The Approach Controller

Sequencing

While the Tower (TWR) controller primarily focuses on departures, the Approach (APP) controller is responsible for managing arrivals, ensuring they are sequenced safely and efficiently. This involves preventing arrivals from being too close together (which could force a go-around due to an occupied runway) or too far apart (which could result in unnecessary airborne holding and increased fuel consumption).

Sequencing can be managed using several key concepts:

- **Separation:** The minimum vertical or lateral distance required between two aircraft. This includes **radar separation** and **wake turbulence separation**, both of which are critical in approach operations.
- **Spacing:** The desired distance between aircraft on final approach, which depends on factors such as weather conditions, airport layout, traffic volume, and pilot proficiency.
- **Compression:** A phenomenon that occurs when a leading aircraft reduces speed on final approach while trailing aircraft continue at a higher speed, causing them to close the gap. Controllers must anticipate this effect and adjust spacing accordingly.

For example, if the required spacing on final approach is 7 NM, an additional 1 NM can be added to account for compression, aiming for **8 NM final spacing** when no additional wake turbulence separation is required.

The APP controller must consider several factors when determining final approach spacing:

- **Airport Layout:** The number of runways, their configurations, and operational capabilities.
- **Runway Exit Design:** High-speed exits allow aircraft to vacate the runway more quickly, reducing spacing requirements.
- **Traffic Volume:** Depending on demand, priority may be given to either arrivals or departures, requiring close coordination with TWR.
- **Low Visibility Procedures (LVPs):** Increased spacing is necessary during reduced visibility conditions.
- **Ground Situational Awareness:** Monitoring ground movements to adjust spacing for optimal traffic flow.

To establish and maintain proper spacing, controllers should first:

1. Reduce the speed of trailing aircraft or
2. Increase the speed of leading aircraft, then adjust the speeds of other aircraft accordingly.

Aircraft may be assigned specific speed instructions, such as:

- **Maximum speed**
- **Minimum clean speed (minimum speed without flaps, speed brakes, or landing gear deployed)**
- **Minimum approach speed**
- **A specified IAS (Indicated Airspeed)**
- Controllers should **avoid instructing aircraft to reduce speed while maintaining a high descent rate**, as these maneuvers are often incompatible.
- Aircraft should be allowed to remain in a clean configuration for as long as possible.
- Above **FL150**, turbojet aircraft should not be reduced to less than **220 knots IAS**, which is close to their minimum clean speed.
- On **intermediate and final approach**, **only minor speed adjustments** (not exceeding **±20 knots IAS**) should be used.

The following speed recommendations ensure efficient sequencing and predictable spacing:

Distance from Runway	Maximum IAS
15 NM	250 knots
12 NM	220 knots
10 NM (Glideslope Intercept)	200 knots
7 NM	190 knots
6 NM	180 knots
5 NM	170 knots
4 NM	160 knots

- **Pilots should not exceed 200 knots upon reaching the glideslope (approximately 10 NM out).**
- The **approach clearance does not cancel speed restrictions**, unless explicitly stated by the controller.
- If unsure whether a pilot is aware of the speed restrictions, it is best to reissue them rather than assume the pilot will adjust preemptively.
- Assigning **180 knots to 6 NM** can lead to less precise approaches, as different aircraft types decelerate at different rates. Using **160 knots to 4 NM** or **170 knots to 5 NM** provides more consistency, reducing spacing deviations to around **0.3–0.4 NM**.
- When workload increases, **reduce aircraft speeds earlier** to maintain control over sequencing.
- Avoid **shortening aircraft paths too much**, as this can disrupt the flow and spacing.
- Use **standard speeds consistently** to maintain an organized sequence.
- Prioritize **situational awareness** and **proactive adjustments** to prevent unnecessary go-arounds.

ATC issues climb and descent clearances to facilitate departures, arrivals, or to help aircraft avoid adverse weather conditions. As a rule of thumb, controllers can estimate that an aircraft descends at approximately **300 feet per NM** (or **1,000 feet per 3 NM**), commonly referred to as the **3:1 rule**.

For example, when guiding an aircraft over the downwind leg, it should not be higher than **8,000 feet abeam the field**; otherwise, it will be too high to turn onto a **10 NM final**. To compensate for excessive altitude, pilots may adjust their descent rate at their discretion. However, controllers may assign a specific descent rate if necessary—but should act promptly, as even with speed brakes, an aircraft's descent rate has its limits.

ATC can also manage vertical speed during both climb and descent to ensure separation between successive or crossing aircraft. This is particularly useful in high-traffic scenarios. In **TopSky radar**, the assigned rate of climb/descent (**ARC function**) is marked in the aircraft's radar label.

