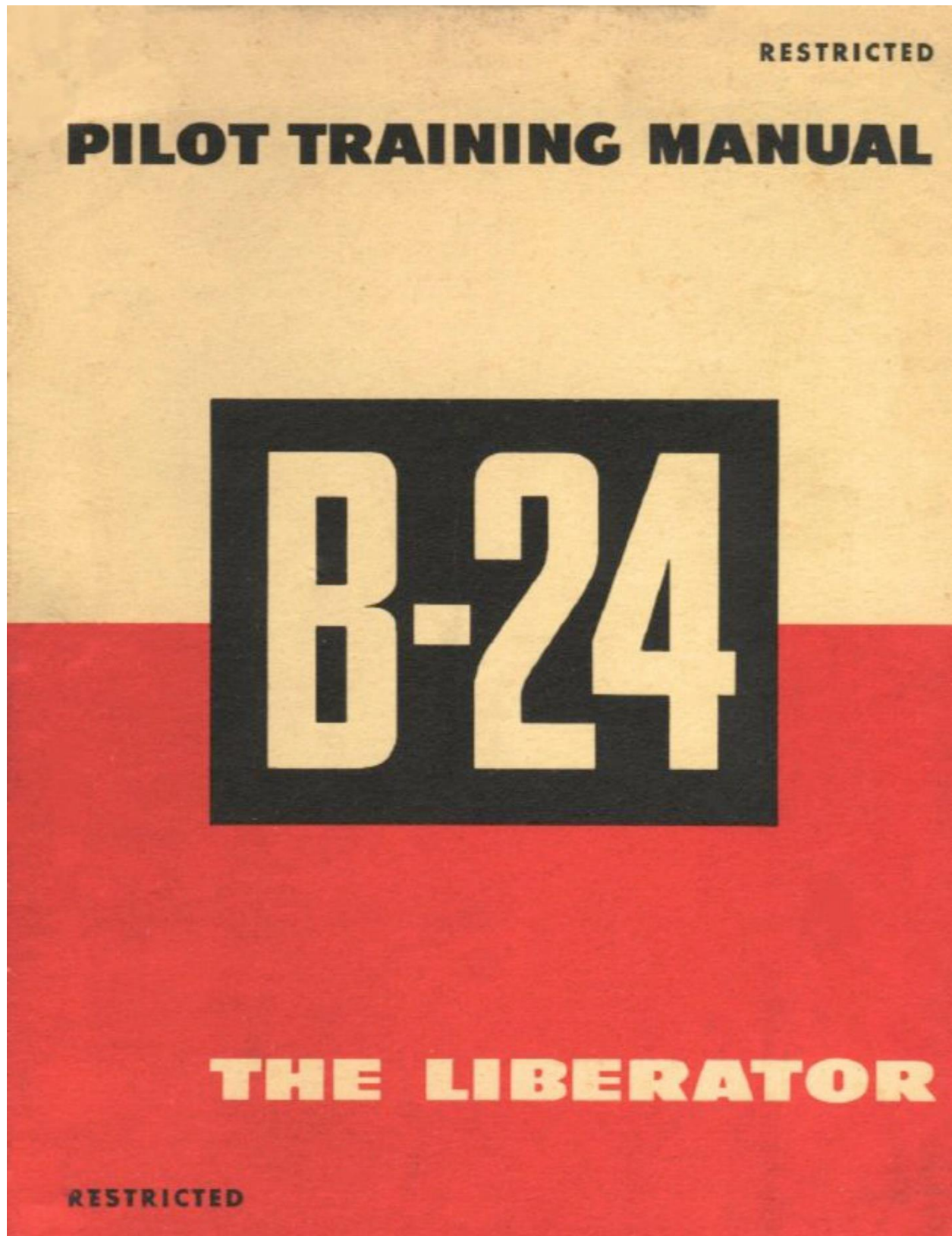




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PILOT TRAINING MANUAL FOR THE

Liberator

B-24

PUBLISHED FOR HEADQUARTERS, AAF

OFFICE OF ASSISTANT CHIEF OF AIR STAFF, TRAINING

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OCTOBER, 1944 - 25,000

APPENDIX B - B-24 PILOT TRAINING



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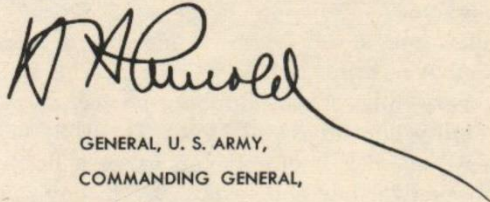
Foreword

THIS MANUAL is the text for your training as a B-24 pilot and airplane commander.

The Air Forces' most experienced training and supervisory personnel have collaborated to make it a complete exposition of what your pilot duties are, how each duty will be performed, and why it must be performed in the manner prescribed.

The techniques and procedures described in this book are standard and mandatory. In this respect the manual serves the dual purpose of a training checklist and a working handbook. Use it to make sure that you learn everything described herein. Use it to study and review the essential facts concerning everything taught. Such additional self-study and review will not only advance your training, but will alleviate the burden of your already overburdened instructors.

This training manual does not replace the Technical Orders for the airplane, which will always be your primary source of information concerning the B-24 so long as you fly it. This is essentially the textbook of the B-24. Used properly, it will enable you to utilize the pertinent Technical Orders to even greater advantage.



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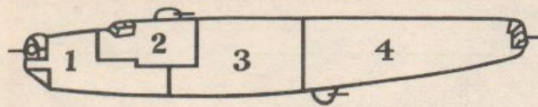
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GENERAL DESCRIPTION

The B-24 is a midwing, land, heavy bombardment airplane of the following approximate over-all dimensions: length 67 feet, 2 inches; height 17 feet, 11 inches; span 110 feet. Weight varies from a basic weight of approximately 38,000 lb. to combat loads of over 60,000 lb.



Compartments



1. Bombardier-navigator's compartment, in the nose of the airplane, contains navigational equipment, bombsight, bomb controls, and nose guns, or in the case of later models, nose turret.

2. Flight deck includes pilots' compartment, radio operator's station and top gun turret.

3. Two bomb bays are in the center of the fuselage under the center wing section. Half deck is located above the rear bomb bay.

4. Rear fuselage compartment contains lower gun turret, waist guns, bottom camera hatch, and photographic equipment. Tail gun turret is in the extreme rear of the fuselage.

Landing Gear

The tricycle gear consists of 2 main wheels and a nosewheel, mounted on air-oil shock struts. The nosewheel is free to swivel 45° each way but should never be turned more than 30°; it is damped against shimmying.

All 3 units are normally extended and re-

tracted hydraulically by a lever on the pilot's control pedestal which also operates the landing gear locking mechanism.

The retractable shock-mounted tail bumper (or tailskid) is operated simultaneously with the landing gear (B-24 C's and early B-24 D's have non-retractable tail bumpers).

The inherent directional stability of the tri-cycle gear is an important aid to the pilot during taxiing, takeoff, landing operation in crosswinds, and with blown tires.

The reason for this is that when the weight of the airplane is distributed on all 3 wheels the center of gravity falls between the nose gear and the main gear. When the airplane is moving, the weight of the B-24 tends to continue in a line straight ahead. Thus, when the airplane gets off heading, the forward weight tends to pull the nose back on heading, decreasing the rate of turn. The faster the airplane is moving the greater the directional stability.

Contrast this with an airplane with conventional gear. Here the center of gravity is aft of the main gear and when the airplane gets off heading, the center of gravity moves toward the outside of the turn, tending to increase rather than decrease the rate of turn.

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Equipment and Systems

The various types of equipment and systems such as the fuel, oil, hydraulic, and other systems are described in detail in separate sections of this manual. Specific and complete practical understanding of these systems is imperative for the pilot because of the emergencies which arise in combat operations.

Armament

Protective armor plate and guns are provided at crew stations as shown in the accompanying illustrations.

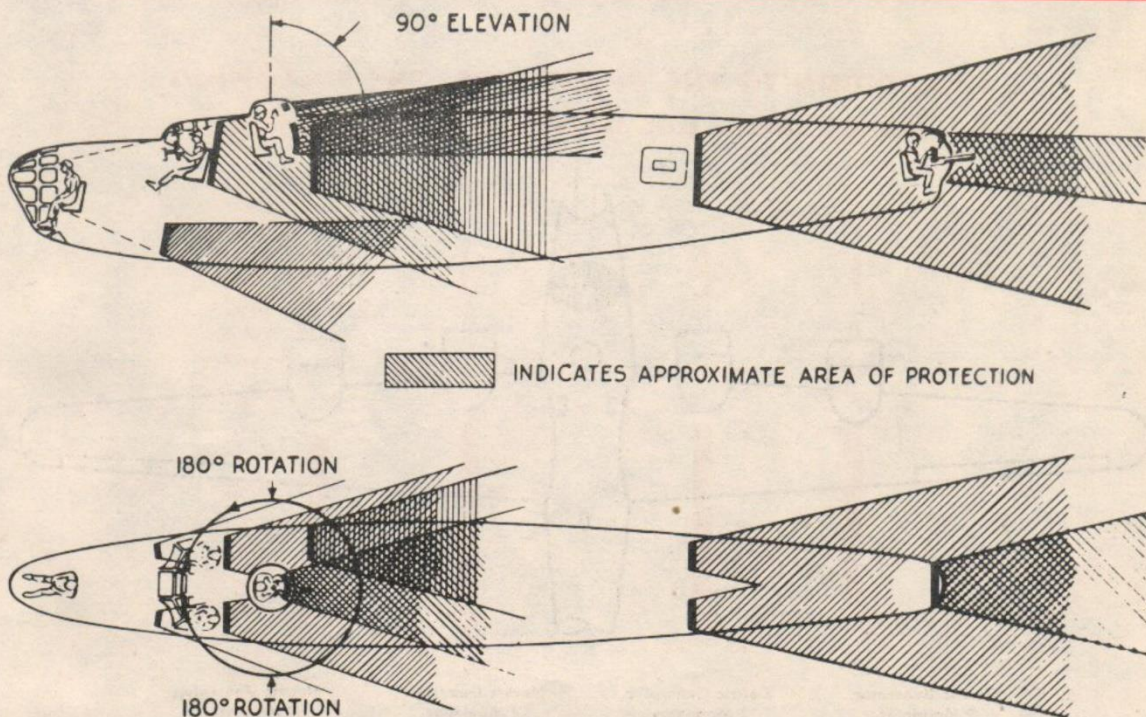
Davis Wing

The B-24 wing is an internally braced, skin-stressed type, tapered, with a high aspect ratio. It is considered one of the most efficient airfoils ever developed and was a radical departure from airfoils in use when the Liberator was designed. Its unusual efficiency accounts

for the combination of high speed, long range and great load-carrying qualities of the airplane. Flaps greatly vary the lift-drag characteristics of the wing, as is evidenced by the fact that normal takeoffs are made with 20° of flaps, that maximum lift and stability at slow cruising speeds can be obtained with 5° to 9° of flaps, and that 10°, 20°, and 40° of flaps effect successively larger reductions in stalling speeds.

Propellers

The 3-bladed propellers are Hamilton-Standard, hydromatic, full-feathering, controllable pitch, constant-speed. Toggle switches on the pilot's pedestal electrically control the governors which maintain the constant-speed feature. To operate the B-24 safely it is imperative that pilots fully understand the principle of the constant-speed propeller, its relationship to engine pressures (manifold pressure and brake mean effective pressure) and know when and when not to use the feathering feature.



