Scott Aviation

Flight Safety Memorandum

To: New and Returning Intern Pilots
From: Scott Dills, Flight Operations Specialist
Date: 03/24/2021
Subject: Checklists

Welcome to the fleet! As an ongoing part of your aviation education I would like to remind you about checklist duties and responsibilities. Flight safety is not just a mindset, it is a culture. And we cannot express the importance of learning and using our industry adapted checklists.

Whether you are a new fleet pilot, a chief industry captain, or a general aviator it is your duty as Pilot In Command (PIC) to conduct every flight with the utmost standards of safety.

In this memo I will describe our industries culture of safety, the use of checklists in professional aviation, common checklist components, checklist complications, and provide ideas for the future. These concepts have been drawn from Federal Aviation Regulations (FAR), industry newsletters, multi-company standards, personal experience, the Federal Aviation Administration (FAA), the National Aeronautics and Space Administration (NASA), and the International Civil Aviation Organization (ICAO).

A Culture of Safety

Since your first days as a student pilot flight safety is a theme that has been repeatedly emphasized. As a response to the ongoing commitment to safety, the FAA periodically updates their mandate for Safety Management System Requirements (SMS) (FAA *Order VS 8000.367B*). This mandate stipulates that our organization maintains a proactive safety program with the intent to:

1. Identify potential hazards.
2. Create adequate safety controls.
3. Continuously measure safety performance.
4. Provide continuous updates on safety-measures to company leadership.
5. Promote the SMS.

Creating an effective flight checklist program is an essential component of our SMS goals.

Every manufacturer (Boeing, Airbus, Bombardier, Embraer, etc.) produces a standard checklist that arrives with its corresponding aircraft type (Degani and Weiner *Cockpit Checklists*, 01).

We then work closely with FAA Principal Operations Inspectors (POI) to make sure that our checklists are consistent with federal regulations (FAA, *Cockpit Check Procedures 121.315*).

In an effort to exceed the SMS standards stated above, Scott Aviation strives to provide our pilots with the most accurate, detailed, and useful checklists in the industry.

An important component of our mission is to instill a safety culture in line with the values of Boeing. We encourage flexibility, information flow, learning, and pilot reporting (Ma, 14). We rely on pilot feedback to create the best checklist designs. Your contributions are encouraged and welcome!

A Complex World of Travel

Air transportation numbers saw a 4.5% increase from approximately 800 billion average revenue passenger kilometers in the month of December 2019 (Uniting Aviation).

With the increasing onset of COVID restrictions throughout 2020, passenger loads dropped precipitously at -94.3% by April of the same year. Slow but modest improvement in passenger travel has increased throughout November 2020 (Uniting Aviation).

Similarly, freight tonnage also took a big dip in April, though improvement appears substantially better by the close of the 2020 travel year (Uniting Aviation). While these numbers indicate substantial challenges, we anticipate a resurgence of global industry numbers in 2021 coinciding with improvements in available COVID 19 vaccinations.

The number of passengers on domestic and international flights conducted by U.S. carriers climbed steadily from November of 2017 with 72.3 million passengers per month, to February of 2020 with 78.6 million passengers per month (Bureau of Transportation Statistics).

The precipitous drop demonstrated in global statistics, was also present in U.S. figures with a dramatic drop in March 2020 to 37.7 million passengers per month. March numbers were outpaced by April 2020 which reported a meager 3 million passengers per month (Bureau of Transportation Statistics).

Even in the midst of these challenges our commitment to safety has not wavered. Despite the worldwide quarantine, we have increased our research and development programs in SMS (including our new

checklist improvements). The eventual and expected return to normalcy (consistent with numbers demonstrated in December 2019) informs our need to continue improving checklist tools for our crews.

What does a Checklist Look Like?

Aviation agencies worldwide have adopted checklists for all phases of flight, both ordinary and extraordinary (Pierobon, 2).

They typically include: preflight ground inspections, flight planning, pre-flight checks, before engine start, engine start, before taxi, taxi checklist, before take-off, after take-off, climb-out, cruise and descent, approach, landing, after-landing, parking and shutdown, securing the aircraft, and emergency procedures checklists (Degani, 9).

When checklists are in use on the flight deck, items are called out by the pilot who is not in control of the aircraft. Captains and First Officers share and alternate these duties as assigned by their corporate operation centers. See **Figure 1** for an example of a Northwest Airlines MD-80 checklist (Degani and Weiner *Human Factors*, 9).

Traditionally, these documents are produced on an 8.5" x 11" sheet of paper, and then stored in large ring-binders (Palmer and Degani, 3). The contents are divided into separate binders based upon topic, which are then stowed within easy reach of flight crews. This includes emergency checklist procedures which are available for reference as needed (Kelsey, *Flight movie*).

