April 3, 2017

Weight and Balance Study

I. ACCIDENT

Location:	Bloomington, Illinois
Date:	April 7, 2015
Time:	0006 central daylight time (CDT) 0506 coordinated universal time (UTC)
Airplane:	N789UP, Cessna 414A modified in accordance with available STC's for engines, spoilers, winglets, and vortex generators

II. VEHICLE PERFORMANCE SPECIALIST

Kevin J. Renze, Ph.D.
Vehicle Performance Division, RE-60
National Transportation Safety Board (NTSB)

1.0 INTRODUCTION

On April 7, 2015, about 0006 central daylight time, a Cessna model 414A twin-engine airplane, N789UP, was substantially damaged when it collided with terrain following a loss of control during an instrument approach to Central Illinois Regional Airport (BMI), Bloomington, Illinois. The airline transport pilot and six passengers were fatally injured. The airplane was owned by and registered to Make It Happen Aviation, LLC, and was operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91 while on an instrument flight rules (IFR) flight plan. Night instrument meteorological conditions prevailed for the cross-country flight that departed Indianapolis International Airport (IND), Indianapolis, Indiana, at 2307 central daylight time.

2.0 METHOD

The airplane weight and balance for the accident flight and the preceding flight were calculated using the itemized weight and balance buildup method. The supporting documentation for the weight and balance study included maintenance records that established the airplane basic empty weight and moment, fuel loading receipts, passenger and crew weights, the preceding flight operating history for the accident airplane, the Pilot's Operating Handbook (POH) and FAA Approved Airplane Flight Manual, applicable Supplemental Type Certificate (STC) documents, and weather conditions.

2.1 Airplane Three-View Drawings

The original Cessna 414A three-view drawing (prior to applicable STC modifications) and the RAM Aircraft, LP three-view drawing are included in Attachment 1. These drawings do not reflect all STC modifications incorporated on N789UP at the time of the accident.

2.2 Fuel Receipts

Copies of the available fuel receipts are provided in Attachment 2.

2.3 Crew and Passenger Weights

The available passenger and crew weights for the accident flight are listed in Table 1. The passenger seating positions and measured, clothed, post-mortem crew and passenger weight data were provided by the McLean County Coroner's Office. These weight data were also used for calculations for the preceding flight leg from BMI to IND.

Table 1: Crew and Passenger Weights

Seat	Weight, lb.	Comment
1	180	Pilot
2	160	Passenger
3	237	Passenger
4	223	Passenger
5	185	Passenger
6	180	Passenger
7	---	Seat not installed
8	176	Passenger

2.4 Approved Airplane Weight and Balance Envelope

The applicable airplane weight and balance data for the Cessna 414A modified in accordance with STC SA8125SW and STC SA4943SW are provided in Attachment 3.

2.5 Flight Operating History and Estimated Fuel Consumption (N789UP)

The N789UP flight operating history was reconstructed for eight flight legs including the accident flight. The results are presented in Table 2.

The N789UP average fuel burn was estimated to be 47.36 gallons per hour based on the documented fuel burn for the first two flights operated on 4/1/2015, from BMI to PWK (about 46 minutes duration) and from PWK to UIN (about 76 minutes duration). These two flights consumed a fuel volume of 96.3 gallons based on available fuel receipts, assuming each wing fuel tank top-off event resulted in each wing tank fueled with a similar outage (i.e., the remaining volume in the tank for fuel to expand if the fuel temperature increases).

Based on the estimated average fuel burn rate, the N789UP fuel available prior to the BMI departure for IND was calculated to be about 114.5 gallons and the fuel available prior to the IND departure for BMI was calculated to be about 133.4 gallons.

2.6 Calculated Weight and Balance (N789UP)

The basic empty weight (BEW) is the standard airplane empty weight including unusable fuel, full operating fluids, and full oil but excluding the weight of crew, passengers, cargo, luggage, personal items, portable equipment, and usable fuel. The maximum zero fuel weight (MZFW) condition is the weight of the airplane in the fully loaded configuration (i.e., BEW, crew, passengers, cargo, luggage, personal items, and portable equipment) excluding usable fuel.

Table 2: Estimated Fuel Consumption (N789UP) Based on Fuel Burn between Two Reported Fuel Top-Off Events

Average Fuel Consumption Rate					47.36	Gal/Hr		
Date	Departure	Destination	Flight Duration, hours	Flight Duration, minutes	Usable Fuel Load at Departure, gallons	Estimated Fuel Used, gallons	Usable Fuel Load at Destination, gallons	Notes
03/31/2015		BMI					206.00	Fuel Top-Off
04/01/2015	BMI	PWK	0.7666	46.0	206.00	36.31	169.69	**Used to estimate fuel burn**
04/01/2015	PWK	UIN	1.2666	76.0	169.69	59.99	109.71	**Used to estimate fuel burn**
04/01/2015		UIN					206.00	Fuel Top-Off
04/01/2015	UIN	PWK	1.1666	70.0	206.00	55.25	150.75	Assumes 47.36 gph
04/01/2015	PWK	BMI	0.7666	46.0	150.75	36.31	114.44	Assumes 47.36 gph
04/02/2015	BMI	MDW	0.7000	42.0	114.44	33.15	81.29	Assumes 47.36 gph
04/02/2015	MDW	BMI	0.5666	34.0	81.29	26.83	54.46	Assumes 47.36 gph
04/06/2015		BMI					114.46	60 Gallons Added; 30 per Side
04/06/2015	BMI	IND	0.8666	52.0	114.46	41.04	73.42	Assumes 47.36 gph
04/06/2015		IND					133.42	60 Gallons Added; 30 per Side
04/07/2015	IND	BMI	0.9833	59.0	133.42	46.57	86.85	Assumes 47.36 gph
							86.85	Gallons remaining at accident
							43.42	Gallons remaining per tank

The calculated weight and balance results for the accident flight and the preceding flight from BMI to IND are summarized in Table 3. The supporting itemized weight and balance buildup tables and weight and balance envelope plots are included in Attachment 4.

Table 3: Calculated Weight and Balance for the Accident Flight and the Preceding Flight

Accident Flight (IND to BMI)	**Weight, lb**	**Limit, lb**	**Exceedance, lb**	**Arm, inches**	**Aft Limit, inches**	**Inches Aft of Aft Limit**
Zero Fuel	6,608	6,515	93	162.69	---	---
Ramp	7,388	7,087	301	162.59	---	---
Takeoff	7,358	7,087	271	162.60	158.24*	4.37
Landing	7,116	6,750	366	162.66	158.96*	3.71
BMI to IND Flight (Accident Seating)	**Weight, lb**	**Limit, lb**	**Exceedance, lb**	**Arm, inches**	**Aft Limit, inches**	**Inches Aft of Aft Limit**
Zero Fuel	6,608	6,515	93	162.69	---	---
Ramp	7,277	7,087	190	162.63	---	---
Takeoff	7,247	7,087	160	162.64	158.56*	4.08
Landing	7,037	6,750	287	162.68	159.19*	3.49
BMI to IND Flight (Most Forward CG)	**Weight, lb**	**Limit. lb**	**Exceedance, lb**	**Arm, inches**	**Aft Limit, inches**	**Inches Aft of Aft Limit**
Zero Fuel	6,608	6,515	93	161.98	---	---
Ramp	7,277	7,087	190	161.99	---	---
Takeoff	7,247	7,087	160	162.00	158.56*	3.43
Landing	7,037	6,750	287	162.02	159.19*	2.83

* Aft center of gravity limit value was linearly extrapolated for weight value outside (above) the approved envelope

The results indicate that the accident airplane load exceeded the maximum zero fuel weight (MZFW) by 93 pounds, the maximum ramp weight by 301 pounds, the maximum takeoff weight (MTOW) by 271 pounds, and the maximum landing weight (MLW) by 366 pounds. The airplane center of gravity was calculated to be aft of the aft limit for both takeoff and landing for each flight scenario considered, even when the most forward center of gravity passenger loading scenario is considered.

2.7 Atmospheric and Wind Data

Weather and wind data collected to support alternate weight and balance calculations for the accident flight and the preceding flight from BMI to IND are included in Attachment 5.

2.8 RAM Aircraft – Series IV Performance and Fuel Burn Data

A comparison of the basic RAM Aircraft – Series IV performance to the Cessna 414A performance and a copy of the RAM Aircraft engine quick reference card (QRC) are provided in Attachment 6

2.9 Weight and Balance Estimates Using Cessna 414A POH and RAM Aircraft Data

The average fuel burn rate of 47.36 pounds per hour was checked by estimating the expected fuel burn for each flight segment for the preceding flight from BMI to IND and the accident flight from IND to BMI. The flight legs considered included:

1. Engine start, taxi, run-up, and takeoff
2. Climb at the cruise climb condition
3. Cruise at 75 percent power
4. Descent
5. Landing and taxi

The time, distance, and fuel burn for each leg were estimated using the Cessna 414 POH and the RAM Aircraft – Series IV Engine QRC. The results are documented in Attachment 7 in spreadsheet form. Using the alternative fuel burn calculation method, the calculated flight time for each leg was within ±3 minutes of the comparable FlightAware data, the calculated cruise speed at 75 percent engine power was within 2 knots of the comparable FlightAware data, and the calculated fuel burn rate was one to two gallons per hour lower (5.85 to 11.70 pounds per hour lower) than the estimated average fuel burn value documented in Table 2.

3.0 CONCLUSION

The results of the weight and balance study indicate that the accident airplane load exceeded the maximum zero fuel weight (MZFW) by 93 pounds, the maximum ramp weight by 301 pounds, the maximum takeoff weight (MTOW) by 271 pounds, and the maximum landing weight (MLW) by 366 pounds. The airplane center of gravity was calculated to be aft of the aft limit for both takeoff and landing for each flight scenario considered, even when the most forward center of gravity passenger loading scenario is considered.

Attachment 1: Airplane Three-View Drawings

THREE-VIEW DRAWING

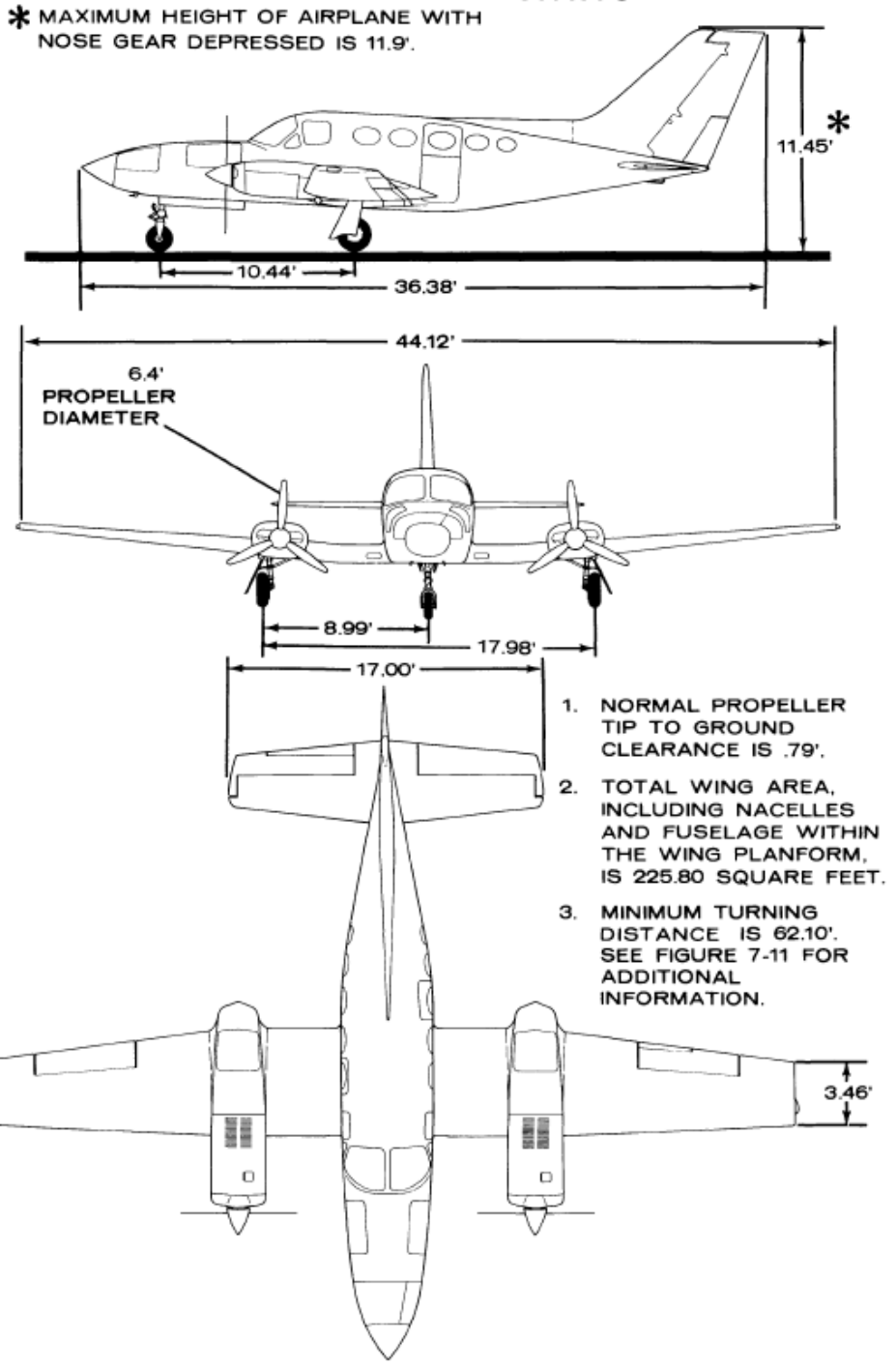
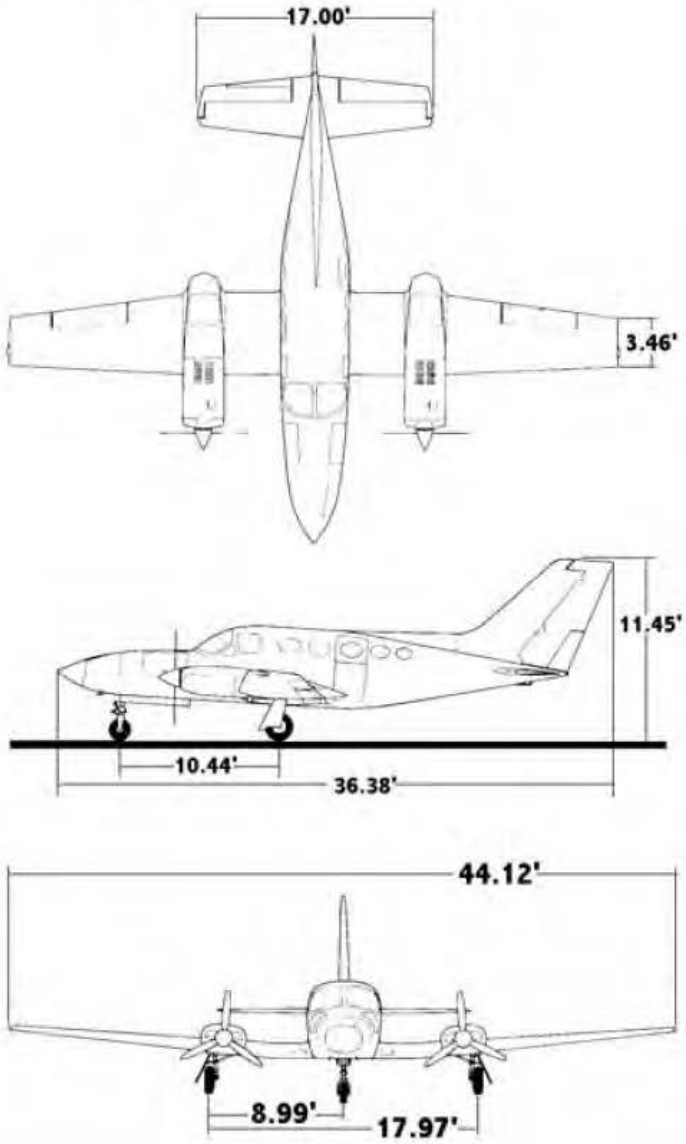


Figure 1-1

Cessna 414A Dimensions



Performance is based on a mid CG with mid cabin and fuel weight on an average day. Performance should always be calculated per flight environment while referring to the Manufacturer's Pilots Operating Handbook and applicable Flight Manual Supplements for the particular airplane. Aircraft Manufacturer's Pilot Operating Handbooks and Aircraft Owner's Manuals should always be available and adhered to by the aircraft Pilot in Command, including attention to applicable FAA approved Flight Manual Supplements and emergency procedures for each individual aircraft. Performance should vary from airplane to airplane, atmospheric day to atmospheric day, one gross weight and CG to another, and pilot to pilot.

