This allows, for instance, to have only one friendly unit targeting a hostile group.

DROP AND RESET

To avoid being pulled too far and waste fuel, the Section should turn away and resume its previous tasking. Drop Criteria are:

- Outside 20nm, TA>60°;
- Inside 20nm, TA>95°;
- Inside 10nm, Drop is not an option as this range is considered WVR.

Those range values are doctrinal for MRM employment. Due to the range and speed of the AIM-54, 20nm can be substituted with this datasheet Engagement Range (35nm). See Decide and following sections for further information.
The Reset is a set of manoeuvres defined to ensure the safety of the Section as it turns its back to the target. Its details are covered in the Post-Decide paragraph.

9.7.5 SECTION PLAN [40-45 NM]

An addition to the doctrinal Timeline, a short briefing at Section level can be useful:

> *Spectre 1-1 [Fwd] ► Spectre, plan skate South, shoot 40nm, one each.*
> *Spectre 1-2 [Fwd] ► Two.*

This is de facto the new timeline contract. It is useful when flying with less experienced players, the tactical situation is rapidly evolving or, for instance, if the Section wants to take advantage of the impressive range of the AIM-54.
If this part is skipped, the plan is defined later, post the Assess and Decide phase.

9.7.6 TACTICAL RANGE CALL [45 NM]

This call is used to inform all other aircraft that the Section is at a specific point of the timeline and engaging the Targeted group. The Tactical control switches from YY to BRAA.
The fighter with the Targeted group in the AoR will communicate by means of the Aft radio. For instance, if the target is low and in the AoR of the wingman:

> *Spectre 1-2 [Aft] ► Spectre, Group north, 45nm.*

9.7.7 MELD [40 NM]

Meld signals the end of the sanitization and both fighters in the Sections will focus their radars on the target.
Per sé is a simple operation but the limitations of the AWG-9 WCS can induce some delays and errors. In primis, TWS radar sweep takes always 2”. In cases of poor SA, this can delay the acquiring operations. In case of high altitude delta, the aircraft with good radar return may pass the antenna elevation angle to the other member of the section. In fact, since the fighters are sanitizing the same amount of azimuth volume, but different altitudes, the most important part of the meld call is the altitude.

> *Spectre 1-1 [Fwd] ► Spectre, meld, BRAA 11 22 33 thousand*

If the target is in the Wingman’s AoA, he will call the meld as follows:

> *Spectre 1-2 [Fwd] ► Spectre, meld, BRAA 33 22 11 thousand*

When melding into a group that is a stack, the altitude should be removed from the meld call. In this scenario, selecting the appropriate radar parameters is fundamental.

9.7.8 SORT [40 NM]

The Sort phase assigns a target to each member of the Section. The Sort is usually a standard contract:

	AZIMUTH	RANGE	ELEVATION
LEADER	Left	Lead	High
WINGMAN	Right	Tail	Low

If a fighter has STT lock, the altitude can be communicated to the other member, so he can sort “around” the call.
If the fighters have different SA, the rule of thumb is:

> *“he who sees two, shoots two; he who sees one shoots none.”*
>
> **P-825/17**

The fighter who only sees one should hold their shot, and the fighter that sees two will employ out of TWS on both contacts.

9.7.9 EMPLOYMENT AND CRANK [35 NM]

The section will fire and crank together. As mentioned, the standard Sort contract is used by default:

- versus a single target, the Leader uses TWS whilst the Wingman STT;
- versus a two-ship group, the Leader employs TWS on the left target, Wingman STT on the right;
- versus a three-ship group, the Leader employs TWS on the left and centre target, Wingman STT on the right target.

In order to maximize the chances of a successful launch two conditions should be met:

- the radar has the appropriate mode selected and a stable track (TWS) or lock (STT);
- the target is IN LAR (Launch Acceptability Region) and the cross-check list has been completed (weapon selected, AA mode, Master Arm).

