SUMMARY
This chapter presents the general planning and conduct of instrument approaches by professional pilots. (Approaches for helicopters are covered in Appendix C.) The information contained in the document may be useful to researchers for developing experimental scenarios for the simulation of approaches and evaluation of new flight deck technologies.

APPROACH PLANNING (Page 5-1)
Some flight planning occurs preflight and some inflight. Depending on many factors (speed of the aircraft, weather information, etc.), the inflight planning phase of an instrument approach can occur 100-200 NM from the destination. There are 5 steps that pilots use for inflight planning, based on their Flight Standards manuals:

1. Gathering of weather information, field conditions and NOTAMS (notices to airmen);
2. Calculations of performance data, approach speeds, and thrust/power settings;
3. Flight deck navigation/communication and automation setup;
4. Instrument approach procedure (IAP) review and IAP briefing to flight crews; and
5. Operational review and operational briefing for flight crews.

The extent of detail that a pilot provides in the planning varies from person to person. SIAPs are standard instrument approach procedures. There are many factors that can limit the usability of an approach and so the type of IAP that should be used can be very difficult to determine. The flight crew needs to answer several questions before determining the appropriate IAP, such as, “Is the aircraft properly equipped for this approach?” These types of questions are answered in this chapter.

WEATHER CONDITIONS
Weather conditions dictate which type of approach to use. Consequently, considering weather is one of the first steps in approach planning. Weather concerns have to do with wind (e.g. wind speed, direction), ceiling, visibility, altimeter settings, temperatures and field conditions. Wind speed and direction can limit the possible approaches to select from and the location of the runways to land on. Some airports have several runways but only a few are equipped for precision approaches. If winds disable runway use, then pilots cannot land. ACARS (aircraft communications addressing and reporting systems), in conjunction with government entities, provides weather info en route for approach planning.

Broadcast weather is the most common inflight method used by flight crews to obtain specific inflight weather information. The Automatic Terminal Information Service (ATIS) is most often used by airports with air traffic control towers. It is broadcast at a very high frequency and is pre-recorded for continuous playback. The automated weather observing programs (AWOS and ASOS) provide real-time weather information, which is used by flight crews for approach planning. Pilots must understand and be familiar with weather around airports because it
influences the approaches they can implement, the amount of fuel used, and alternate approach planning.

AIRPLANE PERFORMANCE OPERATING LIMITATIONS (Page 5-6)
All airplanes are expected to execute a go-around, the approach and landing within certain performance criteria. Air carriers must have in place an approved method for every flight they intend to make. The Aircraft Flight Manual (AFM) or the Pilots Operating Handbook (POH) are the primary sources for flight performance calculations specific to each type of aircraft. They provide the specifications and limitations of each type of aircraft. The plane must land within a certain distance, be able to climb from a missed approach with one engine inoperative, perform a go-around from the final landing stage, and maintain a specified climb gradient with all engines operating and the airplane in the landing configuration. Related to this, planes have more than one allowable flap configuration for landing. “Often, a reduced flap setting for landing will allow the airplane to operate at a higher landing weight into a field that has restrictive obstacles in the missed approach or rejected landing climb path (Pages 5-6).”

The airport approach category (a grouping of aircraft based on the reference landing speed (Vref) at the maximum certificated landing weight) and approach speed are the two other critical performance factors during the planning phase of the IAP. There are five categories labeled A-E in this manual that have definitive associated speeds. Because the approach category can make a difference in the type of approach and can in some cases, prohibit an approach, the approach speed must be calculated and the effects of the approach determined which should be briefed in both the preflight and in flight planning (Page 5-7).

APPROACH CHART FORMATS (Page 5-7)
In Feb. of 2000, NACO began issuing the current format for IAPs, which is commonly referred to as the Pilot Briefing Information format. The NACO charts have names that are at the top and bottom of the chart, including the procedure name, the runway served and the airport location. The airport identifier is also listed immediately after the airport name. For example, at the top right hand side of a NACO chart, “VOR/DME RNAV RWY XX” means that the VOR distance-measuring equipment (DME) is to be used for a RNAV approach procedure to runway XX. GPS overlay procedures, which are based on pre-existing nonprecision approaches, contain the wording “or GPS” in the title. “GPS A” in the title of a NACO chart means that the circling approach is being used without straight-in minimums.