When issuing an **approach clearance**, pilots are expected to descend to the **published altitude** for the approach. If the controller requires a different altitude, this must be explicitly stated.

Vectoring

Radar vectoring is the process of guiding an aircraft using ATC-assigned headings instead of standard IFR procedures (SID/STAR/Instrument Approach). Controllers must adhere to the **Minimum Vectoring Altitude (MVA)**, which ensures obstacle clearance while vectoring aircraft.

When issuing radar vectors, controllers must:

- Inform the pilot of the **purpose** of the vector and specify the limit of the vector (e.g., "Vectoring for ILS approach Runway 36").
- When terminating vectoring, instruct the pilot to **resume own navigation**.
- Aircraft must not be vectored closer than half of the separation minimum (i.e. closer than 2.5 NM if the separation minimum is 5 NM) from the limit of the airspace which the controller is responsible for, unless otherwise specified in local arrangements.
- Avoid vectoring aircraft into **uncontrolled airspace**, except in emergencies or to circumvent severe weather.
- If an aircraft reports **unreliable directional instruments**, instruct the pilot to make all turns at an agreed rate and to comply with instructions immediately upon receipt.

When vectoring an **IFR flight** or issuing a **direct routing that takes an aircraft off an ATS route**, controllers must ensure that **prescribed obstacle clearance** is maintained at all times until the pilot resumes navigation. If necessary, the **minimum vectoring altitude (MVA) must be adjusted for low-temperature corrections**.

Radar vectors can be provided in two ways:

1. **Heading Assignment:** e.g., "Turn left heading 180°."
2. **Relative Turn Instruction:** e.g., "Turn right by 10°."

    - This should only be used when there is insufficient time to request a specific heading.

If a radar vector is not self-explanatory (e.g., for final approach), the **reason should always be provided** (e.g., "Turn left heading 180° for spacing").

Important Considerations:

- When an aircraft is already in a turn, avoid ambiguous instructions like **"Turn left/right by..."** since the aircraft may not know which heading this refers to. Instead, use **"Stop turn"** if an immediate heading correction is needed.
- For **ILS or localizer approaches**, vectoring should be within **30° of the final approach course**.
    - Example: **Runway 36 → Heading 330° or 030° for intercept.**

RNAV Arrivals and Point Merge System

RNAV arrivals are predefined sequences of navigation points that an aircraft must pass over (or near) during its descent. The flight path is often deliberately curved to allow controllers flexibility in managing traffic flow. Controllers may issue **shortcuts** to reduce flight distance or **allow the aircraft to follow the full STAR** to delay its arrival. This method significantly reduces both controller workload and frequency congestion, which is why an increasing number of aerodromes are implementing it.

The **Point Merge System** is a specific **RNAV-based arrival structure** that consists of:

1. **A merging point**
2. **An arc** that arriving aircraft follow until further instruction

Controllers issue a **"direct to"** clearance to the merging point when appropriate. Since the distance from any point along the arc to the merging point remains constant, this method allows for **precise sequencing with minimal workload**.

However, **RNAV arrivals alone may not always provide sufficient spacing**, especially in high-traffic situations. In such cases, **controllers may still need to apply vectoring** to ensure optimal sequencing and separation.

While it is important to consider an aircraft's distance from the extended centerline or ILS feather, controllers should avoid relying too heavily on leader lines and the heading tool. These tools can assist in understanding aircraft performance, but developing a **holistic approach**—including judging headings by eye and using **standard headings**—will improve overall control of the approach sequence.

Final approach spacing should be measured aircraft-to-aircraft rather than focusing solely on how far an aircraft is from the extended centerline. The key consideration is the **relative position** of aircraft along the approach path. As the trailing aircraft nears the localizer, the crucial factor is **how far ahead the leading aircraft is** when determining when to turn the next aircraft onto the localizer.

Ensuring that aircraft intercept at the correct point for their altitude is important. When managing a continuous flow of inbound traffic, controllers should generally aim to **establish aircraft outside of 10 miles** whenever possible. However, once this baseline is set, the **relative positioning of aircraft matters more than their absolute distance from the localizer**.

- **Relative Speed Matters:** Instead of only checking how far an aircraft is from the extended centerline, focus on its speed relative to the aircraft ahead.
- **Perpendicular Base Leg Advantage:** Using a **perpendicular base leg** can help maintain consistent spacing and improve sequencing.
- **Avoid Fixation on Identical Intercept Points:** Aircraft do not need to intercept at exactly the same point every time. The focus should be on maintaining appropriate spacing between aircraft.
- **Localizer Turn Spacing:** When an aircraft is a reasonable distance from the extended centerline, its turn onto the localizer will naturally create around **1 NM of spacing**. Therefore, aircraft should typically be turned **1 NM before** reaching the required spacing down the ILS.