RAM Aircraft, LP • [redacted] Waco, TX 76708
Phone: [redacted] • Fax: [redacted] • [redacted]

Attachment 2: Fuel Receipts (N789UP)

SYNERGY FLIGHT CENTER REFUELER LOG

V 2.0

TRUCK 3 FUEL TYPE 100 LL START GALLONS 933.6 DATE 3-31-15

	START TIME	N#	ENTER AIRCRAFT TYPE, FUEL ORDER OR SERVICE REQUEST (D.P. / N.P.)	TOTALIZERS FRT BEGIN / FRT ENDING	TOTALIZERS REAR BEGIN / REAR ENDING	METER GAL PUMPED	REMAINING IN TRUCK	PRIST/OIL	STOP TIME	TECH	ADDITIONAL NOTES/ CUSTOMER /SIGNATURE
1	0804	SUMPS, GAL:	3 ✓ (HIGHEST ...)	336194.6 START TOTALIZER	— START TOTALIZER	N/A	929.6	N/A	0808	[redacted]	ADD A LINE ITEM EACH TIME RECIRCULATIONS OR SUMPS ARE DONE DURING THE DAY, NOTING THE REASON.
2	0808	MORNING RECIRCULATIONS, NOZZLE & DIFFERENTIAL PRESSURE TESTS. ENTER ANY FUEL SENT TO SUMP SAVER FROM THESE TESTS IN THIS BOX:		336194.6 / 336194.6	— / —	0 ✓	926.6	PRIST SWITCH OFF DURING RECIRCULATION!	0808		DIFFERENTIAL & NOZZLE PRESSURE IS OBSERVED DURING RECIRCULATION OR FIRST FUELING OF THE DAY.
3	0942	1575F	Top off C172	336194.6 / 336222.3	— / —	27.7	898.9	N/A	0948		IF TRUCK IS [illegible] RECORD [illegible] ON BACK OF THIS SHEET. IF NOT WRITE N/A.
4	1112	7891UP	Top off 414A	336222.3 / 336318.3	— / —	96.0	802.9	N/A	1122		
5	1126	8122Z	Top left Dakota	336318.3 / 336329.7	— / —	11.4	791.5	N/A	1130		
6	1132	172WF	5 a side C172	336329.7 / 336339.7	— / —	10.0	781.5	N/A	1136		
7	1236	N/A	ADD LL fuel +200 GAL	336339.7 / 336339.7	— / —	N/A	1,000	N/A	1238		
8	1814	6929T	Top mains Twin	336339.7 / 336420.8	— / —	81.1	918.9	N/A	1822		
9	1834	8122Z	Top off Dakota	336420.8 / 336437.8	— / —	17	901.9	N/A	1838		Tom O.
10	1925	451X	TOP OFF DAKOTA	336437.8 / 336453.8	— / —	16.0	885.9	N/A	1929		DOUG LEONE
11	2128	From Tank 3	Added 111 gal.	336453.8 / 336453.8	— / —	N/A	1,000 ↑ #7806	N/A	2132		
12											
13											
14											
15											
16				336453.8	—						

ADDITIONAL SUMPS AND TESTS: USE SPACES ABOVE

SUBTRACT BEGINNING TOTALIZER: -336194.6 - —

EQUALS TOTAL GALLONS PUMPED/TOTALIZER: = 259.2 = —

259.2 ←READOUT TOTAL

TRUCK TOTAL GALLONS PUMPED: 259.2

WASTE FUEL, GAL: Ø

DEFUEL PERFORMED? NO

PRIST FILL, GAL: N/A

NON-REVENUE FUEL MOVEMENT REFERENCE NO. 1,2,7,11

TRUCK CLOSED BY A. H

PAGE 1 OF 1

A2.2

Make It Happen Aviation

[redacted]

Eureka, IL 61530

Fuel Request

	Left	Right	Top Off
Wing Tanks			
Total Amount		96.0	

Oil Request

	Amount	Type
Left Engine		
Right Engine		

Pilot Signature: [redacted] Date: 31 Mar 15

Line Tech. Signature: [redacted] Date: 31 Mar 15

RECEIPT

Receipt No.	Batch No.	Merchant No.	Terminal ID	Entered By
3465	1365	15952	10290216570	Clairissa Antczak

Delivered On	Destination	Tail No.	Ref No.	Entered On
03/31/2015		N789UP		03/31/2015 11:53:43

Payment Type	Exp Date	Auth No.
American Express [redacted] Keyed	[redacted]	176273

AOC
No

AVFUEL LOCATION
Synergy Flight Center, LLC
KBMI
[redacted]

ACCOUNT
Tom Hileman

DESCRIPTION	UNIT PRICE	QTY	PRODUCT	TAX/DISCOUNT	TOTAL
	USD		USD	USD	USD
Avgas 100LL	[redacted] /GAL	96	[redacted]	Synergy Preferred Customer State Tax Airport Tax Federal Oil Spill Federal Tax Avgas + LUST Sales Tax - State State Environmental Tax [redacted]	[redacted]
TOTAL			[redacted]	[redacted]	[redacted]

Shell Aviation

04/01/15 12:18:48

American Express Sale

Merchant ID: 14436
Terminal ID: 10015434920

Great River Aviation Llc
[redacted] - Quincy Regional
Quincy
62305
[redacted] V1.0.MDH.1.2

Batch 655 Invoice 106708

Entry Method: Swiped
Card #: [redacted]
Exp. Date: [redacted]
Tail #: 789UP

Avgas 100LL 96.30 Gallons		
[redacted]	$	[redacted]
FET Avgas		
[redacted]	$	
State Tax Avgas		
[redacted]	$	
Sales Tax Avgas		
[redacted]	$	
Total	$	[redacted]

Auth Code: 598031 [redacted]

Cardholder Signature

X [redacted]

I AGREE TO PAY THE TOTAL AMOUNT DUE
ACCORDING TO MY CARD TERMS AND CONDITIONS.

KEEP THIS RECEIPT FOR YOUR RECORDS

Merchant Copy

SYNERGY FLIGHT CENTER REFUELER LOG

V 2.0

TRUCK 3 FUEL TYPE 100 LL START GALLONS 950.6 DATE 4-6-15

START TIME	N#	ENTER AIRCRAFT TYPE, FUEL ORDER OR SERVICE REQUEST	D.P. N.P.	TOTALIZERS FRT BEGIN / FRT ENDING	TOTALIZERS REAR BEGIN / REAR ENDING	METER GAL PUMPED	REMAINING IN TRUCK	PRIST/OIL	STOP TIME	TECH	ADDITIONAL NOTES/ CUSTOMER /SIGNATURE
1 0732	SUMPS, GAL: 3	B.P. & HIGHEST N.P. TO BE FILLED OUT FOR ALL SINGLE-POINT FUELINGS.		336815.4 START TOTALIZER	— START TOTALIZER	N/A	947.6	N/A	0734		ADD A LINE ITEM EACH TIME RECIRCULATIONS OR SUMPS ARE DONE DURING THE DAY, NOTING THE REASON.
2 0734	MORNING RECIRCULATIONS, NOZZLE & DIFFERENTIAL PRESSURE TESTS. ENTER ANY FUEL SENT TO SUMP SAVER FROM THESE TESTS IN THIS BOX:		DP: NP:	336815.4 336815.4	— —	0	947.6	PRIST SWITCH OFF DURING RECIRCULATION!	0736		DIFFERENTIAL & NOZZLE PRESSURE IS OBSERVED DURING RECIRCULATION, OR FIRST FUELING OF THE DAY.
3 1122	2937R	top left	DP: NP:	336815.4 336828.6	— —	13.2	934.4	WRITE "PRIST" OR "OIL" USED	1124		IF TRUCK IS TOPPED OFF, RECORD BOTTOM LOAD GALLONS ON BACK OF THIS SHEET. IF NOT, WRITE N/U.
4 1128	1575F	top off - Bottom of Tabs	DP: NP:	336828.6 336850.7	— —	22.1	912.3	N/A	1132		
5 1226	495 ME	top off C182	DP: NP:	336850.7 336913.0	— —	62.3	850	N/A	1232		
6 1326	789 UP	30 psi DIPE IF TRUCK IS TOPPED OFF, WRITE "LOADED ____ GALLONS" IN FUELING NOTES.	DP: NP:	336913.0 336973.0	— —	60	790	N/A	1380		Make it Happen!
7 1442	Tank 3	Added 209 gallons	DP: NP:	336973.0 336973.0	— —	0	1000	N/A	1452		
8 1742	81222	Top off left - Warrior	DP: NP:	336973.0 336988.5	— —	15.5	984.5	N/A	1750		Paul Kreuger
9		DO NOT PRE-FILL START TOTALIZERS. WRITE WHEN→ OPERATION IS PERFORMED.	DP: NP:								
10			DP: NP:								
11			DP: NP:								
12			DP: NP:								
13			DP: NP:								
14			DP: NP:								
15			DP: NP:								
16			DP: NP:	336988.5	—						
				SUBTRACT BEGINNING TOTALIZER:		173.1 ←READOUT TOTAL					
				EQUALS TOTAL GALLONS PUMPED/TOTALIZER:							

ADDITIONAL SUMPS AND TESTS: USE SPACES ABOVE

336815.4	-	336815.4	-
336988.5	=	173.1	=

TRUCK TOTAL GALLONS PUMPED: 173.1

WASTE FUEL, GAL: N/A

PRIST FILL, GAL: N/A

DEFUEL PERFORMED? N/A

TRUCK CLOSED BY RC

PAGE 1 OF 1

NON-REVENUE FUEL MOVEMENT REFERENCE NO. 1,2,7

A2.6

Make It Happen Aviation

[redacted]

Eureka, IL 61530

Fuel Request

	Left	Right	Top Off
Wing Tanks	30 +	30 =	60gal
Total Amount			

Oil Request

	Amount	Type
Left Engine		
Right Engine		

Pilot Signature: [redacted] Date: 30 April 15

Line Tech. Signature [redacted] Date:

RECEIPT

Receipt No.	Batch No.	Merchant No.	Terminal ID	Entered By
3513	1371	15952	10290216570	Madison Plesko

Delivered On	Destination	Tail No.	Ref No.	Entered On
04/06/2015		N789UP		04/06/2015 13:35:39

Payment Type		Exp Date	Auth No.
American Express [redacted]	Keyed	[redacted]	156944

AOC
No

AVFUEL LOCATION
Synergy Flight Center, LLC
KBMI
[redacted]

ACCOUNT
Tom Hileman

DESCRIPTION	UNIT PRICE	QTY	PRODUCT	TAX/DISCOUNT	TOTAL
	USD		USD	USD	USD
Avgas 100LL	[redacted] /GAL	60	[redacted]	Synergy Preferred Customer State Tax Airport Tax Federal Oil Spill Federal Tax Avgas + LUST Sales Tax - State State Environmental Tax [redacted]	[redacted]
TOTAL			[redacted]	[redacted]	[redacted]

Customer Signature

By signing this receipt, I agree I have received and will pay for the above goods and/or services rendered. Card payments are governed by card issuer agreement.

THANK YOU FOR YOUR BUSINESS!

Find Avfuel Worldwide at www.avfuel.com

SYNERGY
FLIGHT CENTER
Dream. Fly. Achieve.

[redacted]
Bloomington, IL 61704
Phone: [redacted] Fax: [redacted]
E-Mail: [redacted] Web: [redacted]

April 9, 2015

Mr. Stanley Swank
Flight Standards District Office
[redacted]
Springfield, IL 62707-8417

Dear Mr. Swank,

Per your request, this statement was written to document the fueling of N789UP on April 6, 2015.

At approximately 1:30 p.m. Paul Goddard, a Synergy fuel technician, was called to perform a fueling on aircraft N789UP. Paul drove to the hangar and staged the truck in front of the aircraft, started an entry in the truck's fueling log and exited the cab. The pilot, Tom Hileman, approached the aircraft and Paul greeted him and asked if he wanted a top-off. Tom replied that he wanted 30 gallons per side. Paul then repeated the order back for confirmation and Tom acknowledged, so Paul then proceeded to hook up the bonding cable and begin the fueling operation. As Paul was attaching the bonding cable, Tom called out from behind the left wing and said "fuel the left side first so I can check the gauges" (which wasn't out of the ordinary with this and other aircraft). Paul started to dispense fuel in the left wing and Tom went inside the aircraft apparently to monitor the fuel gauges. When Paul had dispensed about 28 gallons, Tom gave him a thumbs-up gesture from inside the cockpit. Paul continued fueling the left wing until he dispensed 30 gallons, replaced the fuel cap and continued on to the right wing where he also dispensed 30 gallons. He then stowed all the fueling equipment, removed the bonding cable and finished the fuel log entry in the truck. Tom then came out of the aircraft's hangar with a fuel slip which had the fuel order of 30 gallons per side written on it, which they both signed. Paul returned to the FBO.

Signed,

[redacted]
Richard Anderson
Director of Operations, Synergy Flight Center

Date April 9, 2015

[redacted]
Paul Goddard
Ramp Operations Supervisor, Synergy Flight Center

Date 4-9-15

"To provide our customers with safety-oriented, high quality, affordable solutions for their specific aviation needs, driven by the highest level of customer service."