For large complex aircraft checklists might be stored in multiple manuals, each containing reference data and charts corresponding with the topic (such as the weight and balance charts seen in **Figure 2** (*BAe146 Safe Loading Envelope*)(Burian, 3)). Frequently used checklists might be laminated and marked with dry erase pens.

It is normal practice for flight crews to reference several different flight manuals during ordinary operations. While most of this information is not intended for memorization, some material (such as emergency procedures) is recurrently and rigorously trained in flight simulators. Flight crews routinely rehearse scripted responses to potential emergencies (Kelsey, *Pilot Explains*).

Historically, checklist authors have employed the visual rhetoric called chunking. Chunking is the grouping of similar aircraft systems that have relevant functions. For example: all items necessary for engine startup should be chunked within the rhetorical grouping labeled "Engine Startup" (Degani and Weiner *Human Factors*, 15).

The recommended font types for aviation checklists are Roman and sans-serif. Roman font types are ubiquitous in popular newspapers, periodicals, and literature. Though, sans-serif is becoming widely preferable to Roman fonts (Degani, 9).

The word "sans" means "without." The phrase *sans-serifs* indicates fonts "without" serifs, which are the horizontal strokes present in many font types. Fonts with serifs make individual character identification difficult. These fonts may "run together" and create an uneven appearance (Degani, 9). Therefore sans-serif fonts are essential to effective cockpit documentation.

San-serif includes several different font types. The Gill -Medium sans-serif font type has demonstrated the best levels of reader comprehension (Degani, 10).

Further research has demonstrated that a mix of upper and lower-case characters are preferable to all upper-case or all lower-case. Text printed in all upper-case letters significantly reduces reading speeds, and potentially blurs text together (Degani, 12-15).

While lower-case characters are preferable to upper-case only characters, the best format contains a happy medium between the two (Degani, 12-15).

Font height, stroke width, height to width ratio, x-height, horizontal and vertical spacing, line-length, face, contrast, and color coding are all carefully considered in checklist production (Degani, 16-26).

Basic flight computers called Flight Management Systems (FMS) (see **Figure 3)** are used in unison with paper checklists and reference materials (Bailey, *Your Smartphone*).

In recent years, common practice incorporates laptops and tablets on the flight deck. Computing devices are integrated into the normal procedural flight systems. On aircraft with advanced cockpit design, flight instrumentation transmits information directly into the pilot's electronic device (Pierobon, 2).

Checklists are employed industry-wide in all of the aforementioned variations. Some carriers rely solely on traditional paper methods. Others seek to use electronic checklists exclusively (Palmer and Degani, 1-7).

The flight planning portions of checklists often require the coordination of several external information sources (Degani, *Human Factor*s, 42-51). This is primarily due to the changeable nature of external weather phenomena and fluctuations in passenger, freight, and luggage loads before departure (see **Figure 4**) (*BAe146 Quick Reference Card*).

A checklist item may call for the pilot to review current forecasts reported by a local weather agency (Degani and Weiner *Human Factors*, 42-51). In-route weather reports are often interpreted by carrier agents and distributed via the local company station.

Local station agents provide weight and balance data for current passenger and freight loads, which then must be checked against procedural checklists (*BAe146 Safe Loading Envelope*).

And finally, the aircraft itself may have mechanical or physical peculiarities that cannot be accounted for in the standardized checklists. For example, in 2002 tail #632 was the only 100 series BA-146 in the Air Wisconsin Airlines fleet. Unlike, the 200 and 300 series aircraft in service, #632 had a tight margin for weight and balance calculations. Without careful scrutiny, passenger and luggage loads could potentially offset the aircraft's center of gravity, rendering it "unflyable" (*BAe146 Safe Loading Envelope*) (*BAe146 Quick Reference Card*).

At Scott Aviation we employ a hybrid combination of both traditional paper workflows and modern state-of-the-art electronic checklists. Our crews are initially trained with paper procedural documents, then subsequently issued electronic checklists via company laptops. This hybrid approach provides a failsafe. If electronic versions fail, our pilots will always have a printed version available.

Recommended Checklist Design Components

In 2004 the Boeing company set out to standardize the normal checklist procedures across aircraft types currently in production. These checklist procedural changes were conducted in response to incidents within the industry, and feedback from their worldwide customers. The following passages are drawn from a report by Boeing Flight Manager Jay Abbot. Other sources are subsequently included detailing common checklist attributes.

A call for better globalization in language practices was answered. This was accomplished with an emphasis on repetition in standardized word usage. General phrase concepts such as "the body of an aircraft" and "the tail section" might be condensed down into universally accepted terminology such as the "fuselage" and "empennage" respectively (Abbot, 2-3).

Boeing sought to employ shorter sentence structures and simplify paragraphs into single subjects to pare down potentially congested passages (Abbot, 2-3).

In visual rhetoric, Boeing produced new **scanflow** procedures for both the Captain and First Officer. These scanflows illustrated the respective checklist workflow that each crew member would review during flight operations. Checklist procedures are organized according to these scanflow diagrams (Abbot, 2-3). See **Figures 5 and 6**.

