire Suppression Systems, Lower Cargo Compartments in accordance with Hollingsead International, Inc. Master Data List No. 12106 Rev. A1, dated May 2, 1999 or later FAA approved revision.

Installation of Smoke Detection and Fire Suppression Systems, Lower Cargo Compartments in accordance with Hollingsead International, Inc. Master Data List No. 12106 Rev. C, dated June 25, 1999 or later FAA approved revision.

Limitations and Conditions: This approval should not be incorporated on any certificated products of this model on which other approved modifications are incorporated, unless it is determined that the relationships between this change and any of those previously incorporated modifications will not introduce any adverse effect upon the airworthiness of the certificated product. A copy of this STC and Master Data List No. 12106 must be included in the permanent record of the aircraft. If the holder agrees to permit another person to use this certificate to alter the product, the holder shall give the other person written evidence of that permission.

This certificate and the supporting data which is the basis for approval shall remain in effect until surrendered, suspended, revoked or a termination date is otherwise established by the Administrator of the Federal Aviation Administration.

Date of application: November 12, 1998

Date of issuance: May 11, 1999

Date reissued: June 27, 2005; May 14, 2007; January 25, 2008; January 30, 2008; June 8, 2009

Date amended: June 25, 1999; November 15, 1999; March 26, 2002; December 28, 2007; October 13, 2010

By direction of the Administrator

(Signature)

William J. Ertle II
STC ODA administrator
ODA-955292-NE

(Title)

Any alteration of this certificate is punishable by a fine of not exceeding $1,000, or imprisonment not exceeding 3 years, or both.

This certificate may be transferred in accordance with FAR 21.47.

United States of America
Department of Transportation -- Federal Aviation Administration

Supplemental Type Certificate

(Continuation Sheet)

Number **ST00405LA-D**

Date: October 13, 2010

Description of Type Design Change (Continued):

FAA approved Flight Manual Supplement 20629 Rev. NC, dated June 22, 1999, or later FAA approved revision is required.

Limitations and Conditions (Continued):

Visual Inspection of the fire suppression system fire extinguisher bottle located at Station 540, LBL 10, WL 195 must be accomplished at intervals of 4,000 Flight Cycles in accordance with the Instructions for Continued Airworthiness, Hollingsead Document 20689 Rev. C, dated March 25, 2002, or later approved revision.

This alteration has been evaluated, based on the referenced data and has no effect on the current type design suitability for Extended Range Operations.

This STC does not require a revised Electrical Wiring Interconnection System (EWIS) Instructions for Continued Airworthiness (ICA).

Certification Basis:

Part 26 Regulations:

26.11 Amendment 26-0

PATS Aircraft, LLC
21652 Nanticoke Avenue
Georgetown, DE 19947

APPROVAL OF MINOR TYPE DESIGN CHANGE

1. Minor Change Document #: ST00405LA-MNR-01, Revision IR, date 04/13/2015

2. Affected STC:

Item	Information
STC Number	STC # ST00405LA-D
Date of issue / amendment	Originally Issued May 11, 1999 Last Amended October 13, 2010
Affected Aircraft model / series / serial	Per the STC: 737-700IGW, 737-700C Series
Brief description of STC	Installation of provisions for modifications to the cargo smoke detection and fire suppression systems.
Brief Description of Minor Change	Reductions of the forward cargo compartment volume due to Boeing production change that relocates the EE bay bulkhead from STA 396 to STA 401.
Justification of classification as Minor Change	An analysis has been conducted to determine impact of the EE bay bulkhead relocation and associated cargo compartment volume reduction of the performance of the cargo smoke detection and fire suppression systems. No performance change was noted and no configuration changes are required.

3. Following request from the STC holder, the following list of affected documents/data and associated approvals related to this STC have been reviewed.

Affected Doc #	Rev	Date	Title
R-6212	-	05/28/1999	Statham Test Report
R-6324	B	09/14/2000	Ground & Flight Testing for Cargo Bay Smoke Detection
R-6385	-	06/11/1999	Boeing Business Jet Model and Flight Test Comparison Fire Suppression System
R-6386	B	06/24/1999	FAA Certification by Analysis, Class "C: Cargo Bay Fire Suppression Concentration
R-6435	-	07/16/1999	Boeing Business Jet I 737 Cargo Bay Smoke Detection Certification Testing
R-6814	A	11/03/2003	C-40B/C-40C Cargo Bay Smoke Detection Test Report/Comparative Analysis

Affected Doc #	Rev	Date	Title
R-6913	-	06/07/2002	Boeing Business Jet I 737 Cargo Bay Smoke Detection Mock-up Testing
R-7236	-	04/23/2004	Effect on actual Cargo Bay Fire Suppression Concentration Flight Test Data for an 8,000 to 6,000 Foot Cabin Altitude Change in the Boeing Business Jet 737-700
TO-5767	IR	04/13/2015	Cargo Compartment Fire Protection Assessment

4. The following prior minor revisions to this STC have also been reviewed

Prior Minor Change #	Rev	Date
None noted	—	—

5. This data has been reviewed in accord with the FAA approved ODA Manual.
6. This data and the accumulation of changes are judged to be a minor change to type design as defined by 14CFR §21.93.
7. This approval is by a method acceptable to the FAA Administrator per 14CFR §21.95.

Approved by ODA STC Administrator, OLMSTED, STC Administrator 4/13/2015

(print/type name & sign & fill in date)

Attachments

Instructions

Reference current ODA manual. A Cert Engineer will fill this in and present to the ODA Unit.