Consistency is key when assigning intercept headings. In still wind conditions, a **30-degree intercept heading** should be the standard. Any deviation from this should have a clear justification, such as:

- The aircraft is **closer or further from the ILS feather** than usual, requiring an adjustment to establish them at an appropriate point for their altitude (**typically within ±5°**).
- The controller needs to **increase spacing** by assigning a **wider intercept heading** or **reduce spacing** by using a **tighter intercept heading** (**again, usually within ±5°**).
- **Wind conditions** require an adjustment to maintain a **true 30-degree track to the ILS** .

The previous section highlighted the usefulness of the base leg, but it is important to emphasize its role in maintaining efficient sequencing. The **next aircraft must always be ready to turn onto final** when required.

- Once the required spacing down the approach is achieved, the **following aircraft should be positioned correctly relative to the extended centerline**, ready to be turned onto final.
- If an aircraft is on a **non-perpendicular base leg, heading away from the airport**, it becomes harder to judge spacing along the ILS. The turn toward the localizer will take longer, **creating more than a mile of additional spacing**. In such cases, controllers should **initiate the turn earlier** than they would for an aircraft on a perpendicular base leg.
- However, if an aircraft is **already in position for final**, there is **no need to extend them onto a base leg**—simply turn them onto final immediately.

It is also acceptable to **issue an intercept heading before the aircraft has fully rolled out on base**. This demonstrates **good situational awareness** and ensures spacing down the ILS is maintained efficiently.

To facilitate a **Continuous Descent Approach (CDA)**, pilots should be informed of their **track distance from touchdown** along with their initial descent clearance. This helps them plan a smooth and efficient descent.

The easiest way to determine track distance is by **counting backward** from an aircraft already established on final approach:

1. Identify an aircraft **already on the final approach course**.
2. Count **backward along the approach path** to estimate the distance of aircraft still on base or downwind.

For example, if you are aiming for **7 NM spacing** on final approach in a stream of **A320s**:

- If the **leading aircraft is established at 10 NM**, then the aircraft on **base leg** will be at **approximately 17 NM**.
- The aircraft following that will be at **around 24 NM**.

For **VATSIM operations**, it is recommended to **add an extra NM** to account for the additional track miles flown in turns. So, if targeting **7 NM spacing**, plan for **8 NM** to ensure a consistent separation.

Wind significantly affects **intercept headings**, especially at airfields where aircraft establish from **both sides** of the extended centerline.

Example: East-West Runway with a Northerly Wind

(A wind coming **from the north**)

- Aircraft establishing **from the south** will require a **wider intercept heading** to maintain a **30° intercept track** to the runway.
- Aircraft establishing **from the north** will require a **tighter intercept heading** to maintain the **same 30° intercept track**.

Controllers must **adjust headings accordingly** to ensure consistent and predictable approaches, taking wind direction and strength into account.

Wind conditions can also affect the **headings used for a perpendicular base leg**, requiring adjustments to ensure proper alignment with the localizer.

Example: East-West Runway with a Westerly Wind

(A wind **pushing aircraft to the east**)

- A **360° track** may require a **heading of 350°–355°**.
- A **180° track** may require a **heading of 185°–190°**.
- **Assess the adjustments needed** based on wind direction and strength.
- **Monitor your initial aircraft** to see how these adjustments are working.
- **Communicate wind effects during controller handovers** to maintain consistency.

If there is a **strong headwind** on final approach, precise timing of the **turn onto final** is crucial:

- Once an aircraft is turned onto the **intercept heading**, its **ground speed will decrease** due to the headwind.
- **Turning the trailing aircraft too early** could lead to spacing issues. While **speed control** may help, its effectiveness is limited.
- **Turning the trailing aircraft too late** means that traffic turning into a **strong headwind** will **cover more track miles in the turn** than in still wind conditions.

When adjusting speeds:

- If an aircraft is slowed to **160 knots to 4 NM (or even 150 to 4 NM)** too early, it can significantly affect the aircraft behind.
- **Avoid speeding up aircraft** to close gaps—it rarely works effectively.
- With a **strong crosswind on base leg**, consider how it impacts **aircraft momentum**, even when all aircraft are assigned **180 knots**.