Armament and Angles of Armor Protection Diagram B-24D

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APPENDIX B - B-24 PILOT TRAINING

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Ignition

Engine ignition is provided by 2 American Bosch magnetos, mounted on the rear section of each engine. Separate switches permit either one or both magnetos to be operated on the engine. Battery switches are on the copilot's auxiliary switch panel. A master switch bar located just above the magneto switches is available for simultaneously shorting the primaries of all magnetos and for opening the battery circuit of the main electrical system.

Cowl Flaps

Engine cooling is regulated by means of adjustable cowl flaps which are controlled electrically from the pilot's pedestal. The range of cowl flap control is from closed to $12\frac{1}{4}^{\circ}$ to 30° open, depending on the model airplane.

Carburetors

On No. 42-41115 and subsequent aircraft the Bendix Stromberg carburetor is replaced by the Chandler Evans Co. (Ceco) carburetor.

Engines

The B-24 is equipped with 4 Pratt & Whitney 14-cylinder, twin-row radial, air-cooled engines with internal single-stage, single-speed, engine-driven integral superchargers. Engines are rated to produce up to a total of 4800 horsepower using Grade 100 fuel and takeoff power settings.

Each of the 4 engines is equipped with a turbo-supercharger to furnish compressed air to the fuel induction system at sea-level pressure.

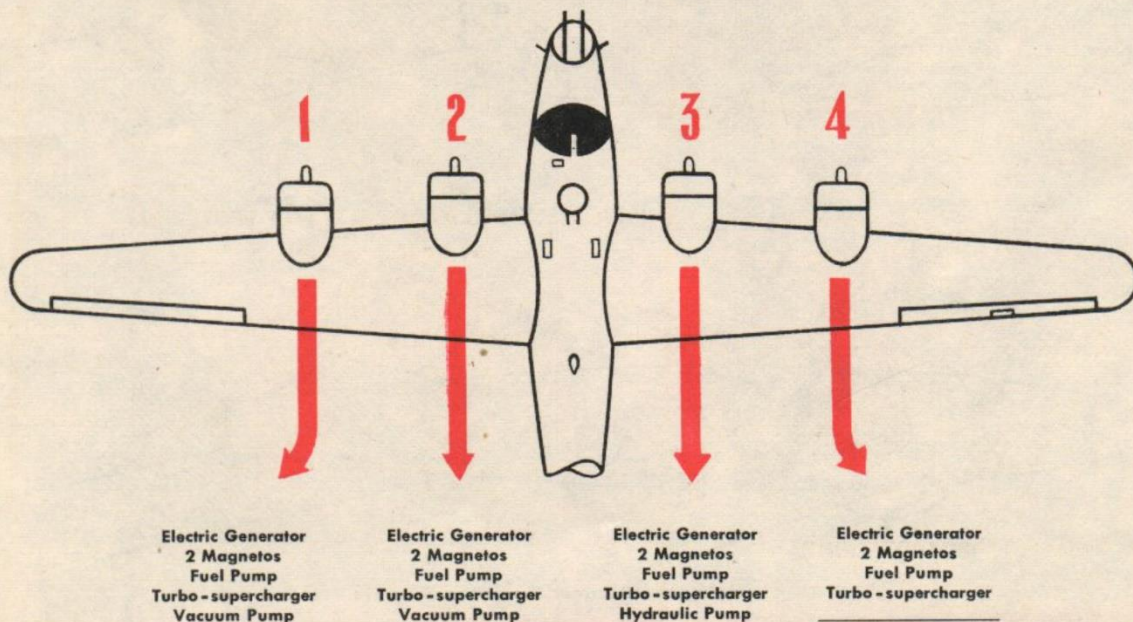
Control Surfaces

Rudders, elevators and ailerons are equipped with trim tabs (except left aileron) and are fabric covered; all other surfaces are metal covered.

Wing Flaps

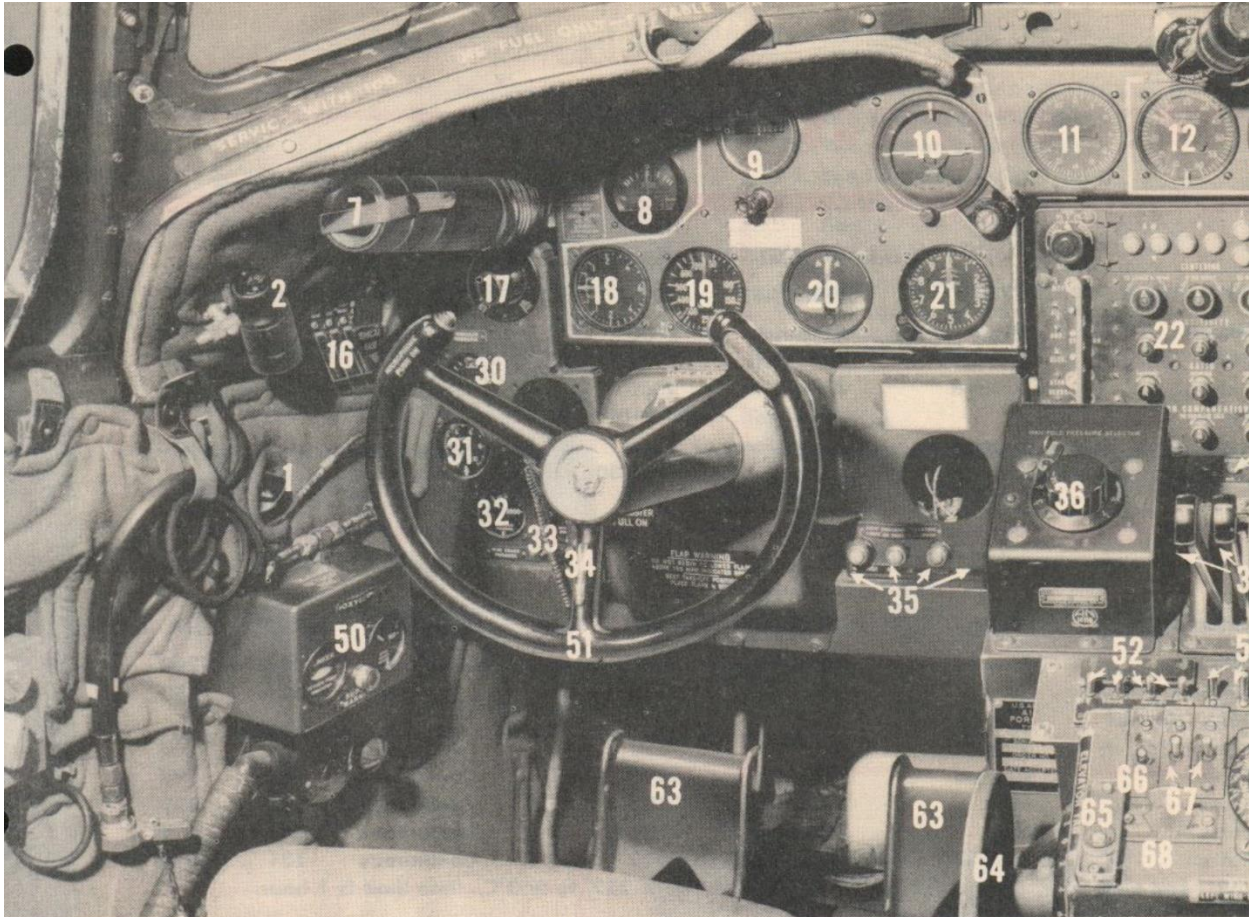
The all-metal, Fowler-type wing flaps retract into the wing center section trailing edge wells. Maximum down travel is 40° .

IN ADDITION TO THE PROPELLERS, THE FOLLOWING MAJOR UNITS ARE DRIVEN BY THE ENGINES



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APPENDIX B - B-24 PILOT TRAINING