1. In item 1, assign serial number to Minor ("MNR")changes on ODA Form XXX as follows:
    a. "STxxxxxNY-MNR-01", citing the applicable STC, "MNR" and "xx" (01, 02, etc).
    b. Note: All minor change type design changes are revision "IR"; if a revision is required then a new serial number minor change will be issued.
    c. ODA Admin staff will maintain a log that lists these serial numbers and their STCs.
2. List the affected STC and its information
3. This is data presented by Engineering as recommended for minor change to type design, Fill in data number, revision, date, and title.
4. Fill in prior minor type design changes from this STC that are not yet incorporated in a major design change
5. Following completion of the MTDRB, Certification will submit this form, MTDRB minutes, and all related documentation / data to the ODA Unit.
6. When satisfied, STC administrator print/type name and sign & date
7. ATTACHMENTS. For distribution, include approved documents as listed in para 2.3
8. DISTRO
    a. Provide copies of form to STC holder & Eng Doc Control
9. FILING
    a. ODA Admin Staff: Log serial number, STC and date of minor change approval. File hard copy and electronic copies of form, MTDRB minutes, data and approvals in minor change folder and original project folder.

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DOCUMENT NO. TO-5767

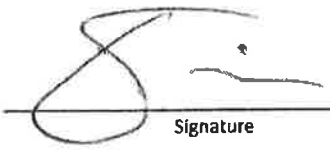
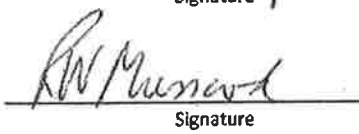
Cargo Compartment Fire Protection Assessment

Boeing Production Relocation of EE Bay Bulkhead, STA 396 to STA 402
Boeing 737-700 Series Aircraft

PROJECT NO. STC # ST00405LA-D
(Minor Change Project # ST00405LA-MNR-01)

Revision IR

April 13, 2015

Cole Eminger UM, Mechanical Systems Typed Name of Preparer	 Signature
Robert Bourgot Certification Engineer Printed Name of Approver and Title	 Signature
Roger Mussard Certification Manager Printed Name of Approver and Title	 Signature
Printed Name of Approver and Title	Signature

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DOCUMENT NO. TO-5767

Cargo Compartment Fire Protection Assessment

Boeing Production Relocation of EE Bay Bulkhead, STA 396 to STA 402
Boeing 737-700 Series Aircraft

PROJECT NO. STC # ST00405LA-D
(Minor Change Project # ST00405LA-MNR-01)

Revision IR

April 13, 2015

Cole Eminger UM, Mechanical Systems Typed Name of Preparer	Signature
Robert Bourgot Certification Engineer Printed Name of Approver and Title	Signature
Roger Mussard Certification Manager Printed Name of Approver and Title	Signature
Printed Name of Approver and Title	Signature

RECORD OF REVISIONS

REV	DESCRIPTION OF CHANGE	PAGES AFFECTED	APPROVED BY	DATE
IR	Initial Release	All	See Title Page	04/13/15

TABLE OF CONTENTS

1. PURPOSE

This document provides substantiation for cargo compartment fire protection systems for 737-700 BBJ aircraft modified per PATS STC # ST00405LA-D following a Boeing production change that relocates the EE bay bulkhead six (6) inches aft from STA 396 to STA 402. This change reduces the air volume of the forward cargo compartment, requiring reevaluation of the performance of the modified cargo fire protection systems.

2. SCOPE

The substantiation of fire protection systems is made on the basis of comparative and/or numeric analysis. Substantiation is provided only for the forward cargo fire protection systems, since the subject Boeing change affects only the forward cargo compartment geometry.

3. DESCRIPTION OF CHANGE AND AFFECTED SYSTEMS

PATS holds STC # ST00405LA-D for modifications to the Boeing production cargo fire protection systems of 737-700 aircraft that enable optimum performance of those systems in conjunction with any possible configuration of PATS auxiliary fuel system (AFS) installation per either STC # ST00936NY or ST01716NY. STC # ST00405LA-D describes modifications that affect the cargo smoke detection and cargo fire suppression system installation for both the forward and aft cargo compartments.

In mid-2014 Boeing introduced a production change in the 737 NG aircraft that provides additional space on the aft side of the E2 electronics shelves in the electronic equipment (EE) bay. This was accomplished by moving the bulkhead that separates the EE bay from the forward cargo compartment aft from STA 396 to STA 402, a distance of six (6) linear inches. As a result, the forward cargo compartment air volume is reduced by 13 cubic feet.

This documents assesses the impact of the EE bay bulkhead relocation on the performance of the forward cargo compartment smoke detection and fire suppression systems. No changes are being made to those systems, except for a minor relocation of the forward cargo smoke detection system control unit (CEU) and the cargo fire extinguisher monitor unit (EMU) due to changes in the mounting provisions, which are installed as part of the AFS STC. This change is being handled as a Minor Change to STC # ST00405LA-D.