Signature FLIGHT SUPPORT
BBA Aviation

N789UP

N789UP

Customer Information		Aircraft Information	
Unknown Company or Owner	Pilot's Name Tom Hileman	C-414 Aircraft Type	N789UP Tail Number
Address 1	Cell Phone [redacted]	ETA 04/06/2015 17:02	Open 4/6/2015 17:02
Address 2	Hotel	ETD 2300	Close
City	Shuttle Pick-Up Time	HGR/HGR#	On-Line Time
State ZipCode	# of Pax Arriving	Security Tag	
Phone Number	# of Pax Departing	6771 POS Invoice Number	

Aircraft Services

Catering: Y / N	100LL [X] JET A [ ] JET A W/FSII [ ]	Requested Time	
Number:	Fuel Instructions: 30 per side to tank	Completed Time	
Linens/Dishes: Y / N		Fuel Truck	Fueler
Crew Car: Y / N		ASR Ticket Number 0	
Newspapers: Y / N	Total Gallons Delivered:	Oil Type and Instructions	
Coffee: Y / N	Other Services:		
Ice: Y / N		GPU	Water
Fax Delivered: Y / N		LAV	Cabin Clean

1: "Signature" refers to Signature Flight Support Corporation, or any of its subsidiaries. "Customer" refers to the legal entity for whom the services have been performed. "Airport" refers to the airport at which the services are performed. "Services" refers collectively to any products and services furnished by Signature to Customer.
2: Customer represents that it currently maintains policies of aircraft and commercial general liability insurance with respect to its aircraft, operations and maintenance, as well as, "all risk" type hull insurance on its aircraft and engines. In the event any third party claim is made against Signature Customer's insurance carrier shall provide primary coverage.
3: Customer agrees to indemnify, save and hold harmless Signature and the Airport from and against any and all claims, suits, damages, fines and penalties including all expenses, reasonable attorneys' fees and costs incidental to the defense of any claims arising out of Signature's acts or omissions, or the act or omissions of its directors, officers, employees, agents or assigns in connection with this Agreement, except to the extent such claims arise from the negligence or willful misconduct of Signature.
4: The parties agree that under no circumstances shall Signature be liable to the customer for indirect, incidental, consequential, special or exemplary damages, whether in contract or tort (including strict liability and negligence), such as, but not limited to, loss of revenue, loss of use or anticipated profits, diminution or loss of value, or costs associated with substitution or replacement aircraft.
5: Customer releases Signature from any damages sustained to Customer's aircraft or other personal property as a result of high winds or other adverse weather conditions.
6: In consideration of the Services provided by Signature, Customer agrees to pay all charges incurred for Services provided with respect to the aircraft described on this Agreement while located at the Airport, including reasonable attorneys' fees if collection is required. Signature shall have the right to retain possession of the aforementioned aircraft or its parts as security for the payment of Services.
7: By providing your email address, you authorize Signature Flight Support Corporation to contact you in the future with customer satisfaction surveys and information about products and services available through the BBA Aviation family of companies. Your email address will solely be used by Signature Flight Support Corporation and its affiliate companies within BBA Aviation and will not be shared with any other entity.

X [redacted] 06 April 15

Signature **Date**

Email Address

On-File Credit Card

On-File Card#:

Comments:

Printed: 04/06/2015 16:03 [redacted]

Invoice #	6771
Invoice Date	04/06/2015 17:57
Customer	Unknown
Registration	N789UP
Operator Id	Jamie T

Signature FLIGHT SUPPORT
BBA Aviation

[redacted]
Indianapolis, Indiana 46241
Phone [redacted]
Fax [redacted]

Services provided by Signature Flight Support - IND from 06 Apr 2015 17:02 to 06 Apr 2015 17:57

Service	Description	Quantity	Unit Price	Tax Amount	Total Price
3101	HANDLING CHARGE	1.00	[redacted]	0.000	[redacted]
1970	HCDISC ABOVEMIN	1.00		0.000	
3216	Event Parking - Multi Engine	1.00		0.000	
1100	100 LL/AVGAS	60.00		0.000	
2005	FED EXCISE-100LL	60.00		0.000	
210150	AvGas State and Local Taxes	60.00		0.000	
2402	AIRPORT FEE - 10	60.00		0.000	
3300	INFRASTRUCTURE FEE	1.00		0.000	
			Subtotal		[redacted]

Total (USD): [redacted]

Paid With AMERICAN EXPRESS [redacted]

Balance Due $0.00

[redacted]

Customer Signature

I agree to the credit card amount shown and to perform the obligations set forth in the terms of the issuer's cardholder agreement.

Your feedback is appreciated. Tell us how we did today by logging into [redacted] and entering Access Code: [redacted]

Join Signature Status today! Visit www.signatureflight.com and start receiving benefits on your next Signature visit. It's free!

We appreciate your business and your vote in the annual FBO surveys.

Did you know that you can now book discounted hotel rates all over the world through the My Signature Customer Portal? Enroll today at signatureflight.com.

Signature. FLIGHT SUPPORT
BBA Aviation

(077)
Aircraft Service Record
1873962

Base _____

DATE: 04/06/15	TAIL #: [redacted] 78YUP
CUSTOMER:	A/C TYPE: Cessna

100LL / AVGAS ☒

AUTO ☐	OIL _____ ☐ : _____	OTHER _____

Gold Cap ☐	Lav ☐	Water ☐	GPU ☐	Hangar ☐
Initials:	Initials:	Initials:	Initials:	Initials:

SPECIAL REQUESTS:

REQUESTED FUEL AMOUNT:

Meter Reading 2 1840823 Finish Meter Reading 1

AVGAS

Meter Reading 2 1840763 Start Meter Reading 1

60 ←Total Gallons→

Fueler's Initials: [redacted]	Unit #: 53	On A/C Time:	Off A/C Time: 1740

DID YOU SECURE OIL/FUEL CAPS AND PANELS?

Received by: (Customer) X

Signature000003

Fuel Unit Balancing and Reconciliation Record

Signature. FLIGHT SUPPORT
BBA Aviation

Page 1 of ____

Diff Pressure (psi) ____ Shift All Capacity 750 Fuel Type 100LL Unit# 53 Date: 4/16/15

Ticket Number	Customer	Outbound Flight Nbr	A/C Type	Tail#	Meter #1	Gallons	Meter #2	Gallons	Total Gallons	Into Unit	Running Balance	Svce Code*	Fueler	On A/C / Off A/C
1873966			C210	93581B	1840982	53	-	-	53		139	7	[redacted]	
1873965			Cirrus	446CD	1840929	29.	—	—	29		192	7	[redacted]	
1873964			[illegible]	7539	1840900	27			27		221	7	[redacted]	
1873963			Helio	5387G	1840873	50	—	—	50		248	7	[redacted]	1950
1873962	—	—	Cessna	[illegible]	1840823	60	—	—	60	—	298	7	[redacted]	1740
1873961	—	—	PA60	700MF	1840763	30	—	—	30	—	355	7	[redacted]	1433
1873960	—	—	C206	93861B	1840733	10	—	—	10	—	365	7	[redacted]	0447
	SUMP	—	—	—	—	—	—	—	3		395			

Start Nbr -> 1840723

Meter Total->

394	Beginning Balance
+	Filled
-	Pumped
-	Sumped
=	Book Inventory
	Physical Inventory
	Variance-Gain/(Loss)

*Service Codes: 1-FOB; 2-Preload; 3-Recirculation; 4-Ballast; 5-Callback; 6-Defuel; 7-Refuel
8-Inop Gauge; 9-A/C Swap; 10-GSE; 11-Other (Specify); B=Bonded Flight

070003 3/96

Attachment 3: Weight and Balance Data (N789UP)

AIRPLANE FLIGHT MANUAL SUPPLEMENT

FM1023, REVISION B

FOR THE CESSNA MODEL 414A

MODIFIED IN ACCORDANCE WITH STC SA8125SW

Installation of RAM Vortex Generators

SERIAL NO:	414A0495
REGISTRATION NO:	N789UP

*This supplement is FAA approved and must be attached to the FAA-approved Airplane Flight Manual when the aircraft has been modified in accordance with STC **SA8125SW**.*

The information contained in this document supplements or supersedes the Airplane Flight Manual only in those areas listed herein. For limitations, procedures, and performance not contained in this supplement, consult the Airplane Flight Manual.

This supplement is applicable only to Cessna 414A airplanes equipped with RAM Aircraft Limited Partnership Winglets and Series III/IV Engines installed in accordance with STCs SA4943SW and SA4546SW, respectively.

[redacted]

Approved _____
FOR S. Frances Cox, Manager
Special Certification Office
Federal Aviation Administration
Fort Worth, Texas 76193-0190

Date: October 18, 2005

RAM

[redacted] Waco, Texas 76708

SECTION 6
WEIGHT AND BALANCE

The following limits apply to the Cessna 414A modified by STC SA8125SW and SA4943SW.

Maximum Zero Fuel Weight: The maximum weight with no useable fuel in the wings is 6515 lbs.

Maximum Landing Weight: The maximum weight for landing operations is 6750 lbs.

Maximum Takeoff Weight: The maximum weight for takeoff operations is 7087 lbs.

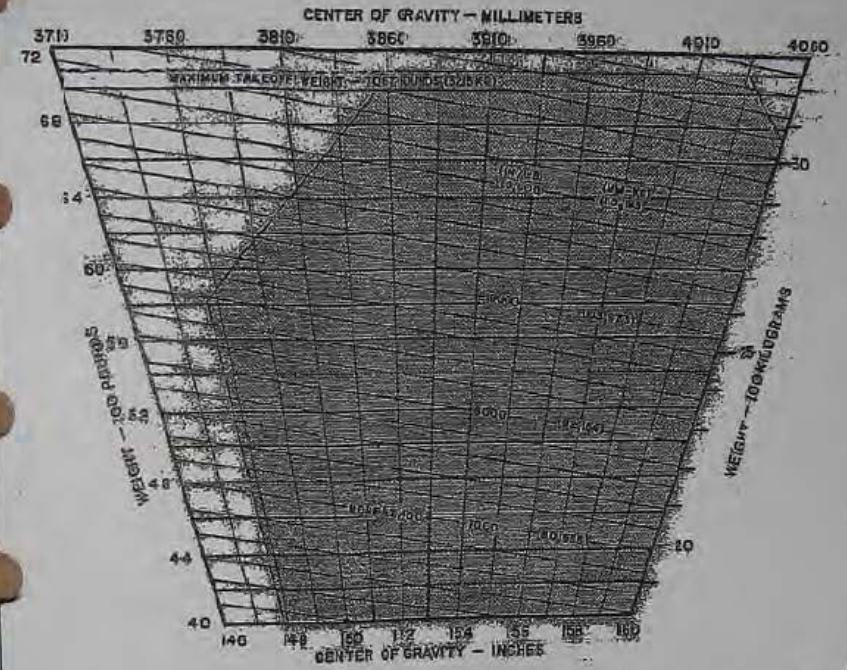
CENTER OF GRAVITY LIMITS: See table below and the following C.G. chart.

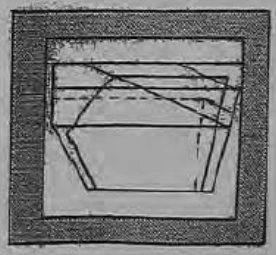
WEIGHT	FORWARD LIMIT	AFT LIMIT
7087	152.2	159.04
6750	151.2	160.04
5800	147.8	160.04
4700	147.8	160.04

NOTE: Linear variation between points.

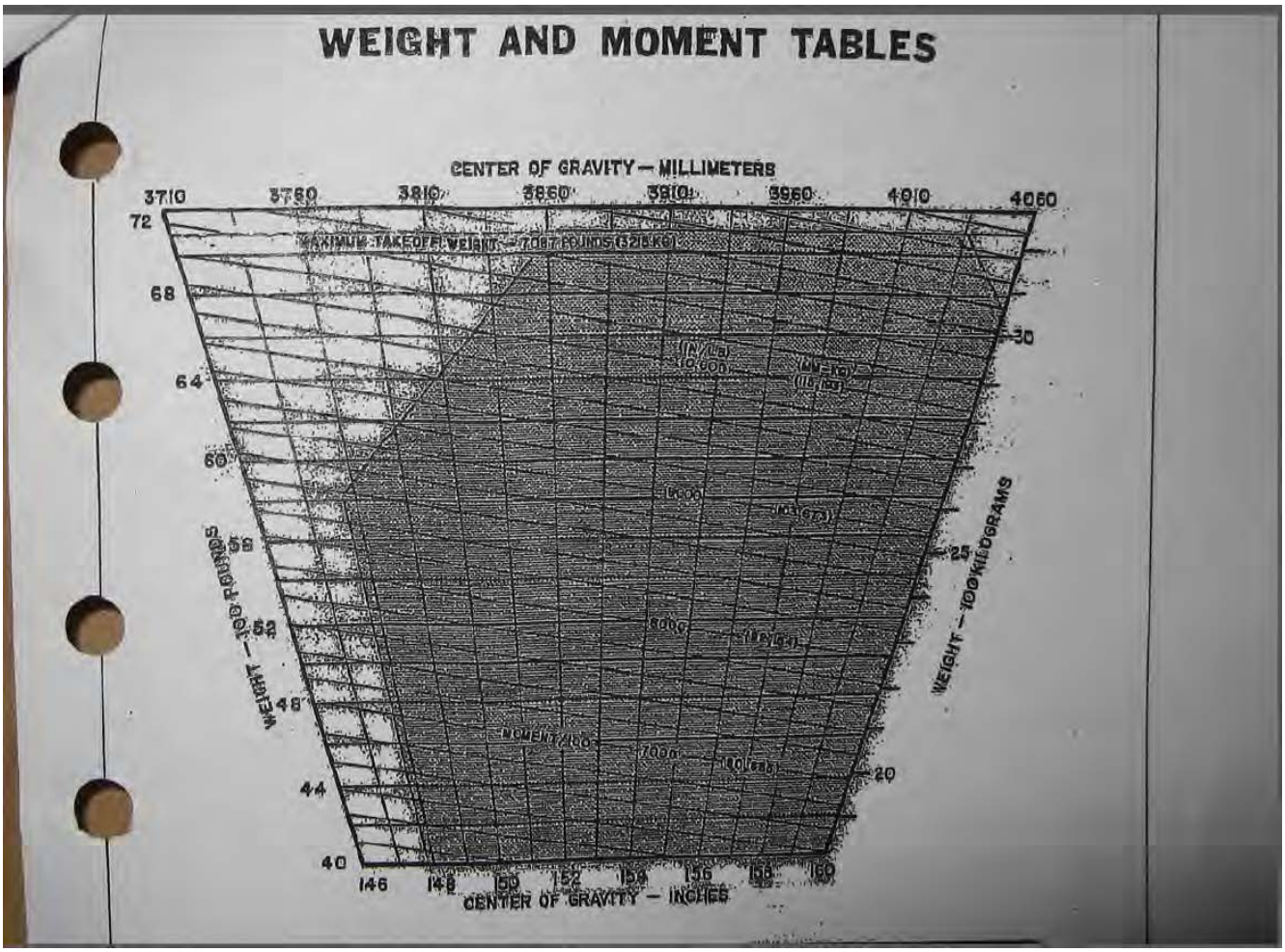
See page 24 for Weight and Moment Table.

WEIGHT AND MOMENT TABLES

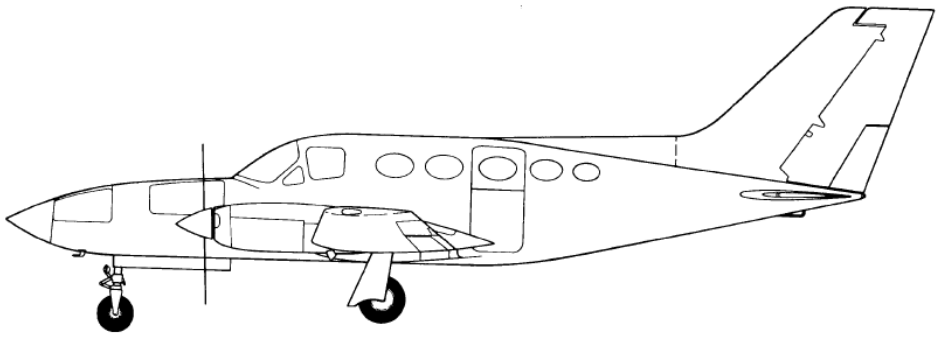




Revision A
FAA Approved
Revised: April 19, 1994


WEIGHT AND MOMENT TABLES
CENTER OF GRAVITY — MILLIMETERS
3710
3760
3810
3860
3910
3960
4010
4060
72
68
64
60
56
52
48
44
40
30
25
20
WEIGHT — 1000 POUNDS
WEIGHT — 1000 KILOGRAMS
146
148
150
152
154
156
158
160
CENTER OF GRAVITY — INCHES

PILOT'S OPERATING HANDBOOK
and
FAA APPROVED AIRPLANE FLIGHT MANUAL



CESSNA AIRCRAFT COMPANY

1980 MODEL 414A

Serial Number_____

Registration Number_____

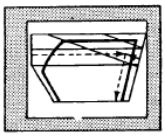
THIS DOCUMENT MUST BE CARRIED
IN THE AIRPLANE AT ALL TIMES

THIS HANDBOOK INCLUDES THE MATERIAL REQUIRED
TO BE FURNISHED TO THE PILOT BY CAR 3
AND CONSTITUTES THE FAA APPROVED AIRPLANE FLIGHT MANUAL.

