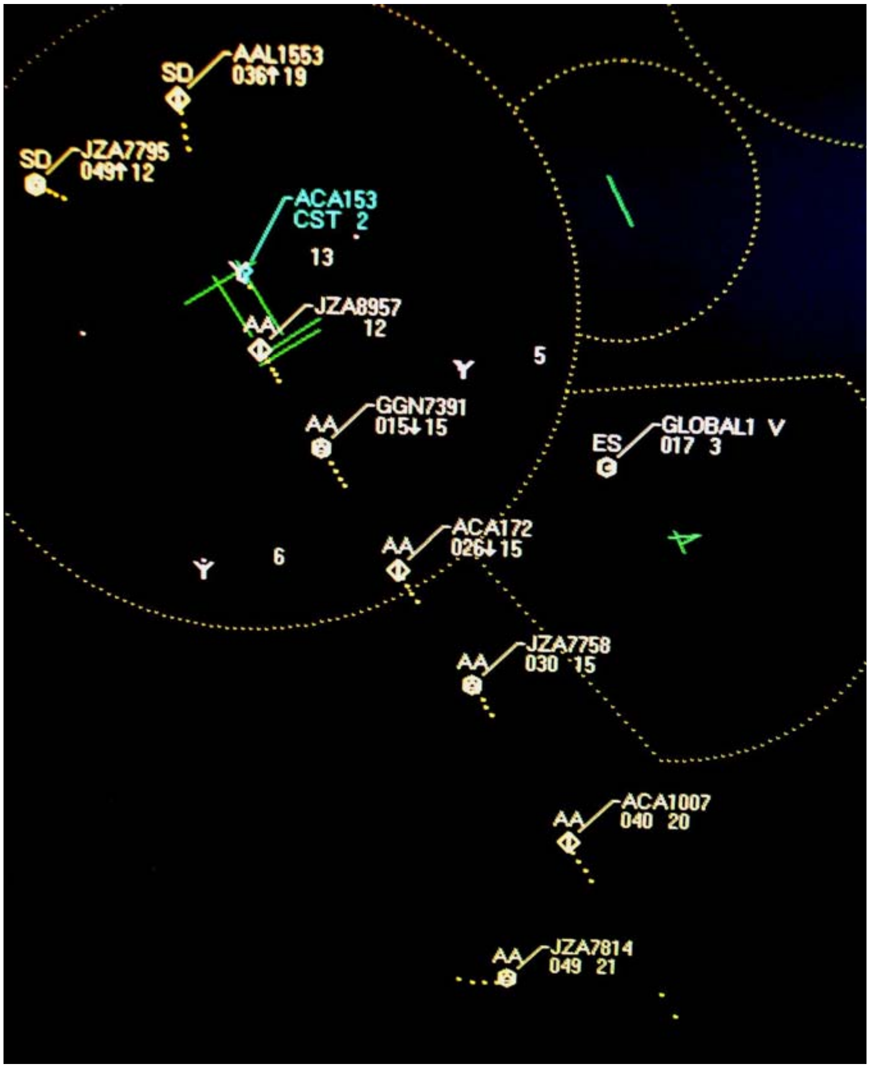
Unit VI – Toronto Arrival



1- Introduction

The Toronto Arrival controller accepts aircraft inbound to Pearson from enroute controllers and provides separation from departures and other arrivals in order that they may conduct an approach to Pearson. Due to the volume of traffic at Pearson, the control of arrivals is quite structured and the traffic pattern tends to remain constant. In order to use the limited arrival airspace effectively, the controller must be proficient at anticipating conflicts and providing accurate spacing between aircraft. In an attempt to be as complete and as realistic as possible the material in this module becomes quite detailed. Some topics are presented for information purposes only as they fall well beyond the scope of the knowledge required to control successfully on VATSIM.

2- Split Operations

Typically on VATSIM Pearson operates with one Arrival controller who handles all of the inbound aircraft and uses the primary frequency 132.80 MHz. When workload increases to the point where two controllers are needed to handle traffic safely, the Arrival position may be split in two ways:

North - South Split

Similar to how the Departure position may be split into North and South Departure, Arrival may be split into North and South positions during east/west operations. When in a North/South split, North arrival works traffic from two bedposts to runway 05/23 and uses the frequency 124.47 MHz. The South Arrival controller works traffic from the remaining two bedposts to runway(s) 06s/24s and uses the frequency 132.8 MHz.

Inner - Outer Split

An Inner/Outer split distributes the workload according to the arrival traffic pattern. The Outer controller works arrivals from the three non straight-in bedposts and establishes the aircraft into two downwind legs before transferring them to the Inner Arrival controller. The Inner controller takes these aircraft and turns them onto base leg and final approach, while integrating the aircraft from the straight-in bedpost. The Inner/Outer split may be used during east/west operations, but is commonly used when on the 33's so that the Inner controller may focus their effort on spacing aircraft precisely on final approach.

3- Separation

M533.2 states that a controller must separate aircraft by 1,000 feet vertically or, when directly behind and less then 1,000 feet below a preceding aircraft, or when following an aircraft conducting an instrument approach by one of the following minima:

Heavy behind a heavy	-	4 miles
Medium behind a heavy	-	5 miles
Light behind a heavy	-	6 miles
Light behind a medium	-	4 miles

When it is the lead aircraft, a B757 is considered to be a heavy.
Typically the Arrival controller will maintain vertical separation between aircraft until such time that the above radar separation is established. For example, the arrival controller may have a faster aircraft overtake a slower one on downwind leg, maintaining vertical separation until the required radar separation is in place. Lateral radar separation between aircraft less than 1,000 feet apart vertically is 3 miles.

4- Arrival Airspace

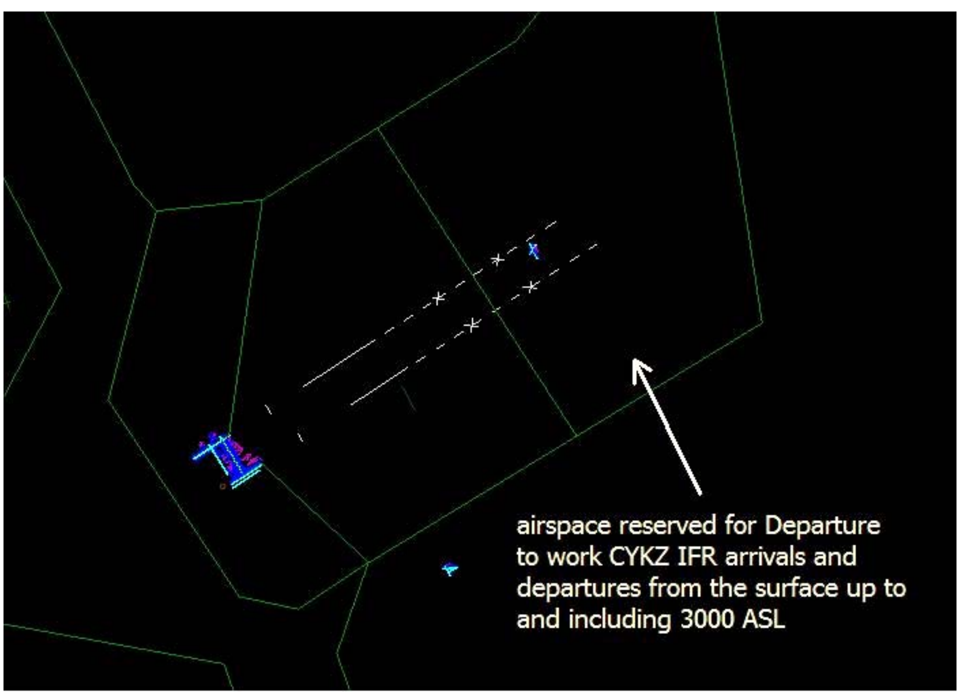
The Toronto Departure module explained the different areas of the Arrival Box and the altitudes which the Departure and Arrival controllers may use. The Toronto Arrival controller's airspace vertically is as follows:

Arrival Corridors	11,000 – 8,000
Pre-Descent area	11,000 – 6,000
Final Approach Area	11,000 – 3,000* (see section 5)

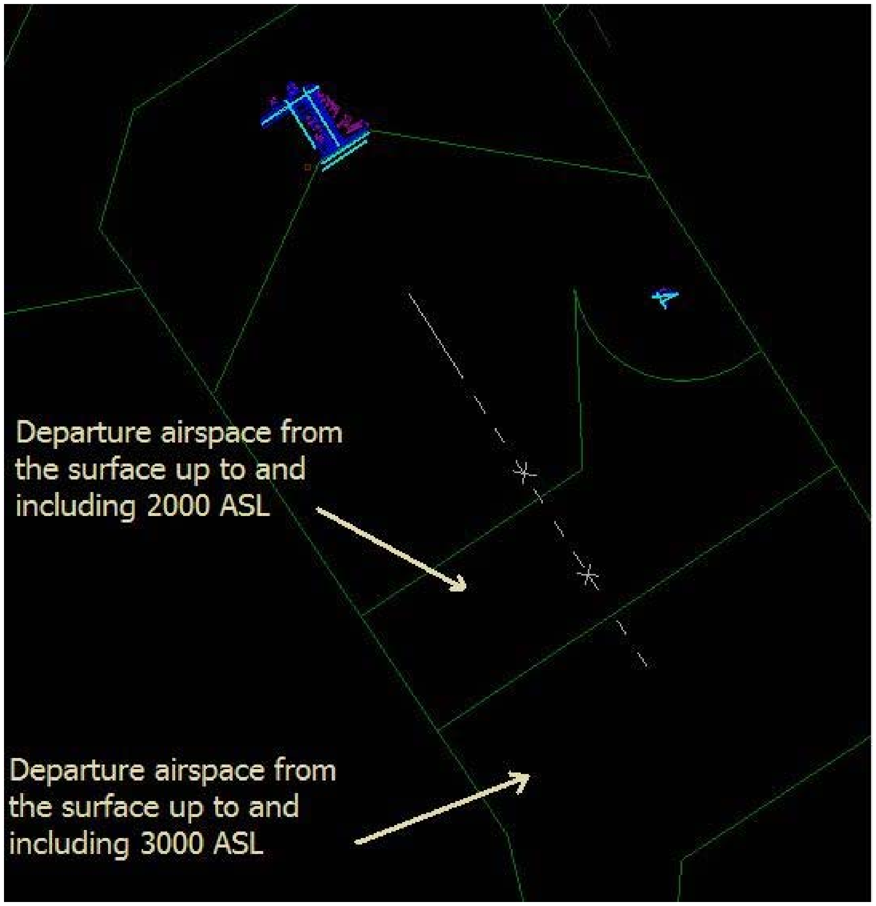
The above altitude ranges are inclusive, meaning that the Arrival controller may assign the altitudes which define the limits of their airspace. It is important to remember that the way the Terminal airspace is handled is dictated by the landing runway or runways at Pearson. The Arrival Box corresponding to the active landing runway(s) must be displayed by both the Departure and Arrival controllers regardless of the active departure runway or runways.

5- Satellite Airport Operations

In order to accommodate IFR traffic into and out of CYKZ and CYTZ, airspace within the Final Approach Area is reserved to prevent conflictions with Pearson arrivals. The most critical situations involve CYKZ when Pearson is landing westbound, and with CYTZ when Pearson is landing on 33L/R. IFR traffic worked by the Departure controller into and out of CYTZ and CYKZ use airspace reserved below the above-lying Arrival airspace in the Final Approach Area. The Arrival controller must not descend any of their aircraft into airspace protected for CYTZ and CYKZ. For example, as seen below when Toronto is landing 23/24R, the Arrival Box contains a section over CYKZ reserved for the Departure controller from 3,000 ASL to the surface. Here Arrival cannot descend aircraft below 4000 until outside of this area.



When Toronto is landing on 33L or 33R, the Final Approach Area overlay contains regions which show airspace reserved for the Departure controller from 2,000 and 3,000 to the surface.



6- Communication and Control Transfer

In general, any handoff should occur as close as possible to the next controller's area of jurisdiction. On VATSIM it is advisable for controllers to initiate early handoffs. Handoffs from the Enroute controller to Arrival may occur up to ten miles outside of the terminal boundary in order to facilitate the communication transfer and to ensure that Arrival is in communication with the aircraft by the time the aircraft enters Terminal airspace. For example, an aircraft inbound to Simcoe VOR will normally be handed off from Centre to Arrival once it has been observed to have made a left turn towards WASIE at an appropriate speed and altitude in order to comply with any issued restrictions. It is important to note that acceptance of a handoff from the Centre controller outside of the Terminal airspace does not constitute a transfer of control of that aircraft to the Arrival controller **M139.4**. Because Arrival does not have control of the aircraft until it enters the Terminal airspace, they may not authorize a change in the aircraft's altitude, route or speed **M139.3**. In addition, acceptance of a handoff by Arrival of an aircraft outside of the Terminal airspace does not relieve the Centre controller of ensuring separation for that aircraft. For example, if the Centre controller has two aircraft approaching the Terminal boundary and it appears that separation may be compromised, the Arrival controller is not responsible to ensure that separation between the two aircraft is sustained. If the Centre controller has failed to ensure separation, Arrival, with co-ordination with Centre must take action to attempt to preserve separation between aircraft if possible.

Arrival should initiate a handoff of an arriving aircraft to Tower as soon as they are satisfied that the aircraft is established on final approach to the proper runway and separation will be assured with other arrivals to the same or parallel runway. Ideally on VATSIM, aircraft should be in communication with Tower prior to reaching the FAF so that Tower will have sufficient time to issue control instructions to the aircraft if required. **M495.2** states that control of an arriving IFR aircraft is automatically transferred from the IFR unit to the Tower as soon as the aircraft has landed unless otherwise coordinated. This means that the IFR unit (Arrival) is responsible for the radar separation between aircraft until they have landed. This is not the case with Toronto Tower. As mentioned in previous modules Toronto Tower is different than other towers in that it has authority to assume control of all arrivals at the FAF. Interpreted literally this means that Arrival is only responsible for separation between aircraft until the time that they pass the FAF. This statement is not meant to imply that it is acceptable for the Arrival controller to handoff aircraft with improper or proper, yet decreasing spacing simply because the tower will be responsible for them at the FAF. In a situation where proper separation between an aircraft on final and an aircraft inside the FAF is decreasing, the Arrival controller must issue control instructions to try to maintain appropriate separation.

7- Enroute Responsibilities

Unless otherwise coordinated, aircraft landing Pearson enter the Terminal via one of the following Terminal entry points or bed-post fixes: FLINE, WASIE, LINNG or ROKTO. The Centre controller instructs jets entering the Terminal to:

- Cross the straight-in fix at a speed of 210 kts and at 7000

- Cross the non straight-in fixes at 250 kts and at an altitude of:

	9,000 at FLINE	
11,000 at ROKTO		10,000 at WASIE
	10,000 at LINNG	

Jet arrivals inbound to Pearson when not via a bed-post fix must be pre-coordinated with Arrival, pointed out to Departure and are to track direct YYZ VOR to cross 25 miles from YYZ VOR at 7000 and 210 kts when proceeding towards a straight-in runway. When proceeding to a non-straight in runway, jets cross 25 miles from YYZ VOR at 10000 and 250 kts.