In addition to internal flight operations checklists, Boeing produced greater emphasis to their aircrafts' exterior procedures, which included a graphic explanation of a standardized "walk-around" route. (Abbot 6,13). See **Figure 7.**

Boeing renamed "pilot not flying" to the more accurate "pilot monitoring" moniker. The difference is subtle, but carries significant meaning (Abbot, 15).

The phrase "pilot not flying" possesses a possible connotation of no responsibility. In contrast, "pilot monitoring" implies that the pilot currently not in control of the aircraft is responsible for actively monitoring all of the activities performed by the other pilot (Abbot, 15).

Recent efforts by Boeing to reduce checklist complexity has focused upon furthering the concept of *chunking* into cognitive constructs. These cognitive constructs are based on keyword headings (Abbot, 23).

This is accomplished by conducting recurrent pilot training sessions. These rigorous sessions seek to imprint cognitive scripts into the pilot's memory. The pilot is then able to recall these rhetorical "chunks" of information when a checklist keyword item is called (Abbot, 23).

Earlier research conducted by NASA firmly established several call and response protocols that should be essential to the checklist process. (1) When a pilot responds to a checklist item they should respond with the intended status or value that is created by the action listed on the checklist. (2) Pilots should physically pantomime, gesture, or touch the item being checked. This provides physical and visual cues that the pilot is actively participating in the review. (3) The most critical items should be listed near the beginning of the checklist in case potential interruptions arise later in the process (Degani and Weiner *Human Factors*, 15-16).

Checklist Complications

The most encompassing challenge is to produce checklists that can be employed universally across aircraft types, series, and fleets. Aircraft cockpit designs vary significantly. Therefore, placement of important aircraft systems may be potentially unique to a type and series.

A checklist workflow that is oriented to closely follow a specific aircraft design, may proceed fluidly from one checklist item to the next. However, if that same checklist is used with another type or series aircraft it may prove inadequate (Pierobon, 2).

Checklists that are presented in electronic format may be subject to additional complications such as screen size and screen glare which may require pilots to zoom and scroll to find desired information. Screen size limits the amount of information that is available to pilots at any given time. (Burian, 3),

Inflight checklists also become cumbersome during especially hectic or busy transitions during flight. It is the responsibility of the PIC to determine when checklists are appropriate and necessary. While we repeatedly express the need for procedural compliance, we do recognize that crews should always *fly the airplane first*. Procedural artifacts should always be a secondary consideration (Degani and Weiner *Human Factors*, 43).

Visual distractions such as smoke in the cockpit are also a potential hazard. An appropriately sized font, shorter sentence structures, and standardized language are crucial for conveying information during critical situations (Burian, 3).

Since our company is a multi-aircraft fleet, it is difficult to create a universally applicable checklist. This is an ongoing challenge for our SMS research and development team.

Ideas for the Future

In the effort to improve procedural effectiveness our research and development team is in the process of updating our checklist program. The following items are all recommendations that have been requested by flight crews, SMS committees, our board of directors, and various stakeholders directly involved with our operations, Scott Aviation plans to initiate these program updates by the end of 2022.

Company standard laptops will be issued to all current crew members including captains, first officers, flight instructors, and interns. Each device will have standardized settings, screen size, and checklist software manufactured by our research and development team.