4. REFERENCED DOCUMENTS

The following documents (latest revision, unless otherwise specified) are referenced by this report:

- D218A018-6 — Cargo Compartment Fire Protection System Certification Data for 727 and 737 Aircraft (Boeing, Rev P, dated 6 Dec 2005)
- 14 CFR Part 25 — Airworthiness Standards: Transport Category Airplanes
- AC 25-22 — Certification of Transport Airplane Mechanical Systems
- R-6212 — Statham Test Report (Kidde Aerospace)
- R-6386 — FAA Certification by Analysis, Class "C" Cargo Bay Fire Suppression Concentration
- NFPA 12A — Standard on Halon 1301 Fire Extinguishing Systems (NFPA, 1973)

5. APPLICABLE REGULATIONS

Compliance finding will be limited to performance of the forward cargo compartment fire protections systems as a result of the changes to compartment geometry caused by the EE bay bulkhead relocation. Compliance with the following regulations will be substantiated by this report:

5.1. CARGO SMOKE DETECTION

The following rules per 14 CFR Part 25 are applicable to the cargo smoke detection system:

- §25.857(c)(1), Amd't 25-60
- §25.858(a), Amd't 25-54
- §25.1301(d), Amd't 25-0
- §25.1309(a), Amd't 25-41

5.2. CARGO FIRE SUPPRESSION

The following rules per 14 CFR Part 25 are applicable to the cargo fire suppression system:

- §25.851(b)(2), Amd't 25-74
- §25.855(h)(3), Amd't 25-72
- §25.857(c)(2), Amd't 25-60
- §25.1301(d), Amd't 25-0
- §25.1309(a), Amd't 25-41

6. ANALYSIS

6.1. CARGO SMOKE DETECTION

Cargo Compartment Smoke Detection System Performance Assessment:

The forward cargo compartment smoke detection system consists of four (4) smoke detectors installed in pans in the cargo compartment ceiling in a "dual loop" arrangement, which allows for aircraft dispatch with either the "A" or "B" loop inoperative. STC # ST00405LA-D modifies the smoke detection system for optimized function when PATS auxiliary fuel tanks are installed. The cargo compartment smoke detection system modifications include relocation of several smoke detector pans and replacement of the forward two smoke detector pans with larger pans capable of mounting two smoke detectors, for use when two or more auxiliary fuel tanks are installed. The forward cargo smoke detector control unit (CEU) is relocated from the ceiling to a sidewall mounted equipment pallet that is installed as part of the auxiliary fuel system.

No changes to the smoke detector pan locations or smoke detector configuration are required as a result of the EE bay bulkhead relocation. Per Boeing report D218A018-6, Boeing has previously substantiated the smoke detectors using a geometric analysis, which has demonstrated acceptable smoke detection alarm times for distances of approximately 100 inches or less from any possible smoke source location to the nearest smoke detectors. The EE bay bulkhead is moved aft six (6) inches as part of the Boeing change and this effectively shortens the distance to smoke detectors for any smoke sources in the area of the bulkhead. Detection times for smoke source locations in the forward part of the cargo compartment should improve slightly, while detections times for smoke sources in other areas would be expected to remain unchanged. Slight relocation of the forward cargo CEU, required due to changes in the equipment mounting pallet, will have no impact on smoke detection system performance.

Compliance Assessment:

No changes to the cargo compartment smoke detection system as configured per STC # ST00405LA-D are required to accommodate the Boeing EE bay bulkhead relocation. System performance is essentially unchanged. The smoke detection system continues to fulfil the performance requirements of §28.858(a), and the functionality requirements of §§25.1301(d) and 25.1309(a) are substantiated by similarity. This assessment indicates that the cargo compartment smoke detection system is "approved", thereby satisfying the requirements of §25.857(c)(1). No additional substantiation or testing is required.

6.2. CARGO FIRE SUPPRESSION

Cargo Compartment Fire Suppression System Performance Assessment:

The cargo compartment fire suppression system consists of fire extinguisher bottles, fire suppression agent distribution plumbing, and a number of fire suppression nozzles installed in the cargo compartment ceilings. STC # ST00405LA-D modifies the Boeing installed fire suppression system for optimized function when PATS auxiliary fuel tanks are installed. The cargo compartment fire suppression system modifications include installation of additional fire suppression nozzles and associated plumbing, addition of a third fire extinguisher bottle, and control architecture changes facilitated by a new Extinguisher Monitor Unit (EMU). The EMU is installed next to the smoke detection system CEU on a sidewall mounted equipment pallet that is installed as part of the auxiliary fuel system.

The performance of the 737-700 cargo fire suppression system was previously substantiated for STC # ST00405LA-D by flight test and analysis as documented in Kidde Aerospace reports R-6121 and R-6386, respectively. No changes to the fire suppression system plumbing, mechanical architecture, or system control electronics are required as a result of the EE bay bulkhead relocation. The EMU is moved slightly due changes in the equipment mounting pallet provisions and this will have no impact on system performance. However, reduction of the cargo compartment volume caused by the bulkhead relocation requires evaluation of fire suppression system performance for the forward cargo compartment.

Factors Affecting Fire Suppression System Performance:

The analytical method applied by PATS is based on standard calculation methods developed by the National Fire Protection Association (NFPA). Report NFPA 12A presents equations that have become the industry standard for calculating fire suppression agent concentration. Using these equations, suppression agent concentration at any time during a discharge event can be predicted as a function of the volume being protected and the ventilation rate of that volume.

Normally, the empty volume of the cargo compartment is used in the analysis. However, for the 737-700 BBJ the compartment volumes are changed as a function of the installed auxiliary fuel tank configuration. The larger volumes associated with empty cargo compartments and no cargo load are most critical considering the establishment of the initial minimum "knock down" Halon concentration, minimum 5%. The smaller volumes have been shown to be most critical for maintenance of the minimum 3% Halon concentration required for the duration of the maximum emergency flight deviation of 180 minutes, plus an additional 15 minutes (195 minutes, total), required for ETOPS approval. Since the cargo compartment has been previously substantiated at maximum volume and the EE bay bulkhead relocation reduces the cargo compartment volume by 13 ft^3, this analysis is limited to fire suppression performance assessment of the forward cargo compartment in the smallest possible air volume condition.