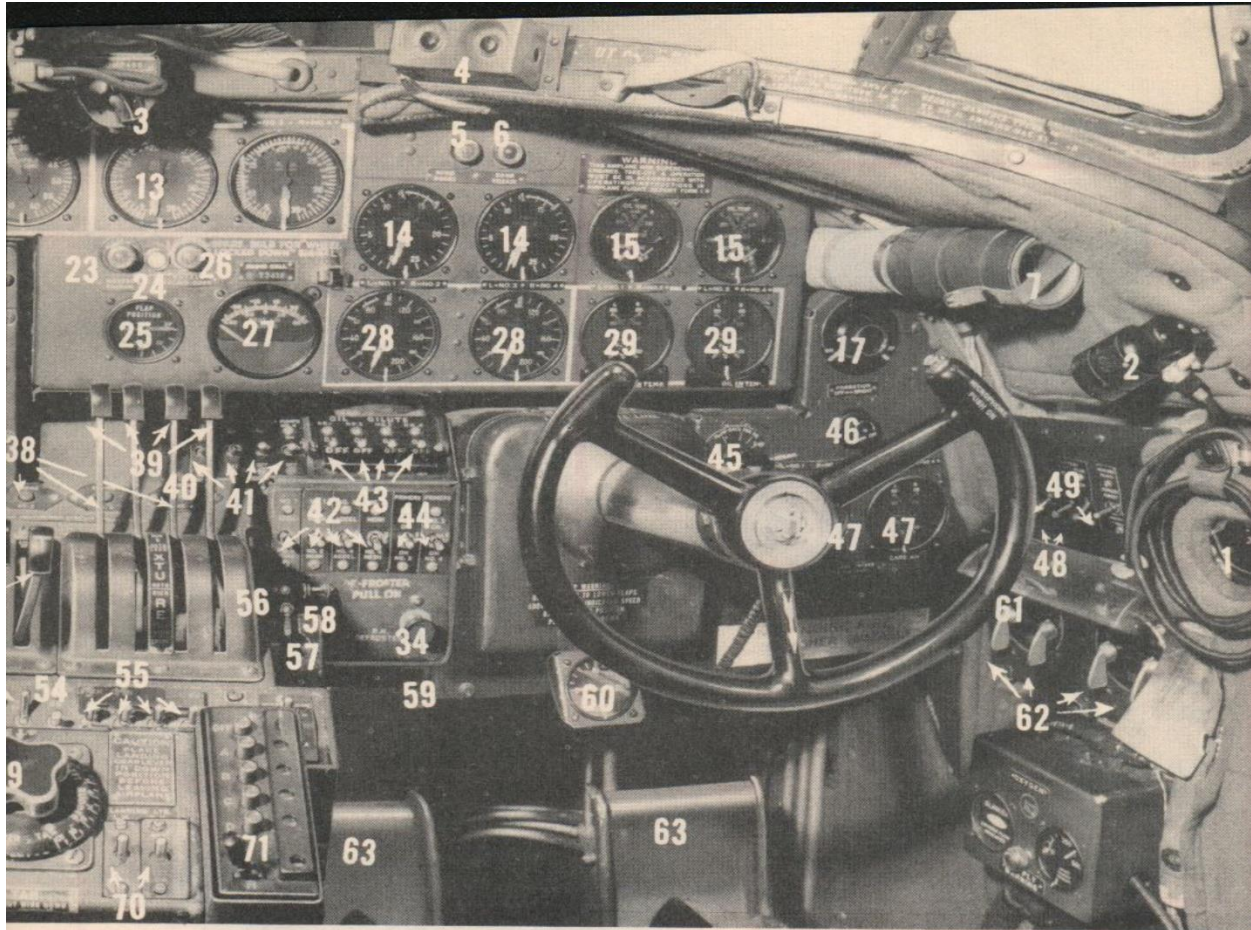


Cockpit of the Liberator... B-24

- | | |
|------------------------------------|--|
| 1. Fluorescent Light Switches | 19. Airspeed Indicator |
| 2. 24 Volt DC Fluorescent Light | 20. Turn and Bank Indicator |
| 3. Magnetic Compass Light Rheostat | 21. Altimeter |
| 4. IFF Radio Destroyer Switch | 22. C-1 Automatic Pilot |
| 5. Bomb Doors Indicator | 23. Marker Beacon Indicator |
| 6. Bomb Release Indicator | 24. Landing Gear Indicator Test Button |
| 7. Defroster Ducts | 25. Flap Position Indicator |
| 8. Pilot Director Indicator | 26. Landing Gear Indicator |
| 9. Directional Gyro | 27. Free Air Temperature Gage |
| 10. Gyro Horizon | 28. Oil Pressure Gages |
| 11. Radio Compass Indicator | 29. Oil Temperature Gages |
| 12. Manifold Pressure Gages | 30. Hydraulic Pressure Gages |
| 13. Tachometers | 31. Suction Gage |
| 14. Fuel Pressure Gages | 32. Inboard Brake Pressure Gage |
| 15. Cylinder Temperature Gages | 33. Outboard Brake Pressure Gage |
| 16. Chemical Release Switches | 34. Defroster Controls |
| 17. Ventilators | 35. Propeller Governor Limit Lights |
| 18. Rate-of-climb Indicator | 36. Turbo Boost Selector |

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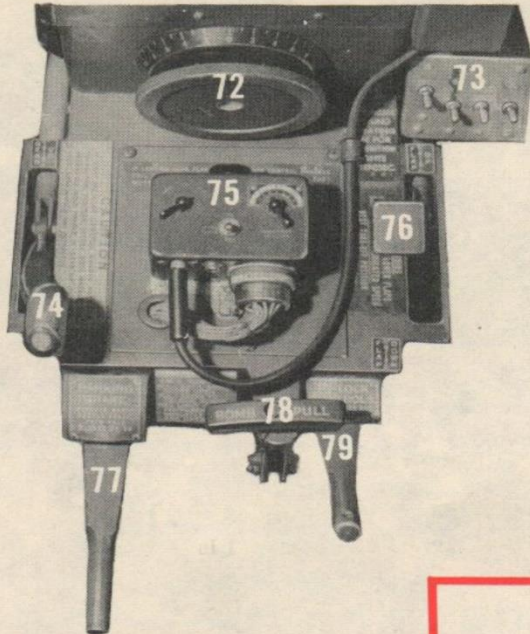


LOT'S INSTRUMENTS AND CONTROLS

- | | |
|---|-----------------------------------|
| 37. Throttles | 55. Cowl Flap Switches |
| 38. Propeller Feathering Circuit Breakers | 56. SCR 535 Power Switch |
| 39. Mixture Controls | 57. Throttle Friction Lock |
| 40. Bomb Bay Fuel Transfer Switch | 58. SCR 535 Emergency Switch |
| 41. Booster Pump Switches | 59. De-icer Control |
| 42. Engine Starter Switches | 60. De-icer Pressure Gage |
| 43. Oil Dilution Switches | 61. Emergency Ignition Switch Bar |
| 44. Primer Switches | 62. Ignition Switches |
| 45. Anti-icer Control | 63. Brake Pedals |
| 46. Formation Lights Rheostat | 64. Elevator Tab Control Wheel |
| 47. Carburetor Air Temperature Gages | 65. Alarm Button |
| 48. Main Storage Battery Switches | 66. Passing Light Switch |
| 49. Heater and Defroster Switches | 67. Navigation Light Switches |
| 50. Oxygen Panels | 68. A C Inverter Switch |
| 51. Pilot's Wheel | 69. Rudder Tab Control Knob |
| 52. Propeller Switches | 70. Landing Light Switches |
| 53. Intercooler Shutter Switches | 71. SCR 522 Control Box |
| 54. Pitot Heater Switch | |

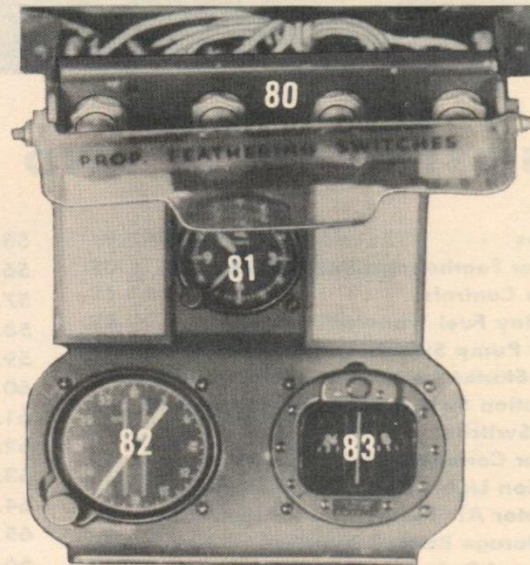
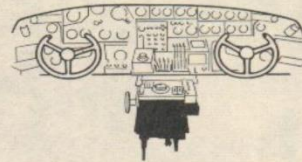
APPENDIX B - B-24 PILOT TRAINING

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- 72. Aileron Tab Control Wheel
- 73. Recognition Light Switches
- 74. Landing Gear Control Lever
- 75. Command Radio Transmitter Control Box
- 76. Wing Flap Control Lever
- 77. Parking Brake Handle
- 78. Emergency Bomb Release Handle
- 79. Controls Lock Handle

← **BASE OF
CONTROL PEDESTAL**



- 80. Propeller Feathering Switches
- 81. Clock
- 82. Remote Indicating Compass
- 83. Magnetic Compass

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THE CHECKLIST

No pilot (in his right mind) neglects the checklist in a 4-engine airplane. Your mission, your airplane and your crew are too important for half-measures. No pilot can ignore the checklist on flight after flight without getting into serious trouble. A big-shot attitude toward the checklist is risky and sets a bad example for your copilot and your crew. To old-time B-24 pilots, who have been through the mill, the checklist is as vital a piece of equipment as the rudders or the flaps.

Approved Checklist Technique

Develop a professional teamwork technique in using the checklist so that you and your copilot are double-checking each other all the time. Require complete cooperation from your copilot and engineer. Sloppy crew work is usually a direct reflection of the attitude of the airplane commander. Following is approved checklist technique:

1. Pilot calls, "Checklist!"
2. Copilot picks up the checklist and holds it throughout the procedure.
3. Copilot calls out each checklist item in

sequence, in a loud, clear voice, and indexes the list with thumb or finger to be sure nothing is omitted.

4. Pilot, copilot or engineer makes a positive check of the item when it is called out and calls back the answer.

Caution

Never start on the next checklist point until the preceding one is completed, or the result will be confusion and omissions. **Believe and practice this.** Don't wait for bitter experience to prove it. Never say "Okay" without checking. Sloppy use of the checklist is responsible for more emergencies than almost any other form of pilot error.

Snap Into It

Get some snap into the checklist procedures. Alert, professional cockpit work with items called off and answered in clear, ringing tones will lift the spirits of your crew and get them on the ball just as a good quarterback's signals bring his team to life.

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AAF OFFICIAL CHECKLIST

B-24 D, E, G, H & J

AFTER TAKEOFF

- 1. Wheels—Up (Brakes applied)
- 2. Superchargers—Set for climb
- 3. Throttles—Set for climb
- 4. Props—2550 rpm
- 5. Wing flaps—Up
- 6. Booster pumps—Off
- 7. Cowl flaps—As required

BEFORE LANDING

- 1. Altimeter setting—Checked
- * 2. Crew to stations (Nose clear)
- * 3. Auxiliary hydraulic pump—On
- * 4. Brake press. and parking brake—Check and off
- 5. Autopilot—Off
- * 6. Gear handle—Down
- * 7. Mixtures—Auto-rich
- * 8. Props—2400 rpm
- 9. Intercoolers—Open
- * 10. Cowl flaps—As required
- * 11. Booster pumps—On
- 12. Wing de-icers—Off
- * 13. Wheels—Checked, light on, handle neutral
- 14. Ball turret and trailing ant.—Retracted
- 15. Wing flaps—10°

FINAL APPROACH

- 1. Props—High rpm

- 2. Superchargers—Set and locked
- 3. Wing flaps—40°
- 4. Airspeed—Call out.

RUNNING TAKEOFF

- 1. Wing flaps—20°
- 2. Trim tabs—Set for takeoff

GO-AROUND

- 1. Power—Applied
- 2. Airspeed—Check
- 3. Wing flaps—20°
- 4. Wheels—Up

END OF LANDING ROLL

- 1. Superchargers—Off
- 2. Booster pumps—Off
- 3. Generators—Off
- 4. Wing flaps—Up
- 5. Cowl flaps—Open
- 6. Aux. power unit—As required
- 7. Brake pressure—Check

TO SECURE AIRPLANE

- 1. Engines—Stopped
- 2. Switches—Off
- 3. Wheel chocks—In place
- 4. Gear handle—Down
- 5. Flight controls—Locked

*Items with asterisk for subsequent landings.

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AAF OFFICIAL CHECKLIST

B-24 D, E, G, H & J

BEFORE STARTING ENGINES

- 1. Form 1A—Checked
- 2. Loading—Checked
- 3. Wheel chocks—In place
- 4. Pitot covers—Removed
- 5. Gas tank caps—Checked
- 6. Flight controls—Checked
- 7. Fuel tank valves and amount—Checked
- 8. Generators—Off
- 9. Carburetor air filters—As required
- 10. Main line and batt. selectors—On
- 11. Auxiliary power unit and hyd. pump—On
- 12. Brake press. and parking brake—Checked and On
- 13. Gyros—Uncaged
- 14. Autopilot—Off
- 15. Superchargers—Off
- 16. Props—High rpm
- 17. AC power switch—On
- 18. Intercoolers—Open
- 19. Pitot heater—Checked
- 20. Cowl flaps—Open
- 21. Mixtures—Idle cut-off
- 22. Wing flaps—Up
- 23. Wing de-icers; prop and carb. anti-icers—Off

START ENGINES

- 1. Call clear, fire guard—Posted
- 2. Ignition switches—On

- 3. Throttles—Cracked
- 4. Booster pump—On
- 5. Start engines—Check oil pressure
- 6. Flight indicator—Check righting

BEFORE TAXIING

- 1. All instruments—Checked
- 2. Vacuum—Check (Both)
- 3. Radio, altimeter and time—Checked
- 4. Alarm bell—Checked
- 5. Wheel chocks—Removed