> *Spectre 1-1 [Aft] ► Spectre 1-1, Fox-3*
> *Spectre 1-1 [Fwd] ► Spectre 1-1, Crank left*

In case multiple missiles are launched to separate tracks at the same time, the call is:

> *Spectre 1-1 [Aft] ► Spectre 1-1, Fox-3, two ships*

If another missile is fired to a target whilst the first missile is still flying, the call is:

> *Spectre 1-1 [Aft] ► Spectre 1-1, second Fox-3*

The **Crank** is an informative/directive call. Consists in a manoeuvre aiming to increase the lateral separation with the target. The crank manoeuvre is performed whether the Section launches or not.
If, due to the geometry, the Wingman risks losing the target (ergo, the antenna reaches its limits and can't illuminate the target any more if the turn continues), he should call:

> *Spectre 1-2 [Fwd] ► Spectre 1-2, Gimbals*

The Leader than must manoeuvre to prevent the loss of lock. If the LRIO is about to lose the target for the same reason, he has to immediately call Gimbals in the ICS.
In order to be effective, the introduced separation should be ~50° of ATA (Antenna Train Angle, topic I plan to cover when I'll discuss the Intercept Geometry). Fighter velocity vector must have more of a cross-range component than a downrange component, this is fairly easy to assess by means of the TID in Aircraft Stabilized mode (discussed in Chapter 6.3.3).

9.7.10 ASSESS

Whilst Cranking, the Section assess the situation, until the missile status changes, DOR and later MAR are reached, leading to the Decide phase.

Appropriate calls should be made when the missile status changes:

- at missile timeout;
- if the missile is trashed;
- if the missile is active.

Timeout means that the missile has reached its intended target (it does not imply a kill). The relative call is includes the who the missile was shot to, the group they are part of and the altitude:

> *Spectre 1-1 [Aft] ► Spectre 1-1, timeout, single only, group north, 33 thousand.*

If a missile is Trashed, it means it has been defeated by ECM, target manoeuvring or other issues.

> *Spectre 1-1 [Aft] ► Spectre 1-1, shot trashed.*

Pitbull informs that the missile has activated its internal radar and it does not require support from the mother aircraft any more (I haven't tested if maintaining the lock helps the missile though). This means that the aircraft is now able to manoeuvre freely.

The current implementation of the F-14B should display a timer (Time To Impact) and an indication of the status of the missile but it is quite unreliable. Is the WCS that gives the "Go Active" command to the AIM-54, and the TTI timer of an active missile should blink.

The Section should also evaluate their sensors and SA:

- RWR: Spike / Nails / Naked;
- Radar: Clean;
- Visual: Tally / No Joy.

The Section can also ask the Controller to provide the Separation from the target group:

> *Spectre 1-1 [Aft] ► Darkstar, Spectre 1-1, separation Group north.*
> *Darkstar [Aft] ► Spectre 1-1, Darkstar, Group north separation 11 22 33 thousand, hot, hostile.*

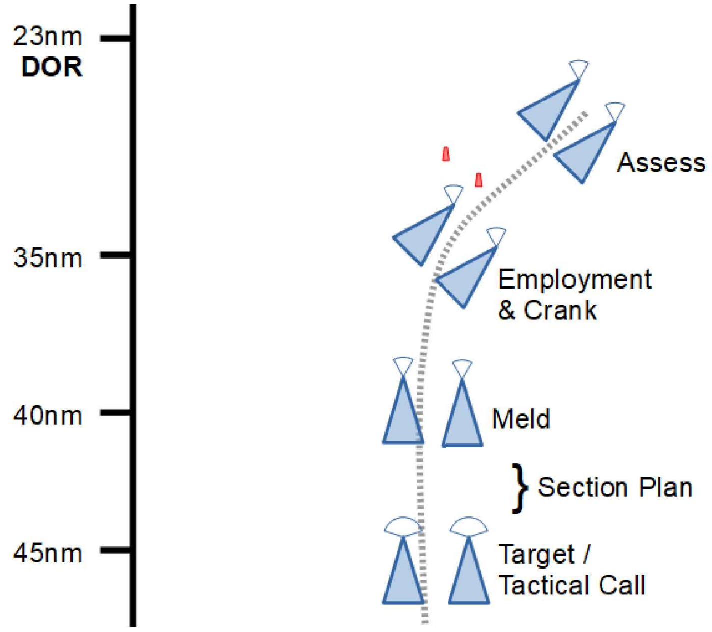

Figure 292: Timeline: Target, Meld, Employment, Assess.