There is a communications strip at the top of the NACO approach charts that gives flight crews the radio frequencies they can expect to be assigned to during the approach.

APPROACH CONTROL (Page 5-12)
Approach control is responsible for controlling all instrument flights operating within its area of responsibility and may serve more than one airport. Control is executed mainly through the ASR (airport surveillance radar). Prior to arrival at the IAF (Initial Approach Fix), instructions are received from the ARTCC (air route traffic control centers) by the flight crew to contact approach control on a particular frequency. When radar is approved for approach control service, it is used not only for radar approaches, but also for vectors in conjunction with published non-radar approaches using conventional NAVAIDs. When radar handoffs are initiated (either between the ARTCC and approach control or between two approach controls), then aircraft are cleared to an outer fix most appropriate to the route being flown and given holding instructions. After release to approach control, aircraft are vectored to the final approach course. The pilot will not turn inbound on the final approach course unless an approach clearance has been issued.
The ARTCCs can provide approach services (if they are approved to do so) for some airports however, the radar precision provided is not the same as the AESR or precision approach radar. Many airports do not have approach control facilities and so it is important for pilots to understand the differences between approaches with and without control. Air traffic control towers are responsible for safe, orderly and expeditious flow of all traffic that is landing, taking off, operating on (and in the vicinity of) an airport. In the absence of a control tower, executing an instrument approach is much the same as making a visual approach to that airport.

**PRIMARY NAVAID (Page 5-15)**
Most conventional approach procedures are built around a primary final approach NAVAID. Some procedures, such as a RNAV (GPS) approaches, are not. If a NAVAID is used (e.g., VOR DME), it needs to be included in an IAP briefing, set into the active navigation radio (or back up) and identified as a possible course guidance.

**COURSES (Page 5-15)**
Aircraft that are cleared to a holding fix do not receive new route information; instead, ATC expects the last assigned route to still exist, including the feeder route. Feeder routes that lead to the IAF are part of the approach clearance.

**AREA NAVIGATION COURSES (Page 5-16)**
RNAV (GPS) approach procedures have their own tracking issues because they are flown using an onboard navigation database, which can be coupled with manual flying. The database coding directs the navigation system and is comprised of waypoint (WP) sequencing for the approach and missed approach.

**ALTITUDES (Page 5-16)**
Prescribed altitudes can be represented in four different ways: minimums, maximums, recommended and mandatory. The National Imagery and Mapping Agency (NIMA) explains that minimums are denoted by underscore numerals and the maximums are denoted by the overscored numerals. MSA (Minimum safe altitudes) are published on charts for emergency use.

**FINAL APPROACH FIX ALTITUDE (Page 5-17)**
The IAP briefing should include information on the FAF altitude. On the charts it is designated by a cross on a nonprecision approach and by a lightening bolt symbol (glideslope intercept altitude) on the precision approach. When crossing the FAF, it is critical that the aircraft (no matter what aircraft is being flown) has the proper airspeed, altitude and configuration. Pilots find the current altitude when intercepting the glideslope and they compare altitudes (observed versus expected) to identify any instrument errors.

**MINIMUM DESCENT ALTITUDE, DECISION ALTITUDE, AND DECISION HEIGHT (Page 5-18)**
Decision altitude (DA) is currently used on RNAV approach charts with vertical descent guidance. In CAT I and CAT II approaches, DHs (Decision Heights) are references to AGL and measured with a radio altimeter. The height above touchdown (HAT) for a CAT I precision approach is normally 200 feet above the touchdown zone elevation. The Airplane Terminal Instrument Procedures, Airport Authorizations and Limitations lists the lowest authorized landing minimums that the plane can use while conducting an instrument approach.