BEFORE TAKEOFF

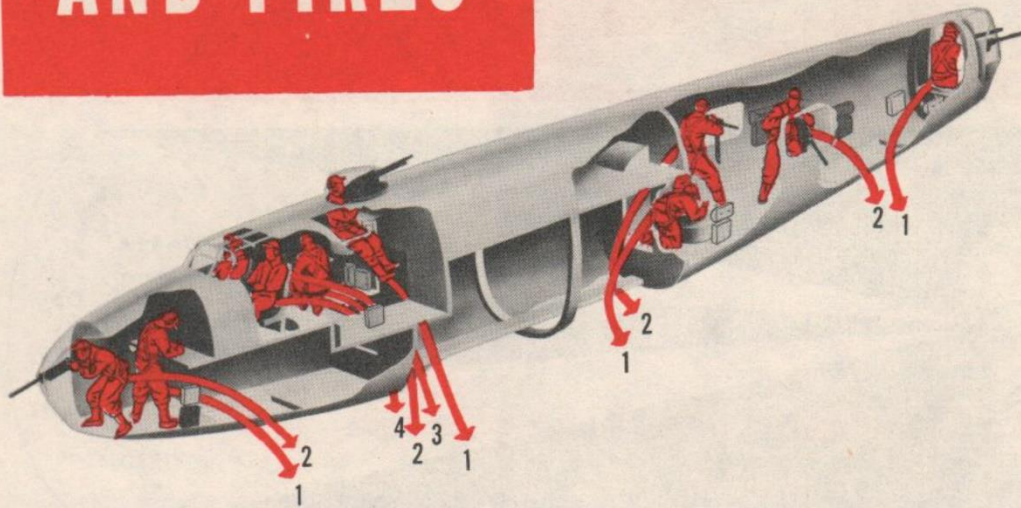
- * 1. Trim tabs—Set for takeoff
- * 2. Mixtures—Auto-rich
- 3. Exercise props, supercharger and flaps
- 4. Props—High rpm
- 5. Run up engines
- * 6. Superchargers—Set and locked
- * 7. Gyros—Set and uncaged
- * 8. Wing flaps—20°
- * 9. Flight controls—Checked
- *10. Doors and hatches—Closed
- *11. Aux. hyd. pump and power unit—Off
- *12. Generators—As required
- *13. Cowl flaps—Trail
- *14. Booster pumps—On

*Items with asterisk for subsequent takeoff.

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BAILOUT DITCHING AND FIRES



BAILING OUT OF THE B-24

It is the responsibility of the airplane commander to make certain on every flight:

1. That a parachute is available and satisfactorily fitted for each person making the flight.
2. That the parachute is conveniently located at the normal position of the person making the flight and that he knows its location, how to put it on, how and where to leave the airplane, how to open the chute and how to land and collapse the chute. (See P.I.F.)

3. That a life vest is worn under the chute harness on all over-water flights and that the crew knows the location, how to attach and how to use the individual seat-type dinghy.

4. That all persons aboard know the bailout signals and the bailout procedure to be followed.

The easiest and most effective way to carry out this responsibility is to appoint a parachute officer (usually the engineer) who will make a special study of equipment, its use, approved bailout signals, and the proper method of leaving the aircraft. He will assist in conducting bailout drill once each week on the ground until the entire crew is proficient, and as often thereafter as necessary to keep the crew conscious of the proper care and wearing of equipment.

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Such drill only takes a few minutes at the conclusion of a practice mission.

When to Bail Out

In all cases it is the positive responsibility of the airplane commander to decide when a bail-out emergency exists. Never shirk your responsibility by putting it up to the crew. In case of fire, fuel exhaustion, midair collision, weather which makes a landing dangerous, or other hazardous circumstances only you, the airplane commander, can judge the extent of the danger and whether or not the crew should bail out.

Radio Your Position

The instant you suspect an emergency is developing, get your position from the navigator and have the radio operator broadcast your position and your difficulty. This may save hours or even days for rescue parties searching for you.

Bailout Signals

(Check to be sure all crew members can hear the alarm bell in flight.)

Prepare to Bail Out: Three short rings on the alarm bell. Also warn the crew by interphone and obtain acknowledgment from each crew member.

Bail Out of the Airplane: One long sustained ring.

Don't Bail Out: If you have given the signal "Prepare to bail out," don't hit the bell again or the boys will all leave. If you want to call off the emergency, send the engineer to do it or notify crew members by interphone. Where pilots have used a series of short rings to call off the emergency, half the crew have in some cases hit the silk. Then you have to send people to look for them.

Bailout Procedure

1. At the signal "Prepare to bail out," all the crew will acknowledge by interphone and make immediate preparations to leave the ship, checking parachute snaps and attaching the quick attachable-type chute if so equipped.

2. Pilot or bombardier (at pilot's direction) will open the bomb bay doors and jettison bombs to provide clearance for jumping; navi-



Leaving
Through The
Bomb Bay



Leaving
Through The
Nosewheel
Hatch

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APPENDIX B - B-24 PILOT TRAINING

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Leaving
Through
Belly Hatch



Legs Together
And Straight
When Clear
Of The Ship



gator will open the nosewheel hatch by pulling down on the 2 red handles at Station 1.0 on the cross-member under navigator's table; tail gunner opens belly hatch. These are the 3 best bailout exits.

3. Crew should check each other's equipment to be sure it is properly fastened and attached.

4. Pilot slows airplane down to 150 mph (to 140 mph with 20° of flaps) before giving bailout signal.

5. Order and method of leaving the airplane:

a. Navigator and bombardier (nose turret gunner) leaves through the nosewheel hatch one after the other, facing front of ship, crouching near opening with hands on each side and lunging headfirst and forward;

b. Tail gunner leaves from the belly hatch, followed by left waist gunner, by crouching facing the front of the airplane, and lunging headfirst and forward through the hatch.

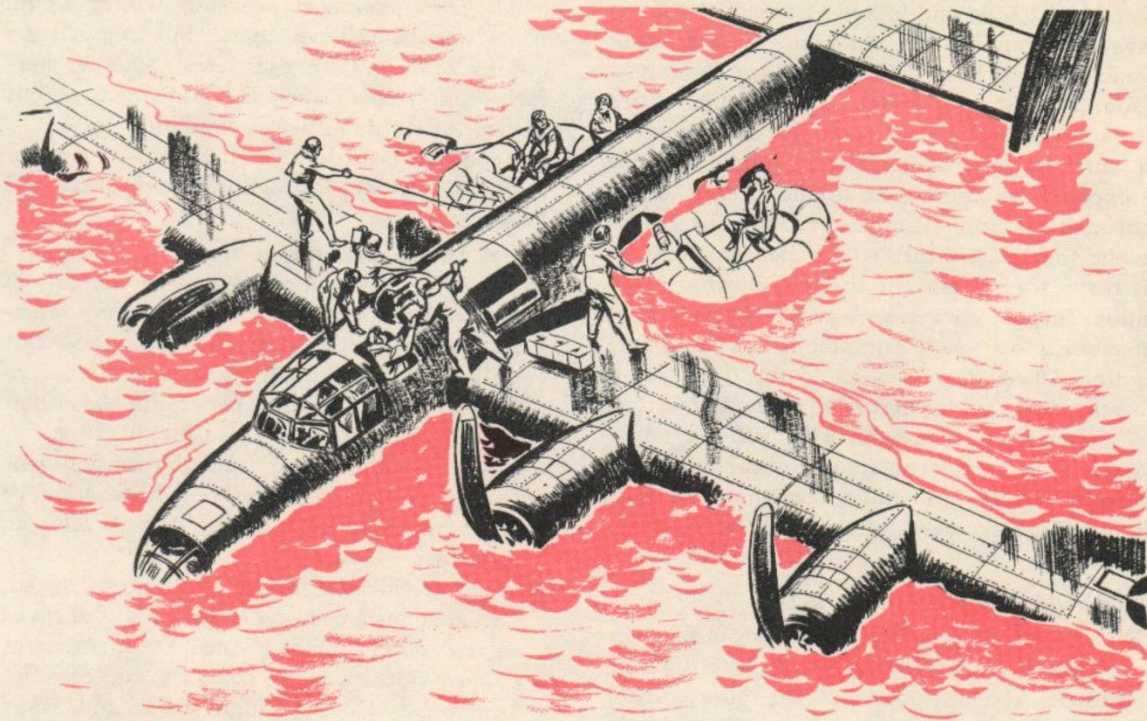
c. Ball turret gunner and right waist gunner leave through rear bomb bay; flight engineer, radio operator, copilot and pilot also leave in that order through the bomb bays, crouching on the catwalk facing the front of the airplane and lunging headfirst and as much forward as possible.

Warning: It is extremely important in all cases to face the front of a B-24 and lunge out and forward headfirst. The airplane is traveling fast and if you jump toward the rear there is danger of being slapped up against the airplane. If you jump feet first, the wind can catch your legs and bang your head on the edge of the hatch. If the airplane is in a turn or a spin, lunge toward the inside.

6. Don't pull the ripcord until you have straightened your legs and are well clear of the airplane. See P.I.F. for excellent instructions on how to fall and how to land under various circumstances.

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DITCHING THE B-24

The best procedure for ditching any airplane is to conduct your flight in such a way that ditching is not necessary. Repeated ditchings have occurred because of improper fuel procedure and improper use of boost, rpm, lack of understanding of anti-icing and de-icing equipment, poor navigation, and improper technique for 3 and 2-engine operation.

Remember, if you aren't maintaining altitude on 3 or 2 engines, lighten your load:

1. Jettison the bomb load.
2. Jettison guns and ammunition if not in danger of attack.
3. Jettison camera and all equipment not necessary for navigation or for survival on the sea.

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If possible, be ready to ditch before you get below 1000 feet. But don't give up flying the airplane if you have sufficient fuel. When your load is lightened, you still may be able to keep 'er in the air with smooth flying and proper control. If you can hold it, a few hundred feet is as good an altitude as 10,000 feet. As you use up fuel, it will become easier to hold your altitude and you may even be able to climb.

Enemy fire, weather or other circumstances may force you to ditch. That's when advance planning and drill are life savers. A margin of 30 seconds may mean the difference between life and death for some of your crew. At the order "Prepare for ditching" each crew member must know his specific duties so well that in the emergency he will perform them almost automatically.

Ditching Officer and Drill

Designate one member of the crew (usually the copilot) as ditching officer. Require him to brief your crew (including yourself) on the prob-

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lems of ditching and to keep track of the latest available information. At least once a week conduct a ditching drill as you are coming in from a practice mission. Require the entire crew to take ditching positions and simulate a ditching operation. After propellers are stopped have them exit in the correct order through the proper hatches with all the equipment (except life rafts) that they would have if there was water out there. Time the operation. Inspect crew members with your ditching officer to see if equipment has been forgotten. Check the crew as to the duties they would have performed and their knowledge of the use of equipment. This will pay dividends if you ever run into the real thing. All members of the crew must wear their life vests at all times on over-water flights and understand their use.

Ditching Procedure for the B-24

The moment a ditching emergency arises the pilot gives the signal for crew to take ditching positions, the altitude, and the approximate number of minutes before impact. This should be acknowledged by the crew in this order: copilot, navigator, bombardier, nose gunner*, flight engineer, radio operator, right waist gunner, left waist gunner, belly gunner, and tail gunner, with the words, "Copilot ditching, navigator ditching," etc.

*Ten-man crew would have only one waist gunner if it has a nose gunner. All positions are mentioned as a guide. Each airplane commander will have to adapt procedures to his particular needs and equipment.