Centre shall: Provide a minimum of 10 miles-in-trail between successive, similar type aircraft to a Terminal entry fix with spacing remaining constant or increasing.

Centre may: Co-ordinate turboprop arrivals to Pearson to enter Terminal airspace at an altitude 1,000 feet below the altitude which jets enter the Terminal, when not inbound to the straight-in bedpost fix.

8- Noise Abatement

As in the case of Tower and Departure controllers, noise abatement is an issue for which the Arrival controller also has a responsibility to help in minimizing noise levels to the community. On VATSIM, aircraft noise is not an issue however the Arrival controller should still attempt to follow the guidelines set out in order to increase realism of simulation. Arrival controllers whenever possible should apply control techniques that allow continuous descents, few speed reductions and reduced power settings and never deviate from the noise abatement procedures unless for safety reasons **M136.1**. In order to minimize noise levels, jet aircraft are vectored to intercept final at or above 3,000 ASL with a turn onto final no closer than the FAF. The published noise abatement procedures in the CAP describe the restrictions in place to enable aircrews to fly approaches into Pearson satisfying the GTAA's noise requirements. Approach noise is minimized when:

- The aircraft maintains 3,000 ASL or above until intercepting the final approach course

- Interception of the final approach course occurs at or outside the FAF and

- The aircraft remains on or above the glide slope or an assumed 3.0 degree glide slope.

9- Service Priority

Normally Air Traffic Controllers provide service to aircraft on a 'first come, first served' basis however there are exceptions to the rule **M132.1**. Highest priority is given to:

- An aircraft that has declared an emergency, or appears to be in a state of emergency but is unable to inform ATC and

- An aircraft that informs ATC that it may be compelled to land due to factors other than fuel shortage effecting its safe operation.

Second highest priority is given to MEDEVAC flights. At Toronto MEDEVAC flights are given the closest runway to where they will be parking unless it violates noise abatement procedures. Because of miscommunication between ATC and aircrews, reports of fuel shortage are handled as follows **M132.4**: If an aircraft informs ATC of fuel shortage or uses any non-standard phraseology which indicates a possible concern about a fuel shortage, the controller is to ask whether the pilot is declaring and emergency. Priority will be given to the flight if in fact an emergency is declared. In the past there has been some confusion when a pilot would declare they are at 'minimum fuel'. Minimum fuel is not a declaration of an emergency but it indicates that an emergency could occur with any undue delay **M132.5N**. The Enroute controller will advise Arrival well in advance of any inbound aircraft that requires priority service.

10- Approaches at CYYZ

Aircraft landing at Toronto Pearson are required to fly straight-in instrument or visual approaches. Circling approaches, contact approaches and full procedure instrument approaches are not permitted. Flight paths of straight-in instrument and visual approaches are restricted to comply with the published noise abatement procedures in the CAP. On VATSIM there are no localizer or glide slope unservicablilites so ILS and visual approaches will always be in use. At times when a component of an ILS has been NOTAMed unservicable, it may be simulated on VATSIM, however there is no requirement for aircraft to fly a non-precision approach such as a localizer, NDB, RNAV or a visual approach. When weather limits fall below the CAT I ILS minima, Pearson uses runway 05 or 06L for arrivals capable of flying a CAT II ILS approach. Runways 05 and 06L are the only CAT II and CAT III certified runways at Pearson. CAT II and CAT III ILS approaches will be discussed in more detail in section 22.

11- Indicated Airspeed, True Airspeed, Ground Speed and Wind Effect

It is important for the Arrival controller to have an understanding of the relationship between true, indicated and ground speed. What is seen on the controller's radar display is ground speed while the airspeed that controllers and pilots refer to in practice is indicated airspeed. Indicated airspeed is the speed displayed in the flight deck and can be thought of as a measure of how hard air is being pushed against the aircraft's nose as it flies. Because of the effects of temperature and density with altitude, indicated airspeed is not an accurate measurement of how fast the aircraft is really moving through the air. True airspeed measures how fast an aircraft is actually moving through the air and can be calculated from IAS taking into account the effects of outside air temperature and density. Under standard conditions and at sea level, True Airspeed (TAS) equals Indicated Airspeed (IAS). However as altitude increases, TAS increases greater than IAS does. Under standard conditions, TAS increases 2% more than IAS does per 1000 feet of altitude. For an aircraft indicating 250 kts this equates to an extra 5 kts for every 1000 feet of altitude. Thus an aircraft indicating 250 kts at 10,000 under standard conditions will have a TAS of 300kts. With no wind, radar will show the aircraft moving at 300 kts GS while the pilot flies the aircraft at 250 IAS. The discrepancy in speed is further affected by the winds aloft. A 20 knot tailwind acting on this aircraft will show the controller the aircraft as having a ground speed of 320 kts which is 70 kts higher than the 250 kts IAS which the pilot is flying at.

The Arrival controller must also be aware of the effect of the winds aloft on an aircraft's track. For aircraft on FMS STARs, the effect of wind on their track is irrelevant since they fly directly from fix to fix. However, an aircraft that is flying a radar vector will show a track on radar which results from the compass heading being flown by the aircraft and the drift effects caused by wind. To try and maintain consistent downwind and base legs, the controller must take drift into account and correct for it. If unsure of what the winds aloft are, the controller may ask a pilot for a spot wind report to help determining what type of corrective heading should be used. Generally the winds aloft around Pearson are from the west or northwest. Even when surface winds are from the east and require operations on runways 05/06L, the winds aloft may still be sizable from the west.

The following is an example of the effects of winds aloft, IAS and TAS to the Arrival controller. With surface winds 270/20 it is reasonable to expect that the winds aloft to be greater than those at the surface, and therefore an aircraft overhead ROKTO at 11,000 and 250 kts IAS would show a ground speed of well over 300 kts. Once on left downwind leg for runway 24R, still with a tailwind component, an aircraft indicating 210 kts will likely show a groundspeed of over 250 kts. The groundspeed of an aircraft on downwind will normally decrease as the aircraft descends for two reasons. The first is that wind speed normally diminishes closer to the ground and secondly even when maintaining a constant IAS in descent, the difference between TAS and IAS decreases with altitude. When the aircraft turns base, it may show a sharp drop in ground speed as the tailwind component now acts as a crosswind component and tries to push the aircraft to the east while it is pointed in a north northwest direction. Once turned onto final, groundspeed may drop significantly again as the aircraft slows for final approach and the crosswind component encountered on base changes into a headwind component on final.

12- Arrival Pattern

The Arrival controller will try to maintain a constant rectangular pattern of arrival traffic in the vicinity of the airport. This is done by forming one or two linear downwind legs. Keeping downwind legs fairly close to the airport allows the Arrival controller to better judge when to turn aircraft from downwind leg onto base leg. Inbound aircraft that will have to fly from one end of the airport to the other for landing; for example from YWT to land 24R, will fly a track that takes them close to the departure end of the active runway(s). This flight path helps to minimize the amount of time that a departing aircraft may have to level off below an arrival in a head-to-head situation. Aircraft which do not indicate an FMS or RNAV STAR in their flight plan are to be vectored to final.

13- Minimum Vectoring Altitude

The minimum vectoring altitude by definition is the lowest altitude at which an aircraft may be vectored by ATC. This altitude meets both obstruction clearance and radio coverage requirements in the airspace specified. The minimum vectoring altitude (which is also the minimum IFR altitude) within 26 miles of Pearson airport is 3,000 ASL except for the area south of the north shore of Lake Ontario where the MVA is 2,000 ASL. IFR traffic to and from City Centre airport may be vectored at 2,000 ASL over Lake Ontario. Within 3 miles of the CN Tower the MVA is 3,100 ASL and this is the reason 3,100 ASL appears on the FMS STARs at the DTWs GUBOV and VIXAN. For simplicity on VATSIM we will disregard 3,100 and use 3,000 as the MVA.

