

switch. The following lights can be dimmed by the warning/caution lights knob, but once in the dimmed lighting range cannot be varied in intensity: MASTER CAUTION light, landing gear handle warning, L BAR warning, HOOK warning, L BLEED warning, R BLEED warning, APU FIRE warning, left and right engine FIRE warning.

**2.17.3 Voice Alert System.** For certain critical warnings and cautions, voice alert transmissions are sent to the pilot’s headset. When a condition occurs to trigger one of the critical warnings or cautions, the voice alert system provides a message to the headset. The message is repeated twice; for example, “APU FIRE, APU FIRE”. The voice alert requires no reset action on the pilot’s part and the alert is not repeated unless the original condition ceases for 5 seconds or more and then recurs. The ALTITUDE voice alert, when initiated by the primary radar low altitude warning, has a high priority for its first annunciation and is repeated continuously at the lowest priority until reset or disabled by the pilot. For cautions with voice alert, the voice alert replaces the master caution tone; however, the master caution tone backs up the voice alert system, and provides a tone if the voice alert system malfunctions. FIRE, APU FIRE, L BLEED, and R BLEED warnings are not backed up by the master caution tone. Voice alert is the only audio warning for these problems. With dual generator failure, the following voice alert warnings operate from battery power: APU FIRE, L(R) FIRE, and L(R) BLEED. The ALTITUDE voice alert warning, all voice alert cautions, and the master caution tone are inoperative on battery power during dual generator failure.

CAUTION	VOICE ALERT
IFF 4	MODE 4 REPLY
DEL ON, MECH ON, FLAPS OFF, AIL OFF, RUD OFF, FLAPS SCHED, or G-LIM 7.5 G	FLIGHT CONTROLS

CAUTION	VOICE ALERT
FCS HOT	FLIGHT COMPUTER HOT
L(R) OVRSPD, L(R) EGT HI, L(R) IN TEMP, L(R) FLAMEOUT, L(R) OIL PR, or L(R) STALL	ENGINE LEFT (RIGHT)
FUEL LO	FUEL LOW
BINGO	BINGO

WARNING	VOICE ALERT
ALTITUDE LOW	ALTITUDE [1] WARNING
L(R) BLEED AIR	BLEED AIR LEFT (RIGHT)
L(R) FIRE	ENGINE FIRE LEFT (RIGHT)
APU FIRE	APU FIRE
[1] MC OFP 92A and 10A	

**2.17.3.1 Ground Proximity Warning System (GPWS)(MC OFP 10A+, 11C+, 13C, and 15C).** GPWS is a safety backup system that warns the aircrew of impending controlled flight into terrain (CFIT). The GPWS is executed by an algorithm within the mission computer OFP. It operates when MC1 is powered on. The GPWS option located on the A/C sublevel display allows the pilot to disable/enable the system. The GPWS option is reached by pressing MENU, HSI, DATA, A/C. The GPWS algorithm commands distinctive visual and aural cues to alert and direct recovery from an impending CFIT condition. All GPWS warnings should be treated as imminent flight into terrain, unless reassessed situational awareness dictates otherwise. Pilot response to a valid warning should be instinctive and immediate, using the maximum capabilities of the aircraft to recover until safely clear of

terrain. The GPWS is inoperative with failed INS or ADC. It is recommended that the GPWS function be disabled to prevent false GPWS warnings during landing due to inaccurate vertical velocity.

### WARNING

GPWS has no forward looking or predictive capability. It provides no protection under the following conditions:

- RADALT, ADC, MC1 or INS off or failed.
- Transonic flight (0.95-1.04 IMN) outside the valid RADALT data envelope.
- For 1.5 seconds after a break X is displayed.
- Less than 6 seconds after weight off wheels.
- Less than 5 seconds or greater than 120 seconds outside the valid RADALT data envelope (+/- 50° pitch and AOB).
- Dives greater than 50° after 2 minutes above 5,000 feet AGL.
- After a waveoff until exceeding a 1000 fpm climb for five seconds.