There is no ventilation system in the 737-700 cargo compartments. Nonetheless, the compartments are known to leak through the compartment liner, equalization valves, cargo door seals, etc., and are therefore considered "ventilated". In order to present an accurate analysis, the leak rate of the cargo compartment must be well established. Boeing has conducted a comprehensive series of flight test for fire suppression system performance in the 737 Series aircraft, as documented in Boeing report D218A018-6. Boeing has provided a copy of this document to PATS to support substantiation of the modified 737-700 cargo fire protection systems. The leak rate of the 737-700 forward cargo compartment documented in report D218A018-6 is 211 cubic feet per hour (CFH).

The ambient pressure and temperature environment into which the Halon is discharged is a factor in the volumetric concentration calculation. Lower cabin altitude is generally accepted as a more comfortable environment for passengers and for the BBJ aircraft Boeing offers a modification that will permit operation at a 6,500 ft cabin. The lower cabin altitude is more critical in terms of fire suppression as the volumetric concentration for a fixed amount of Halon gas discharged into a closed volume will be diminished as ambient pressure increases. PATS has applied a 6,000 ft cabin environment for the BBJ fire suppression analysis, which is conservative. Temperature is also a factor in calculating the volume occupied by Halon following discharge. Lower temperatures allow less expansion of the Halon gas, which reduces the calculated volumetric concentration. PATS assumes a conservative 32^0 F cargo compartment temperature.

The analytical method assumes uniform distribution of fire suppression agent within the cargo compartment interior. To accomplish this, multiple discharge nozzles with radial distribution patterns are installed in the cargo compartment ceiling, positioned for best possible coverage.

Analytical Method:

The calculation method presented below has been developed by PATS based on the standard equations outlined in NFPA Report 12A. Per NFPA 12A, the weight (W) of Halon 1301 required to achieve a given concentration (C) in an enclosed volume (V) can be calculated as follows:

(1) $W = (V/s)(C/100)$

Where;

W = the weight of Halon 1301 discharged into the enclosure (lb)
V = the air volume of the enclosure (ft^3)
s = 2.2062 + 0.005046T, specific volume of Halon (ft^3/lb) as a function of temperature
T = temperature of the protected volume (^{0}F)
C = Halon 1301 concentration (% by volume)

The specific volume calculation is valid at sea level. For calculations made at higher altitudes, the result should be multiplied by the ratio of ambient cabin pressure to standard sea level pressure, f_a. So corrected specific volume, $s_c = s\ f_a$. The equation may be rewritten:

(2) $C_o = 100Ws_c/V$

This equation is then used to determine what the initial concentration of Halon, C_o, will be following discharge of a known quantity of Halon into a known volume.

As stated previously, the initial Halon concentration will immediately begin to decay exponentially due to ventilation. NFPA 12A shows that this may be calculated:

(3) $C = C_o e^{-Rt/V}$

Where;

C = Halon 1301 concentration (% by volume) at time "t"
C_o = initial Halon 1301 concentration (% by volume)
R = the ventilation rate (ft^3/min)
t = elapsed time since initial concentration was reached (min)
V = the air volume of the enclosure (ft^3)
e = natural logarithm base 2.71828

In practice, the cargo compartment leakage, or ventilation, rate is calculated using this equation by applying a curve fit to flight test data. The modeled results are overlaid upon the plotted average test data. The leakage rate used in the model is adjusted until the best match is obtained. Once the ventilation rate is determined from test data it is applied to the analytical model, which may then be used to account for variations in compartment interior volume that may occur as a result of reconfiguration or other factors. In the case of aircraft cargo compartments this includes cargo loading, which occupies space and therefore reduces compartment air volume.

Equations (2) and (3) above may be used to create a model of concentration over time for a simple, single high-rate discharge fire suppression system. However, in the 737-700 BBJ additional metered discharge of Halon is provided, continually adding fire suppression agent following the initial high-rate discharge in order to offset loss due to compartment leakage. To account for this feature of the fire suppression system, the change to Halon concentration due to supplemental metered Halon addition must be calculated and factored into the model. This is effectively accomplished by differentiating Equation (2) with respect to time. Simplified, the result is:

(4) $C = 100Hs_c/R$

Where;

C = Halon 1301 concentration (% by volume)
H = dW/dt, the rate of Halon addition (lb/min)
s_c = altitude corrected specific volume of Halon (ft^3/lb)
R = dV/dt, the ventilation rate (ft^3/min),

The fire suppression system model used in this analysis is based on a combination of equations (3) and (4), where the term based on equation (3) is used to describe the decay of fire suppression agent over time and the term based on equation (4) is used to describe the effect of continued addition of Halon. The resulting equation is:

(5) $C = 100[(C_o/100 - Hs_c/R)\, e^{-R/V} + Hs_c/R]$, for t = 1 minute intervals

Halon decay term Halon addition term

The calculation is iterated in one minute intervals from initial discharge through the expected landing time following a maximum duration in-flight emergency diversion (ETOPS, 180 minute diversion, plus 15 minutes for descent and landing, 195 minutes total).