14- Aircraft Speed and Speed Restrictions

All aircraft enter the Terminal with a speed restriction issued by the Enroute controller. After having passed their bedpost fix, an aircraft may begin slowing as they get closer to the field without notifying ATC. Arrival may instruct an aircraft to adjust its speed if required, to achieve or maintain spacing, or to minimize vectoring **M544.1**. Aviation regulations require that an aircraft within 10 miles of a controlled airport and at an altitude of less than 3,000 AGL may not exceed 200 knots. For Pearson, which has an elevation of roughly 600 ASL, this means aircraft should be at 200 knots indicated or less once they begin to descend below 3600 ASL. The speed restrictions depicted on the FMS STARs comply with the above restriction. Although pilot technique varies, in general aircraft will try and maintain as high a speed as possible until they are required to slow to comply with a speed restriction imposed by ATC, or must begin to slow in order to configure the aircraft for their approach. If not inbound from the straight-in fix, aircraft will typically maintain 250kts until entering a downwind leg. Once on downwind aircraft will slow, but may stay above their 'minimum clean' airspeed which enables them save fuel by not having to deploy slats or flaps which cause extra drag. This speed will vary from aircraft to aircraft and depends on aircraft weight; however an airspeed in the range of 210-220 kts permits most jet aircraft to remain 'clean'. As the aircraft continues to descend on downwind they are expected to slow to 200 kts or less as they pass through 3,600 ASL to comply with above mentioned aviation regulation.

Aircraft speeds are to be issued in multiples of 10 knots of indicated airspeed **M544.2A**, and pilots are expected to maintain the assigned speed within plus or minus 10 kts **M544.2A.N**. When assigning speeds to aircraft, it should be done in a manner which does not necessitate alternating increases and decreases in speed **M544.5**. Speed assignments when applied to arriving aircraft should always be a decreasing trend. The minimum assignable speeds to aircraft are governed by type, distance from the aircraft and altitude. When an aircraft is within 20 miles of the airport the minimum assignable speed to a jet is 160 kts, and is 120kts for a prop.

To aid in providing the Tower with consistent space between arrivals, when a runway is used concurrently for arrivals and departures (mixed-mode) the Arrival Controller instructs aircraft to cross the FAF at a speed no greater than:

- 160 IAS when in IFR conditions

- 170 IAS when in VFR conditions

These restrictions help to ensure that the amount of time aircraft take to fly from the FAF to the threshold remains consistent in order to aid the Tower in departing aircraft between consecutive arrivals. The Arrival controller may wish to apply the speed restriction to aircraft earlier than at the FAF in order to preserve spacing between successive arrivals turned onto final approach. For example consider two aircraft being vectored to final with the first aircraft turned onto the localizer with an assigned speed of 190kts and told to cross the FAF at 170kts. Instructing the next aircraft to maintain a speed of 170kts now and until the FAF ensures that spacing between the two aircraft will not decrease. Normally on VATSIM the speed of an aircraft on final approach should not need to be restricted.

15- Initial Contact

On initial contact with an aircraft landing at Pearson on VATSIM, the Arrival controller shall identify themselves and state the aircraft's assigned runway for landing and the Toronto altimeter.

Example: "American 343, Toronto Arrival, runway 24R altimeter 29.76"

Because there is no provision for a full, proper ATIS message on VATSIM it is not required for the aircraft to state they have received the Arrival controller's brief ATIS message. In reality the Toronto ATIS would contain the latest weather, runway surface conditions (if applicable), the IFR approach or approaches, the departure runway or runways and inform aircrews when simultaneous parallel approaches or departures are in progress. A request for a runway other than an active arrival runway must be co-coordinated and authorized by Toronto Tower before approved. Each aircraft should state their present altitude on initial contact with the Arrival controller and their altitude restriction if they haven't yet reached level flight. The controller must verify the aircraft's stated altitude with the altitude display on their radar **M503.1** prior to using it as a means to provide vertical separation with any other aircraft. If there is a discrepancy between the aircraft's stated altitude and the altitude shown on the radar display the controller should re-issue the current altimeter and request another altitude verification from the pilot **M503.2**. An altitude discrepancy is possible if the pilot has forgotten to change their altimeter from the standard pressure setting of 29.92 to the local altimeter setting while in descent through FL180.

It is not required to inform an aircraft that they are radar identified if the aircraft was transferred via a radar handoff from Centre **M511.1I**. When Centre is not on-line radar identification of an arrival is normally accomplished by having the aircraft 'squawk ident' **M511.1E**. An arriving aircraft can also be radar identified when it makes a position report over a fix displayed on the radar display and its position and direction of flight is consistent with the pilot's report **M511.1B**.

16- RNAV STARs

An RNAV STAR makes use of aircraft aRea NAVigation capabilities to permit the pilot to fly the lateral (point to point) portion of the published procedure all the way from the bedpost fix to interception of the localizer. A pilot that is able, and has been authorized to fly an RNAV STAR relieves the Arrival controller of vectoring that aircraft to final approach. In Canada it was the request of one of the major airlines that started the development into the FMS STARs. The STARs benefit both ATC and pilots by streamlining arrival procedures and help airlines reduce fuel costs. For these reasons an aircraft that has filed an RNAV STAR should be permitted to conduct their own navigation to the fullest extent possible **M569.1** traffic permitting.

There are two categories of RNAV STARs published for Pearson, those to be used during quiet hours (BORDN, WASIE, LINNG and ROKTO) and the daytime STARs (MANS, SIMCO, YOUTH, and WTRLO). Other than different altitude and speed constraints to reduce noise levels during quiet hours, the night and daytime STARs are essentially the same.

The STARs can be further classified into two types; open and closed STARs. A closed RNAV STAR consists of a track which takes the aircraft from the straight-in bedpost to join the localizer at the FACF (Final Approach Course Fix). An example of this is the WTRLO arrival for runways 05 and 06L. An open RNAV STAR takes aircraft from a non-straight in bedpost fix along a track that ends at a Downwind Termination Waypoint or DTW. Upon reaching the DTW the aircraft either continues downwind on the heading depicted on the chart, or when authorized by ATC to do so, turns directly to the FACF to intercept the localizer of their assigned runway. An example of this is the WTRLO arrival for runways 23 and 24R.

The way RNAV STARs at Toronto are handled is possibly different than the way RNAV STARs are handled at other airports in Canada. In order to reduce the possibility of confusion with pilots, Toronto ATC refrains from using the word "cleared" with an aircraft flying an RNAV STAR until an approach clearance is issued. **M569.2** states that an aircraft with an RNAV STAR included in the route portion of their flight plan is to be considered as previously cleared for the STAR. This means that there is no need or requirement for Centre or Arrival to re-clear an aircraft for a STAR. This might differ from what could be heard at a place like Halifax: "ACA123 cleared the FUNDY6 Arrival for runway 23, maintain 6,000". In terms of the vertical profile of the STARs, it is stated on all of the plates that "all altitudes will be issued by ATC". The Arrival controller is to issue lower altitudes to aircraft in a manner so that they remain within the arrival airspace as they proceed toward the field. Without an approach clearance, once a non straight-in aircraft reaches its DTW, the RNAV STAR is cancelled and the aircraft is expected to fly the heading depicted on the STAR. In fact, anytime that an aircraft is issued a radar vector it cancels the RNAV STAR **M569.1N.** It is important to remember that it will take the pilot a few seconds to engage their FMS once an approach clearance is issued and for this reason Arrival should issue an approach clearance prior to the aircraft reaching 3 miles from the DTW **M569.3**.