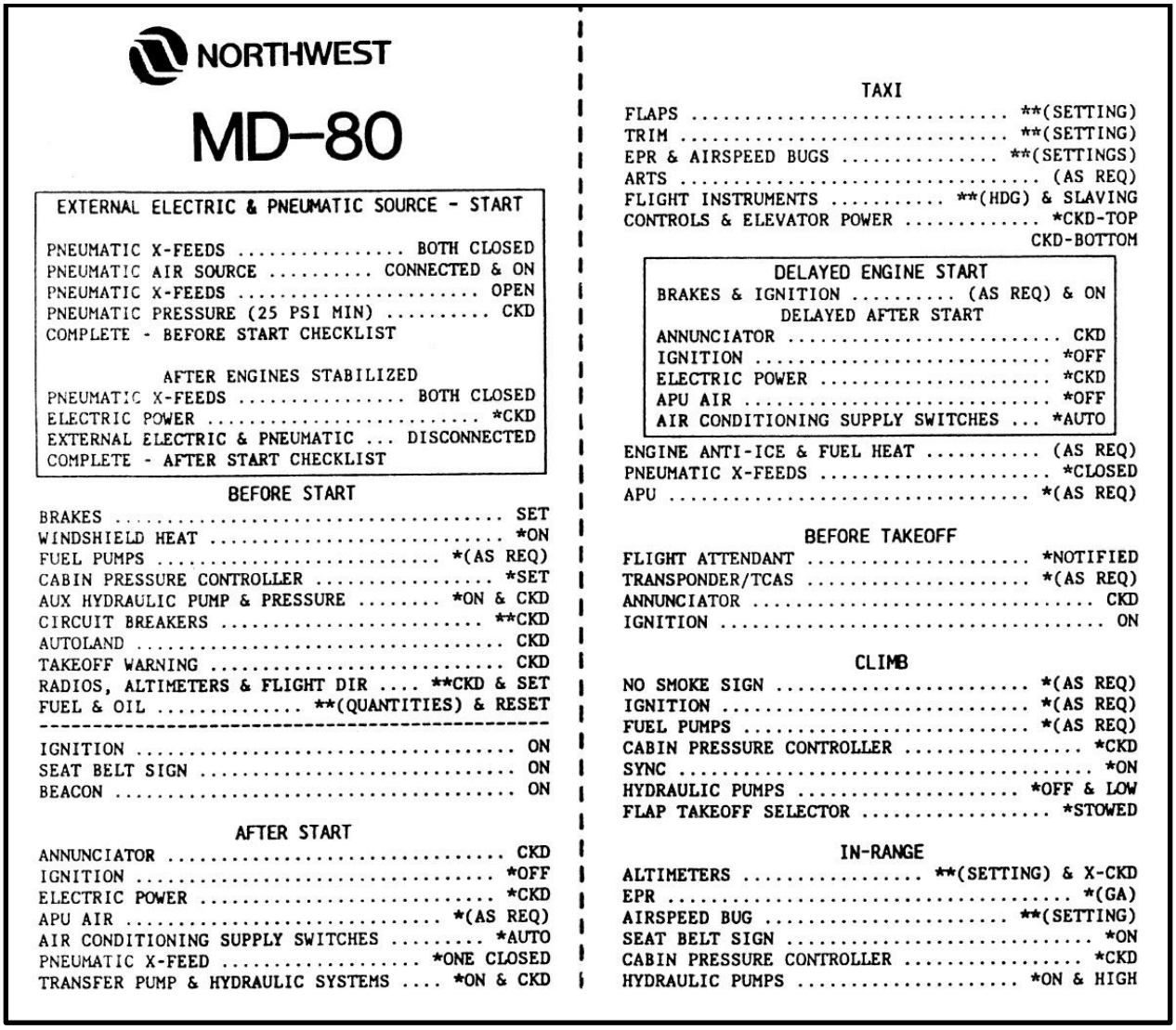
Our software development team is updating our proprietary software with these recommendations:

1. More effective search boxes will be included with multiple term possibilities (ex. powerplant or engine).
2. The software search box can be voice activated at the pilot's discretion. Flight headsets will be integrated with the checklist workflow via the FMS.
3. All checklist chunks will be available for instant recall at the command of the pilot at any phase of the flight.
4. Checklists will automatically proceed to the next workflow once a "chunk" has been completed.
5. The pilots will be able to move backwards and forwards through the checklist workflow as needed.

6. Graphic User Interface (GUI) buttons will be large and clearly marked on the workflow.
7. Updated airspeeds, altitudes, engine performance, radio settings, pressure, oxygen levels, directional data, flap and trim values, and turn percentage settings will be communicated instantly from the aircraft's inherent FMS. The software will update the checklist in real-time based upon changes in these values.
8. Paper checklists will be printed from the new software via PDF export. Pilots will undergo routine training on paper and electronic checklists.

In our continuing commitment to safety our SMS teams will be conducting interviews with all crew members throughout the rollout process of our new checklist procedures. We appreciate your hard work and commitment to our safety culture. Please take note of any changes that you would like to see with our new procedural checklists. You can contact our SMS team via email at any time to make suggestions during this ongoing process. Thank You! And, Welcome to the fleet!

Figure 1: Northwest Airlines MD-80 Checklist (Degani and Weiner Human Factors, 9)



NORTHWEST

MD–80

EXTERNAL ELECTRIC & PNEUMATIC SOURCE - START

PNEUMATIC X-FEEDS ..... BOTH CLOSED
PNEUMATIC AIR SOURCE ..... CONNECTED & ON
PNEUMATIC X-FEEDS ..... OPEN
PNEUMATIC PRESSURE (25 PSI MIN) ..... CKD
COMPLETE - BEFORE START CHECKLIST

AFTER ENGINES STABILIZED
PNEUMATIC X-FEEDS ..... BOTH CLOSED
ELECTRIC POWER ..... *CKD
EXTERNAL ELECTRIC & PNEUMATIC ... DISCONNECTED
COMPLETE - AFTER START CHECKLIST

BEFORE START

BRAKES ..... SET
WINDSHIELD HEAT ..... *ON
FUEL PUMPS ..... *(AS REQ)
CABIN PRESSURE CONTROLLER ..... *SET
AUX HYDRAULIC PUMP & PRESSURE ..... *ON & CKD
CIRCUIT BREAKERS ..... **CKD
AUTOLAND ..... CKD
TAKEOFF WARNING ..... CKD
RADIOS, ALTIMETERS & FLIGHT DIR .... **CKD & SET
FUEL & OIL ..... **(QUANTITIES) & RESET