GPWS provides only limited protection and may not provide adequate warning under the following conditions:

- Rising terrain of greater than 2° slope.
- Coast mode (5-120 seconds outside valid RADALT envelope).
- Within GPWS defined LAT envelope (+/- 30° AOB, 0-30° dive, 450-560 KCAS).
- Below 150 feet AGL and 200 KCAS.

**2.17.3.1.1 Sensors/Modes.** The GPWS is a look down system with no forward look capability. GPWS uses the RADALT, INS, and ADC, with the RADALT as the primary source of information for terrain clearance. RADALT data is considered valid by GPWS below 4,950 feet AGL and at a pitch or angle of bank less than 50°. Outside the valid RADALT data envelope,

one of two options is used: 1) “COAST” mode: for level terrain protection continues after a 5 sec delay for up to two minutes assuming a constant terrain elevation. 2) “BYPASS” mode: for uneven terrain or while in the transonic region (0.95 - 1.04 Mach) GPWS is turned off to prevent nuisance cues. (Terrain with less than a 2° slope is defined as level). Full protection is resumed from both modes when valid RADALT data is restored.

### 2.17.3.1.2 CFIT Protection Provided - Altitude Loss During Recovery (ALDR).

#### Above 150 feet AGL -

GPWS provides CFIT protection by continuously calculating, at current flight conditions, the altitude required to recover above the terrain. A warning is issued when the altitude required for recovery, plus a variable safety buffer and an added terrain clearance altitude, is greater than the current altitude above terrain. (The terrain clearance altitude varies between 30 feet, 50 feet, and 90 feet depending on flight conditions). GPWS calculates the altitude required for recovery from a pilot response time, a roll to wings level, and a dive recovery. The allowable pilot response time varies, depending on flight conditions, and is at a minimum (1/2 second) in the GPWS LAT envelope ( $\pm 30^\circ$  AOB, 0 - 30° dive, 450-560 knots). The altitude lost while rolling to wings level is based on a 1/2 to 3/4 lateral stick displacement roll at 1 g. The altitude loss during the dive recovery is based on a target g onset rate and a target sustained g as shown below.

	Target g onset rate	Target sustained g
Airspeed < 400 knots or AOB > 30°	80% of available g onset rate up to 5g/sec	80% of g available up to 5 g
Airspeed $\geq 400$ knots and AOB $\leq 30^\circ$	80% of available g onset rate up to 6g/sec	90% of g available up to 6 g

**NOTE**

These g onset rates and sustained g levels require an aggressive pilot response.

**Below 150 feet AGL -**

Protection is provided by warnings issued when current flight conditions could potentially result in CFIT. The warnings are based on the time since weight-on-wheels or a waveoff and then on a combination of landing gear position, airspeed, altitude, and sink rate. (A waveoff is defined as 1000 fpm rate of climb for more than 5 seconds while below both 500 feet AGL and 200 knots.) The following conditions will cause a warning to be issued below 150 feet AGL:

1. When more than 60 seconds since weight-on- wheels or a waveoff:
  - a. Floor Altitude  
Descending below 90 feet AGL with the airspeed greater than 200 knots.
  - b. Check Gear  
Descending below 150 feet AGL with the landing gear not down and the airspeed less than 200 knots.
  - c. Landing Sink Rate  
Descending below 150 feet AGL with the landing gear down, the airspeed less than 200 knots and a sink rate greater than a schedule designed to prevent hard landings. The allowable sink rate schedule varies from a maximum of 2,040 fpm to a minimum of 1,488 fpm based on altitude and weight.
  - d. Bank Angle  
Below 150 feet AGL, airspeed less than 200 knots and the AOB greater than 45 ° for one second.
2. When less than 60 seconds since weight-on- wheels or a waveoff:
  - a. Floor Altitude  
Descending below 90 feet AGL with the airspeed greater than 250 knots.

## b. Takeoff Sink Rate

Descending below 150 feet AGL with airspeed less than 250 knots and a sink rate greater than 300 fpm.