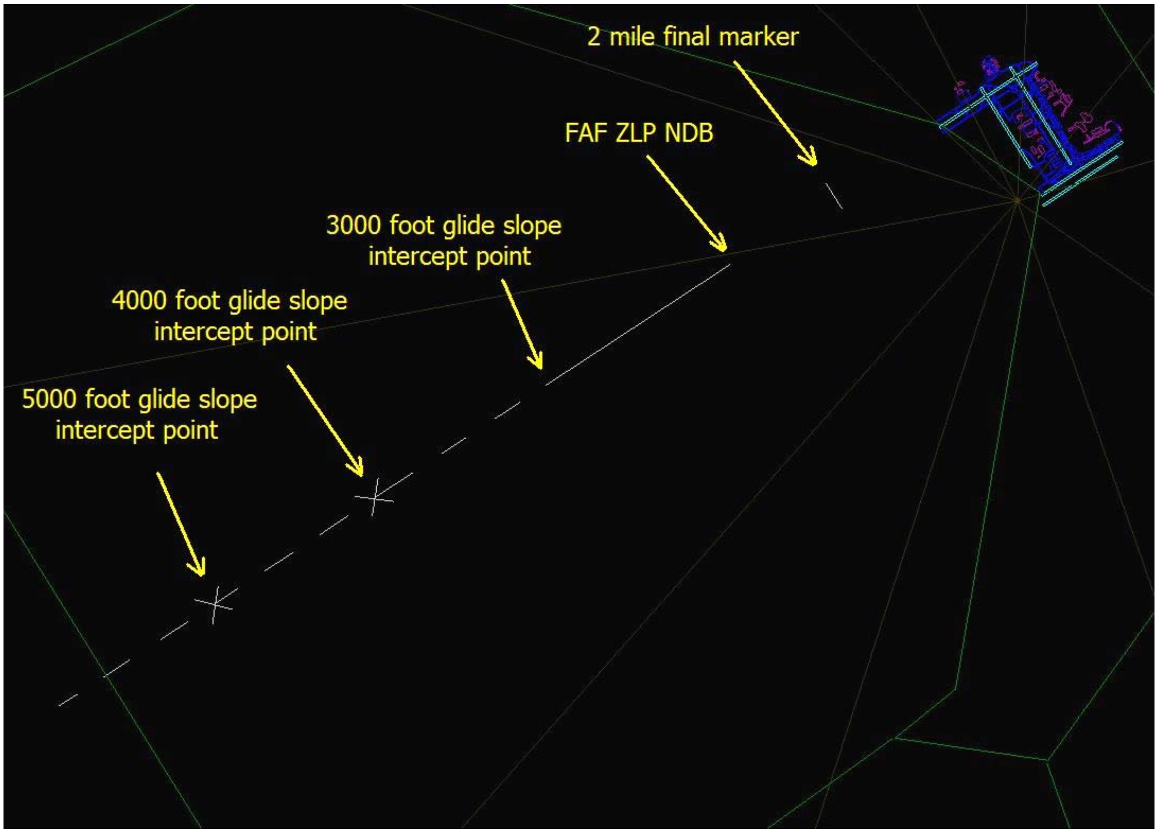
17- Vectoring Aircraft to Final Approach

Arrival is to vector aircraft to a position from which they are to be turned final:

- At an angle of 30 degrees or less and
- At a position at least 2 miles from the point where final descent begins

An intercept angle of 30 degrees or less permits the aircraft to execute a shallow turn to join final and, when using an autopilot should allow the aircraft to lock onto the localizer and become properly established without drifting through the final approach course. The phrase 'the point where final descent begins' refers to the location where the aircraft will leave its last assigned altitude and descend on the glide slope. The ASRC/VRC Terminal sector file contains final approach path overlays which are to be displayed for the active landing runway(s). Each overlay consists of a dotted final approach path with two crosshairs along it followed by a solid line segment which ends approximately 4 miles from the landing threshold. From the landing threshold back, the solid line begins at the FAF and ends at the 3,000 ASL glide slope point. The two sets of crosshairs beyond the solid line segment represent the 4,000 and 5,000 foot glide slope interception points respectively. The end of the dotted line is at the 6,000 foot glide slope intercept point. With the overlay displayed, the Arrival controller is able to see the locations where aircraft should be turned onto final in order to comply with **M564.1**.

Runway 05 final approach course overlay



The requirement to intercept final at a point 2 miles from the glide slope intercept point may be reduced to 1 mile if the conditions of **M564.2** are met. The most important point of **M564.2** is that an aircraft may be turned to intercept final one mile prior to the glide path interception point if the glide path is intercepted at 3,000 AGL or above. Since the elevation of Pearson is roughly 600 ASL, this means that aircraft that intercept final at 3,000 ASL must be 2 miles from the glide slope intercept and aircraft intercepting final at 4,000 ASL or above may do so 1 mile from the 4,000 foot glide slope point. **M564.3** states that the distance an aircraft can be vectored to final can be further reduced to any distance, but no closer than the FAF provided the aircraft requests it. It would be unlikely that a jet would be able to land successfully at Pearson if put on final approach at the FAF and at 3,000 to abide to the noise restrictions. Being at 3,000 ASL at any FAF puts the aircraft well above the glide slope requiring it to descend rapidly in an unstable approach.

18- Single Arrival Runway

Unlike the real Pearson airport which normally must have two arrival runways active to keep pace with traffic demands, on VATSIM usually a single arrival runway will suffice. During the night and periods of low traffic, Pearson will downgrade its operation to one which lessens the noise impact to the community yet is still able to accommodate the anticipated traffic levels by using a single arrival and a single departure runway. A benefit to having a dedicated arrival runway is that the Arrival controller can 'jam' the runway with arrivals since it will not be used at the same time for departures. This allows spacing on final to be 3 miles or the applicable radar wake turbulence minima. As mentioned in the Tower module, when a runway is used in 'mixed mode' Arrival spacing becomes 5 miles or more in order to accommodate departures.

There is an exception to the wake turbulence separation standards of **M532.2** (shown in section 3) which permits the separation between IFR arrivals under certain circumstances to be reduced. The exception **M532.1C** is applied at Pearson when landing runway 33L and permits arrival spacing to be reduced from 3 miles to 2.5 miles provided:

- The lead aircraft is not a heavy
- The following aircraft's wake turbulence category is the same or heavier than that of the lead aircraft and
- The runway is bare

In addition to the above requirements, the Tower must ensure:

- All the runway exits for that runway are visible and
- The length of time required for an arriving aircraft to proceed from over the landing threshold until they are clear of the runway is 50 seconds or less (this is known as runway occupancy time or 'ROT').

This exception came about to try and mitigate the drop in arrival capacity when Pearson is forced into a 33 operation. Reducing the required spacing on final from 3 nm to 2.5 nm (when possible) helps to increase the acceptance rate slightly. This reduced spacing on 33L will not be simulated on VATSIM.

19- Approach Information and the Approach Clearance

Normally a controller handling arriving aircraft will clear them to a fix from which an instrument approach may be carried out from **M561.2**. When in a Terminal radar environment like Toronto Terminal, **M561.3** states that an arriving aircraft need not be issued a clearance limit. Once the controller initiates vectoring of an aircraft they are to inform the aircraft of the purpose of the vectors and/or the point to which the aircraft is being vectored **M541.3**. Although an aircraft that does not file an FMS STAR should be informed that they will be vectored to final, usually **M541.3** is disregarded because it is obvious as to what the Arrival controller will be doing for them. The exception to **M541.3** is when an aircraft flying an open FMS STAR has reached the DTW and is proceeding on the heading depicted on the STAR. Since the STAR already states that aircraft are to fly the depicted heading for radar vectors to final, it would be redundant for the controller to also advise them of this.