Holding Stacks

There are several reasons why **holding** may be necessary in air traffic management:

1. **Spacing Management:** The approach controller (APP) may be unable to maintain the required spacing between arriving aircraft due to high traffic volume. Holding helps create the necessary separation.
2. **Runway Closure or Restrictions:** If the runway is closed or temporarily unavailable, APP may stop accepting arrivals, requiring aircraft to hold.
3. **Delay Absorption:** Holding is used to **manage delays** efficiently, preventing congestion in the terminal area.

- **Level Separation:** Aircraft in the same holding pattern must always be separated by altitude.
- **Pilot Uncertainty:** If a pilot is unfamiliar with holding procedures, ATC must provide **clear and detailed hold instructions**.
- **Extended Delays:** If significant delays are expected, aircraft should be informed as early as possible. When practical, they may be given the option to **reduce speed en route** to absorb the delay rather than holding.
- **ACC Responsibility:** When delays are anticipated, the **Area Control Center (ACC)** is generally responsible for:
  - Clearing aircraft to the holding fix.

    - Issuing **holding instructions** and an **expected approach time (EAT)** or onward clearance time.
- **APP and TWR Coordination:**
    - After coordinating with **APP**, ACC may clear an arriving aircraft to a **visual holding location** until further advised.
    - Similarly, after coordinating with **TWR**, APP may hold an arriving aircraft at a **visual holding location** until further advised by Tower.
- Aircraft are typically held at **designated holding fixes**, which are usually part of the published **approach procedure**.
- At **regional airports**, designated holding fixes are commonly located along standard arrival routes.
- If required to maintain a safe and orderly flow of traffic, an aircraft may be instructed to **orbit at its present position** or at another specified position, provided **obstacle clearance** is ensured.

The standard holding pattern consists of:

- A **racetrack-shaped circuit** with **turns to the right** (unless otherwise specified).
- **Inbound and outbound legs**, typically flown at standard speeds based on aircraft category.
- A **holding fix**, which serves as the entry point and reference for the hold.

Controllers should ensure that aircraft are instructed clearly on **entry procedures, holding speeds, and altitude assignments** to maintain safe and efficient traffic flow.

Aircraft holding at a **designated fix** or **visual holding location** should be assigned levels in a way that facilitates an **efficient and orderly approach sequence**.

- **Standard Level Assignment:**
    - The **first aircraft to arrive** at the holding fix is typically assigned the **lowest level**.
    - Subsequent aircraft are assigned **successively higher levels** to maintain safe vertical separation.

The **general rule** is that the **first aircraft to enter the hold is the first to leave**, ensuring an orderly flow of traffic.

- If an aircraft has **reduced speed** to absorb delay, it may lose its priority in the sequence.
- Priority for landing follows standard protocol:
    1. **Emergency aircraft**
    2. **HOSP (Medical Flights)**
    3. **SAR (Search and Rescue Operations)**
    4. **Other aircraft in sequence**

Holding patterns are **always managed by the Center (CTR) controller**. When a holding pattern is required, controllers should:

- **Reduce speeds early**: Aircraft en route to the holding fix should be slowed to **minimum clean speed** whenever possible. This minimizes time spent in holding, improving fuel efficiency.
- **Maintain 1,000 ft vertical separation** between aircraft entering the hold.
- **Use descent rates efficiently**: Assigning appropriate **rates of descent** ensures aircraft arrive at the holding fix in a properly sequenced manner, maintaining separation.

When issuing a holding clearance, the following elements should be included:

1. **Holding Location:**
    - "HOLD AT / OVER (significant point, name of facility, or fix)"
2. **Altitude Assignment:**
    - "MAINTAIN / CLIMB / DESCEND (level)"
    - *(Include any additional instructions if necessary)*
3. **Expected Further Clearance:**
    - "EXPECT FURTHER CLEARANCE AT (time)"
    - "EXPECT FURTHER CLEARANCE IN (minutes)"
    - "EXPECTED APPROACH TIME (time)"

Pilots must always be informed of:

- **Where to hold** (holding fix)
- **At what altitude** (assigned level)
- **Expected approach time (EAT)** if the hold is expected to last more than **20 minutes**

For **military aircraft (e.g., single- or two-seater jets)**, an **EAT must always be provided**, regardless of the 20-minute threshold. These aircraft typically have **strict fuel planning** and may need to **divert directly to an alternate** if delays extend beyond expectations.

If a **new EAT deviates by 5 minutes or more** from the previously issued EAT, the pilot must be informed of the change.