Alarm Bell Ditching Signals:

1. Crew to ditching positions—6 short rings.
2. Brace for ditching—1 long ring just before impact.

Procedure

Immediately, all crew members should loosen shirt collars and remove oxygen masks unless above 12,000 feet, in which case oxygen continues to be used until notification by the pilot.

All crew members wearing winter flying boots should remove them, but remove no other clothing. Then each crew member performs his specific duties. Have life vests on but do not inflate them before landing.

Upon specific order from the pilot, crew members will remove parachutes and parachute harnesses.

Duties Before Landing on Water

Pilot: After giving the warning he remains in the normal flight position for ditching. Fastens safety belt and shoulder harness but unfastens parachute straps. Shortly before impact, he gives a long ring on the alarm bell to notify the crew to brace for ditching.

Copilot: Remains in normal flight position. Unfastens parachute straps and fastens safety belt and shoulder harness. Assists pilot as necessary.

Navigator: Calculates position, course, speed, and estimated position of ditching and gives information to radio operator. Destroys secret papers. Gathers maps, compass, and celestial equipment. Goes to flight deck and takes ditching position.

Bombardier: Jettisons bombs and closes bomb doors. Destroys bombsight. Goes to rear compartment, checks position of others and takes ditching position.

Nose Gunner: Jettisons ammunition, locks nose turret in forward position, and goes to ditching position.

Flight Engineer: Turns guns aft. Shoots out or jettisons ammunition. Avoid getting shell cases jammed in the bomb doors. Opens and removes top hatch and jettisons it and loose equipment through the bomb bay and checks it closed. Closes floor door and rear door to flight deck after navigator comes up. Takes up emergency ration box, attaching rope to arm, and takes ditching position.

Radio Operator: Turns IFF to distress, switches on liaison transmitter (turned to MF DF frequency) sends SOS, position, and call sign continuously. On order from the pilot he clamps down key, hinges up radio table and takes ditching position after attaching rope of emergency radio equipment to his arm (if radio is located on flight deck).

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Left Waist Gunner: Opens left waist window and leaves it open, jettisons left waist gun, ammunition and all loose equipment, preferably through the belly hatch to avoid damaging tail surfaces. Gets emergency ration box and attaches rope to arm. Takes ditching position.

Right Waist Gunner: Opens right waist window and leaves it open. Jettisons right waist gun, ammunition and loose equipment, preferably through the belly hatch to avoid damaging tail surfaces. Secures water or supplies, goes to ditching position and remains on interphone.

Belly Gunner: Retracts ball turret and jettisons ammunition, preferably through belly hatch if time permits. Takes ditching position.

Tail Gunner: Lines up turret directly aft and locks. Comes out of tail, helps jettison ammunition and check belly hatch firmly closed, secures emergency radio rope to arm (if stored in rear compartment). Takes up ditching position.



Warning: If time permits, waist windows should be removed and jettisoned through the belly hatch to avoid danger of their closing and jamming shut on impact. It is most important that all bottom hatches be closed and that the top hatch and waist windows be open.

Ditching Positions

It is difficult to specify exact ditching positions for each crew member because location and type of equipment will vary. Ditching officer should study recommended positions and check them during drill. There are 3 suitable general locations: the flight deck, the rear compartment

forward of the waist windows, and the half deck. The half deck is one of the best ditching positions in the airplane and as many men as possible should lie there with feet braced forward, protected with coats and cushions against sharp edges. This relieves some of the strain from the ditching belt and the men on the half deck could aid others if injured by water or carried back onto tail.

Lying down with feet braced forward is the best position for bracing. If in a sitting position with back braced against a solid surface, head should be clasped in hands to hold it against the snap of impact.

The dangers from a hard landing are that the top turret can be torn loose, and if bomb bay doors are caved inward, water may fracture No. 6 bulkhead and flood the rear compartment.

Definite position assignments should be made after consultation between the airplane commander and the ditching officer. Usually those on the flight deck will include pilot, copilot, radio operator, engineer, and navigator. Those in the rear compartment or on the half deck usually will include bombardier, the 2 waist gunners (or waist gunner and nose gunner), belly gunner, and tail gunner.

Technique of Landing the Airplane

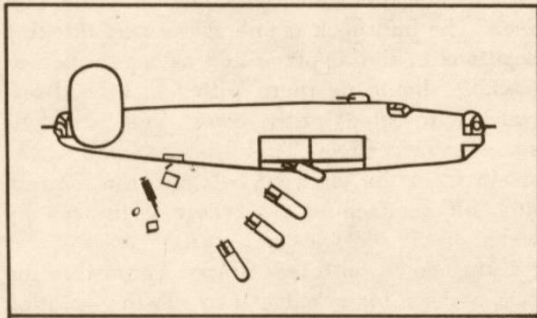
To properly land the airplane, it is necessary to know the direction and velocity of the wind and the character of the waves. Consult P.I.F. and your navigator concerning how to determine whether there is a calm sea, waves, or a ground swell and the direction and velocity of wind. When flying over water it is just as important to know these things as it is to know the nature of terrain during flights over land. Don't wait until you have to ditch to try to learn them. On over-water flights, require the navigator to supply this information (where possible) along with position reports.

In Any Sea

In the B-24 airplane in particular, it is of the utmost importance to avoid a high rate of sink. That's one of the reasons for jettisoning all the weight possible before impact. Get the airplane slowed down before you start your glide and

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control sink with power if possible. It is better to glide with half flaps and bring full flaps down to slow the speed as you flare out above the water than to establish a high rate of sink that will bring the airplane crashing down onto the water. As much as possible, grease 'er onto the water just as you would grease a belly landing on concrete, even though this requires landing somewhat faster. Don't attempt to land tail-low, because this puts too much strain on Station 6. Don't drop it in or you will collapse the bomb bay doors and force water against bulkhead No. 6. The landing recommended above is based on combat experience.

Landing on a Calm Sea

If the surface is calm, without a definite wave formation, and white caps have not appeared, ditch upwind.

Landing on a Swell

If surface is spotted with white caps but foam is not yet being blown into spray, ditch along the top and parallel with swell.

Landing in High Waves

If foam is whipped into spray, wind velocity is too great to land crosswind. Ditch upwind on upslope of wave. This is the procedure for a high wind and heavy sea.

Caution: There may be more than one impact. Warn the crew to hold positions until the aircraft comes to rest.

Procedures After Landing

The airplane will remain afloat usually from

1 to 5 or 10 minutes. As soon as the airplane comes to rest, engineer will pull releases on the life rafts. Exits will be made as fast as possible with necessary equipment as follows:

Exits Through the Flight Deck Hatch: (Each man inflates life vest after clearing hatch.) Navigator first, receives emergency radio (if stored in radio compartment) from the radio operator and goes to left raft; radio operator second, after handing radio to navigator, goes to left raft; engineer third, receives ration box from copilot and goes to right raft; copilot fourth, after handing ration box to engineer, goes to right raft, takes command; pilot fifth, hands out water and other supplies and goes to left raft and takes command.

Exits From Rear Compartment: (Life vests should be inflated after individuals are clear of the waist windows so vests won't interfere with exit if hatches are under water. Right waist gunner (or nose gunner) first, through right waist window to right raft, carrying water or other supplies; belly gunner second, through right waist window to right raft; bombardier third, through right window to right raft; left waist gunner first, through left window to left raft, holding to ration-box rope; tail gunner second, through left waist window after throwing out radio (if in his charge) holding tightly to rope, to left raft.

Note: If time and circumstances permit, take out the frequency meter and be sure to keep it dry. By attaching antenna from the Gibson Girl emergency radio to frequency meter, it can be operated as an efficient receiver to provide 2-way communication for several hours.

The Time Element

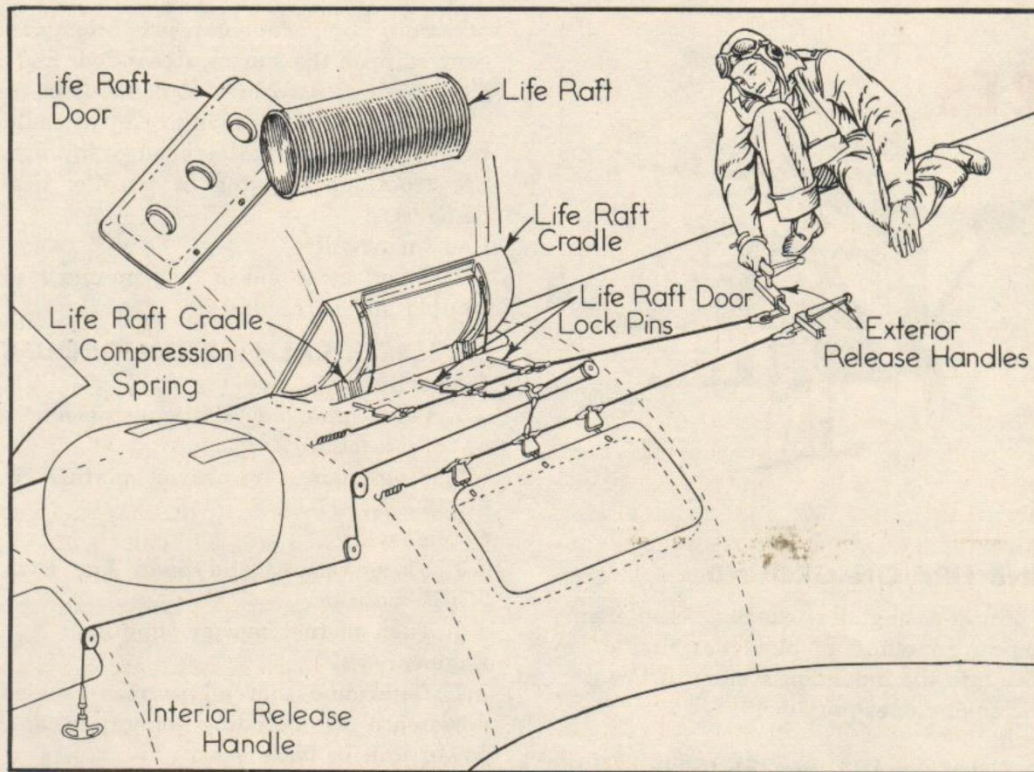
Speed is important, but so is procedure. Give first attention to injured persons. Don't leave necessary equipment behind or you will face starvation and have no means of signaling for help. Drill to get maximum teamwork.

Survival

Ditching officer should study P.I.F. and survival booklets and instruct crew so all will know how to make the most of life raft equipment, how to signal, and how to survive on the sea.

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LIFE RAFTS

Two type A-2 life rafts are carried in the fuselage above the wing between Stations 4.2 and 4.4. To release either raft from inside the airplane, pull the T handle located as follows: On aircraft up to and including 41-11938, handle is at the rear of the flight deck, left side; on 41-23640 and after, handle is just aft of the pilot's escape hatch. The pull cable releases the lock pins which hold the life raft doors closed and allows the spring bungee to throw the raft out, clear of the fuselage. A ripcord attached to the raft cradle automatically opens the valve which controls the raft inflation from the CO₂ bottle. To release either raft from outside the airplane, the lever flush in the fuselage aft of each door should be lifted and twisted 90°. This action pulls the same cable and releases the raft in the same manner as described above. Do not release rafts until airplane is at rest in the water.