CESSNA AIRCRAFT COMPANY
Wallace Division
Wichita, Kansas

1 NOVEMBER 1979

WEIGHT AND MOMENT TABLES



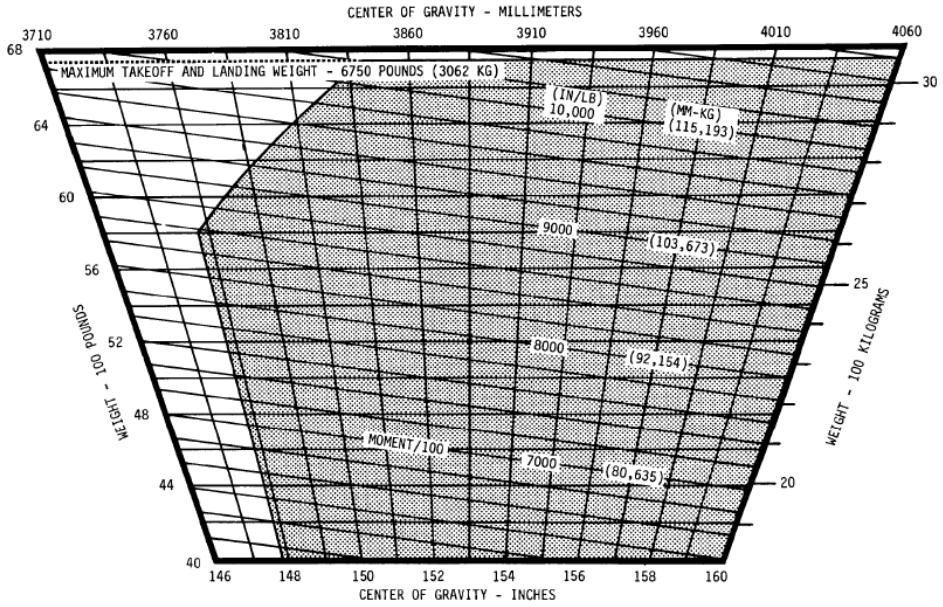


Figure 6-2 (Sheet 2 of 2)

WEIGHT AND MOMENT TABLES

CREW AND PASSENGERS

WEIGHT (POUNDS)	1ST OR 2ND SEATS ARM = 137"	3RD OR 4TH SEATS		5TH OR 6TH SEATS ARM = 218"	TOILET SEAT ARM = 250"	7TH OR 8TH SEATS ARM = 261"
		FORWARD FACING ARM = 175"	AFT FACING ARM = 178"			
	MOMENT/100					
10	14	18	18	22	25	26
20	27	35	36	44	50	52
30	41	52	53	65	75	78
40	55	70	71	87	100	104
50	68	88	89	109	125	130
60	82	105	107	131	150	157
70	96	122	125	153	175	183
80	110	140	142	174	200	209
90	123	158	160	196	225	235
100	137	175	178	218	250	261
110	151	192	196	240	275	287
120	164	210	214	262	300	313
130	178	228	231	283	325	339
140	192	245	249	305	350	365
150	206	262	267	327	375	392
160	219	280	285	349	400	418
170	233	298	303	371	425	444
180	247	315	320	392	450	470
190	260	332	338	414	475	496
200	274	350	356	436	500	522
210	288	368	374	458	525	548
220	301	385	392	480	550	574
230	315	402	409	501	575	600
240	329	420	427	523	600	626
250	342	438	445	545	625	652
260	356	455	463	567	650	679
270	370	472	481	589	675	705
280	384	490	498	610	700	731
290	397	508	516	632	725	757
300	411	525	534	654	750	783

FUEL

GALLONS (AT 6.0 POUNDS PER GALLON)	WEIGHT (POUNDS)	MOMENT/100 ARM VARIES	GALLONS (AT 6.0 POUNDS PER GALLON)	WEIGHT (POUNDS)	MOMENT/100 ARM VARIES
5	30	50	105	630	1022
10	60	99	110	660	1070
15	90	148	115	690	1113
20	120	197	120	720	1166
25	150	246	125	750	1214
28	168	275	130	780	1262
30	180	294	135	810	1310
35	210	343	140	840	1359
40	240	392	145	870	1407
45	270	440	150	900	1455
50	300	489	155	930	1503
55	330	537	160	960	1550
56	336	547	165	990	1598
60	360	586	170	1020	1646
65	390	635	175	1050	1694
70	420	683	180	1080	1742
75	450	731	185	1110	1790
80	480	780	190	1140	1838
85	510	828	195	1170	1886
90	540	877	200	1200	1934
95	570	925	204	1224	1971
100	600	973			

BAGGAGE AND CABINET CONTENTS

WEIGHT (POUNDS)	AVIONICS BAY ARM = 32"	NOSE COMPARTMENT ARM = 71"	WING LOCKERS ARM = 186"	AFT CABIN			
				BAY "A" ARM = 265"	BAY "B" ARM = 282"	REFRESHMENT BAR ARM = 279"	OVERHEAD CABINET ARM = 282"
	MOMENT/100						
10	3	7	19	26	28	28	28
20	6	14	37	53	56	56	56
30	10	21	56	80	85		
40	13	28	74	106	113		
50	16	36	93	133	141		
60	19	43	112	160	169		
70	22	50	130	186	197		
80	26	57	149	213	226		
90	29	64	167	239	254		
100	32	71	186	266	282		
110	35	78	205	293			
120	38	85	223	319			
130	42	92	242	346			
140	45	99	260	372			
150	48	107	279	399			
160	51	114	298	426			
170	54	121	316	452			
180	58	128	335	479			
190	61	135	353	505			
200	64	142	372	532			
210	67	149	391	559			
220	70	156	409	585			
230	74	163	428	612			
240	77	170	446	638			
250	80	178	465	665			
260		185	484	692			
270		192	502	718			
280		199	521	745			
290		206	539	771			
300		213	558	798			
310		220	577	825			
320		227	595	851			
330		234	614	878			
340		241	632	904			
350		248	651	931			
360			570	958			
370			688	984			
380			707	1011			
390			725	1037			
400			744	1064			

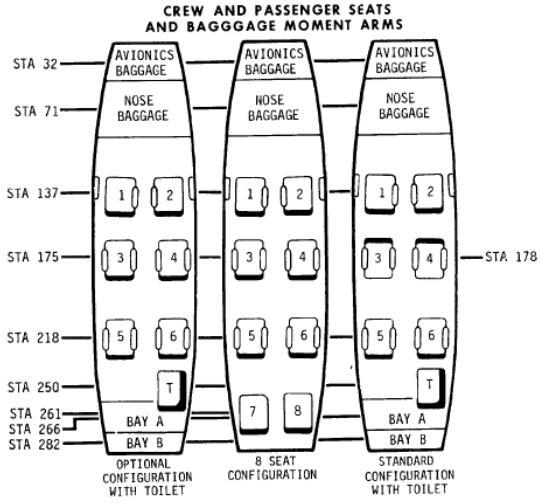


Figure 6-2 (Sheet 1 of 2)

Aircraft Weight and Balance Revision

Tail Number: **N789UP**			Date: 11/27/13
Prepared by: Ozark Air Services,inc [redacted] Cahokia,Il 62206			Work Order No: A1367 Type Certificate Data No:
Aircraft Make: Cessna	Model: 414A	Serial No: 414A0495	Time: HM2008.1
Registered Owner: Make it Happen Aviation LLC		Address: [redacted] McLean IL 61776	
Maximum Weight **7087**		CG Range FWD **152.2**	AFT **159.0**
As Received; Date of Previous Weight and Balance: June 2 04	**Useful Load:** 1864	**EW:** 5223	**EWCG:** 156.63	**Moment:** 818064
Notes:			

	Weight	Arm	Moment
Removed Garmin MX 20 with tray	-4.65	101.8	-473.37
Removed IN 152A radar indicator with tray	-6.8	103.9	-706.52
Installed Avidyne EX 600 MFD W/tray	6.8	103.8	705.84
Installed Avidyne TAS 605 TCAS System	6.8	31.75	215.90
Installed top TAS Antenna	.66	147	97.02
Installed bottom TAS Antenna	.75	180.45	135.34
	0.00	0.00	0.00
	0.00	0.00	0.00
	0.00	0.00	0.00
	0.00	0.00	0.00

☒ As Calculated ☐ As Weighed	Moment 818038.21 Weight 5226.56	**New Empty Weight CG** **156.52**	**New Useful Load** **1860.44**
		Signature [redacted]	
		Repair Agency or License No: [redacted]	

A1367

Ozark Air Services

WORK ORDER

OZARK AR SERVICES, INC.

[redacted] Cahokia, IL 62206

FAA Repair Station [redacted] [redacted] TX [redacted] Fax [redacted]

NAME Brandis / Scott Bitner	REGISTRATION NO. N789UP MAKE / MODEL CESSNA 414A	DATE 08/07/13
ADDRESS	AIRCRAFT SERIAL NO. 414A0495 SERIAL NO. / TOTAL HOURS HM 2008.1	PHONE FAX
CITY, STATE, ZIP	ADDITIONAL DATA	E-MAIL ADDRESS

SERVICE DESCRIPTION

1	PRELIMINARY INSP.
2	INSTALL (TAS) TRAFFIC SYSTEM. W/AVIDYNE EX600 MFD.
3	RESTACK RADIO RACKS.
4	LIGHTNING DETECT INOP.
5	~~WANT~~ CUSTOMER WANTS RADAR/MFD COMPATABILITY OPTIONS
6	GNS 430W ENTER BUTTON INOP / INTERMITTANT.

"The limited warranties applying to the parts utilized in the repairs are those which may be offered by the manufacturer,. We herby expressly disclaim all warranties, either expressed or implied, including any limited warranties of the merchantability or fitness for a particular purpose and neither assumes. nor authorizes any other person to assume for the company any liability in connection with the sale of any part or service. Buyer shall not be entitled to recover from th company any consequential damages, to property, damages for loss of use, loss of time, loss of profits or income, or any other incidental damages."

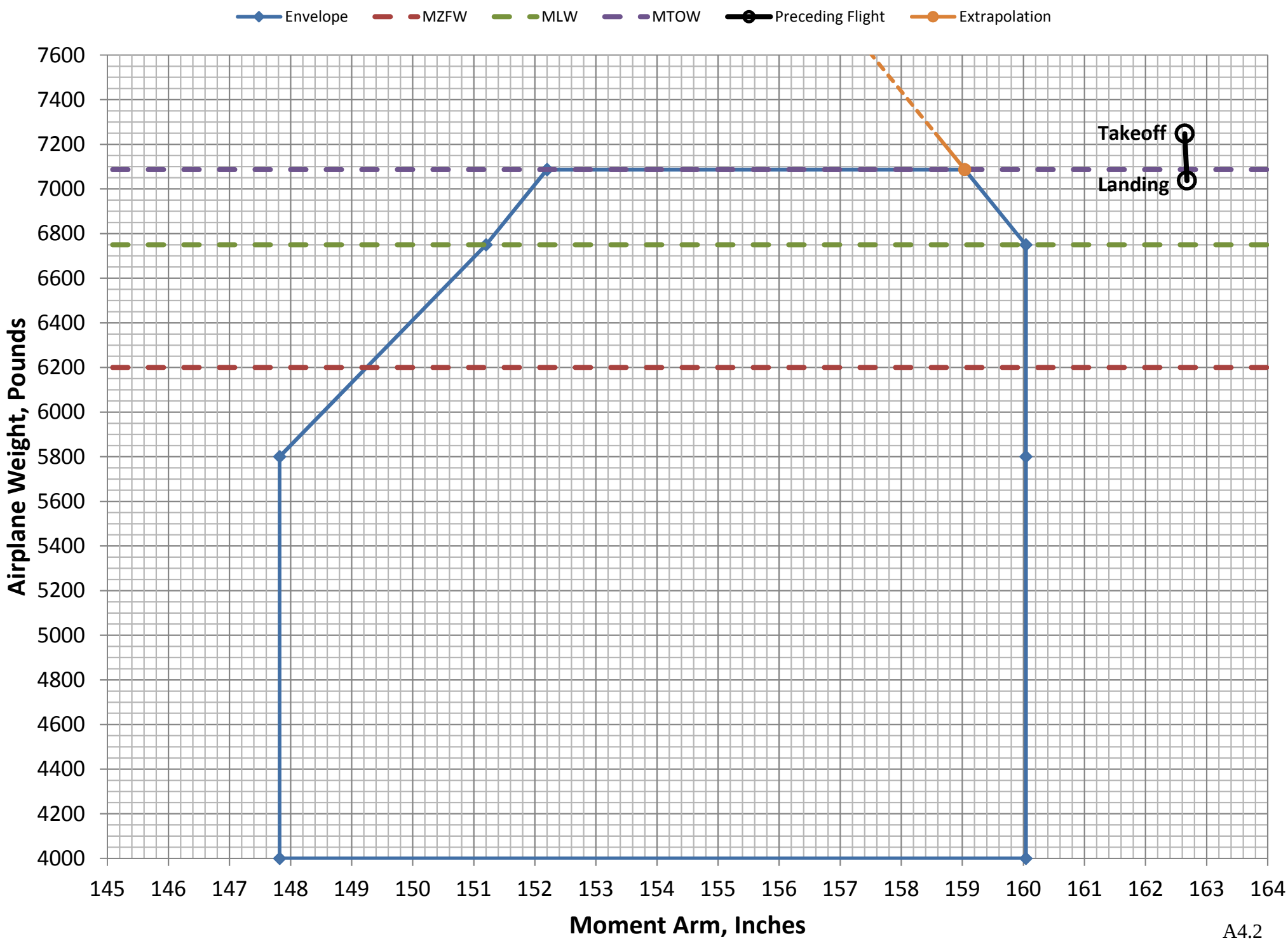
I hereby authorize the above work to be done along with the necessary material and herby grant Ozark Air Services employees' permission to operate the aircraft herein described for the purpose of testing and or inspection. An expressed mechanics lien is hereby acknowledged on the aircraft to secure the amount of repairs thereto. OAS will not be held responsible for loss or damage to the aircraft or articles left in case of fire, theft, or any other cause beyond our control. If it becomes necessary for OAS to employ a collection agency and or an attorney to collect this account, I the undersigned agree to pay all court cost plus a reasonable attorney's and or collection agency fee. X [redacted]	THE AIRCRAFT, AIRFRAME, AIRCRAFT ENGINE, PROPELLER, OR APPLIANCE IDENTIFIED ABOVE WAS REPAIRED AND INSPECTED IN ACCORDANCE WITH CURRENT REGULATIONS OF THE FEDERAL AVIATION ADMINISTRATION AND IS APPROVED FOR RETURN TO SERVICE. PERTINENT DETAILS OF THE REPAIR ARE FILE AT THIS REPAIR STATION IN ACCORDANCE WITH THE FAA CFR'S. SIGNED: [redacted] DATE 11/29/13 FOR OZARK AIR SERVICES, INC.