The Arrival controller terminates vectoring of an aircraft once the aircraft has been cleared for an approach **M547.1A** and **M547.2** states that it is not necessary to inform the aircraft that vectoring has been discontinued. Because radar vectoring is terminated by an approach clearance, **M545.1B** states that the controller must inform the aircraft of its position unless it is known that the pilot has the information. Many modern jet and prop aircraft flying today contain GPS and moving map displays which give the pilot a means to know exactly where the aircraft is at any given time. For this reason especially during times of high controller workload **M545.1B** is sometimes disregarded.

An Approach clearance is something that the Arrival controller gives at some point in time to every aircraft that they are in contact with. An approach clearance is an authorization for an aircraft to proceed to the destination airport by the means issued in the approach clearance, which may include restrictions. At Pearson most approaches are straight-in ILS approaches. The approach clearance is to contain the name of the approach as it appears on the chart in the CAP publication such as "ILS runway 06L". If the aircraft is vectored to the final approach course, the name of the airport need not be included in the approach clearance, and in fact in a busy Terminal such as Pearson the airport name is always omitted for brevity.

M563.1 states that approach information is to be issued to an aircraft when on the final approach course, or immediately before the turn to the final approach course. Approach information includes:

- The vector to intercept the final approach course
- The distance from the FAF, final approach course or the airport
- The approach clearance and
- Instructions to change to the Tower

For an aircraft flying an ILS approach, the final approach course is the localizer of the assigned arrival runway. Position information may be issued in different ways such as: "12 miles east of the airport", "2 miles south of the localizer" or "6 miles from NOAHA". With all of the information above included, an example of complete approach information is:

"American 343, turn left heading 270 intercept the 24R localizer, 5 miles from NOAHA, cleared straight-in ILS 24R approach. Contact Toronto Tower now 118.35"

In practice, the Arrival controller would never issue a frequency change in conjunction with the approach clearance as above, because at that point in time the aircraft has yet to become established on the final approach course and must be monitored for compliance until it does. Instructions to change to the Tower are normally given later on VATSIM so that the Tower will be in contact with the aircraft prior to them reaching the FAF.

Because an approach clearance cancels any previously imposed altitude or speed restrictions issued to an aircraft, the controller must re-issue any necessary restrictions. **M563.2** states that the controller must specify altitude restrictions to ensure that the aircraft does not descend below the minimum IFR altitude until they are on the final approach course, if an approach clearance is issued prior to the final approach course. To ensure aircraft remain above the minimum IFR altitude (here the MVA) the controller may issue "not below 3,000 until established on the localizer" with the approach clearance. This restriction not only complies with **M563.2**, it also ensures the aircraft's flight path will adhere to the noise abatement procedures. Speed restrictions may be expressed in relation to the FAF by: "cross NOAHA at 160/170 kts", or "speed 160/170kts or greater to NOAHA".

With all of the elements of approach information issued at once a very long transmission is created which in turn requires a very long readback. To avoid frequency congestion, approach information is normally issued in more than one transmission such as:

- "American 343, turn left heading 270 intercept the 24R localizer"

- "American 343, 5 miles from NOAHA, cleared straight-in ILS runway 24R approach, leave 3,000 on the glide slope"

- "American 343, cross NOAHA at 170 kts contact Toronto Tower now 118.35"

The phrase "leave 3,000 on the glide slope" tells the aircraft to descend from their last assigned altitude of 3,000 only when intercepting the glide slope. In practice this is sometimes stated as: "leave 3 on the slope"

20- Parallel ILS Approaches

There are two distinct types of parallel ILS approaches which may be run at Pearson: Dependent and Independent parallel ILS approaches.

Dependent parallel ILS approaches require that the controller uses vertical and/or radar separation between aircraft until such time that the aircraft become established on their respective localizers. Then once established on their respective localizers, diagonal radar separation between the aircraft must be maintained.

When independent parallel ILS approaches are in use, aircraft do not have to be staggered on adjacent localizers by a specific radar separation, however more stringent rules are required to be obeyed because aircraft are permitted to be closer together than what normal radar separation allows. With simultaneous independent ILS approaches, aircraft on parallel localizers may be flying side by side on final approach.

Simultaneous Dependent Parallel ILS Approaches

M572.1 provides all the details of how simultaneous *dependent* ILS approaches are to be conducted. The main points of interest are:

- All aircraft intercept final at least 2 miles from the glide path intercept
- There is no provision to reduce the distance to intercept the glide path to 1 mile
- 3 miles or 1,000 feet of vertical separation is maintained until both aircraft are established on their respective localizers
- When the distance between parallel runways is between 2,000 and 4,300 feet, successive aircraft on adjacent localizers must be spaced diagonally by at least 1.5 miles
- When the distance between parallel runways is greater than 4,300 but less than 9,000 feet, successive aircraft on adjacent localizers must be spaced diagonally by at least 2 miles.

At Pearson, because the distance between runways 15L/R and 33L/R is less than 9000 feet, they must be operated dependently.

Simultaneous Independent Parallel ILS Approaches

Because independent parallel approaches permit aircraft on adjacent localizers to be in close proximity to each other being separated by less than 3 miles or 1,000 feet vertically, stringent procedures must followed in order to ensure safety **M571.1**. Whenever SIPIA's are in progress, there must be a controller manning the ILS Monitor position. The ILS Monitor's function is to continually watch IFR aircraft conducting SIPIA's within 15 miles of the airport on radar. The ILS Monitor takes action if necessary on their own frequency which over-rides the Tower's frequency should control instructions need to be issued for separation purposes. The ILS Monitor watches aircraft as they fly along their localizer making sure that they remain in their Normal Operating Zone or 'NOZ'. The NOZ is a tube of airspace that surrounds each of the final approach course localizers and provides sufficient room for normal aircraft maneuvering when on final approach. If an aircraft approaches the edge of their NOZ the ILS Monitor will provide a vector back to the centerline. The ILS monitor also watches a section of airspace between the final approach courses of the parallel runways called the No Transgression Zone, or 'NTZ'. The NTZ is an area 2,000 feet wide that lies between the parallel runways. If an aircraft's track appears as though it will penetrate the NTZ the ILS Monitor will vector the aircraft back to their centerline. If an aircraft has or is just about to penetrate the NTZ the ILS Monitor will issue instructions to the aircraft on the adjacent localizer so as to avoid the deviating aircraft. The ILS Monitor is essential for safety because aircraft may be side by side and close to each other's altitude when on final. The ILS monitor will not be simulated on VATSIM. To run SIPIA's:

- Aircraft intercept final at least 2 miles from the glide slope intercept
- Aircraft are provided with at least 1 mile of straight and level flight prior to intercepting the final approach course and
- At least 1,000 feet of vertical separation is maintained between aircraft using parallel localizers until they both are established on their localizer and are within their NOZ.

The purpose of providing 1 mile of straight and level flight prior to intercepting the localizer is to give aircraft time to dissipate any excess speed and prevent overshooting the final approach course.

21- Parallel Approaches at Pearson

At Pearson whenever Arrival conducts parallel operations controllers use what is known as 'Hi-Lo' procedures. 'Hi-Lo' procedures provide 1,000 feet of separation between arriving aircraft until they are established on their respective localizers. Runways 06L/24R and 15L/33R are considered the standard 'low side' runways and 05/23 and 15R/33L the 'high side' runways. With co-ordination between Arrival controllers the 'high' and 'low' side runways may be changed. The controller vectoring to the low-side runway will have their aircraft turn final at 3,000 or above and the high-side controller's aircraft will turn final at 4,000 or above. The low-side controller is responsible to ensure compliance with the high-low procedures.