**WARNING**

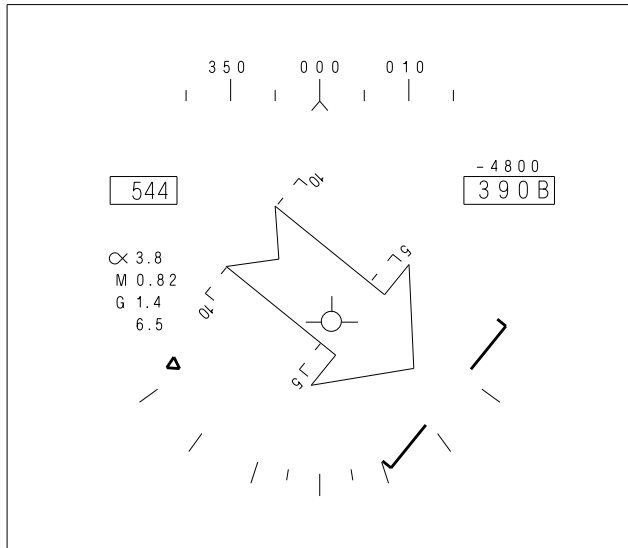
- Below 150 feet AGL, GPWS does not directly account for the recovery capabilities of the aircraft so recovery may not be possible following a warning.
- At certain high speed, high gross weight conditions, overriding the g limiter may be required for recovery from dives greater than 50° and will likely be required for dives between 10 and 25°.
- No protection is provided for dives greater than 50° following a high altitude ingress (greater than 2 minutes above 5,000 feet AGL).

**NOTE**

High speed, heavy gross weight conditions vary from around 550 knots at 38,000 lb to about 480 knots at 48,000 lb.

**2.17.3.1.3 GPWS Visual Cues.** Once a GPWS warning is required the visual warning cue, a steady arrow located in the center of the HUD, is displayed. The recovery arrow is always pointed perpendicular to the horizon in the direction of pull required for recovery. The visual warning cue is displayed simultaneously with the voice warning and is removed when GPWS calculates a CFIT condition no longer exists. There is no visual cue with a check gear warning.

**2.17.3.1.4 GPWS Aural Cues.** Along with the visual warning cue the system issues directive voice commands as follows:



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**Figure 2-33. Visual Warning Cue**

**If F/A-18A/B aircraft before AFC 253 or 292 -**

The aural cue “RECOVER.....RECOVER” is used for all GPWS CFIT conditions. It has priority over all other cues and is twice as loud as the existing cues.

**If F/A-18A aircraft after AFC 253 or 292 or F/A-18C/D aircraft -**

“POWER.....POWER” if the airspeed is less than 210 knots.

“PULL UP.....PULL UP” if the airspeed is greater than or equal to 210 knots.

“CHECK GEAR.....CHECK GEAR” when descending below 150 feet AGL (less than 200 knots) if the gear is not down and locked and more than 60 seconds since a weight-on-wheels or a waveoff.

With MC OFP 11C and 13C - “ROLL OUT.....ROLL OUT” if the (AOB) angle of bank is greater than 45°.

With MC OFP 15C - “ROLL LEFT.....ROLL LEFT” or “ROLL RIGHT.....ROLL RIGHT” if the (AOB) angle of bank is greater than 45°.

The voice commands are repeated every 2 seconds (every 8 sec for check gear warnings) and in the C/D will automatically transition to the appropriate voice command for the current stage of recovery (e.g. “ROLL OUT.....ROLL OUT” followed by “PULL UP.....PULL UP” when AOB is returned to less than 45°). The voice commands are terminated when the appropriate recovery maneuver is initiated (e.g., a pull up initiated within 1/2 g of the GPWS calculated target g).

**WARNING**

- Complying with the directive voice command but delaying other required actions may result in an unrecoverable situation (e.g., adding power but delaying an aft stick pull following the voice command “POWER.....POWER”).
- GPWS voice warnings are inhibited during RADALT warnings or during system voice alerts.