Validation of the PATS Analytical Model:

A plot of Halon concentration versus time from Boeing report D218A018-6 for the baseline (unmodified) 737-700 with an ETOPS configured cargo fire suppression system is shown in Figure 1 below.

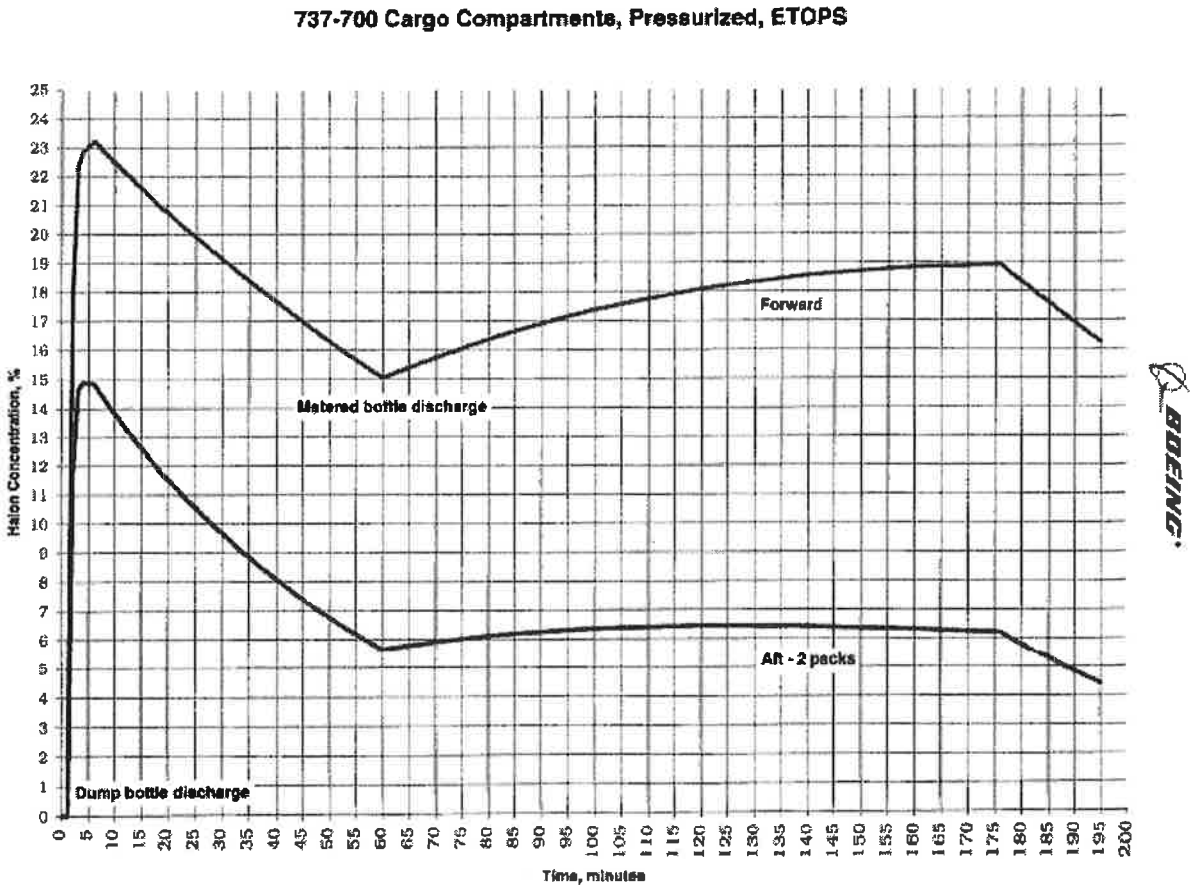

Figure 1
Plot of Boeing 737-700 Cargo Fire Suppression Analysis (ETOPS)
Boeing Analytical Model, from Boeing report # D218A018-6, Figure 3.3.2.9-3

The upper curve is the plot for the forward cargo compartment fire suppression system performance. Boeing's analysis assumes a 33 lb high-rate discharge (HRD) fire extinguisher ("fire bottle") discharged at time $t = t_0$, a 33 lb low-rate discharge (LRD, or "metered") fire extinguisher discharged at $t = t_0+60$ minutes and flowing Halon at 0.24 lb/min, forward cargo compartment air volume of 438 ft^3 (no cargo load), and forward cargo compartment leak rate of 211 ft^3/hour. Cabin altitude of 7,500 ft and a nominal cargo compartment temperature of 40^0 F are assumed. Key features of the plot are peak initial Halon concentration of just over 23%, diminishing to approximately 16% at HRD discharge time ($t = t_0+60$ minutes), concentration then increasing during LRD discharge to approximately 19% at LRD depletion ($t = t_0+175$ minutes), finally decaying to just over 16% at event end, $t = t_0+195$ minutes.

The same parameters were input into the PATS analytical model. A plot of Halon concentration versus time using the PATS model is shown in Figure 2.