At Toronto, runways 33L and 33R fall under the category of dependent parallel runways which are between 2,500 and 4,300 feet apart. Therefore when aircraft are on final approach simultaneously to 33L and 33R they must be spaced diagonally by at least 1.5 miles. Because the parallel east-west runways (05/23 and 06L/R-24L/R) are more than 9,000 feet apart, when operated dependently, standard lateral radar separation of 3 miles is used between aircraft once established on adjacent localizers.

Simultaneous dependent approaches may be conducted when in a 'land one, depart one' configuration. In a land one, depart one configuration, one runway is designated as the primary arrival runway and the other parallel as the departure runway. The departure runway may also serve as the secondary or 'off-load' approach runway. The 'off-load' runway is normally only used when the arrival traffic becomes temporarily heavy.
'Dual' is a term used at Pearson to describe an operation that provides a balanced arrival and departure load to a set of parallel runways. 'Dedicated' is a term used to indicate when fully independent runway operations are in use. When in a dedicated operation, departures are assigned their runway based on their flight planned route and arrivals are sent to a specific runway based on their terminal entry fix. We have seen how this type of operation eliminates cross-overs and complexity for Departure, but the same can be said for Arrival when landing traffic is assigned to specific runways.

When in a 05/06L operation:	YMS and YWT traffic land runway 05
	YSO and LINNG traffic land runway 06L
When in a 23/24R operation:	YMS and YSO traffic land runway 23
	YWT and LINNG traffic land runway 24R

22- Triple Operation

For the Arrival controller the 'Triple' operation at Toronto is simply simultaneous independent parallel ILS approaches using the two outermost parallel runways. During the triple, simultaneous parallel departures are conducted on the inner of the two south close parallels along with runway 05/23. This configuration provides Toronto with one mixed mode runway, a dedicated arrival runway and a dedicated departure runway. Essentially the south complex changes from a single runway operated in mixed mode (06L/24R) to a land-one depart-one using 24L/06R and 24R/06L. The impact of the triple operation to Arrival controllers is minimal compared to the Airport controllers.

23- CAT II and CAT III approaches

In general CAT I ILS limits are visibility of ½ mile (which corresponds to a Runway Visual Range of 2600 feet) and a 200 foot ceiling. All runways at Toronto are equipped with RVR equipment which is utilized to obtain a real time measurement of how far along the runway an aircraft will be able to see. In low visibility situations RVR is used to determine ground visibility and is used instead of the visibility reported on the MEATR sequence. On VATSIM there is no RVR, so prevailing visibility will always be taken as the reported visibility from the latest METAR sequence. It should be noted that the CAT I ILS minima for runways 24L/24R and 33L/33R are slightly higher than the typical ½ mile visibility and 200 feet ceiling. Differences in approach lighting is one of the reasons for this. If weather drops below CAT I minima, the only approaches available are to runways 05 and 06L which are CAT II equipped. The CAT II minima for these runways is a ceiling of 100 feet and an RVR of 1200 feet which corresponds to approximately ¼ mile visibility. When Pearson falls below CAT I limits the GTAA's low visibility procedures come into effect. Nowadays, the majority of aircraft that fly into Pearson are at least CAT II equipped and are able to conduct an approach in poor weather. If the weather continues to deteriorate below CAT II minima then the CAT III ILS approaches (CAT IIIA) to 05 and 06L are the only possible way to arrive to Pearson. The CAT IIIA weather minima is simply an RVR of 600 feet, which corresponds to a visibility of approximately 1/8th mile. There is no ceiling minima associated with CAT III, however in such poor conditions taxiing can become hazardous.
Although arrivals continue to land when Pearson is CAT II or CAT III, the arrival rate drops significantly. Because CAT II and CAT III approaches are flown entirely by aircraft automation, protection of the localizer and glide path signals becomes critical. To sterilize the airspace around the localizer and glide path signals, controllers must ensure that an arriving aircraft does not reach 4 miles from the end of the runway before the previous lander has taxied clear of the ILS critical area **M534.1A M535.1A**. The ILS critical area is the area within which, if an aircraft or vehicle is present, could potentially interfere with the radio signals from the glide path or localizer. This may not seem like a restriction of much significance, but during low visibility conditions aircraft taxi very slowly and can take a long time to vacate and taxi clear of the ILS critical area. Generally during CAT II/III, spacing between successive arrivals needs to be 8 miles or more. Arrival is required to ensure that aircraft vectored for CAT II or CAT III approaches are established on the localizer and provided with at least 2 miles of level flight prior to glide path interception **M534.2 M535.3**. This is to permit the aircraft to fly a coupled automatic approach. The requirement for spacing between arrivals and departures is also quite restrictive, again due to the need to sterilize the ILS critical area for the arrivals. In CAT II/III, a departing aircraft must be airborne, and have overflown the localizer antenna serving that runway before the next arrival has reached 4 miles from the end of the runway **M534.1B M535.1B**. This again leads to increased spacing on final being necessary. When runway 05 or 06L is used in mixed mode during low visibility conditions, the spacing between successive arrivals may need to be increased to 10 miles or more.

24- Visual Approaches

By definition a visual approach is a procedure where an IFR aircraft operating in VFR weather conditions when authorized to do so, proceeds to the destination airport in visual meteorological conditions (VMC). Visual approaches are beneficial to Arrival because when they can be authorized the aircraft becomes responsible for their own separation and wake turbulence avoidance from their traffic. A visual approach may be requested by the pilot, or initiated by the controller **M566.1N**. The controller may not authorize a visual approach clearance unless the weather meets the official criteria, whether or not the aircraft requests or states they are able to fly a visual approach. At Toronto the minimum weather conditions are visibility of 5 miles and ceiling of 3,000 feet. In addition to the weather requirements, the aircraft must be within 15 miles of the airport in order to be issued a visual approach clearance. The restrictions in place for visual approaches are the same as the noise abatement restrictions that we have seen previously. Once issued a visual approach clearance the pilot becomes responsible to comply with the noise abatement restrictions, however the Arrival controller, workload permitting is expected to provide guidance to a pilot who they have reason to believe may be unfamiliar with them. For example 'not below 3,000 until established on final, cleared visual approach runway 24R' restricts the aircraft's flight path to conform to a noise abatement requirement.

An aircraft may be cleared for a visual approach provided:

A- The reported ceiling is 3,000 AGL or greater and visibility 5 miles or greater

B- IFR separation is maintained from other aircraft until the aircraft is instructed to maintain visual separation from the proceeding arriving aircraft once cleared for a visual approach.

C- The aircraft reports sighting the airport if there is no proceeding aircraft, or the aircraft they will be instructed to follow

D- You ensure that the aircraft will be able to complete its approach by following a flight path that will not compromise separation with other IFR aircraft

E- In multiple traffic situations you ensure that there is no mistaken identification by having the pilot confirm the type and position of the aircraft to be followed

Point B is interpreted as there must be a form of IFR separation in place between aircraft prior to clearing an aircraft for a visual approach. Part D follows along similar lines in order to ensure that an aircraft cleared for a visual approach will be able to complete its approach without compromising separation with other traffic. For example a B752 would not be able to fly a visual approach to follow a C172 simply because of their approach speeds. An aircraft that is anticipating flying a visual approach may be vectored to a position near the airport from where the visual approach will be flown. Arrival must ensure that the aircraft will be able to fly a stabilized approach to the airport from the point where they are vectored to.

Visual Approaches to Multiple Runways

The criteria for visual approaches to multiple runways is broken into four categories. The first three deal with parallel runways of differing distances between them and the fourth is concerned with visual approaches to intersecting and converging runways which is not pertinent at Toronto Pearson.