**VERTICAL NAVIGATION (Page 5-18)**
Historically, the only way to get glidepath information during an approach was to use a ground-based precision NAVAID. Modern RNAV equipment allows flight crews to display an
electronically generated descent to minimums during approaches that would otherwise require multiple level-offs at step down fixes. During a conventional nonprecision approach, information about the constant descent angle from the FAF to the runway threshold must be provided. Descent below the MDA (minimum decision altitude) is only authorized when appropriate weather conditions warrant it. A constant descent rate has many safety advantages compared to the traditional nonprecision descent approach; (1) a stabilized approach can be maintained from the FAF to landing (2) the glideslope can serve as a backup for terrain clearances and can help minimize the effects of visual illusions on approach and landing.

RNAV APPROACH AUTHORIZATION (Page 5-22)
There are many different levels of authorizations when it comes to the use of RNAV approach systems. The type of equipment installed, the redundancy of that equipment, its operational status, the level of flight crew training and the operator’s FAA authorization all affect the pilot’s ability to use the RNAV information on an approach.

AIRPORT/RUNWAY INFORMATION (Page 5-24)
A thorough approach briefing should include the airport and runway environment information. NACO approach charts include a runway sketch to make important airport information easily accessible to pilots. Airports with complex runway and taxi configurations have an extra full-page diagram attached to the NACO chart.

AUTOMATED SETUP ITEMS (Page 5-24)
Once the approach and runways have been selected, each crewmember sets up their “side” of the cockpit. There are a few automated items that can be set-up ahead of time such as airspeed bugs, altimeter bugs (to the DA, DH, or MDA), the go around thrust/power setting, the radio altimeter bug and the navigation/communication radios.

FLIGHT MANAGEMENT SYSTEMS (Page 5-26)
FMS equipped airplanes give crew members many options for setting-up the FMC (Flight management computer) depending on the approach and company procedures. The amount of information available in the computer depends on the aircraft, but the crew can make modifications if something is not pre-programmed in the computer.

AUTOPilot MODES (Page 5-26)
Autopilots can usually be used to fly approaches even if the FMC is not working. There are many different autopilot modes to climb or descend the airplane. The pilot controls the airplane through the autopilot by selecting the pitch modes and/or roll modes as well as the associated auto-throttle modes. The “mode control panel” is normally accessible by both pilots. Most aircraft have sophisticated auto-flight systems and auto throttles that have the capability to select modes to carry-out the planes flight path. These auto-flight systems also have the capability to “capture” or level-off at the pre-selected altitudes as well as track a LOC (localizer) and glideslope (G/S) or VOR course. In a precision approach, the PF (pilot flying) controls the airspeed with the speed selector on the mode control panel (MCP) and calls for flaps and landing gear as needed (which the PNF (pilot not-flying) selects). Approach control clears the plane for approach. The PF makes no immediate changes to the autopilot mode to prevent the aircraft from capturing a false glideslope. The PNF resets the altitude selector and the PF selects the pitch mode. In addition to slowing the plane and calling configuration changes, the PF selects the approach mode (APP). The PF should have the aircraft fully configured for landing before intercepting the glideslope to ensure a stabilized approach. When the airplane intercepts the G/S, the pitch mode changes to G/S. When the G/S is captured by the autopilot, the PNF selects the missed approach altitude in the altitude pre-selector as requested by the PF. The airplane will
continue to track the glideslope. The minimum altitude at which the PF is authorized to disconnect the autopilot is airplane specific. The differences when flying the underlying nonprecision approach begin when the aircraft has leveled off at 2200 feet. “It is extremely important for both pilots to be absolutely sure that the correct altitude is selected for the MDA so that the airplane will not inadvertently descend below the MDA (Page 5-28).”

STABILIZED APPROACH (Page 5-28)
In IMC (instrument meteorological conditions) you must continuously evaluate instrument information throughout an approach to properly maneuver the aircraft (or monitor autopilot performance) and to decide on the proper course of action at the decision point. Large speed and configuration changes during an approach can seriously degrade situational awareness and complicate decisions on the proper action to take at the decision height. You must begin to form a decision concerning the probable success of an approach before reaching the decision point.