OAS Form: 02

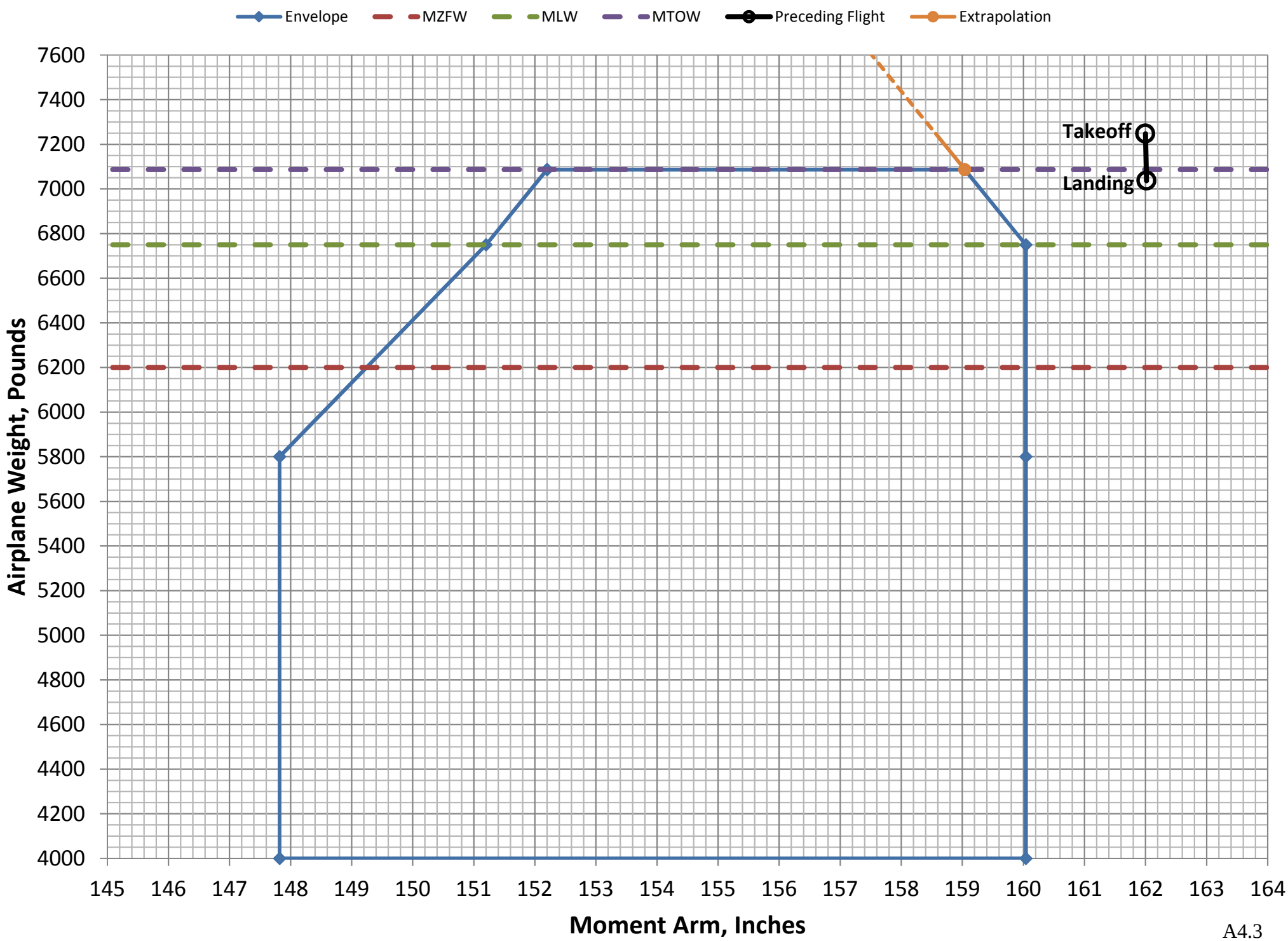
Revision Number: 1

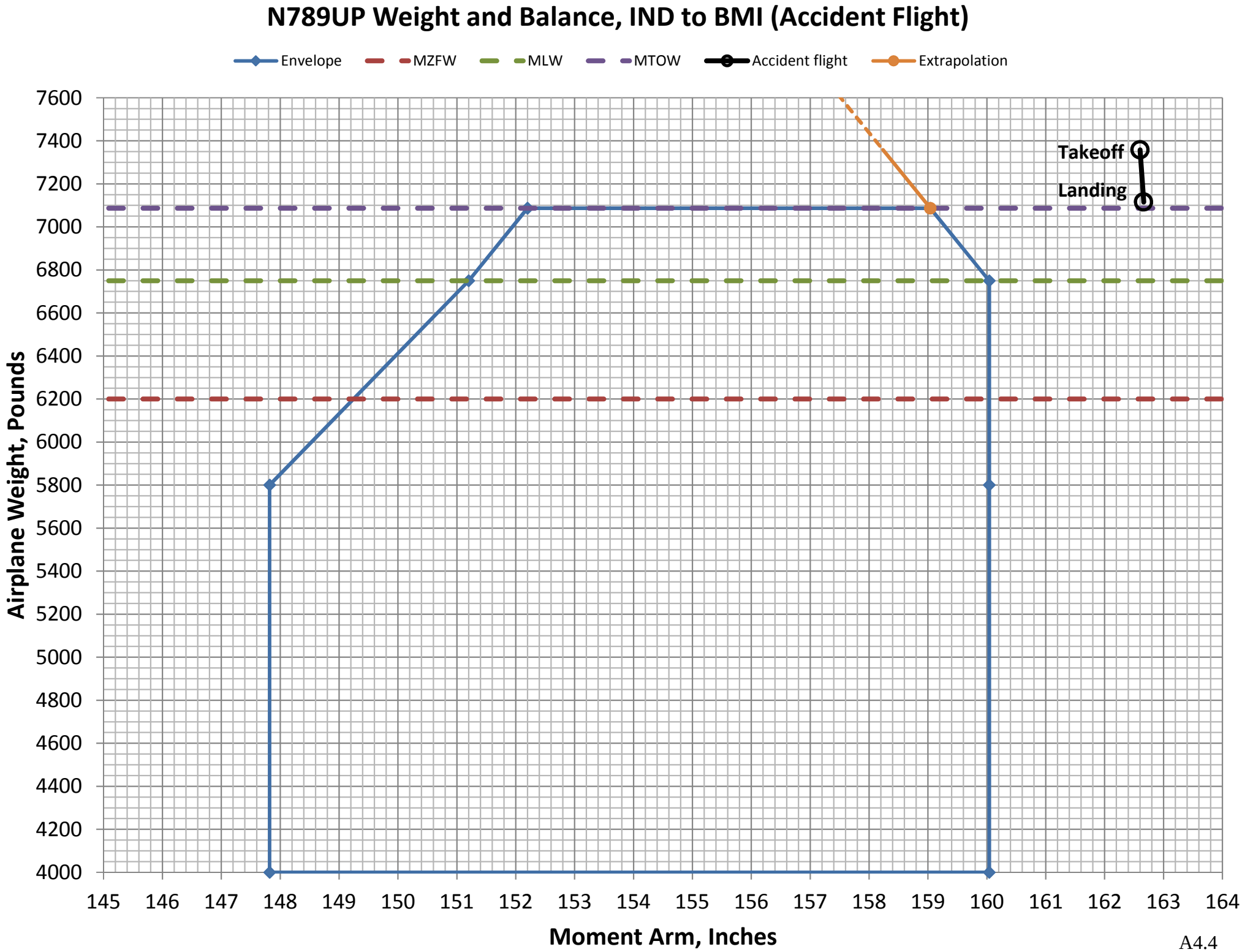
A1367

Attachment 4: Weight and Balance Results (N789UP)


N789UP Weight and Balance, BMI to IND (Passenger Loading Same as Accident)
Envelope
MZFW
MLW
MTOW
Preceding Flight
Extrapolation
Takeoff
Landing
Airplane Weight, Pounds
7600
7400
7200
7000
6800
6600
6400
6200
6000
5800
5600
5400
5200
5000
4800
4600
4400
4200
4000
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
Moment Arm, Inches

N789UP Weight and Balance, BMI to IND (Passenger Loading for Most Forward CG)




N789UP Weight and Balance, IND to BMI (Accident Flight)
Envelope
MZFW
MLW
MTOW
Accident flight
Extrapolation
Takeoff
Landing
Airplane Weight, Pounds
7600
7400
7200
7000
6800
6600
6400
6200
6000
5800
5600
5400
5200
5000
4800
4600
4400
4200
4000
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
Moment Arm, Inches

BMI to IND, Passenger Loading Same as Accident Flight

Serial number	414A0495
Registration no.	N789UP

		Weight, lb	Arm, Inches	Moment/100	
BEW		**5226.56**	**156.52**	**8180.61**	
Crew/Pax. Seat					
	1	**195**	137	267.15	195 lb = 180 lb + 15 lb (backpack)
	2	160	137	219.20	
	3	237	178	421.86	
	4	223	178	396.94	
	5	185	218	403.30	
	6	180	218	392.40	
	7		250	0.00	
	8	176	250	440.00	
Crew/Passengers		**1356**	**187.38**	**2540.85**	
Cargo					
	Avionics		32	0.00	
	Nose	20	71	14.20	
	Wing - Left		186	0.00	
	Wing - Right		186	0.00	
	Aft 1		266	0.00	
	Aft 2		282	0.00	
	Refreshment Bar	5	279	13.95	
	Overhead Cabinet		282	0.00	
Cargo		**25**	**112.60**	**28.15**	

				Exceedance	Limits	
ZFW	**6,608**	**162.69**	**10749.61**	92.6	**6515 lb**	**MZFW**
Ramp Fuel (114.46 gal.)	**669.6**	**1.62**	**1085.35**			
Ramp Weight	**7,277**	**162.63**	**11834.96**	190.2	**7087 lb**	**Max. Ramp**
T.O. Fuel (Ramp Fuel - 30 lb)	**639.6**	**1.62**	**1037.35**			
TOW	**7,247**	**162.64**	**11786.96**	160.2	**7087 lb**	**MTOW**
Landing Fuel (73.42 gal.)	**429.5**	**1.63**	**698.21**			
Landing Weight	**7,037**	**162.68**	**11447.82**	287.1	**6750 lb**	**MLW**

	Weight	Limit	Inches Aft of Aft Limit	
Takeoff	7,247	158.56	4.08	Assumes passenger loading same as accident flight
Landing	7,037	159.19	3.49	Assumes passenger loading same as accident flight

Serial number 414A0495

Registration no. N789UP

BMI to IND, Best Case (Most Forward Passenger C.G.)

		Weight, lb	Arm, Inches	Moment/100	
BEW		**5226.56**	**156.52**	**8180.61**	
Crew/Pax. Seat					
	1	**195**	137	267.15	195 lb = 180 lb + 15 lb (backpack)
	2	237	137	324.69	
	3	223	178	396.94	
	4	185	178	329.30	
	5	180	218	392.40	
	6	176	218	383.68	
	7		250	0.00	
	8	160	250	400.00	
Crew/Passengers		**1356**	**183.94**	**2494.16**	
Cargo					
	Avionics		32	0.00	
	Nose	20	71	14.20	
	Wing - Left		186	0.00	
	Wing - Right		186	0.00	
	Aft 1		266	0.00	
	Aft 2		282	0.00	
	Refreshment Bar	5	279	13.95	
	Overhead Cabinet		282	0.00	
Cargo		**25**	**112.60**	**28.15**	

				Exceedance	Limits	
ZFW	**6,608**	**161.98**	**10702.92**	92.6	**6515 lb**	**MZFW**
Ramp Fuel (114.46 gal.)	**669.6**	**1.62**	**1085.35**			
Ramp Weight	**7,277**	**161.99**	**11788.27**	190.2	**7087 lb**	**Max. Ramp**
T.O. Fuel (Ramp Fuel - 30 lb)	**639.6**	**1.62**	**1037.35**			
TOW	**7,247**	**162.00**	**11740.27**	160.2	**7087 lb**	**MTOW**
Landing Fuel (73.42 gal.)	**429.5**	**1.63**	**698.21**			
Landing Weight	**7,037**	**162.02**	**11401.13**	287.1	**6750 lb**	**MLW**

	Weight	Limit	Inches Aft of Aft Limit	
Takeoff	7,247	158.56	3.43	Estimated best case (most forward c.g.)
Landing	7,037	159.19	2.83	Estimated best case (most forward c.g.)

IND to BMI, Accident Flight

Serial number	414A0495
Registration no.	N789UP

		Weight, lb	Arm, Inches	Moment/100		
BEW		**5226.56**	**156.52**	**8180.61**		
Crew/Pax. Seat						
	1	**195**	137	267.15	195 lb = 180 lb + 15 lb (backpack)	
	2	160	137	219.20		
	3	237	178	421.86		
	4	223	178	396.94		
	5	185	218	403.30		
	6	180	218	392.40		
	7		250	0.00		
	8	176	250	440.00		
Crew/Passengers		**1356**	**187.38**	**2540.85**		
Cargo						
	Avionics		32	0.00		
	Nose	20	71	14.20		
	Wing - Left		186	0.00		
	Wing - Right		186	0.00		
	Aft 1		266	0.00		
	Aft 2		282	0.00		
	Refreshment Bar	5	279	13.95		
	Overhead Cabinet		282	0.00		
Cargo		**25**	**112.60**	**28.15**		

				Exceedance	Limits	
ZFW	**6,608**	**162.69**	**10749.61**	92.6	**6515 lb**	**MZFW**
Ramp Fuel (133.42 gal.)	**780.5**	**1.62**	**1262.81**			
Ramp Weight	**7,388**	**162.59**	**12012.42**	301.1	**7087 lb**	**Max. Ramp**
T.O. Fuel (Ramp Fuel - 30 lb)	**750.5**	**1.62**	**1214.81**			
TOW	**7,358**	**162.60**	**11964.42**	271.1	**7087 lb**	**MTOW**
Landing Fuel (86.85 gal.)	**508.0725**	**1.62**	**824.92**			
Landing Weight	**7,116**	**162.66**	**11574.53**	365.6	**6750 lb**	**MLW**

	Weight	Limit	Inches Aft of Aft Limit	
Takeoff	7,358	158.24	4.37	IND to BMI, Accident Flight
Landing	7,116	158.96	3.71	IND to BMI, Accident Flight

Attachment 5: Atmospheric and Wind Data

High Resolution ASOS Data

The 5 minute ASOS data for KBMI was also obtained and documented surrounding the time of the accident from 2340 through 0025 CDT (0440Z-0525Z). Within a minute prior to the accident, the ASOS was reporting the following conditions:

Central Illinois Regional Airport weather at 0005 CDT, automated, wind from 060° at 6 knots, visibility 1/2 statue mile, runway 29 visual range 4,000 variable 6,000 feet, weather light rain and fog, ceiling overcast at 200 feet agl, temperature and dew point 13° C, altimeter 29.98 inches of mercury. Remarks; automated observation system, lightning distant east, hourly precipitation less than 0.01 inches.