I- Visual approaches to parallel runways less than 2,500 feet apart

The only runways this applies to at Toronto are the set of close parallels 24L/24R and 06L/06R. A visual approach may be authorized, when in addition to the original visual approach conditions:
- IFR separation is maintained until the aircraft reports sighting any preceding aircraft on final approach to the adjacent runway
- The aircraft is instructed to maintain visual separation from the reported traffic and
- A heavy aircraft is not permitted to pass any aircraft or a medium aircraft to pass a light aircraft

The last point is present to avoid wake turbulence issues with aircraft on adjacent final approach courses. For example an A340 on 24L may pull up alongside a B737 on 24R but not pass them, which would be quite interesting to actually see.

II- Visual approaches to parallel runways between 2,500 and 4,300 feet apart

For this situation in with both aircraft are being vectored for visual approaches:
- IFR separation must be maintained until the aircraft are established on a heading to intercept the extended runway centerline at an angle of 30 degrees or less and
- ***both*** aircraft have received and acknowledged visual approach clearances

The runways which apply here are 33L/33R and 15L/15R. The above situation could be of an aircraft on a 360 heading at 4,000 to fly a visual approach to 33L and an aircraft on a 300 heading at 3,000 to fly a visual approach to runway 33R. The intent of having aircraft on headings of 30 degrees or less to join final is so that no steep turns are required that would cause a loss of visual with traffic due to the aircraft being in a wing high turn. In this situation both aircraft must see each other, the airport, and any traffic they will be following ahead on their own runway. IFR separation must be in place until both aircraft have their visual approach clearance, meaning typically vertical separation will be kept until that time. Once both aircraft have their visual approach clearance, IFR separation need not be applied by the controller and there is no requirement to have aircraft staggered diagonally on final approach. There is also no restriction as to one aircraft passing the other on final approach because of the extra distance between the runways. If one aircraft is being vectored for an ILS approach instead of a visual approach, then the aircraft conducting the visual approach does not need to see the aircraft on vectors for the ILS to the adjacent parallel runway. Traffic information is to be passed concerning the traffic on the adjacent parallel runway flying the ILS and a restriction is applied restricting the flight path of the aircraft conducting the visual approach. This restriction could be: ‘do not cross the ‘centreline’.

III- Visual approaches to parallel runways separated by 4,300 feet or more

This concerns visual approaches to the parallel runways 05/06L, 05/06R, 23/24R or 23/24L. In this scenario with both aircraft being vectored for visual approaches:

- IFR separation is maintained until ***one*** of the aircraft has received and acknowledged the visual approach clearance. This means although IFR separation is in place, as soon as one of the aircraft has its visual approach clearance, IFR separation need not be applied any longer. This could be a scenario with an aircraft on a 330 heading at 3,000 on left base for 24R and an aircraft on a 210 heading to intercept final on 23 at 4,000. As soon as one of the aircraft sees the other, the airport and the traffic they are to follow and both are issued a visual approach clearance, IFR separation need not be applied any further. The aircraft on the visual approach may descend to the same altitude as the other aircraft and they could turn final to their runways at the same altitude. Again a restriction regarding the flight paths would be issued to the aircraft.

25- Missed Approaches

Arrival receives control of an aircraft that has conducted a missed approach inside Departure airspace and at an altitude of, or climbing to 4,000. Normally the aircraft is received on a heading to take it out of the arrival box. The Arrival controller then takes the aircraft and re-sequences it with other arrivals for a second approach by bringing the aircraft back into the arrival box as soon as possible.

26- Arrival Techniques

To become proficient at Arrival, the controller must be able to look ahead and project the flight paths of aircraft. In addition to practice, the following information may be of use.

Resolve conflicts early

It is important to identify and resolve traffic conflictions as early as possible. The main confliction points are the locations abeam the landing runway at the mid-downwind points. For example when landing 23/24R traffic inbound from LINNG will conflict with traffic inbound from YWT south of the field near VERKO. The correct traffic sequence should be determined based on the relative speed and distance the aircraft are from the confliction point. When the controller decides who they will make number one, control techniques of speed control, vertical separation and vectoring are used in order to make the sequence work. If an aircraft needs to be vectored for spacing from other traffic they can be taken off an FMS arrival at any point in time however the reason for the cancellation of the STAR should be given. Care should be taken when deciding to slow an aircraft to establish a sequence if the aircraft still has many miles to fly within the Terminal. Slowing an aircraft when they are still quite far from the airport can cause a ripple effect if it is busy. Slowing one aircraft may necessitate slowing subsequent aircraft behind them also. For this reason vectoring should be the primary means of establishing a downwind sequence and it is best accomplished when initiated far from a confliction point.

Altitude and Speed

Remember that aircraft are heavy and typically cannot descend and reduce speed at the same time. If a descent is issued to an aircraft along with a speed reduction, the controller should not expect the aircraft to be able to accomplish this reasonably well. When asking for a speed reduction in conjunction with a descent clearance, when one action is desired to be accomplished before the other, the controller should state the requests sequentially. For example 'American 343 speed 210 kts or less then maintain 4,000', or 'American 343 maintain 4,000 when level speed 210 kts'.

Get aircraft onto final as soon as possible

In order to stay ahead in Arrival, the controller must continually strive towards keeping spacing to a minimum on final. When space is used effectively aircraft will be spending as little time in the air as possible not adding to the workload. There are two critical times for Arrival- one is deciding when to turn an aircraft from downwind onto base to follow traffic on final and the other is deciding when there is enough of a gap to turn an aircraft onto final ahead of one already established on a straight-in approach. One method to keep finals as short as possible is to realize that an aircraft on a good downwind leg is typically 3 miles from their final approach course. Assume there is traffic at 3,000 on final 24R and an aircraft on the lefthand downwind 24R, both being medium types and the intent is to have 3 miles between them. The aircraft on the left downwind would normally be at 4,000 to preserve vertical separation from the aircraft on final approach. Since the two aircraft will pass abeam each other by 3 miles or more, the aircraft on the downwind leg can be turned base and issued descent to 3,000 the moment it has passed the traffic on final. The traffic on the downwind leg will normally have a sizably higher ground speed than the aircraft on final, but when turned base leg and final into the headwind, the spacing should not decrease and the groundspeeds should quickly become compatible. When deciding weather or not there is enough room to 'stuff a hole' with an aircraft, the controller must first know how much space they will have to have in front of, and behind their traffic. If the gap is not sufficient to accommodate the aircraft then that aircraft will have to continue downwind unless control instructions can be issued to help increase the size of the hole in time. For example consider a runway used only for arrivals with two medium category aircraft on final, with an opportunity of stuffing the hole with a heavy. The spacing between aircraft needs to end up as: medium aircraft – (3 miles) – heavy aircraft – (5 miles) – medium aircraft. Therefore the gap to accommodate a heavy in between two mediums needs to be at least 8 miles. If there is sufficient space to accomplish this, the turns given to the heavy from downwind to base and from base to final must be done precisely.

Always have a backup plan

Always be ready with 'plan B' if things don't unfold the way they had been originally planned. This holds especially true on VATSIM where the unexpected must always be prepared for. Pilots on VATSIM can fly unpredictably even at the best of times and quick reaction by Arrival is necessary.

Be flexible

Although the traffic patterns used within the terminal are usually fixed, sometimes a little bit of creativity can go a long way to help you out. For example when landing 33L, the MANS RNAV STAR takes traffic inbound from FLINE to 33L via a right hand approach. If arrival traffic is heavy from Mans and YSO VORs to join the right hand downwind while there isn't much traffic approaching from the west via YWT, traffic from YMS could be vectored for a left hand approach to 33L. Another plan could be to bring an aircraft inbound from YSO overhead the airport to join a left hand downwind to 33L. The extra mileage an aircraft would have to fly to bring it to the opposite side of the airport and into an area with less traffic could help buy some extra time to clear up traffic backlog and keep finals to a reasonable length if it was busy.