IGNITION ..... ON
SEAT BELT SIGN ..... ON
BEACON ..... ON

AFTER START

ANNUNCIATOR ..... CKD
IGNITION ..... *OFF
ELECTRIC POWER ..... *CKD
APU AIR ..... *(AS REQ)
AIR CONDITIONING SUPPLY SWITCHES ..... *AUTO
PNEUMATIC X-FEED ..... *ONE CLOSED
TRANSFER PUMP & HYDRAULIC SYSTEMS .... *ON & CKD

TAXI

FLAPS ..... **(SETTING)
TRIM ..... **(SETTING)
EPR & AIRSPEED BUGS ..... **(SETTINGS)
ARTS ..... (AS REQ)
FLIGHT INSTRUMENTS ..... **(HDG) & SLAVING
CONTROLS & ELEVATOR POWER ..... *CKD-TOP
CKD-BOTTOM

DELAYED ENGINE START
BRAKES & IGNITION ..... (AS REQ) & ON
DELAYED AFTER START
ANNUNCIATOR ..... CKD
IGNITION ..... *OFF
ELECTRIC POWER ..... *CKD
APU AIR ..... *OFF
AIR CONDITIONING SUPPLY SWITCHES ... *AUTO

ENGINE ANTI-ICE & FUEL HEAT ..... (AS REQ)
PNEUMATIC X-FEEDS ..... *CLOSED
APU ..... *(AS REQ)

BEFORE TAKEOFF

FLIGHT ATTENDANT ..... *NOTIFIED
TRANSPONDER/TCAS ..... *(AS REQ)
ANNUNCIATOR ..... CKD
IGNITION ..... ON

CLIMB

NO SMOKE SIGN ..... *(AS REQ)
IGNITION ..... *(AS REQ)
FUEL PUMPS ..... *(AS REQ)
CABIN PRESSURE CONTROLLER ..... *CKD
SYNC ..... *ON
HYDRAULIC PUMPS ..... *OFF & LOW
FLAP TAKEOFF SELECTOR ..... *STOWED

IN-RANGE

ALTIMETERS ..... **(SETTING) & X-CKD
EPR ..... *(GA)
AIRSPEED BUG ..... **(SETTING)
SEAT BELT SIGN ..... *ON
CABIN PRESSURE CONTROLLER ..... *CKD
HYDRAULIC PUMPS ..... *ON & HIGH

Figure 2: BAe146 Safe Loading Envelope (Air Wisconsin Airlines)