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**DUTIES
AND RESPONSIBILITIES
of the
AIRPLANE COMMANDER**

Here's where they separate the men from the boys. You can be one of the best B-24 pilots ever trained and still fail as an airplane commander. In addition to qualifying yourself as a top-flight pilot, you have the job of building a fighting team that you can rely on in any emergency. Failure of any member of the crew to do the right thing at the right time may mean failure of your mission, unnecessary loss of life and possible loss of your airplane.

You Can't Pass the Buck

Your authority as airplane commander carries with it responsibility that you can not shirk. Your engineer is a trained specialist, but his training is incomplete. He knows how to transfer fuel, but does he know how to transfer it in the particular airplane you are flying? It isn't enough that he **thinks** so. You must **know** what he knows. It is up to you to perfect the basic training he has been given. An oversight

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of this kind cost a B-24 and 2 lives in the Pacific.

You are now flying a 10-man weapon. It is your airplane, and your crew. You are responsible for the safety and efficiency of the crew at all times—not just when you are flying, but for the full 24 hours of every day while you are in command.

Your crew is made up of specialists. Each man—whether he is the navigator, bombardier, engineer, radio operator, or one of the gunners—is an expert in his line. But how well he does his job, and how efficiently he plays his part as a member of your combat team, will depend to a great extent on how well you play your own part as the airplane commander.

Know Your Crew

Learn all you can about each member of your crew just as soon after he joins your outfit as possible. Where is his home? What is his education? Is he married? What jobs has he had? Where did he get his flight training? How does he like the idea of being assigned to a B-24?

Your job is to learn all you can about each crew member so you can evaluate his qualifications, initiative, proficiency and reliability.

Know His Personal Habits

It is no business of yours whether a crew member spends his free hours in prayer, gambling, or hunting turtle's eggs unless these habits interfere with the proper performance of his duty. Then his business is your business. You can't afford to see a mission jeopardized because a crew member doesn't get enough sleep, comes to duty with a hangover, starts on a high-altitude mission with gas-producing food in his stomach, or is so distracted by worry that he cannot concentrate on the task at hand.

See that your men are properly quartered, clothed, and fed. There will be many times, when your airplane and crew are away from the home base, when you may even have to carry your interest to the extent of financing them yourself. Remember always that you are the commanding officer of a miniature army—a specialized army; and that morale is one of the biggest problems for the commander of any army, large or small.

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Crew Discipline

Your success as the airplane commander will depend in a large measure on the respect, confidence, and trust which the crew feels for you. It will depend also on how well you maintain crew discipline.

Your position commands obedience and respect. This does not mean that you have to be stiff-necked, overbearing, or aloof. Such characteristics certainly will defeat your purpose.

Be friendly, understanding, but firm. Know your job, and, by the way you perform your duties daily, impress upon the crew that you do know your job. Keep close to your men, and let them realize that their interests are uppermost in your mind. Make fair decisions, after due consideration of all the facts involved; but make them in such a way as to impress upon your crew that your decisions are made to stick.

Crew discipline is vitally important, but it need not be as difficult a problem as it sounds. Good discipline in an air crew breeds comradeship and high morale. And the combination is unbeatable.

You can be a good CO and still be a regular guy. You can command respect from your men, and still be one of them.

"To associate discipline with informality, comradeship, a leveling of rank, and at times a shift in actual command away from the leader, may seem paradoxical," says a former combat group commander. "Certainly, it isn't down the military groove. But it is discipline just the same—and the kind of discipline that brings success in the air."

Crew Training

Train your crew as a team. Keep abreast of their training. It won't be possible for you to follow each man's courses of instruction, but you can keep a close check on his record and progress.

Get to know each man's duties and problems. Know his job, and try to devise ways and means of helping him to perform it more efficiently.

Each crew member naturally feels great pride in the importance of his particular specialty. You can help him to develop this pride

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to include the manner in which he performs that duty. To do that you must possess and maintain a very thorough knowledge of each man's job and the problems he has to deal with in the performance of his duties.

Are You Ready to Fight?

Are your guns working? The only way you can be sure is to know how competent and reliable your gunners are. It is uncomfortable to get caught by a swarm of enemy fighters and find that your guns won't function.

What about your navigator? You can't do his job for him throughout training in the states and expect him to guide you safely over a thousand miles of water to a speck on the map. Remember that there aren't any check points in the ocean and you have to rely on your navigator.

Your bombs miss the target. Long hours of flying wasted . . . why? It may be because the bombsight gyro was not turned on long enough in advance or because the bombsight was not kept warm by means of the heater so that when the bombardier put his warm face to the eyepiece, it fogged up and was unusable. Who is at fault? The bombardier is, of course, primarily to blame, but in the background there is usually lack of leadership, guidance and inspiration. No crew is ever any more on the ball than its airplane commander.

Practical Questions

1. Are you the airplane commander, qualifying yourself to do justice to your crew?
2. Can all of your crew fly at high altitudes without discomfort or physical handicap?
3. Does anyone in your crew get airsick?
4. Are the turret gunners too big for their turrets?
5. Can the copilot take over in emergency?
6. Does the radio operator understand DF aids?
7. Do the gunners know how to unload and stow their guns?
8. Do the engineer and the copilot (and do you) know how to use the load adjuster and how to load the airplane properly?
9. Do the engineer and copilot (and you) use

the control charts on every flight to check your knowledge of power settings and the efficient performance of your airplane?

10. Does your crew know emergency procedures and signals?

11. Is each member of your crew properly equipped?

12. What can you do to prevent or relieve anoxia, air sickness, fatigue?

13. Who is qualified to render first aid?

14. How's the morale of your outfit? Are they eager or do they sluff off?

15. How will your crew react in emergency?

These are just a few of the practical questions you as airplane commander must be able to answer to your own satisfaction.

RULES TO BE ENFORCED ON EVERY FLIGHT BY THE AIRPLANE COMMANDER

1. Smoking

- a. No smoking in airplane at an altitude of less than 1000 feet.
- b. No smoking during fuel transfer.
- c. Never carry lighted cigarette through bomb bays.
- d. Never attempt to throw a lighted cigarette from the airplane. Put it out first.

2. Parachutes

- a. All persons aboard will wear parachute harness at all times from takeoff to landing.
- b. Each person aboard will have a parachute on every flight.

3. Propellers

- a. No person will walk through propellers at any time whether they are turning or not.
- b. No person will leave the airplane when propellers are turning unless personally ordered to do so by the airplane commander.

4. Oxygen Masks

- a. Oxygen masks will be carried on all day flights where altitude may exceed 10,000 feet

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APPENDIX B - B-24 PILOT TRAINING

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and on all night flights, regardless of altitude.

b. Day: All persons will use oxygen starting at 7000 to 10,000 feet on all day flights where altitude at any time will exceed 10,000 feet.

c. Night: All persons will use oxygen from the ground up on all flights during which altitude may exceed 10,000 feet.

5. Training

a. Tell your crew the purpose of each mission and what you expect each to accomplish.

b. Keep the crew busy throughout the flight. Get position reports from the navigator; send them out through the radio operator. Put the engineer to work in the cruise control and maximum range charts. Require the copilot to keep a record of engine performance. Give them a workout. Encourage them to use their skill. Let them sleep in their own bunks—not

in a B-24. A team is an active outfit. Make the most of every practice mission.

c. Practice all emergency procedures at least once a week; bailout, ditching and fire drill.

6. Inspections

a. Check your airplane with reference to the particular mission you are undertaking. **Check everything.**

b. Check your crew for equipment, preparedness and understanding.

7. Interphone

a. Keep the interphone chattering. Ask for immediate reports of aircraft, trains, and ships just as you would expect them in combat—with proper identification.

b. Require interphone reports every 15 minutes from all crew men when on oxygen.

SUGGESTED COMBAT CREW DUTY ASSIGNMENTS

PILOT

Principal duty : Airplane Commander
Secondary duty: Pilot
Added duty : Navigation Specialist

COPLOT

Principal duty : Assistant Airplane Commander
Secondary duty: Airplane Engineering Officer and Assistant Pilot
Added duty : Fire Officer
Added duty : Navigational Specialist
Added duty : Gunfire Control Officer

NAVIGATOR

Principal duty : Navigator
Secondary duty: Qualified as Nose Turret Gunner
Added duty : Assistant Bombardier
Added duty : Oxygen and Equipment Officer
Added duty : First Aid Specialist

BOMBARDIER

Principal duty : Bombardier
Secondary duty: Qualified as Nose Turret Gunner
Added duty : Airplane Armament Officer
Added duty : Ditching Officer
Added duty : Navigation Specialist

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APPENDIX B - B-24 PILOT TRAINING

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AERIAL ENGINEER

Principal duty : Aerial Engineer
Secondary duty: Top Turret Gunner
Added duty : Qualified for Copilot Duties
Added duty : Parachute Officer
Added duty : First Aid Specialist
Added duty : Assistant Radio Operator

RADIO OPERATOR

Principal duty : Radio Operator
Secondary duty: Waist Gunner
Added duty : Assistant Airplane Engineer
Added duty : First Aid Specialist
Added duty : Qualified as Top Turret Gunner

NOSE TURRET GUNNER

Principal duty : Nose Turret Gunner
Secondary duty: Turret Specialist
Added duty : Assistant to Armament Officer

BELLY TURRET GUNNER

Principal duty : Belly Turret Gunner
Secondary duty: Turret Specialist
Added duty : Assistant to Ditching Officer

TAIL TURRET GUNNER

Principal duty : Tail Turret Gunner
Secondary duty: Turret Specialist
Added duty : Assistant to Parachute Officer

Purpose of Assigning Added Duties

These assignments are not just so many titles. Each duty represents a specific job to be done. As airplane commander, you are **responsible** for everything but you can't **do** everything. These assignments, properly explained, will arouse the enthusiasm, energy and initiative of your crew. You have the right to demand that each crew member become an expert and maintain expert status in the particular duties assigned to him. There is nothing ironclad about the added duty assignments. These can be shifted around if there is a clear-cut advantage in doing so. For example, the suggested added

duty of the crew oxygen and equipment officer can be shifted from the navigator to the bombardier or to one of the other crew members if he is better qualified or indicates a greater interest in the problem. The main thing is to **spread** the duties, encourage the individual to become an expert and then require him to educate and supervise the rest of the crew regarding his particular specialty. Ask the crew member to read all he can and learn all he can about his specific duties; to be prepared to conduct and aid in inspections and drills, and to give the crew periodic instruction in his

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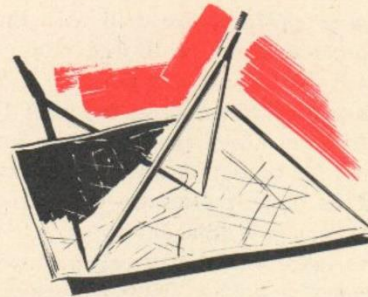
specialty. You, as airplane commander, are the sparkplug of this plan. You will assign duties, call drills, and give your specialists as much opportunity as possible to spread their knowledge. To aid you, here are definitions of some of the less understood added duties.