DESCENT RATES AND GLIDEPATHS FOR NONPRECISION APPROACHES (Page 5-28)
“Maximum Acceptable Descent Rates: Operational experience and research have shown that a descent rate of greater than approximately 1,000 FPM is unacceptable during the final stages of an approach (below 1,000 feet AGL). This is due to human perceptual limitations, independent of the type of airplane or helicopter. Therefore, the operational practices and techniques must ensure that descent rates greater than 1,000 FPM are not permitted in either the instrument or visual portions of an approach and landing operation (Page 5-28).” To verify that a plane is on an approximately 3 degree glidpath, a calculation of “300-foot-to-1 NM” should be used.

TRANSITION TO VISUAL (Page 5-29)
The transition from instrument flight to visual flight during an instrument approach can be very challenging, especially during low visibility operations. Approaches with vertical guidance add to the safety of the transition because the approach is already stabilized upon visually acquiring the runway references. One to two-hundred feet prior to reaching the DA, DH or MDA, most of the PNF’s attention should be outside the cockpit, looking for at least one visual referent. The PF should stay focused on the instruments until the PNF calls out any visuals and/or the runway. The PF should then begin the transition to visual flight.

MISSED APPROACH (Page 5-29)
There are many reasons why a missed approach is executed but the primary reason is that the flight visibility prescribed in the IAP does not exist or the required visual references for the runway cannot be seen upon arrival at the DA, DH or MAP (Missed Approach Point). However, once below the DA, DH or MDA, a missed approach must be executed if the required visibility is then lost or the runway environment is no longer visible. A missed approach is also required if men, equipment or animals are on the runway or the approach becomes unstabilized and a normal landing cannot be performed. When a missed approach is executed prior to reaching the MAP, the pilot is required to continue along the final approach course, at an altitude above the DA, DH or MDA until reaching the MAP before making any turns. The missed approach segment begins at the MAP and continues until the aircraft has reached the designated fix and a holding pattern has been entered.

EXAMPLES OF APPROACH BRIEFING (Page 5-33)
The approach briefing begins with a general discussion of the ATIS information, weather, terrain, NOTAMs, approaches in use, runway conditions, performance considerations, expected route to the final approach course and traffic situations. The briefing can be used as a checklist to ensure that all items have been set-up correctly.
INSTRUMENT APPROACH PROCEDURE SEGMENTS (Page 5-35)
A “feeder route” depicted on the IAP charts is a designated course for aircraft to proceed from the en route structure to the IAF. (Page 5-35 of the Handbook has a diagram of all of the approach segments and various fixes.)

TERMINAL ROUTES (Page 5-36)
In instances when the IAF is part of the en route structure and feeder routes are not required, a transition or terminal route is still needed for aircraft to proceed from the IAP to the IF (Intermediate Fix).

DME ARCS (Page 5-36)
DME arcs also provide transitions to the approach course. DME arcs are actually approach segments while feeder routes, by definition, are not. DME arcs occur when the plane has departed the en route phase and has begun the approach and is maneuvering to enter the intermediate or final segment of the approach.

INITIAL APPROACH SEGMENT (Page 5-37)
The purpose of the initial approach segment is to provide a method for aligning the aircraft with the intermediate or final approach segment. The initial approach segment begins at an IAF and usually ends where it joins the intermediate approach segment or at an IF.

INTERMEDIATE APPROACH SEGMENT (Page 5-37)
The intermediate segment provides course, distance and minimum altitude information. It is normally aligned within 30 degrees of the final approach course, begins at the IF and ends at the beginning of the approach segment.

FINAL APPROACH SEGMENT (Page 5-38)
This segment, with the vertical guidance or a precision approach, begins where the glideslope intercepts the minimum intercept altitude shown on an approach chart. For a nonprecision approach, the segment begins either at a designated FAF, depicted as a cross on the profile view, or at the point where the aircraft has established inbound on the final approach course. When a FAF is not designated (VOR or NDB approaches), this point is typically where the procedure turn intersects the final approach course inbound. This point is called the FAP (Final Approach Point). There are three procedures based on the final approach course guidance: (1) Precision Approach (PA) (2) Approach with vertical guidance (APV), and (3) Nonprecision approach (NPA).