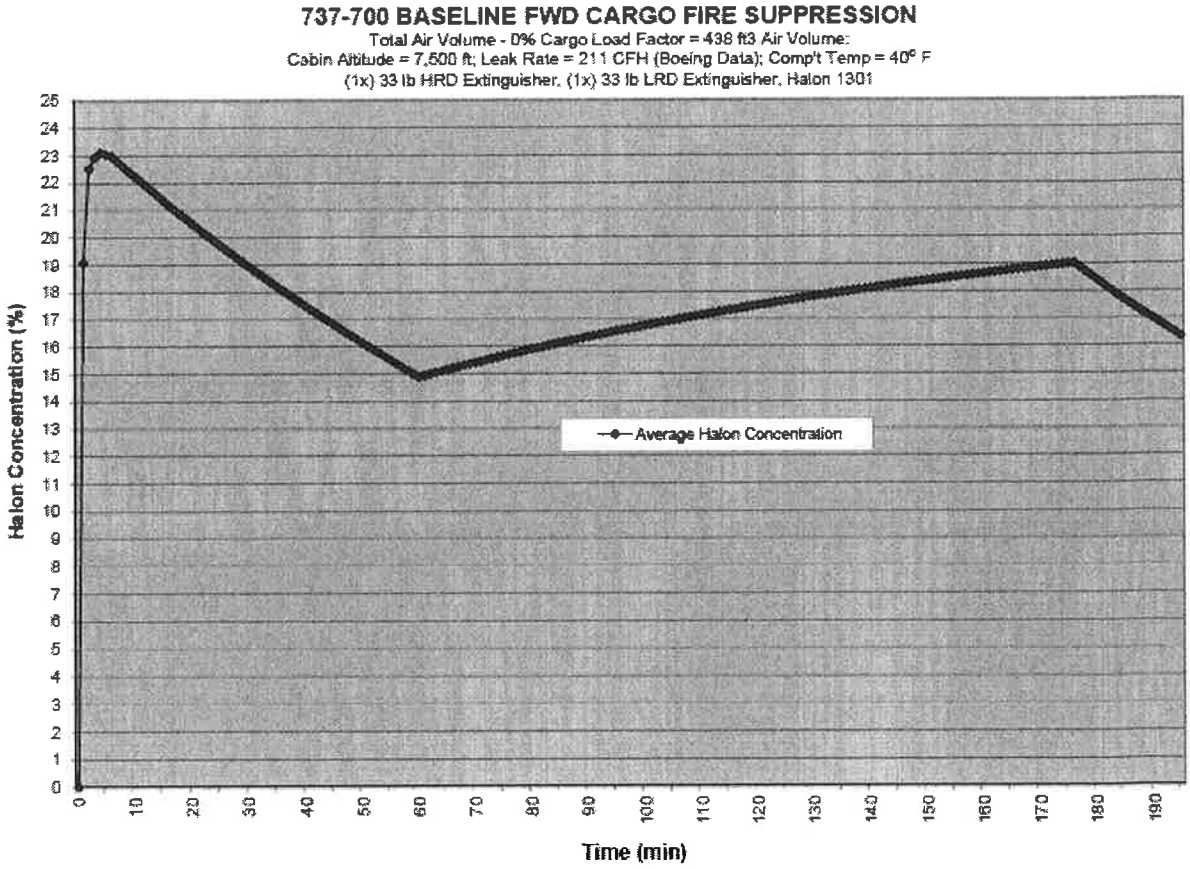

Figure 2
Plot of Boeing 737-700 Cargo Fire Suppression Analysis (ETOPS)
PATS Analytical Model

The plot created using the PATS analytical model as shown in Figure 2 matches the Boeing plot very closely and the values at key inflection points are nearly identical. The Boeing analytical model was validated based on comparison to flight test data for the 737-400 and was determined to return results that were accurate to within 1% of the flight test values. PATS analytical model is valid based on the comparison with Boeing's validated analytical model.

737-700 BBJ Fire Suppression System Performance Analysis:

For the 737-700 BBJ aircraft, the fire suppression system architecture is changed from the Boeing production ETOPS version installation by the addition of a new, smaller HRD fire bottle (16 lb vs. 33 lb) and conversion of the Boeing production HRD fire bottle to LRD by the addition of a metering unit. The new EMU controls discharge of the 16 lb HRD fire bottle concurrent with the first 33 lb LRD fire bottle at initial discharge command ($t = t_0$). The second LRD fire bottle is automatically discharged 60 minutes after initial discharge ($t = t_0$+60 minutes) using the unmodified flight deck control panel.

The Halon flow rate into the cargo compartment is very high during the first few minutes as the 16 pound HRD bottle is discharged. Complete HRD fire bottle discharge is assumed to occur in about five minutes with roughly 80% of the fire bottle contents emptied in the first minute. The first LRD fire bottle is concurrently discharged with the HRD and immediately begins to flow at 0.24 lb/min to offset loss due to compartment leakage. The metered fire bottles will not discharge their full contents due to container geometry and a 20% loss factor of agent is assumed for the LRD fire bottles. A second LRD fire bottle is discharged 60 minutes after initial commanded discharge (t = t_0+60 minutes). Each metered fire bottle takes about 115 minutes to deplete its contents. Therefore, sustaining flow for the first 60 minutes after HRD discharge is 0.24 lb/min. At time t = t_0+60 minutes, the second LRD is discharged and sustaining Halon flow rate increases to 0.48 lb/min. At time t = t_0+115 minutes the first LRD depletes and sustaining Halon flow is reduced to 0.24 lb/min. Sustaining Halon flow continues until approximately time t = t_0+175 minutes when the second LRD fire bottle is depleted and metered Halon flow stops.

The result of the analysis with the cargo compartment volume reduced due to the EE bay bulkhead relocation is shown in Figure 3.