Definitions of Added Duties

Airplane Engineering Officer—It is the duty of this officer (almost always the copilot) to know more about the airplane than any member of the crew and to see that all other crew members are instructed in all procedures pertaining to the airplane. The engineering officer should be able, by judicious questioning, to size up a new flight engineer in a few minutes' time. He should be able to perform any of the flight engineer's duties. It is his job to see that all crew members are instructed in the proper methods of transferring fuel. He is charged with the duty of seeing that proper records of engine operations are kept from flight to flight so that faulty operation will be detected before it becomes serious. He should be intimately familiar with the cruise control, climb, and maximum range charts and should educate the engineer in their use.

Gunfire Control Officer—It has been found that the copilot is in the best position to serve as gunfire control officer. He has the best view of developing attacks, although he cannot possibly see all enemy fighters. Although he does not attempt to actively direct the fire from all guns, he does supervise the calling of attacks, maintains strict interphone discipline, and sees that the plan and procedure for controlling fire is strictly followed. He is responsible for seeing that the crew is properly indoctrinated in the use of the throat microphone and established practice-mission procedures which will simulate as nearly as possible the interphone conversations that would be necessary in combat. In the heat of battle, crew members tend to talk too fast, speak in too high a tone, or allow the microphone to be improperly placed. The gunfire control officer will develop the interphone proficiency to a point where absolute cooperation between gun stations can be maintained on interphone.

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Navigation Specialist—Individuals with this assignment should understand all aids to navigation, understand how the navigator's log is kept, and be able in emergency to ascertain the location of the airplane and help to bring it back to base. Obviously, these men cannot be fully qualified navigators, but should know everything possible about navigation procedures that may be of aid in case the navigator is incapacitated.

Oxygen and Equipment Officer—This job requires a detailed understanding of the equipment and its operation. This officer confers with the personal equipment officer of the squadron regarding the use of all equipment, precautions to be taken, proper fit and care, and sees that all crew members are properly instructed. He makes periodic inspections of the crew as directed by the pilot to see that oxygen equipment is properly fitted and used. He checks all crew members on the use of walk-around bottles and sees that correct procedures are followed on high-altitude missions.

First-Aid Specialist—This assignment should be given, as far as possible, to individuals who already have a good knowledge of first aid. However, there should be one specialist in the nose, one in the rear compartment and one on the flight deck. If individuals in these compartments are not familiar with first aid, pilot should see that they receive adequate instruction. Combat reports reveal that lack of knowledge of first aid has cost lives on combat missions.

Fire Officer—This officer, usually the copilot, should know the location of all fire-fighting apparatus and know specifically when and how to use it. He should instruct the entire crew on their exact duties in case of fires. He will

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arrange a program of fire drill with the pilot, aid in conducting the drill, and point out all mistakes. He will conduct a periodic inspection of the ship for fire hazards, see that the fire prevention rules are obeyed and be responsible to the pilot for proper precautions against fire.

Qualified as Turret Gunner—Crew members whose stations are adjacent to turrets should be able to take over the turret and operate it if emergency requires. Turret specialists instruct such crew members in the operation of the turret and use spare time in flight and on the ground to qualify such crew members as emergency turret gunners. Then they can give assistance in case of trouble with the turret or if the turret specialist is incapacitated.

Airplane Armament Officer—The armament officer must be familiar with all armament throughout the ship, the protection it provides and how it can best be used. In addition to his duties in connection with the loading, arming and dropping of bombs, he aids the pilot in enforcing the safety regulations regarding practice bombing, practice gunnery, and proper loading, unloading, and stowing of guns. In case of accidental discharge of a gun, he, with the gunner and pilot, will usually be considered at fault, on the ground that he has insufficiently instructed the gunner in procedures and precautions.

Ditching Officer—This officer will keep the pilot informed of all the latest ditching procedures by collecting and presenting to the pilot any information on this subject. He will arrange a schedule of ditching drills with the pilot, will aid in conducting them, and will inspect ditching positions and the removal of equipment from the airplane. He will see that crew members actually take ditching positions and he will continue to require drills until the crew is proficient.

Parachute Officer—This officer will see that each crew member has his own properly fitted parachute, that he knows how to use it, that he knows how and where to leave the ship

and how to open the chute and descend. (See P.I.F.) He will plan a drill schedule with the pilot and aid in parachute drill. Through the pilot he will see that rules regarding the care, inspection, fitting and wearing of parachutes are observed in accordance with AAF regulations and requirements.

Turret Specialist—The turret specialist must know not only how to operate his turret but how to repair it and put it back in operation if necessary. He will give instruction at every opportunity to crew members near his station to qualify them as assistant turret gunners.

Assistant Assignments—An assistant is one who can take over a job and do it as well as the regularly assigned individual if necessary. The assistant radio operator, for example, should be able to take over and operate the radio as well (or almost as well) as the regular radio operator, etc. The most valuable man on a team is the one who can take over other jobs than his own if and when required to do so.

The above is by no means a complete statement of this problem but it should give the airplane commander the idea of what it means to “train your crew,” for every man to “know every other man’s job,” and what is meant by teamwork. These are not empty phrases. Every 15 minutes wasted on a mission means your crew is 15 minutes less well prepared for combat. There is no reason for your radio equipment to be idle. Your engineer has no time to sleep or sit and vegetate if he is carrying out his job of teaching all crew members to transfer fuel, working the cruise control charts, really keeping on the ball. You **have** to fly a practice mission . . . so why not run it so that your crew will get all they can out of it? It is real pleasure to develop topnotch proficiency and teamwork, and your crew will actually enjoy missions more if they feel that their skills are being utilized to the fullest extent, if only in practice.

It is worth while to discuss here also the principal duties of each of the crew members to aid the commander in judging their ability.

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COPILOT

The copilot is the executive officer: your chief assistant, understudy, and strong right arm. He must be familiar enough with every one of your duties—both as pilot and airplane commander—and be able to take over and act in your place at any time.

He must be able to fly the airplane under all conditions as well as you would fly it yourself.

He must be extremely proficient in engine operation, and know instinctively what to do to keep the airplane flying smoothly even though he is not handling the controls.

He must have a thorough knowledge of cruising control data, and know how to apply it at the proper time.

He is also the engineering officer aboard the airplane, and maintains a complete log of performance data.

He must be a qualified instrument pilot.

He must be qualified to navigate during day or night by pilotage, dead reckoning, and by use of radio aids.

He must be proficient in the operation of all radio equipment located in the pilot's compartment.

In formation flying, he must be able to make engine adjustments almost automatically.

He must be prepared to take over on instruments when the formation is climbing through an overcast, thus enabling you to watch the rest of the formation.

Always remember that the copilot is a fully trained, rated pilot just like yourself. He is subordinate to you only by virtue of your position as the airplane commander. But the B-24 is a lot of airplane; more airplane than any one pilot can handle alone over a long period of time. Therefore, you have been provided with

a second pilot who will share the duties of flight operation.

Treat your copilot as a brother pilot. Remember that the more proficient he is as a **pilot**, the more efficiently he will be able to perform the duties of the vital post he holds as your second in command.

Be sure that he is always allowed to do his share of the flying, in the copilot's seat, on take-offs, landings, and on instruments.

The importance of the copilot is eloquently testified by airplane commanders overseas. There have been numerous cases in which the pilot has been disabled or killed in flight and the copilot has taken full command of both airplane and crew, completed the mission, and returned safely to the home base. Usually, the copilots who have distinguished themselves under such conditions have been copilots who have been respected and trained by the airplane commander as **pilots**.

Bear in mind that the pilot in the right-hand seat of your airplane is preparing himself for an airplane commander's post too. Allow him every chance to develop his ability and to profit by your experience.



NAVIGATOR

The navigator's job is to direct your flight from departure to destination and return. He must know the exact position of the airplane at all times. In order for you to understand fully how best to get most reliable service from your navigator, you must know as much about his job as possible.

Navigation is the art of determining geographic positions by means of (a) pilotage, (b) dead reckoning, (c) radio, or (d) celestial navigation, or any combination of these 4 methods. By any one or combination of methods the navigator determines the position of the airplane in relation to the earth.

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RESTRICTED**Pilotage**

Pilotage is the method of determining the airplane's position by visual reference to the ground. The importance of accurate pilotage cannot be overstressed. In combat navigation, all bombing targets are approached by pilotage, and in many theaters the route is maintained by pilotage. This requires not merely the vicinity type, but **pin-point pilotage**. The exact position of the airplane must be known not within 5 miles, but within $\frac{1}{4}$ of a mile.

The navigator does this by constant reference to groundspeeds, the ground, and to his maps and charts. ETA's are established for points ahead. During the mission, as long as he can maintain visual contact with the ground, the navigator can establish these pin-point positions so that the exact track of the airplane will be known when the mission is completed.

Dead Reckoning

Dead reckoning is the basis of all other types of navigation. For instance, if the navigator is doing pilotage, and computes ETA's for points ahead, he is using dead reckoning.

Dead reckoning determines the position of the airplane at any given time by keeping an account of the track and distance flown over the earth's surface from the point of departure or the last known position.

Dead reckoning can be subdivided into two classes:

1. **Dead reckoning based on a series of known positions.** For example, you, as pilot, start on a mission from London to Berlin at 25,000 feet. For the first hour your navigator keeps track by pilotage, at the same time recording the heading and airspeed which you are holding. According to plan at the end of the first hour the airplane goes above the clouds, thus losing contact with the ground. By means of dead reckoning from his last pilotage point, the navigator is able to tell the position of the aircraft at any time. The first hour's travel has given him the wind prevalent at the altitude, and the track and groundspeed being made. By computing track and distance from the last pilotage point, he can always tell the position of the air-

plane. When your airplane comes out of the clouds near Berlin, the navigator will have a very close approximation of his exact position, and will be able to pick up pilotage points very quickly.

2. **Dead reckoning as a result of visual references other than pilotage.** When flying over water, desert, or barren land, where no reliable pilotage points are available, very accurate DR navigation still can be performed. By means of the drift meter the navigator is able to determine drift, the angle between the heading of the aircraft and the track of the aircraft over the ground. The true heading of the aircraft is obtained by application of compass error to the compass reading. The true heading plus or minus the drift (as read on the drift meter) gives the track of the airplane. At a constant airspeed, drift on 2 or more headings will give the navigator information necessary to obtain the wind by use of his computer. Groundspeed is computed easily once the wind, heading, and airspeed are known. So by constant recording of true heading, true airspeed, drift, and groundspeed, the navigator is able to determine accurately the position of the aircraft at any given time. For greatest accuracy, constant courses and airspeeds must be maintained by the pilot. If course or airspeed is changed, notify the navigator so he can record these changes.

Radio

Radio navigation makes use of various radio aids to determine position. The development of many new radio devices has increased the use of radio in combat zones. However, the ease with which radio aids can be jammed, or bent, limits the use of radio to that of a check on DR and pilotage. The navigator, in conjunction with the radioman, is responsible for all radio procedures, approaches, etc., that are in effect in the theater.

Celestial

Celestial navigation is the science of determining position by reference to 2 or more celestial bodies. The navigator uses a sextant accurate time and numerous tables to obtain what

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he calls a line of position. Actually this line is part of a circle on which the altitude of the particular body is constant for that instant of time. An intersection of 2 or more of these lines gives the navigator a fix. These fixes can be relied on as being accurate within approximately 10 miles. The reason for inaccuracy is the instability of the airplane as it moves through space, causing acceleration of the sextant bubble (a level denoting the horizontal). Because of this acceleration, the navigator takes observations over a period of time so that the acceleration error will cancel out to some extent. If the navigator tells the pilot when he wishes to take an observation, extremely careful flying on the part of the pilot during the few minutes it takes to make the observations will result in much greater accuracy. Generally speaking, the only celestial navigation used by a combat crew is during the delivering flight to the theater. But in all cases celestial navigation is used as a check on dead reckoning and pilotage except where celestial is the only method available, such as on long over-water flights, etc.