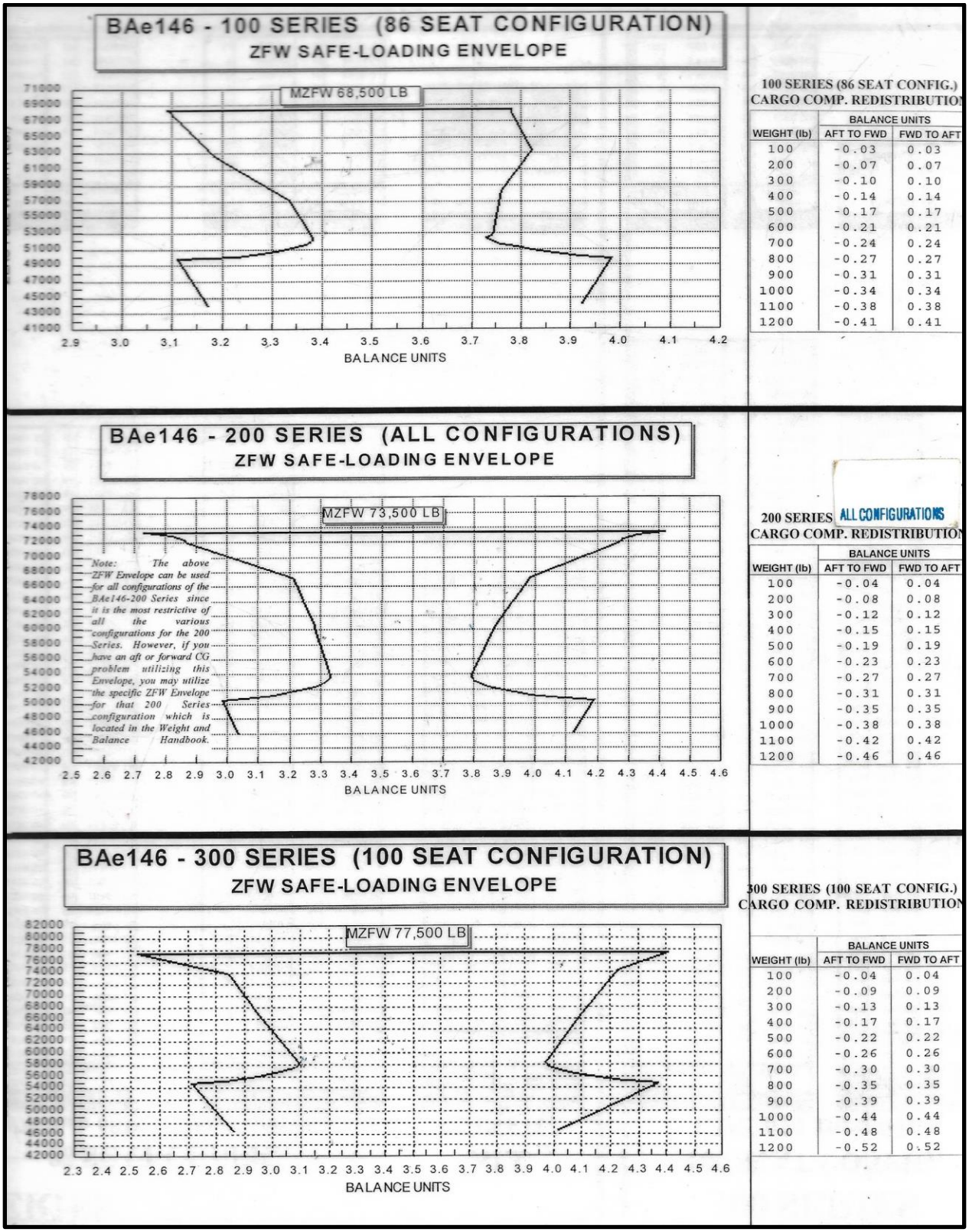


Figure 3: Flight Management Computer (Captain Boeing)

Figure 4: Weight and Balance Quick Reference Card (Air Wisconsin Airlines)

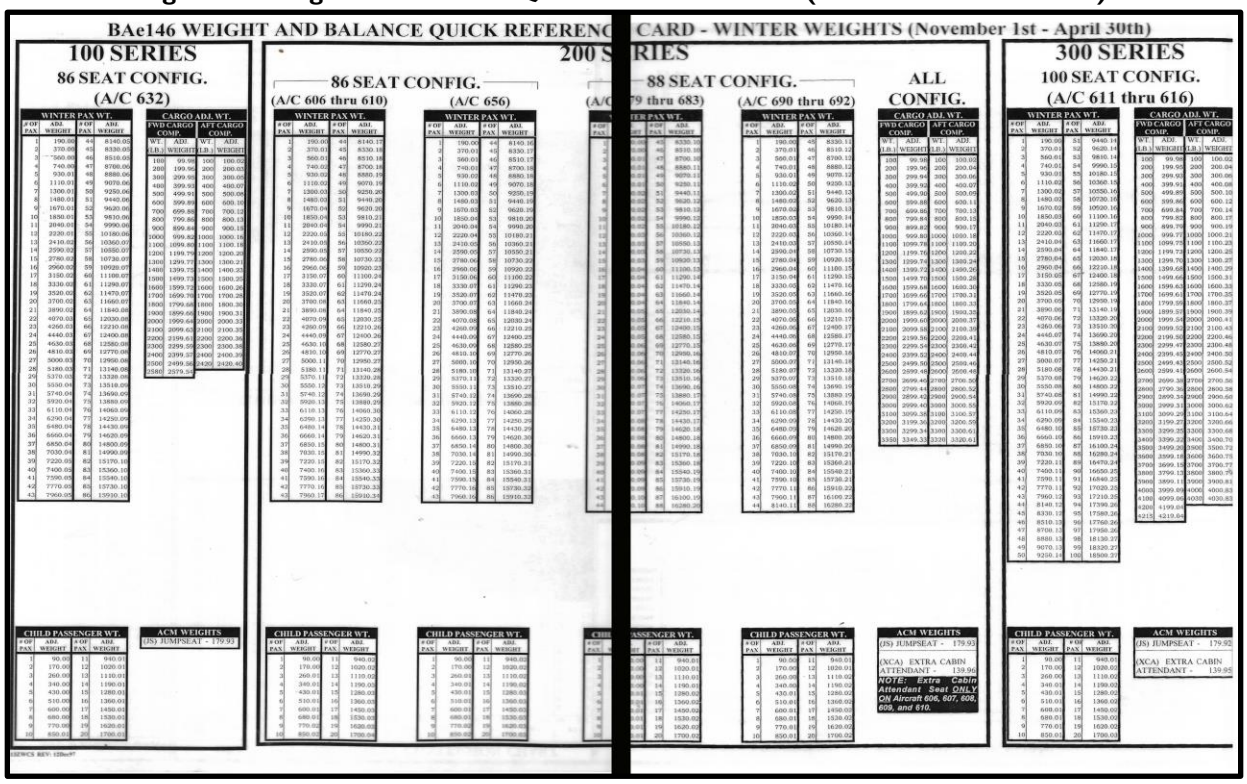


Figure 5: Captain Flying. Greyed out Area (Abbot, 10)