The raw observations were as follows:

METAR KBMI 070440Z AUTO 11005KT 1SM R29/P6000FT –RA BR OVC002 13/13 A299 RMK A02 OVC V BKN

METAR KBMI 070445Z AUTO 10003KT 1SM R29/P6000FT –RA BR OVC002 13/13 A2999 RMK A02

METAR KBMI 070450Z AUTO 08004KT 3/4SM R29/P6000FT –RA BR OVC002 13/13 A2999 RMK A02 T01270127 P0000 SLP153

METAR KBMI 070455Z AUTO 06004KT 3/4SM R29/6000VP6000FT –RA BR OVC002 13/13 A2999 RMK A02 T01270127 LTG DSNT E P0000 SLP153

METAR KBMI 070500Z AUTO 07005KT 3/4SM R29/5000VP6000FT –RA BR OVC002 13/13 A2999 RMK A02 LTG DSNT E

METAR KBMI 070505Z AUTO 06006KT 1/2SM R29/4000V6000FT –RA BR OVC002 13/13 A2998 RMK A02 LTG DSNT E P0000

SPECI KBMI 070510Z AUTO 07006KT 1/2SM R29/4000V5000FT –RA FG OVC002 13/13 A2998 RMK A02 P0000

METAR KBMI 070515Z AUTO 08006KT 1/2SM R29/4000V5000FT –RA FG OVC002 13/13 A2998 RMK A02

METAR KBMI 070520Z AUTO 09006KT 1/2SM R29/4000V5000FT –RA FG OVC002 13/13 A2998 RMK A02

METAR KBMI 070525Z AUTO 09006KT 1/2SM R29/4000V5000FT FG OVC002 13/13 A2998 RMK A02 RAE25

Query made at 03/29/2017 19:55:17 UTC

Time interval: from 04/06/2015 18:00 to 04/07/2015 07:59 UTC

KBMI, Bloomington / Normal (United States).
WMO index: -----. Latitude 40-29N. Longitude 088-55W. Altitude 267 m.

METAR/SPECI from KBMI, Bloomington / Normal (United States).		
SA	06/04/2015 18:56->	METAR KBMI 061856Z 20009KT 10SM OVC037 16/07 A2999 RMK AO2 T01550072 SLP156=
SA	06/04/2015 19:56->	METAR KBMI 061956Z 19009KT 10SM FEW028 SCT040 OVC050 17/08 A2997 RMK AO2 T01660083 SLP146=
SA	06/04/2015 20:56->	METAR KBMI 062056Z 16010KT 10SM BKN034 17/09 A2995 RMK AO2 58018 T01720088 SLP139=
SA	06/04/2015 21:56->	METAR KBMI 062156Z 16012KT 10SM BKN030 17/10 A2995 RMK AO2 T01720100 SLP138=
SA	06/04/2015 22:56->	METAR KBMI 062256Z 18010KT 10SM OVC030 17/10 A2995 RMK AO2 T01660100 SLP141=
SP	06/04/2015 23:29->	*SPECI KBMI 062329Z 17010KT 10SM OVC028 17/11 A2994 RMK AO2=*
SA	06/04/2015 23:56->	METAR KBMI 062356Z 15008KT 10SM OVC028 16/10 A2993 RMK AO2 58006 T01610100 10177 20150 OVC V BKN SLP135=
SA	07/04/2015 00:56->	METAR KBMI 070056Z 16013KT 10SM OVC024 15/11 A2994 RMK AO2 T01500111 SLP137=
SP	07/04/2015 01:45->	*SPECI KBMI 070145Z 17010KT 10SM BKN014 OVC022 14/12 A2996 RMK AO2=*
SA	07/04/2015 01:56->	METAR KBMI 070156Z 17012G18KT 10SM BKN012 OVC018 14/12 A2997 RMK AO2 T01380116 BKN V OVC SLP148=
SA	07/04/2015 02:56->	METAR KBMI 070256Z 15004KT 10SM OVC012 14/12 A2998 RMK AO2 53017 T01380116 SLP152=
SP	07/04/2015 03:48->	*SPECI KBMI 070348Z AUTO 14007KT 1 3/4SM -RA BR OVC010 13/12 A2999 RMK AO2 RAB39 P0000=*
SA	07/04/2015 03:56->	METAR KBMI 070356Z AUTO 15006KT 1 3/4SM -RA BR SCT001 OVC010 13/12 A2999 RMK AO2 T01270122 RAB39 P0000 SLP154=
SP	07/04/2015 04:03->	*SPECI KBMI 070403Z AUTO 14006KT 2SM -RA BR SCT001 OVC008 13/13 A2999 RMK AO2 CIG 004V010 P0000=*
SP	07/04/2015 04:23->	*SPECI KBMI 070423Z AUTO 11005KT 1 3/4SM -RA BR OVC004 13/13 A2998 RMK AO2 CIG 001V007 P0000=*
SP	07/04/2015 04:37->	*SPECI KBMI 070437Z AUTO 11005KT 1SM R29/P6000FT -RA BR BKN002 OVC006 13/13 A2999 RMK AO2 P0000=*
SA	07/04/2015 04:56->	METAR KBMI 070456Z AUTO 06004KT 3/4SM R29/6000VP6000FT -RA BR OVC002 13/13 A2999 RMK AO2 T01270127 LTG DSNT E P0000 SLP153=

SP	07/04/2015 05:11->	*SPECI KBMI 070511Z AUTO 07006KT 1/2SM R29/4000V5000FT -RA FG OVC002 13/13 A2998 RMK AO2 P0000=*
SP	07/04/2015 05:41->	*SPECI KBMI 070541Z AUTO 11004KT 3/4SM R29/3500V5500FT BR OVC002 13/13 A2999 RMK AO2 RAE25 P0000=*
SP	07/04/2015 05:48->	*SPECI KBMI 070548Z AUTO 10005KT 1/2SM R29/3000V4000FT FG OVC002 13/13 A2998 RMK AO2 RAE25 P0000=*
SA	07/04/2015 05:56->	**METAR KBMI 070556Z AUTO 11005KT 1/2SM R29/3500V4000FT FG OVC002 13/13 A2998 RMK AO2 50000 60000 T01270127 10161 20127 401770100 RAE25 P0000 SLP152=**
SP	07/04/2015 06:15->	*SPECI KBMI 070615Z AUTO 11007KT 3/4SM R29/5000VP6000FT BR OVC002 13/13 A2998 RMK AO2 P0001=*
SP	07/04/2015 06:25->	*SPECI KBMI 070625Z AUTO 11006KT 1SM R29/P6000FT BR OVC002 13/13 A2998 RMK AO2 P0001=*
SA	07/04/2015 06:56->	**METAR KBMI 070656Z AUTO 11006KT 1SM R29/P6000FT BR OVC002 13/13 A2998 RMK AO2 T01270127 P0001 SLP149=**
SP	07/04/2015 07:29->	*SPECI KBMI 070729Z AUTO 13004KT 3/4SM R29/5000VP6000FT BR OVC002 13/13 A2997 RMK AO2 RAB11E26 P0000=*
SP	07/04/2015 07:39->	*SPECI KBMI 070739Z AUTO 14004KT 1 1/4SM BR OVC002 13/13 A2997 RMK AO2 RAB11E33 P0000=*
SA	07/04/2015 07:56->	**METAR KBMI 070756Z AUTO 15005KT 1 1/2SM -RA BR OVC002 13/13 A2996 RMK AO2 T01270127 RAB11E33B49 P0001 SLP145=**

No short TAF reports from KBMI during solicited interval in the database.

large TAF from KBMI, Bloomington / Normal (United States).		
FT	06/04/2015 23:26->	**TAF KBMI 062326Z 0700/0724 16010KT P6SM OVC025 FM070600 14006KT P6SM VCSH OVC025 FM071000 08008KT 3SM -SHRA VCTS OVC012CB FM071900 06012KT P6SM BKN020=**
FT	07/04/2015 01:48->	**TAF AMD KBMI 070148Z 0702/0724 16010KT P6SM OVC012 FM070600 14006KT P6SM VCSH OVC010 FM071000 08008KT 3SM -SHRA VCTS OVC012CB FM071900 06012KT P6SM BKN020=**
FT	07/04/2015 05:38->	**TAF KBMI 070538Z 0706/0806 08006KT 1/2SM -DZ FG OVC002 FM071300 07005KT 1 1/2SM BR VCSH OVC002 FM071600 09010KT 5SM BR OVC010 FM080200 15010KT P6SM BKN012=**

Query made at 03/29/2017 19:59:24 UTC

Time interval: from 04/06/2015 18:00 to 04/07/2015 07:59 UTC

KIND, Indianapolis, Indianapolis International Airport (United States).
WMO index: 72438. Latitude 39-43-30N. Longitude 086-16-55W. Altitude 243 m.

METAR/SPECI from KIND, Indianapolis, Indianapolis International Airport (United States).		
SP	06/04/2015 18:19->	*SPECI KIND 061819Z 19010KT 10SM OVC029 14/08 A3004 RMK AO2 T01440078=*
SA	06/04/2015 18:54->	METAR KIND 061854Z 19010KT 10SM OVC026 15/08 A3003 RMK AO2 SLP169 T01500083=
SA	06/04/2015 19:54->	METAR KIND 061954Z 18010KT 10SM BKN023 OVC028 15/09 A3002 RMK AO2 SLP165 T01500094=
SA	06/04/2015 20:54->	METAR KIND 062054Z 20007KT 10SM OVC024 15/09 A3001 RMK AO2 SLP161 T01500094 58011=
SA	06/04/2015 21:54->	METAR KIND 062154Z 19009KT 10SM SCT021 OVC027 15/11 A3000 RMK AO2 RAB30E39 SLP157 P0000 T01500106=
SA	06/04/2015 22:54->	METAR KIND 062254Z 19008KT 10SM BKN025 OVC031 16/10 A2998 RMK AO2 SLP152 T01560100=
SA	06/04/2015 23:54->	METAR KIND 062354Z 19008KT 10SM OVC027 16/11 A2999 RMK AO2 SLP155 60000 T01560106 10156 20139 55006=
SA	07/04/2015 00:54->	METAR KIND 070054Z 18009KT 10SM OVC020 15/11 A2999 RMK AO2 SLP156 T01500111=
SP	07/04/2015 01:31->	*SPECI KIND 070131Z 18008KT 10SM BKN010 OVC018 15/12 A3000 RMK AO2 T01500117=*
SA	07/04/2015 01:54->	METAR KIND 070154Z 18007KT 10SM BKN010 OVC014 15/12 A3001 RMK AO2 SLP160 T01500122=
SP	07/04/2015 02:27->	*SPECI KIND 070227Z 18007KT 10SM SCT013 OVC021 15/12 A3001 RMK AO2 T01500122=*
SA	07/04/2015 02:54->	METAR KIND 070254Z 17007KT 10SM FEW013 OVC021 15/12 A3001 RMK AO2 SLP160 T01500122 51005=
SA	07/04/2015 03:54->	METAR KIND 070354Z 14009KT 10SM BKN019 OVC030 14/12 A3000 RMK AO2 SLP159 T01440117=
SA	07/04/2015 04:54->	METAR KIND 070454Z 14008KT 10SM OVC020 14/11 A3001 RMK AO2 SLP160 T01440111 401670083=

SP	07/04/2015 05:52->	***SPECI KIND 070552Z 13005KT 10SM OVC014 14/11 A3000 RMK AO2=***
SA	07/04/2015 05:54->	**METAR KIND 070554Z 14005KT 10SM OVC014 14/11 A3000 RMK AO2 SLP159 T01440111 10156 20144 51000=**
SA	07/04/2015 06:54->	**METAR KIND 070654Z 15006KT 4SM -RA BR OVC012 14/12 A3000 RMK AO2 RAB27 SLP156 P0000 T01390117=**
SA	07/04/2015 07:54->	**METAR KIND 070754Z 15007KT 10SM OVC011 14/12 A2998 RMK AO2 RAE22DZB22E32 SLP150 FRQ LTGIC DSNT SW-W CB DSNT SW-W MOV NE P0000 T01390122=**

No short TAF reports from KIND during solicited interval in the database.

large TAF from KIND, Indianapolis, Indianapolis International Airport (United States).		
FT	06/04/2015 20:29->	**TAF AMD KIND 062029Z 0620/0724 19010KT P6SM OVC025 FM070000 18008KT P6SM OVC012 FM070200 17007KT 5SM BR OVC008 FM070500 18008KT 2SM -SHRA BR VCTS BKN004 OVC010CB FM071600 21010KT 6SM BR BKN018 OVC030 FM072000 22012KT P6SM BKN030=**
FT	06/04/2015 22:04->	**TAF AMD KIND 062204Z 0622/0724 19010KT P6SM OVC025 FM070000 17007KT 5SM BR OVC008 FM070300 18007KT 2SM -SHRA BR BKN004 OVC010 FM070500 18008KT 2SM -SHRA BR VCTS BKN004 OVC010CB FM071000 19009KT 2SM -SHRA BR OVC004 FM071600 21010KT 6SM BR BKN018 OVC030 FM072000 22012KT P6SM BKN030=**
FT	06/04/2015 23:30->	**TAF KIND 062330Z 0700/0806 19008KT P6SM OVC020 FM070130 17007KT 4SM BR OVC010 FM070300 18007KT 2SM -SHRA BR BKN004 OVC010 FM070500 18008KT 2SM -SHRA BR VCTS BKN004 OVC010CB FM071000 18007KT 2SM -SHRA BR OVC004 FM071500 09007KT 5SM BR OVC007 FM071900 10008KT P6SM OVC020 FM080400 12009KT 5SM -SHRA BR OVC009=**
FT	07/04/2015 02:21->	**TAF AMD KIND 070221Z 0702/0806 17007KT 5SM BR OVC008 FM070400 18007KT 2SM -SHRA BR BKN004 OVC010 FM070600 18008KT 2SM -SHRA BR VCTS BKN004 OVC010CB FM071000 18007KT 2SM -SHRA BR OVC004 FM071500 09007KT 5SM BR OVC007 FM071900 10008KT P6SM OVC020 FM080400 12009KT 5SM -SHRA BR OVC009=**
FT	07/04/2015 03:15->	**TAF AMD KIND 070315Z 0703/0806 17007KT P6SM OVC009 FM070400 18007KT**

		6SM -SHRA BR BKN006 OVC010 FM070600 18008KT 2SM -SHRA BR VCTS BKN004 OVC010CB FM071000 18007KT 2SM -SHRA BR OVC004 FM071500 09007KT 5SM BR OVC007 FM071900 10008KT P6SM OVC020 FM080400 12009KT 5SM -SHRA BR OVC009=
FT	07/04/2015 05:20->	**TAF KIND 070520Z 0706/0812 15007KT 6SM -SHRA BR BKN006 OVC010 FM070800 15008KT 3SM -SHRA BR VCTS BKN004 OVC010CB FM071000 16007KT 2SM -SHRA BR OVC004 FM071500 09007KT 5SM BR OVC007 FM071900 10008KT P6SM OVC020 FM080400 12009KT 5SM -SHRA BR OVC009=**

Wind Data (BMI)