Instrument Calibration

Instrument calibration is an important duty of the navigator. All navigation depends directly on the accuracy of his instruments. Correct calibration requires close cooperation and extremely careful flying by the pilot. Instruments to be calibrated include the altimeter, all compasses, airspeed indicators, alignment of the astrocompass, astrograph, and drift meter, and checks on the navigator's sextant and watch.

Pilot-Navigator Preflight Planning

1. Pilot and navigator must study flight plan of the route to be flown, and select alternate airports.
2. Study the weather **with** the navigator. Know what weather you are likely to encounter. Decide what action is to be taken. Know the weather conditions at the alternate airports.
3. Inform your navigator of what airspeed and altitude you wish to fly so that he can prepare his flight plan.
4. Learn what type of navigation the navigator intends to use: pilotage, dead reckoning,

radio, celestial, or a combination of all methods.

5. Determine check points; plan to make radio fixes.

6. Work out an effective communication method with your navigator to be used in flight.

7. Synchronize your watch with your navigator's.

Pilot-Navigator in Flight

1. **Constant course**—For accurate navigation you, the pilot, must fly a constant course. The navigator has many computations and notations to make in his log. Constantly changing course makes his job more difficult. A good navigator is supposed to be able to follow the pilot, but he cannot be taking compass readings all the time.

2. **Constant airspeed** must be held as nearly as possible. This is as important to the navigator as is a constant course in determining position.

3. **Precision flying** by the pilot greatly affects the accuracy of the navigator's instrument readings, particularly celestial readings. A slight error in celestial reading can cause considerable error in determining positions. You can help the navigator by providing as steady a platform as possible from which he can take readings. The navigator should notify you when he intends to take readings so that the airplane can be leveled off and flown as smoothly as possible preferably by using the automatic pilot. Do not allow your navigator to be disturbed while he is taking celestial readings.

4. **Notify the navigator in advance of any change in flight** such as change in altitude, course, or airspeed. If change in flight plan is to be made, consult the navigator. Talk over the proposed change so that he can plan the flight and advise you concerning it.

5. In the event there is doubt as to the position of the airplane, pilot and navigator should work together, refer to the navigator's flight log, talk the problem over and decide together the best course of action to take.

6. Check your compasses at intervals with those of the navigator, noting any deviation.

7. Require your navigator to give position reports at regular intervals.

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8. You are ultimately responsible for getting the airplane to its destination. Therefore, it is your duty to know your position at all times.

9. Encourage your navigator to use as many of the methods of navigation as possible as a means of double-checking and for practice.

Post-flight Critique

After every flight get together with the navigator and discuss the flight and compare notes. Go over the navigator's log. If there have been serious navigational errors, discuss them with the navigator and determine their cause. If the navigator has been at fault, caution him that it is his job to see that the same mistake does not occur again. If the error has been caused by faulty instruments, see that they are corrected before another navigation mission is attempted. If your flying has contributed to the inaccuracy of the navigation, try to fly a better course the next mission.

Miscellaneous Duties

The navigator's primary duty is navigating your airplane with a high degree of accuracy. But as a member of the team, he must also have a general knowledge of the entire operation of the airplane.

He has a .50-cal. machine gun at his station, and he must be able to use it skillfully and to service it in emergencies.

He must be familiar with the oxygen system, know how to operate the turrets, radio equipment, and fuel transfer system.

He must know the location of all fuses and spare fuses, lights and spare lights, affecting navigation.

He must be familiar with emergency procedures, such as the manual operation of landing gear, bomb bay doors, and flaps, and the proper procedures for crash landings, ditching, bailout, etc.

THE BOMBARDIER

Accurate and effective bombing is the ultimate purpose of your entire airplane and crew. Every other function is preparatory to hitting and destroying the target.

That's your bombardier's job. The success or failure of the mission depends upon what



he accomplishes in the short interval of the bombing run.

When the bombardier takes over the airplane for the run on the target, he is in command. He will tell you what he wants done, and until he gives you the word "Bombs away," his word is virtually law.

A great deal, therefore depends on the understanding between bombardier and pilot. You expect your bombardier to know his job when he takes over. He expects you to understand the problems involved in his job, and to give him full cooperation. Teamwork between pilot and bombardier is essential.

Under any given set of conditions, ground speed, altitude, direction, etc., there is only one point in space where a bomb may be released from the airplane to hit a predetermined object on the ground.

There are many things with which a bombardier must be thoroughly familiar in order to release his bombs at the right point to hit this predetermined target.

He must know and understand his bomb-sight, what it does, and how it does it.

He must thoroughly understand the operation and upkeep of his bombing instruments and equipment.

He must know that his racks, switches, controls, releases, doors, linkage, etc., are in first-class operating condition.

He must understand the automatic pilot as it pertains to bombing.

He must know how to set it up, make air adjustments and minor repairs while in flight.

He must know how to operate all gun positions in the airplane.

He must know how to load and how to clear simple stoppages and jams of guns in flight.

He must be able to load and fuse his own bombs.

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He must understand the destruction power of bombs and must know the vulnerable spots on various types of targets.

He must understand the bombing problem, bombing probabilities, bombing errors, etc.

He must be thoroughly versed in target identification and in aircraft identification.

The bombardier should be familiar with the duties of all members of the crew and should be able to assist the navigator in case the navigator becomes incapacitated.

For the bombardier to be able to do his job, the pilot of the aircraft must place the aircraft in the proper position to arrive at a point on a circle about the target from which the bombs can be released to hit the target.

Unless the pilot performs his part of the bombing run correctly, even the best bombardier in the world will be unable to bomb accurately. The pilot's failure to hold airspeed and altitude will cause the following bombing errors:

1. Flying too high: bomb will hit over.
2. Flying too low: bomb will fall short.
3. Flying too fast: bomb will fall short.
4. Flying too slow: bomb will hit over.



THE RADIO OPERATOR

There is a lot of radio equipment in today's B-24's. There is one special man who is supposed to know all there is to know about this equipment. Sometimes he does but often he doesn't. His deficiencies often do not become apparent until the crew is in the combat zone, when it is too late. Too often the lives of pilots and crew are lost because the radio operator has accepted his responsibility indifferently.

Radio is a subject that cannot be learned in a day. It cannot be mastered in 6 weeks, but sufficient knowledge can be imparted to the radio man during his period of training in the United States providing he is willing to study.

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It is imperative that you check your radio operator's ability to handle his job before taking him overseas as part of your crew. To do this you may have to check the various instructor-departments to find out any weakness in the radio operator's training and proficiency and to aid the instructors in overcoming such weaknesses.

Training in the various phases of the heavy bomber program is designed to fit each member of the crew for the handling of his jobs. The radio operator will be required to:

1. Render position reports every 30 minutes.
2. Assist the navigator in taking fixes.
3. Keep the liaison and command sets properly tuned and in good operating order.
4. Understand from an operational point of view:

- (a) Instrument landing
- (b) IFF
- (c) VHF

and other navigational aids equipment in your airplane.

5. Maintain a log.

In addition to being radio operator, the radio man is also a gunner. During periods of combat he will be required to leave his watch at the radio and take up his guns. He is often required to learn photography. Some of the best pictures taken in the Southwest Pacific were taken by radio operators. The radio operator who cannot perform his job properly may be the weakest member of your crew. And the crew is no stronger than its weakest member.



THE ENGINEER

Size up the man who is to be your engineer. This man is supposed to know more about the mechanical features of the airplane you are to fly than any other member of the crew.

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He has been trained in the Air Forces' highly specialized technical schools. Probably he has served some time as a crew chief. Nevertheless there may be some blank spots in his training which you, as a pilot and airplane commander, must fill in.

Think back on your own training. In many courses of instruction, you had a lot of things thrown at you from right and left. You had to concentrate on how to fly; and where your equipment was concerned you learned to rely more and more on the enlisted personnel, particularly the crew chief and the engineer, to advise you about things that were not taught to you because of lack of time and the arrangement of the training program.

Both pilot and engineer have a responsibility to work closely together to supplement and fill in the blank spots in each other's education.

To be a qualified combat engineer a man must know his airplane, his engines, and his armament equipment thoroughly and know how to strip, clean and re-assemble the guns. This is a big responsibility: the lives of the entire crew, the safety of the equipment, the success of the mission depend squarely upon it.

He must work closely with the copilot, checking engine operation, fuel consumption, and the operation of all equipment.

He must be able to work with the bombardier, and know how to cock, lock, and load the bomb racks.

It is up to you, the airplane commander, to see that he is familiar with these duties, and, if he is hazy concerning them, to have the bombardier give him special help and instruction.

He should have a general knowledge of radio equipment and be able to assist in tuning transmitters and receivers.

Your engineer should be your chief source of information concerning the airplane. He should know more about the equipment than anyone, yourself included.

You, in turn, are his source of information concerning flying. Bear this in mind in all your discussions with the engineer. The more complete you can make his knowledge of the reasons behind every function of the equipment,

the more valuable he will be as a member of the crew. Who knows? Some day that little bit of extra knowledge in the engineer's mind may save the day in an emergency.

Generally, in emergencies, the engineer will be the man to whom you turn first. Build up his pride, his confidence, his knowledge. Know him personally; check on the extent of his knowledge. Make him a man upon whom you can rely.



THE GUNNERS

The B-24 is a most effective gun platform, but its effectiveness can be either amplified or defeated by the way the gunners in your crew perform their duties in action.

Your gunners belong to one of two distinct categories: turret gunners and flexible gunners.

The power turret gunners require many mental and physical qualities similar to what we know as inherent flying ability, since the operation of the power turret and gunsight are much like airplane operation.

While the flexible gunner does not require the same delicate touch as the turret gunner, he must have a fine sense of timing and be familiar with the rudiments of exterior ballistics.

All gunners should be familiar with the coverage area of all gun positions, and be prepared to bring the proper gun to bear as the condition may warrant.

They should be experts in aircraft identification.

Where the Sperry turret is used, failure to set the target dimension dial properly on the K-type sight will result in miscalculation of range.

They must be familiar thoroughly with the Browning aircraft machine gun. They should know how to maintain the guns, how to clear

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APPENDIX B - B-24 PILOT TRAINING

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jams and stoppages, and how to harmonize the sights with the guns.

While participating in training flights, the gunners should be operating their turrets constantly, tracking with the flexible guns even when actual firing is not practical. Other airplanes flying in the vicinity offer excellent tracking targets. Automobiles, houses, and other ground objects afford excellent tracking targets during low-altitude flights.

The importance of teamwork cannot be over-

emphasized. One poorly trained gunner, or one man not on the alert, can be the weak link that destroys the entire crew.

Keep the interest of your gunners alive at all times. Any form of competition among the gunners themselves will stimulate interest to a high degree.

Finally, each gunner should fire the guns at each station to familiarize himself with the other man's position and to insure knowledge of operation in the event of an emergency.