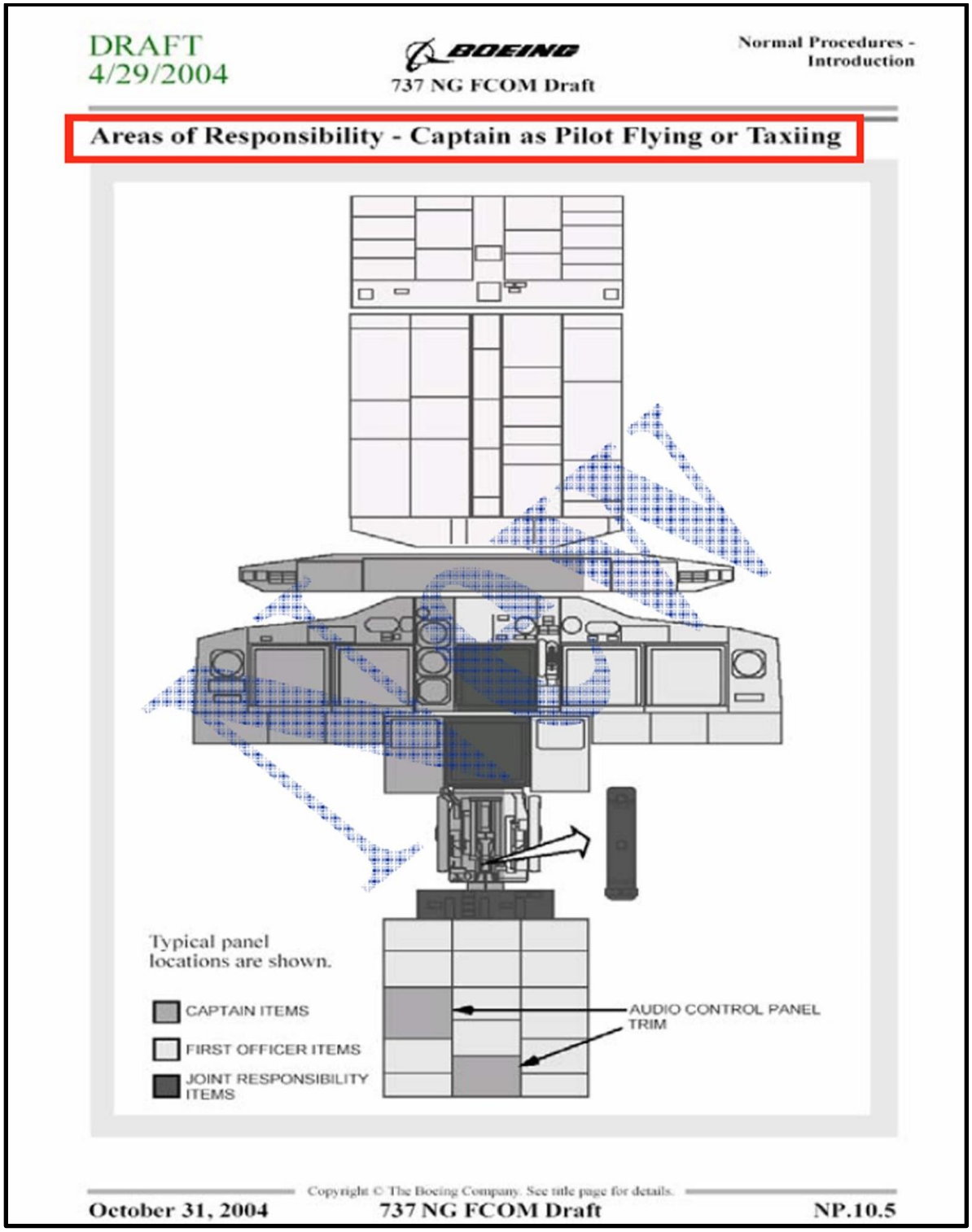


Figure 6: First Officer Flying. Greyed out Area (Abbot, 10)