In addition to the standard holding instruction, controllers may issue a **detailed holding instruction** if necessary. This includes:

1. **Holding fix**
2. **Assigned holding level**
3. **Inbound magnetic track to the holding fix**
4. **Turn direction (standard is right turns)**
5. **Outbound leg duration or distance (if applicable)**
    - Below **FL140 → 1-minute outbound leg**
    - At or above **FL150 → 1.5-minute outbound leg**
6. **Time at which the flight can be continued or the next clearance can be expected**

A **general holding instruction** is typically sufficient, but a **detailed instruction** must be given in these cases:

- The pilot is required to hold **using a different procedure** than the published one.
- The pilot reports they **do not know the published holding procedure**.
- The pilot must enter a holding pattern **at a point with no published holding procedure**.
- In **TopSky radar**, aircraft callsigns and altitudes can be **highlighted in color** within holding stacks for better visibility.
- **Holding altitudes should not be excessively high**. If a holding stack reaches **above FL200**, controllers should **open a second holding fix** at a different location.
- If an **adjacent center sector** can no longer accept inbounds due to excessive holding requirements, they must establish a **new enroute holding fix** to manage the traffic overflow.

Managing aircraft in a **holding pattern** is straightforward when they are simply circling, but the real challenge begins when **approach control (APP) starts accepting arrivals again**. At this point, **CTR must ensure aircraft exit the holding pattern with proper sequencing**, specifically achieving **10 NM spacing** before handoff to APP.

- **Transferring the entire holding stack to APP** is only effective if APP has at least the **lowest 3-4 aircraft on their frequency**.
- This allows APP to **sequence aircraft efficiently** without wasting airspace.
- **Ideally, CTR manages the exit from holding** and only transfers aircraft to APP **once spacing is properly established**.
- **Poor Tactic to Avoid:**
    - Allowing each aircraft to **complete a full hold before handing it off to APP** results in **random and inefficient spacing**, making the **10 NM separation goal purely coincidental**.

1. **Plan Ahead**: The **next aircraft** to exit holding should be instructed **well in advance** to remain on the outbound leg of the hold, effectively flying a **downwind** pattern.
2. **Timing the Turn Back**:
    - When the aircraft is **slightly past the abeam point** relative to the preceding traffic (which is already inbound to the fix), issue a turn instruction.
    - This ensures the aircraft **falls in line behind the preceding aircraft**, creating the **desired 10 NM spacing**.
3. **Why More Spacing is Needed Compared to ILS Vectoring**:
    - Aircraft in a holding pattern are typically at a **higher altitude** and therefore have a **higher ground speed (GS)**.
    - Despite flying at approximately **220 KIAS**, their **true airspeed (TAS) is much higher**, requiring additional spacing.
4. **Maintain a Continuous Flow**:
    - As soon as an aircraft **exits holding and turns back toward the fix**, the **next aircraft must already be preparing for its exit**.
    - This ensures **smooth and efficient sequencing**, preventing gaps or bunching.

Effective holding management **requires proactive planning**. Controllers must:

- **Anticipate spacing requirements** before initiating aircraft exits.
- **Avoid inefficient full-pattern holds** before clearance.
- **Use outbound legs strategically** to maintain **orderly sequencing**.
- **Coordinate with APP** to ensure **handoffs occur at the right moment**.

Efficiently **clearing aircraft from holding patterns** requires continuous coordination and proactive level assignments.

1. **Follow Up on Cleared Levels Quickly**:
    - As soon as an aircraft **exits the holding pattern**, immediately **clear the aircraft above it** down to the newly available level.
    - You can instruct aircraft to **report reaching the assigned level**, ensuring you can **promptly clear the next aircraft above it** without delays.
    - This process **maintains a smooth cascade** of aircraft descending through the holding stack.
2. **Managing Holding Exits Like ILS Sequencing**:
    - Similar to **feeding aircraft to the ILS**, clearing aircraft from a hold requires structured sequencing.
    - **Think of the holding pattern like a downwind and final approach:**
        - The outbound leg acts as a **downwind**.
        - The inbound leg leading back to the fix functions as the **final approach**.
    - Aircraft should be instructed to **maintain outbound heading in advance**—failure to do so can result in **significant additional track miles** and disrupt sequencing.

Holding should be **used only as long as necessary** to prevent arrival gaps and ensure smooth traffic flow.

1. **APP and CTR Coordination**:
    - APP and CTR must communicate to determine how long aircraft **need to be delayed** to prevent excessive spacing or an empty arrival queue.
    - In many cases, **just one lap in the holding pattern** (approximately **4 to 5 minutes**) is sufficient to **restore approach capacity**.
2. **Planning the End of Holding**:
    - Consider the **timing of the last aircraft on final approach at APP** to determine when holding should begin to be reduced.
    - Taking into account the **remaining inbound distance**, CTR can **strategically reduce holding usage** to ensure a continuous flow of arrivals.

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