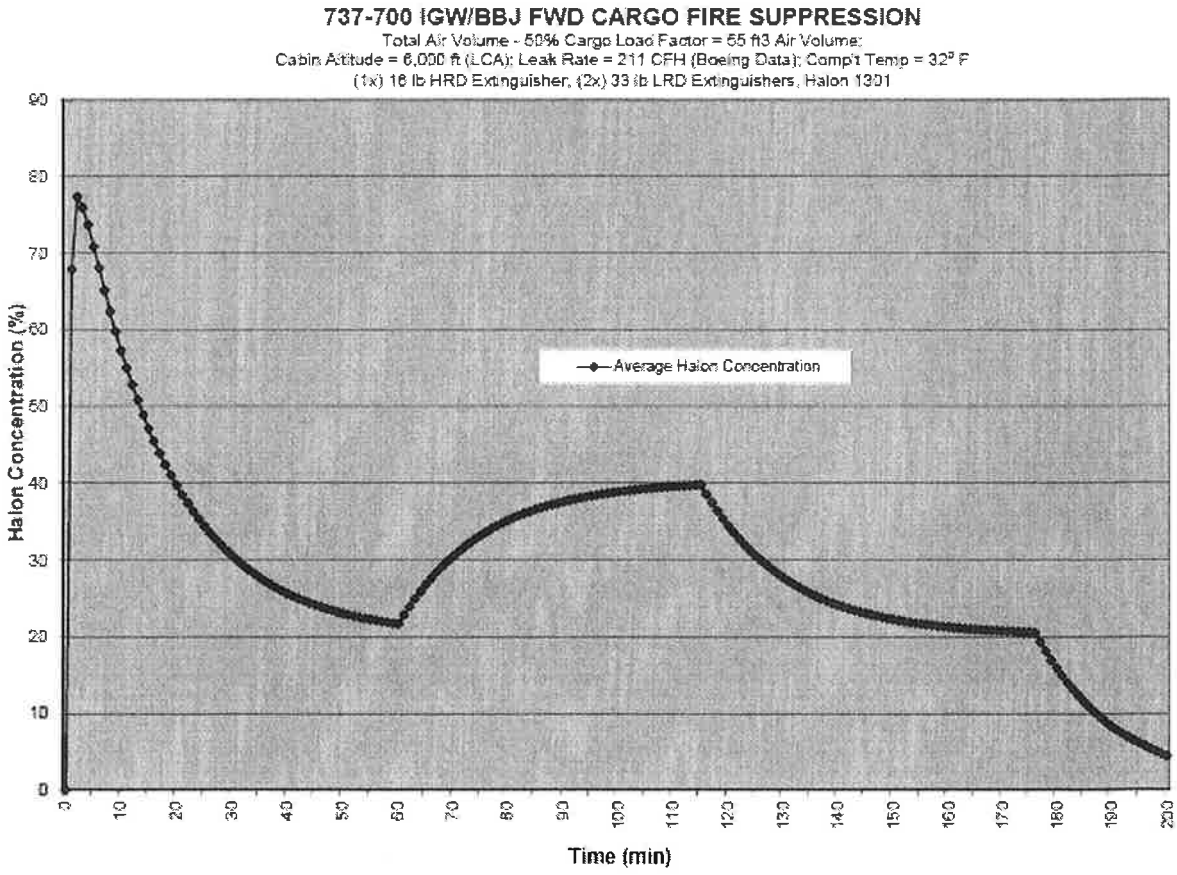

Figure 3
Plot of Boeing 737-700 BBJ Cargo Fire Suppression Analysis (ETOPS)
PATS Analytical Model, EE Bay Bulkhead Relocated from STA 396 to STA 402

PATS fire suppression analytical model is adapted for analysis of the 737-700 IGW/BBJ fire suppression system by addressing the specific architecture of the modified fire suppression equipment. The analysis considers the changed fire bottle arrangement, discharge timing, and unique Halon flow rates. As previously noted, conservative values for cabin altitude (6,000 ft) and cargo compartment temperature (32^0 F) are used in the PATS model. The air volume used in the analysis reflects the smallest, and therefore most conservative, volume including reduction of cargo compartment volume by 13 ft^3 from previous values to account for the EE bay bulkhead relocation, maximum compliment of AFS tanks (4-tank forward installation), and a 50% cargo load factor. The resulting air volume used in the analysis is 55 ft^3.

Traditionally accepted values for fire suppression system initial and sustained concentration levels are documented in the section of AC 25-22 dealing with 14 CFR Part 25, §25.851. As shown in Figure 3, the initial concentration of Halon in the forward cargo compartment peaks at greater than 75%, easily exceeding the minimum 5% required for knock-down of a flaming fire. Sustained Halon concentration in excess of 3% required for continued suppression of a deep-seated smoldering fire is shown for the full emergency diversion duration required to support 180-minute ETOPS approval. Halon concentration in the forward cargo compartment after landing (at 195 minutes and corrected for cabin altitude change to sea level) will be in excess of 4%, assuring continued suppression of a cargo fire during aircraft evacuation subsequent to landing.

Compliance Assessment:

The analysis of cargo fire suppression system performance was limited to the forward cargo compartment only, since the Boeing production change affected only the EE bay bulkhead. The analysis was accomplished using conservative values for cargo compartment volume, cabin altitude, and cargo compartment temperature, and was accomplished using a valid computational model. The analysis shows that Halon concentration in the forward cargo compartment will exceed 5% at initial discharge and can be expected to be sustained above 3% for the remainder of a maximum duration emergency flight diversion of 180 minutes plus an additional 15 minutes for descent and landing, thereby satisfying the requirements for 180-minute ETOPS approval.