20150406 nam12
MODEL SOUNDING

GRID POINT 391.50 213.29
LAT/LON/ELEV: 40.48 -88.92 267m

04/06/2015 18Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20542.	-60.1	-88.5	286.6	5.9
100.	16215.	-59.3	-84.8	281.0	23.1
150.	13685.	-62.0	-78.0	276.6	34.4
200.	11929.	-62.5	-64.0	268.3	44.5
250.	10527.	-53.3	-56.6	266.3	40.2
300.	9327.	-44.0	-47.7	267.0	34.1
350.	8276.	-36.2	-50.4	269.7	30.6
400.	7335.	-28.1	-56.8	268.2	28.8
450.	6479.	-22.0	-41.5	266.7	24.5
500.	5697.	-17.1	-34.9	264.7	19.7
550.	4976.	-11.5	-32.3	264.0	16.3
600.	4302.	-5.8	-30.1	266.0	13.3
650.	3670.	-0.7	-28.2	268.1	10.9
700.	3073.	4.0	-28.9	265.2	9.7
725.	2788.	5.9	-27.5	261.2	9.8
750.	2510.	7.4	-20.5	256.7	10.0
775.	2240.	8.4	-9.8	252.1	10.0
800.	1978.	6.7	-0.6	245.6	10.4
825.	1726.	6.0	5.1	243.4	9.8
850.	1481.	7.6	6.7	241.1	7.2
875.	1242.	7.4	5.8	214.7	4.2
900.	1009.	8.0	5.8	175.4	2.9
925.	783.	8.8	4.9	156.7	3.5
950.	561.	11.6	5.6	158.2	3.1
975.	343.	14.3	6.6	169.3	2.8
987.	240.	16.5	7.8	171.1	2.9

20150406 nam12
MODEL SOUNDING

GRID POINT 391.50 213.29
LAT/LON/ELEV: 40.48 -88.92 267m

04/06/2015 21Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20538.	-61.0	-89.1	307.4	5.7
100.	16221.	-59.6	-88.2	277.8	24.3
150.	13687.	-61.7	-78.4	267.2	35.2
200.	11925.	-62.7	-66.7	266.0	40.4
250.	10525.	-53.8	-57.2	260.8	36.7
300.	9327.	-43.5	-47.1	264.2	32.4
350.	8274.	-36.5	-44.4	268.9	28.4
400.	7334.	-28.6	-59.1	269.3	27.0
450.	6479.	-21.8	-47.6	269.6	23.9
500.	5697.	-17.3	-32.2	265.6	18.5
550.	4976.	-11.7	-29.0	268.6	16.1
600.	4303.	-5.9	-28.7	266.2	13.7
650.	3671.	-0.6	-27.2	264.8	11.1
700.	3074.	4.4	-26.1	263.6	9.8
725.	2788.	6.6	-26.8	261.6	9.0
750.	2509.	8.4	-27.1	257.5	8.2
775.	2238.	9.7	-18.5	251.7	7.5
800.	1975.	8.2	-3.2	238.0	7.7
825.	1722.	6.8	5.6	221.4	8.4
850.	1476.	8.7	7.9	205.9	7.4
875.	1235.	9.4	8.3	187.6	7.1
900.	1001.	9.8	8.5	171.4	6.8
925.	774.	9.8	7.8	156.7	7.0
950.	551.	12.0	8.1	156.1	6.9
975.	333.	14.3	8.7	155.9	6.5
986.	240.	16.4	9.3	155.6	5.9

20150407 nam12
MODEL SOUNDING

GRID POINT 391.50 213.29
LAT/LON/ELEV: 40.48 -88.92 267m

04/07/2015 03Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20544.	-60.9	-88.8	302.4	5.5
100.	16234.	-60.0	-88.5	280.1	22.5
150.	13700.	-60.6	-80.1	271.8	33.9
200.	11929.	-63.1	-69.0	263.2	34.6
250.	10532.	-54.2	-59.2	271.2	33.0
300.	9339.	-44.8	-52.4	271.4	29.2
350.	8288.	-35.7	-49.2	270.4	26.8
400.	7344.	-27.7	-52.5	270.7	22.4
450.	6488.	-22.0	-56.2	269.5	17.6
500.	5708.	-19.0	-20.2	266.8	15.1
550.	4990.	-12.1	-14.8	263.0	17.1
600.	4316.	-5.7	-12.3	253.4	17.2
650.	3682.	-0.4	-7.4	241.9	15.8
700.	3084.	4.5	-7.1	231.8	14.4
725.	2797.	6.7	-8.5	227.6	13.4
750.	2518.	8.4	-7.6	224.3	12.2
775.	2247.	8.9	-1.5	223.3	11.1
800.	1985.	8.6	6.1	223.6	11.3
825.	1730.	7.9	7.6	220.1	11.7
850.	1483.	9.6	9.4	213.7	11.2
875.	1241.	9.6	9.0	208.6	10.6
900.	1007.	9.3	8.5	202.8	9.3
925.	780.	10.4	9.3	188.9	10.3
950.	556.	12.0	10.4	175.9	10.0
975.	338.	12.9	11.2	155.2	6.5
986.	240.	12.8	11.5	136.2	2.6

20150407 nam12
MODEL SOUNDING

GRID POINT 391.50 213.29
LAT/LON/ELEV: 40.48 -88.92 267m

04/07/2015 06Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20553.	-61.5	-89.0	307.5	4.0
100.	16246.	-60.0	-88.5	281.1	20.7
150.	13712.	-60.1	-80.3	268.9	29.8
200.	11939.	-62.9	-72.0	259.7	33.6
250.	10540.	-54.2	-57.2	265.1	28.9
300.	9345.	-44.2	-47.6	266.1	26.5
350.	8293.	-35.8	-45.2	266.3	26.2
400.	7350.	-27.7	-46.8	266.5	24.1
450.	6492.	-20.7	-45.4	263.5	22.2
500.	5705.	-16.4	-30.8	255.3	19.4
550.	4985.	-12.2	-19.1	254.8	16.7
600.	4311.	-6.0	-17.5	255.7	16.2
650.	3678.	-0.3	-15.4	249.3	15.8
700.	3081.	4.1	-9.8	238.7	15.5
725.	2795.	5.9	-5.5	235.5	15.3
750.	2517.	6.9	-0.3	236.8	14.4
775.	2247.	7.4	3.7	241.8	13.1
800.	1985.	8.5	4.4	247.5	11.5
825.	1730.	10.0	3.6	248.4	9.5
850.	1482.	9.1	5.2	241.2	7.5
875.	1242.	9.9	6.5	234.9	6.7
900.	1007.	10.6	6.3	218.3	6.2
925.	778.	11.7	8.5	203.5	7.5
950.	554.	12.9	10.9	184.4	6.5
975.	336.	12.8	11.9	129.1	4.9
986.	240.	12.5	11.8	112.5	2.0

Wind Data (DNV)

20150406 nam12
MODEL SOUNDING

GRID POINT 401.15 211.12
LAT/LON/ELEV: 40.20 -87.60 212m

04/06/2015 18Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20552.	-60.4	-88.6	286.7	6.1
100.	16226.	-59.2	-85.0	282.7	23.3
150.	13698.	-62.2	-77.7	279.6	35.2
200.	11941.	-62.3	-64.0	271.4	45.8
250.	10540.	-53.2	-56.7	267.7	41.6
300.	9338.	-43.5	-47.3	268.0	36.0
350.	8285.	-35.9	-51.4	269.8	32.6
400.	7342.	-27.4	-57.3	269.9	30.5
450.	6485.	-21.8	-40.6	268.6	24.9
500.	5702.	-16.9	-34.2	265.7	20.2
550.	4980.	-11.1	-28.2	265.1	17.5
600.	4305.	-5.6	-27.6	264.6	15.7
650.	3673.	-1.0	-29.0	263.3	13.9
700.	3078.	3.4	-19.9	258.1	13.0
725.	2793.	4.5	-9.7	252.5	13.4
750.	2517.	4.8	0.0	245.4	14.0
775.	2249.	5.0	2.9	240.9	13.5
800.	1989.	6.4	5.7	239.4	11.5
825.	1736.	7.6	7.1	238.3	8.5
850.	1489.	8.2	7.6	226.0	6.7
875.	1249.	7.9	7.5	212.2	7.1
900.	1017.	7.1	6.8	198.1	6.5
925.	791.	8.4	5.4	179.1	5.6
950.	570.	10.9	6.0	174.3	5.1
975.	352.	13.5	6.7	179.3	4.8
993.	200.	16.1	8.1	183.8	4.4

20150406 nam12
MODEL SOUNDING

GRID POINT 401.15 211.12
LAT/LON/ELEV: 40.20 -87.60 212m

04/06/2015 21Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20542.	-61.2	-89.2	302.6	5.9
100.	16224.	-59.3	-87.9	280.2	24.6
150.	13693.	-62.2	-78.2	272.4	35.6
200.	11935.	-62.7	-65.6	269.2	42.6
250.	10535.	-53.6	-57.1	262.9	38.7
300.	9335.	-43.1	-46.7	265.9	33.6
350.	8280.	-36.6	-41.4	270.9	28.6
400.	7340.	-28.2	-54.8	272.3	27.1
450.	6483.	-21.5	-48.4	273.1	24.1
500.	5701.	-17.1	-32.8	271.7	18.8
550.	4980.	-11.5	-29.1	273.0	16.1
600.	4306.	-5.9	-27.8	270.3	13.7
650.	3674.	-0.8	-31.0	264.2	12.1
700.	3078.	3.7	-28.8	256.9	11.5
725.	2793.	5.3	-17.7	253.4	11.1
750.	2515.	6.3	-5.8	246.7	10.8
775.	2246.	7.0	1.1	235.4	11.0
800.	1986.	6.3	6.0	228.1	11.4
825.	1732.	7.9	7.6	222.1	9.9
850.	1485.	9.0	8.7	211.2	9.4
875.	1244.	9.5	9.2	207.7	9.4
900.	1010.	9.3	9.0	198.7	8.9
925.	783.	8.8	8.0	173.6	7.0
950.	561.	10.9	8.5	170.8	6.7
975.	343.	13.0	9.0	170.0	6.1
991.	200.	14.9	9.8	168.0	4.8

20150407 nam12
MODEL SOUNDING

GRID POINT 401.15 211.12
LAT/LON/ELEV: 40.20 -87.60 212m

04/07/2015 03Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20549.	-60.7	-88.6	305.5	5.9
100.	16236.	-60.2	-88.6	285.2	22.3
150.	13707.	-61.5	-79.9	271.5	36.6
200.	11940.	-63.0	-67.8	261.1	37.0
250.	10541.	-53.7	-60.1	270.1	34.4
300.	9345.	-44.5	-52.6	272.3	30.2
350.	8293.	-35.4	-48.8	273.2	27.6
400.	7349.	-27.9	-46.2	274.7	23.3
450.	6495.	-23.6	-28.5	277.4	18.0
500.	5718.	-18.1	-18.8	275.8	16.5
550.	4997.	-11.9	-12.3	270.4	16.6
600.	4323.	-6.3	-7.9	261.4	15.0
650.	3692.	-0.9	-7.5	254.4	13.2
700.	3094.	4.5	-8.3	242.8	11.5
725.	2808.	6.6	-9.3	235.0	11.0
750.	2529.	8.4	-7.7	228.7	11.2
775.	2258.	8.6	0.0	225.2	12.4
800.	1996.	7.2	6.8	223.0	14.9
825.	1742.	7.8	7.6	222.1	16.2
850.	1495.	10.4	9.3	221.2	15.6
875.	1253.	11.2	10.2	219.2	14.6
900.	1017.	10.7	9.3	215.4	12.5
925.	788.	11.0	9.9	205.9	11.9
950.	565.	12.2	11.1	191.4	9.5
975.	347.	12.8	11.8	158.2	7.8
992.	200.	12.0	11.6	128.5	2.7

20150407 nam12
MODEL SOUNDING

GRID POINT 401.15 211.12
LAT/LON/ELEV: 40.20 -87.60 212m

04/07/2015 06Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20549.	-61.5	-89.0	307.2	4.6
100.	16246.	-60.4	-85.6	283.9	20.4
150.	13713.	-60.2	-79.7	271.2	31.0
200.	11943.	-63.5	-69.3	261.3	35.6
250.	10546.	-54.0	-57.1	263.3	30.8
300.	9351.	-44.5	-48.1	267.7	28.1
350.	8300.	-35.9	-44.5	269.9	27.2
400.	7356.	-27.5	-42.3	270.2	24.8
450.	6498.	-20.9	-36.2	267.0	21.9
500.	5714.	-17.4	-21.3	258.9	17.3
550.	4994.	-12.1	-15.6	260.7	15.5
600.	4320.	-6.4	-12.7	257.0	15.2
650.	3689.	-1.4	-7.5	245.4	14.6
700.	3094.	3.3	-4.8	239.2	14.1
725.	2808.	5.8	-4.3	239.5	13.5
750.	2529.	7.8	-2.9	241.8	13.2
775.	2258.	8.6	1.0	242.1	14.2
800.	1996.	8.3	5.0	241.2	15.2
825.	1742.	8.2	6.3	242.1	15.4
850.	1494.	10.5	7.8	243.1	15.4
875.	1252.	11.7	9.5	240.8	14.5
900.	1016.	12.0	9.5	235.6	12.6
925.	786.	12.7	10.4	221.4	12.0
950.	561.	13.4	11.9	204.8	10.3
975.	342.	13.6	12.7	177.2	6.5
992.	200.	13.0	12.5	129.3	2.3

Wind Data (IND)

20150406 nam12
MODEL SOUNDING

GRID POINT 411.04 207.26
LAT/LON/ELEV: 39.73 -86.27 246m

04/06/2015 18Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20546.	-60.9	-89.0	287.9	6.8
100.	16227.	-59.0	-87.7	283.8	22.8
150.	13700.	-63.2	-77.9	282.5	36.1
200.	11947.	-62.5	-64.2	274.9	46.4
250.	10547.	-53.1	-56.5	270.5	42.5
300.	9344.	-43.2	-47.2	270.2	38.2
350.	8290.	-35.7	-52.7	270.8	34.9
400.	7345.	-27.2	-54.7	272.9	31.7
450.	6488.	-22.1	-40.4	270.8	24.5
500.	5707.	-17.3	-31.6	267.9	20.2
550.	4985.	-11.3	-23.3	267.7	19.5
600.	4311.	-6.2	-18.7	266.0	17.8
650.	3680.	-1.6	-16.2	264.2	15.4
700.	3087.	1.0	-2.8	254.0	16.0
725.	2804.	2.1	0.6	247.1	17.1
750.	2530.	3.8	3.4	244.4	17.1
775.	2262.	6.5	5.9	243.2	15.2
800.	2000.	7.9	7.3	240.3	13.5
825.	1745.	7.9	7.3	234.0	13.2
850.	1499.	8.2	7.6	229.2	13.6
875.	1259.	7.8	7.2	223.8	10.9
900.	1027.	7.6	6.7	207.9	8.3
925.	800.	9.2	6.5	198.1	6.4
950.	578.	11.2	6.5	203.8	4.7
975.	360.	13.3	7.1	204.5	4.1
989.	242.	14.9	8.4	197.7	3.5