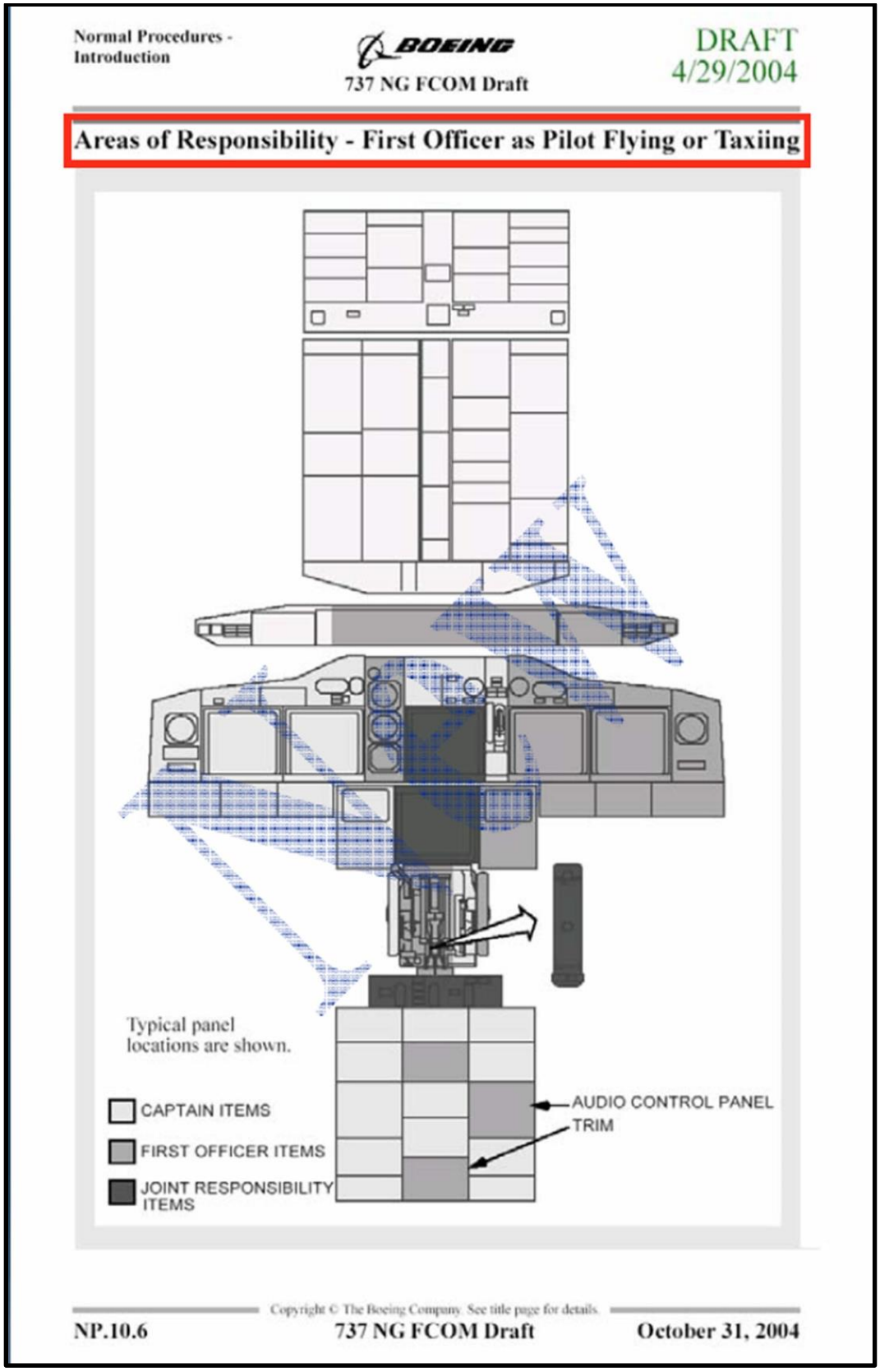


Figure 7: Exterior Inspection (Abbot, 6)

Exterior Inspection

Before each flight the captain, first officer, or maintenance crew must verify that the airplane is satisfactory for flight.

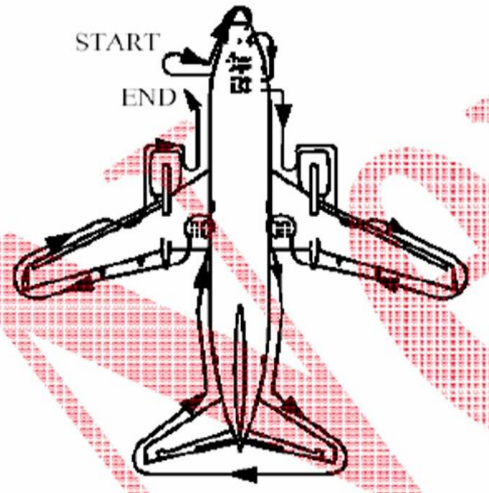
Items at each location may be checked in any sequence.

Use the detailed inspection route below to check the following items:

- surfaces and structures clear and undamaged, no missing parts and no fluid leaks
- tires free of excessive wear, tread separation and damage
- gear struts not fully compressed
- engine inlets and tailpipes clear, access panels secured, no exterior damage, reversers stowed
- doors and access panels (not in use) latched
- probes, vents and static ports undamaged and clear
- skin area adjacent to static ports and pitot probes not wrinkled
- antennas undamaged
- light lenses clean and undamaged

For cold weather operations see Supplementary Procedures.

Inspection Route



Left Forward Fuselage

Probes, sensors, ports, vents, and drains (as applicable).....Check

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