No changes to the cargo compartment fire suppression system as configured per STC # ST00405LA-D are required to accommodate the Boeing EE bay bulkhead relocation. The cargo compartment fire suppression system is substantiated to satisfy the performance requirements of §28.851(b)(2) by numeric analysis. The analysis is supported by and was validated based upon flight test data, and compliance with the requirements of §25.855(h)(3) is shown. Additionally, the functionality requirements of §§25.1301(d) and 25.1309(a) are substantiated. This assessment indicates that the cargo compartment fire suppression system is "approved", thereby satisfying the requirements of §25.857(c)(2). No additional testing is required.

7. CONCLUSION

The impact of the Boeing production EE bay bulkhead relocation on cargo smoke detection system performance has been evaluated. The "one minute" detection criteria specified per 14 CFR Part 25, §28.858(a), Amendment 25-54, and the functionality requirements of §§25.1301(d), Amendment 25-0, and 25.1309(a), Amendment 25-41, are substantiated. The assessment indicates that the cargo smoke detection system is "approved", thereby satisfying the requirements of §25.857(c)(1), Amendment 25-60. No testing is required.

The impact of the Boeing production EE bay bulkhead relocation on cargo fire suppression system performance has been evaluated. There will be no degradation in the performance of the cargo fire suppression system in forward cargo compartment, which is the only compartment affected by the Boeing change. The fire suppression system is of adequate capacity considering compartment volumes and ventilation rates as specified per 14 CFR Part 25, §28.851(b)(2), Amendment 25-74, and the functionality requirements of §§25.1301(d), Amendment 25-0, and 25.1309(a), Amendment 25-41, are substantiated. The supporting analysis for this conclusion is based upon previously conducted flight testing and satisfies the requirements of §25.855(h)(3), Amendment 25-72. This assessment indicates that the cargo suppression system is "approved", thereby satisfying the requirements of §25.857(c)(2), Amendment 25-60. No testing is required.

No changes are made to any of the mechanical fire protection equipment installations as a result of the Boeing production EE bay bulkhead relocation so there is no need to evaluate cargo compartment integrity factors, including cargo liner flammability and smoke penetration protection, or substantiate cargo compartment classification.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

STATEMENT OF COMPLIANCE WITH AIRWORTHINESS STANDARDS

FAA Project No. **ST00405LA-D**

AIRCRAFT OR AIRCRAFT COMPONENT IDENTIFICATION

MAKE	MODEL NO.	TYPE (Aircraft, Engine, Propeller, etc.)	NAME OF APPLICANT/AUTHORIZATION NO.
Boeing	737-700 Series	Aircraft	PATS Aircraft, LLC ODA-955292-NE

LIST OF DATA

IDENTIFICATION	TITLE

NOTE: 1) This Data approval is in support of a Minor Change to STC # ST00405LA-D and DOES NOT constitute DER approval of the data listed herein. This approval is not valid for any other purpose or application. This approval addresses mechanical systems aspects of the listed documentation and additional approvals by other UM disciplines may be required.

2) The following data was reviewed in conjunction with the preparation, review and approval of the listed data:

Doc #	Rev	Date	Title
R-6212	-	05/28/1999	Statham Test Report
R-6324	B	09/14/2000	Ground & Flight Testing for Cargo Bay Smoke Detection
R-6385	-	06/11/1999	Boeing Business Jet Model and Flight Test Comparison Fire Suppression System
R-6386	B	06/24/1999	FAA Certification by Analysis, Class "C: Cargo Bay Fire Suppression Concentration
R-6435	-	07/16/1999	Boeing Business Jet I 737 Cargo Bay Smoke Detection Certification Testing
R-6814	A	11/03/2003	C-40B/C-40C Cargo Bay Smoke Detection Test Report/Comparative Analysis
R-6913	-	06/07/2002	Boeing Business Jet I 737 Cargo Bay Smoke Detection Mock-up Testing
R-7236	-	04/23/2004	Effect on actual Cargo Bay Fire Suppression Concentration Flight Test Data for an 8,000 to 6,000 Foot Cabin Altitude Change in the Boeing Business Jet 737-700

PATS Aircraft Data:
TO-5767, Rev IR
dated 04/13/2015

Cargo Compartment Fire Protection Assessment

----------END OF DATA----------

PURPOSE OF DATA

Data supports a Minor Change to STC # ST00405LA-D that was made necessary by a Boeing production relocation of the EE bay bulkhead from STA 396 to STA 402.

APPLICABLE REQUIREMENTS (List specific sections)

14 CFR PART 25, §§ 25.851(b)(2), Amd't 25-74; 25.855(h)(3), Amd't 25-93; 25.857(c)(1)(2), Amd't 25-93; 25.858(a), Amd't 25-93; 25.1301(d), Amd't 25-0; 25.1309(a), Amd't 25-41.

CERTIFICATION - As directed by the Administrator and in accordance with the conditions and limitations of authorization under 14 CFR, data listed above and on attached sheets numbered N/A have been examined in accordance with established procedures and found to comply with applicable requirements of the Airworthiness Standards listed.

I (We) Therefore:
- ☐ **Recommend approval of these data**
- ☒ **Approve these data**

SIGNATURE(S) OF AUTHORIZED REPRESENTATIVE(S)	NAME	CLASSIFICATION(S)	DATE
	Cole Eminger	Mechanical Systems & Equipment / Flammability	13 April 2015

FAA Form 8100-9 (2-02)