20150406 nam12
MODEL SOUNDING

GRID POINT 411.04 207.26
LAT/LON/ELEV: 39.73 -86.27 246m

04/06/2015 21Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20540.	-61.5	-89.4	299.8	6.5
100.	16231.	-59.1	-87.8	281.8	23.9
150.	13700.	-62.6	-78.5	277.7	36.2
200.	11946.	-62.8	-65.6	272.8	43.7
250.	10548.	-53.4	-56.8	266.2	38.6
300.	9344.	-42.7	-46.1	268.5	34.5
350.	8288.	-36.3	-42.7	273.4	29.2
400.	7347.	-27.8	-67.3	276.5	27.4
450.	6490.	-21.9	-40.6	276.7	23.8
500.	5708.	-17.2	-28.0	276.2	19.0
550.	4987.	-11.6	-22.7	275.2	16.8
600.	4313.	-6.4	-20.0	266.8	15.1
650.	3683.	-1.7	-11.8	257.0	13.4
700.	3089.	2.1	-2.1	246.1	14.9
725.	2804.	3.2	1.4	239.7	16.9
750.	2529.	4.3	4.1	235.0	18.5
775.	2260.	6.6	6.4	231.3	16.8
800.	1999.	7.9	7.6	226.5	15.1
825.	1744.	8.3	8.0	222.0	16.6
850.	1497.	8.5	8.2	220.6	16.8
875.	1257.	9.0	8.7	218.7	16.5
900.	1023.	9.6	9.4	217.4	15.4
925.	795.	9.9	9.4	206.5	11.9
950.	572.	10.9	9.5	190.0	7.8
975.	355.	12.8	10.2	179.7	5.3
988.	242.	13.9	10.9	175.7	3.5

20150407 nam12
MODEL SOUNDING

GRID POINT 411.04 207.26
LAT/LON/ELEV: 39.73 -86.27 246m

04/07/2015 03Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20554.	-60.7	-88.6	311.9	5.4
100.	16243.	-60.5	-85.7	288.2	22.4
150.	13719.	-62.4	-80.5	273.4	38.9
200.	11957.	-63.0	-66.0	262.4	39.8
250.	10556.	-53.0	-60.7	268.7	35.1
300.	9357.	-44.0	-52.2	272.0	30.5
350.	8303.	-35.3	-46.8	275.3	28.0
400.	7359.	-27.9	-50.3	275.5	23.2
450.	6504.	-22.6	-37.0	278.6	17.1
500.	5725.	-18.0	-27.2	280.2	13.2
550.	5006.	-12.3	-22.5	285.0	12.2
600.	4333.	-6.6	-16.3	286.5	13.5
650.	3702.	-1.2	-11.5	278.2	13.1
700.	3106.	3.8	-8.8	255.9	11.1
725.	2820.	5.3	-3.7	244.2	11.6
750.	2543.	5.6	3.1	236.9	13.7
775.	2274.	6.4	6.3	234.2	15.9
800.	2012.	7.7	7.6	233.2	16.7
825.	1757.	8.9	8.6	228.5	16.5
850.	1509.	9.9	8.7	222.4	17.2
875.	1268.	11.0	9.6	221.8	16.2
900.	1032.	11.0	10.8	212.7	12.4
925.	803.	12.3	11.4	203.3	11.2
950.	578.	14.0	11.2	193.5	8.8
975.	359.	13.6	11.7	152.3	6.7
989.	242.	12.2	11.5	120.9	2.3

20150407 nam12
MODEL SOUNDING

GRID POINT 411.04 207.26
LAT/LON/ELEV: 39.73 -86.27 246m

04/07/2015 06Z

PRES HPA	HGT(MSL) M	TEMP C	DEWP C	WDIR DEG	WSPD M/S
50.	20545.	-61.6	-89.0	309.9	4.4
100.	16247.	-61.0	-86.1	284.4	20.5
150.	13722.	-60.8	-80.2	273.7	32.3
200.	11952.	-63.9	-69.0	265.0	37.5
250.	10557.	-53.8	-56.4	265.0	32.8
300.	9360.	-44.3	-48.6	269.0	29.8
350.	8309.	-35.6	-45.1	274.1	27.8
400.	7364.	-27.4	-45.5	275.1	25.0
450.	6506.	-21.8	-32.8	271.3	20.7
500.	5725.	-17.6	-18.5	264.2	14.9
550.	5004.	-12.0	-13.4	262.7	13.2
600.	4331.	-6.8	-9.5	254.6	13.2
650.	3700.	-1.4	-7.6	244.4	13.1
700.	3104.	3.6	-6.9	243.7	12.3
725.	2819.	5.1	-3.1	244.6	12.2
750.	2542.	5.7	1.3	242.0	13.2
775.	2272.	7.1	5.0	238.2	14.7
800.	2010.	9.2	7.6	237.5	16.0
825.	1754.	10.9	9.0	240.7	16.8
850.	1504.	11.3	9.4	243.8	16.6
875.	1261.	11.8	9.9	242.3	15.9
900.	1025.	12.0	10.0	233.0	14.5
925.	795.	12.7	11.2	216.4	12.6
950.	571.	13.7	12.5	201.4	9.3
975.	351.	14.6	12.5	182.2	5.6
987.	242.	13.8	12.2	136.0	2.1

Attachment 6: RAM – Series IV Engine Performance Comparison to Cessna 414A; RAM – Series IV Engine QRC

RAM AIRCRAFT, LP
[redacted] • Waco Regional Airport • [redacted] • Waco, TX 76708
Phone: [redacted] • Fax: [redacted] • [redacted]

ENGINES • PARTS • PROPELLERS • ACCESSORIES • STC'S

Performance - Cessna 414A
RAM - Series IV

Primary Specifications	Cessna 414A	RAM Series IV
Engine Model: Continental TSIO-520-NB	310 hp	325 hp
TBO - hours	1,600	1,600
Fuel Capacity - useable - gallons	206	206
Takeoff Manifold Pressure @ 2700 rpm	38”	41“
Twin Engine Climb - ISA @ 7,105 lbs.	NA	1486
Twin Engine Climb - ISA @ 6,750 lbs.	1500	1580
Single Engine Climb - ISA @ 7,105 lbs.	NA	257
Single Engine Climb - ISA @ 6,750 lbs.	270	316
Cruise Climb Power - ISA + 30°F - RPM & MP	2450 & 31.5”	2500 & 35.0”
Cruise Climb - SL to 18,000 ft - minutes	24	19
Cruise @ 75% - ISA - 20,000 ft. - ktas	208	215
Cruise @ 65% - ISA - 20,000 ft. - ktas	192	203
Cruise @ 55% - ISA - 20,000 ft. - ktas	176	190
Useful Load Increase - lbs.	NA	+355
Ramp Weight - lbs.	6,785	7,140
Gross Weight - lbs.	6,750	7,105
Landing Weight - lbs.	6,750	6,750
Zero Fuel Weight - lbs.	6,515	6,515
With Winglets		
Ramp Weight - lbs.	6,785	7,087
Gross Weight - lbs.	6,750	7,087
Zero Fuel Weight - lbs.	6,515	6,515
Wingspan, or Winglets Tip Top Span	44’-1.5”	45’- 4.8”

Performance should vary from airplane to airplane, atmospheric day to atmospheric day, one gross weight and CG to another, and pilot to pilot.

RAM Recommended Power Settings when using an Electronic Fuel Flow Measurement System. Page 1

PN2402 **Cessna T310/320 & 340/A & 414 & 414A • TSIO-520-NB • 325 hp • Series IV**

Fuel is computed at 5.85 lbs. / gallon.

Aircraft Configuration	MP Setting	RPM	Fuel Flow Setting	EGT °F ±25°F	CHT °F	Oil Temp °F
Takeoff	41" MP	2700	**Full Rich** **34.0** to **35.0** gph 200 to 205 pph	1450°F to 1550°F	200°F min. 300°F to 350°F Ideal	100°F min. 150°F to 190°F Ideal
Climb	35" MP	2500	**26.5 - 27.5** gph 155 - 161 pph	1450°F Calibration Setting at 10,000 ft.	440°F max. 380°F to 410°F Ideal	230°F max. 150°F to 190°F Ideal
75% **244** hp **Cruise**	**Set MP:** **Per Altitude & OAT** See Reverse Side.	2400	**20.4** gph 119 pph	1650°F Maximum	440°F max. 360°F to 410°F Ideal	220°F max 150°F to 190°F Ideal
65% **211** hp **Cruise**	**Set MP:** **Per Altitude & OAT** See Reverse Side.	2300	**17.9** gph 105 pph	1650°F Maximum	430°F max. 360°F to 410°F Ideal	210°F max. 150°F to 190°F Ideal
55% **179** hp **Cruise**	**Set MP:** **Per Altitude & OAT** See Reverse Side.	2300	**15.4** gph 90 pph	1650°F Maximum	430°F max. 360°F to 410°F Ideal	210°F max. 150°F to 190°F Ideal
45% **146** hp **Cruise**	**Set MP:** **Per Altitude & OAT** See Reverse Side.	2200	**12.9** gph 75 pph	1625°F Maximum	420°F max. 360°F to 410°F Ideal	200°F max. 150°F to 190°F Ideal
Normal Descent	35% to 65% Power	Pilot's Discretion	Adjust to → Maintain EGT	1300°F min. 1400°F Ideal	200°F min. 300°F to 390°F Ideal	200°F max. 150°F to 190°F Ideal
Approach & Landing	35% to 65% Power	Pilot's Discretion	Adjust to → Maintain EGT	1200°F min. 1300°F Ideal	200°F min. 300°F to 390°F Ideal	200°F max. 150°F to 190°F Ideal

• In the event of an Emergency, use Full Power at Pilot's Discretion.
• If American Aviation Intercoolers & Scoops are installed: Use RAM Power Card PN2405 and PN2407 for 414A
• Operation outside limits specified above is not approved.

RAM Aircraft, LP • [redacted] • Waco Regional Airport • [redacted] • Waco, Texas 76708 • [redacted] • Fax: [redacted]

RAM Series IV

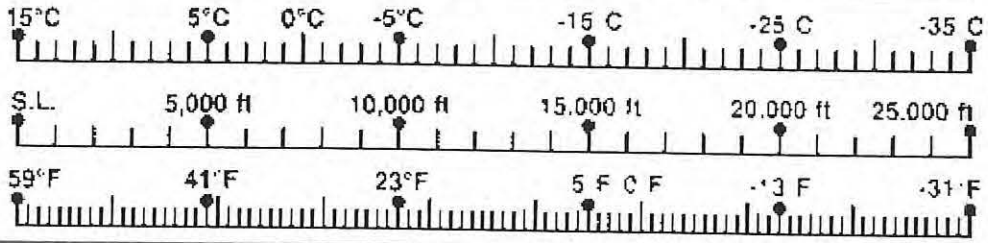
RAM Recommended Cruise Power Settings when using an Electronic Fuel Measurement System

PN 2402 Cessna T310/320 & 340/A & 414 & 414A •TSIO-520-NB •325 hp

Cruise Power:	75% 244 hp	65% 211 hp	55% 179 hp	45% 146 hp
RPM:	2400	2300	2300	2200
Fuel Flow:	20.4gph 119pph	17.9gph 105pph	15.4gph 90pph	12.9gph 75pph
EGT:	1650°F max.	1650°F max.	1650°F max.	1625°F max.
10,000 ft.	MP:			
ISA -30°F - 7°F (-22°C)	32.0″	29.5″	26.5″	22.5″
ISA°F 23°F (-5°C)	33.0″	30.5″	27.5″	23.5″
ISA +30°F 53°F (+12°C)	33.5″	32.0″	28.5″	24.5″
15,000 ft.	MP:			
ISA -30°F -25°F (-32°C)	32.0″	29.5″	26.5″	22.5″
ISA°F 5°F (-15°C)	33.0″	30.5″	27.5″	23.5″
ISA +30°F 35°F (-2°C)	33.5″	32.0″	28.5″	24.5″
20,000 ft.	MP:			
ISA -30°F -42°F (-41°C)	32.0″	29.5″	26.5″	--
ISA°F -12°F (-25°C)	33.0″	30.5″	27.5″	--
ISA +30°F 18°F (-8°C)	33.5″	32.0″	28.5″	--
25,000 ft.	MP: @2450 RPM			
ISA -30°F -60°F (-51°C)	31.5″	29.5″	26.5″	--
ISA°F -30°F (-34°C)	32.5″	30.5″	27.5″	--
ISA +30°F 0°F (-18°C)	33.0″	32.0″	28.5″	--

Note: Setting fuel flow by the peak and enrichen method is not recommended when this chart is available and the fuel flow indicator being used is electronic.

STANDARD DAY TEMPERATURE SCALE



Attachment 7: Estimated Fuel Burn Using the Cessna 414A POH and the RAM – Series IV Engine QRC

Estimated Fuel Burn and Flight Time, BMI to IND

Ramp Weight	7277.0	lb							
Cruise Avg. Weight	7141.1	lb							
				gallons	pounds	nm	min	time, CDT	
Engine start, taxi, takeoff				**5.7**	**33.5**	**0.0**	**0.0**	14:30:00	
Cruise climb		Pres. Alt., ft	Temp, C						
	begin altitude, feet	817	16.5	0.7	4	2.3	1		
	end altitude, feet	9,000	6.5	7.9	46	26.3	11.5		
	segment totals			**7.2**	**42**	**25.8**	**10.5**		
	17.1 knot TW								
Cruise at 75%									
	begin altitude, feet	9,000	5.0						
	end altitude, feet	9,000	5.0						
	segment totals			**20.6**	**120.8**	**104.7**	**30.4**		
	20.9 knot TW								
Descent									
	begin altitude, feet	9,000	3.0	3.5	20.6	27.5	8.7		
	end altitude, feet	710	15.0	0.2	1.0	1.3	0.4		
	segment totals			**3.3**	**19.6**	**27.6**	**8.3**		
	26.4 knot TW								
Landing			assumed	**0.5**	**3**	**0**	**0**		
Taxi			assumed	**0.5**	**3**	**0**	**0**	15:22:00	
			Total	**37.9**	**221.9**	**158.15**	**49.1**	**52.0**	
				gallons	pounds	nm	minutes	minutes	
							POH/RAM	FlightAware	

Fuel Burn	**46.3**	**gph**	
Trip Distance	182.0	sm	FlightAware
	158.16	nm	
Cruise leg	104.72	nm	
	186.0	knots, POH/RAM	
	184.0	knots, FlightAware	
	2.0	knots, difference	

Estimated Fuel Burn and Flight Time, IND to BMI

Ramp Weight	7381.0	lb							
Cruise Avg. Weight	7220.4	lb							
				gallons	pounds	nm	min	time, CDT	
Engine start, taxi, takeoff				**5.7**	**33.5**	**0.0**	**0.0**	23:07:00	
Cruise climb		Pres. Alt., ft	Temp, C						
	begin altitude, feet	719	14.0	0.5	3.2	1.8	0.8		
	end altitude, feet	8,000	6.1	6.8	40	22.9	10		
	segment totals			**6.3**	**36.8**	**19.6**	**9.2**		
	15.7 knot HW								
Cruise at 75%									
	begin altitude, feet	8,000	8.3						
	end altitude, feet	8,000	8.3						
	segment totals			**30.9**	**180.5**	**129.6**	**45.4**		
	12.7 knot HW								
Descent									
	begin altitude, feet	8,000	7.8	3.2	18.9	25.0	8		
	end altitude, feet	812	13.0	0.2	1.2	1.5	0.5		
	segment totals			**3.0**	**17.8**	**22.9**	**7.5**		
	11.7 knot HW								
Landing			assumed	**0.5**	**3**	**0**	**0**		
Taxi			assumed	**0.5**	**3**	**0**	**0**	0:06:00	
			Total	**46.9**	**274.6**	**172.06**	**62.1**	**59.0**	
				gallons	pounds	nm	minutes	minutes	
							POH/RAM	FlightAware	

Fuel Burn	**45.4**	**gph**	
Trip Distance	198.0	sm	FlightAware
	172.06	nm	
Cruise leg	129.56	nm	
	184.0	knots, POH/RAM	
	182.0	knots, FlightAware	
	2.0	knots, difference	