VISUAL AND CONTACT APPROACHES (Page 5-41)
To expedite traffic, the ATC may clear pilots for a visual approach in lieu of the published approach procedure, particularly if flight conditions permit. A contact approach requires less time than the published IAP.

VISUAL APPROACHES (Page 5-41)
A pilot or controller can initiate a visual approach. If the pilots have the airport in sight but do not see the aircraft they have been requested to follow, the ATC may issue the visual approach clearance but will remain responsible for the plane and wake turbulence separation until the followed aircraft is reported to be in sight. A visual approach clearance is authorized when the ceiling is reported or expected to be at least 1000 feet AGL and the visibility is at least 3 SM (Square Miles). Pilots must remain clear of clouds at all times while conducting a visual approach.

CONTACT APPROACHES (Page 5-41)
The (tower) controller, not the ATC, initiates a contact approach for conditions where the visibility is at least 1 SM and the pilot can remain clear of clouds. The main difference between visual and contact approaches is the pilot must request a contact approach while a visual approach is usually assigned or requested by the pilot.

RNAV APPROACHES (Page 5-42)
RNAV classification includes both ground-based and satellite dependent systems.

TERMINAL ARRIVAL AREAS (Page 5-43)
TAAs are the method by which aircraft are transitioned from the RNAV en route structure to the terminal areas with minimal ATC interaction. The TAA consists of a designated volume of airspace to allow aircraft to enter a protected area, offering guaranteed obstacle clearance.

ILS APPROACHES (Page 5-46)
The ILS is the most precise and accurate approach NAVAID currently in use in the NAS (National Airspace System). ILS CAT I precision approaches allow pilots to make approaches 200 feet above the TDZE (Touchdown Zone Elevation) with visibilities as low as 1800 RVR (Runway Visual Range). CAT II and CAT III approaches allow for lower descents and visibility minimums. A single ILS system at an airport can accommodate 29 arrivals per hour on a single runway. Airport capacity is increased with parallel runways using parallel (dependent) ILS, simultaneous parallel ILS (independent), simultaneous parallel ILS (independent), precision runway monitor (PRM) and converging ILS approaches. The differences between these approaches generally has to do with the distances between the runways and the pattern of landings. The converging ILS approaches are runways that have an angle from 15 to 100 degrees between them. ILS approaches have three categories: CAT I, CAT II, and CAT III. CAT II and CAT III require special pilot certification above and beyond CAT I approaches.

MICROWAVE LANDING SYSTEM (Page 5-52)
The MLS (microwave landing system) is a precession instrument approach alternative to the ILS approach. It provides azimuth, elevation, distance information and back azimuth to provide guidance for missed approach procedures. It was initially designed to replace the ILS system. The MLS has multiple advantages including an increased number of radio frequencies, compact ground equipment and complex approach paths. However, MLS installations were cancelled by the FAA in 1994.

VOR APPROACH (Page 5-54)
The VOR is one of the most widely used nonprecision approach types in the NAS. VORs can provide MDAs as low as 250 feet above the runway.

NDB APPROACH (Page 5-57)
Like the VOR approach, the NDB (Non-Directional Radio Homing Beacon) approach can be designed using facilities both on and off the airport, with or without a FAF, with or without DME availability. With the growing use of GPS, most pilots do not use NDB.

RADAR APPROACHES (Page 6-61)
The two types of radar approaches used are the PAR (precision approach radar) and the ASR (Airport surveillance radar). The pilot must request the radar approaches. For radar approaches, planes typically align themselves with runway’s center line.

LOCALIZER APPROACHES (Page 5-62)
This approach is extremely flexible. The localizer and localizer DME approaches can provide both precision and nonprecision approach capabilities. Usually the localizer is used for a nonprecision approach when the glideslope malfunctions.

**COMMENTARY**
In general, this chapter provided useful information on the types and steps in various approach procedures. It also outlined the procedures that pilots must follow in selecting and executing an approach. However, the chapter could have done a better job of pointing out to the exact locations of information referenced in the NACO charts.