9.7.11 DECIDE

As the Crank is established and the situation assessed, the Leader must consider the next step. Proceeding into a merge has more risks but going out may compromise the success of the mission.

F-14 and Merge: Considerations
The CNATRA P-825, 14-36, proposes a series of criteria to assess whether the Section is winning or not and how the flow proceeds towards the Merge if the Section is winning. As a rule of thumb, as F-14 playing in a modern environment we should avoid merging (if not for training purposes) because the adversaries usually have the advantage at shorter ranges due their more modern weapons and devices (AIM-9X, AIM-120C, HMS and so on). The avionics of the F-14B is based on technology from the '60s: even a good and advantageous situation can be flipped in an instant by an AIM-9X, thanks to its incredible off-boresight capability on top of the HMS.
Against similar-era aircraft instead, the F-14 is a very dangerous opponent due to its weapons, flight characteristics and sheer power.

Without going too much into the details, the main criteria to decide whether merging or not are:

- Timeline adherence: if the weapons have been employed at the correct step of the timeline with the appropriate sort;
- Target awareness: if the bandit show that it is targeting us it is about to target the Section (TA<30° or TA<60° and Section is Spiked).

Depending on such considerations, the Plan is developed (note that the Section Plan block seen previously may have already defined the standard contract, although it is not part of the doctrinal Timeline).

- Skate (Launch and Leave): descriptive call to support the missile to timeout and then leave without merging. The Section should leave before DOR (Desired Out Range).
  Abort (+ Direction) is the call to execute aggressive leave (maximum performance turn), Out (+ Direction) is the call to turn to a Cold aspect relative to the target.
  Skate is used as a mean to maintain the distance, launch and then reset.
- Banzai (Launch and Decide): directive call to execute Launch and Defend tactics. It means that the fighters will support the missile until its timeout, then proceed to merge.
  Short Skate (Launch and Leave): it is defined as the directive/informative to execute Launch and Leave before MAR (Minimum Abort Range). As for Skate, it doesn't involve the merge with the target.

LAUNCH AND DECIDE

Whilst Launch and Leave tactics usually imply a reset, leaving open the opportunity of recommitting (albeit at different ranges), Banzai signals the intention of the Section to Commit to the Merge.

> *Spectre 1-1 [Aft] ► Spectre, Banzai.*

If the Section is spiked they should defend right after the missile timeout. The defending manoeuvre consists in beaming and releasing chaffs.

Merging and Radar modes
According to CNATRA P-825, this should happen NLT 8nm and radar should be set to RWS/140/6B/20NM (SRR – Short Range Radar). Merging in the F-14 can be a different experience, I plan to going into its details when the new WCS is completed and released by Heatblur, covering aspects such as the use of the AIM-54 at short range. The Phoenix in fact is fired active off the rail making it completely fire and forget but it is also a very heavy missile. Moreover, the radar suffers again from the lack of 6B and the absence of MPRF, leaving the inexperienced RIO wondering what is the best AWG-9 setting to push. This, on top of the several radar modes usable by the Pilot.

When Spiked, the Section defends. The Leader does not call Spike, he just directs the defensive action.

> *Spectre 1-2 [Fwd] ► Two, spiked;*
> *Spectre 1-2 [Aft] ► Spectre 1-2, timeout, right man, Group north.*

> *Spectre 1-1 [Aft] ► Spectre, defend East;*
> *Spectre 1-1 [ICS] ► Heading 075.*

> *Spectre 1-1 [Aft] ► Spectre 1-1, timeout, left man, Group north.*

Then, when the section is Naked, the Section should turn 110°-130° into the target and prepare to switch to SRM:

> *Spectre 1-2 [Fwd] ► Two, naked.*

> *Spectre 1-1 [Aft] ► Spectre, in left;*

> *Spectre 1-1 [Fwd] ► Heading 340.*

If the Section is still Spiked after Notching for more than 10", it should Abort.

LAUNCH AND LEAVE

The main difference between Skate and Short Stake is the Leave distance from the target. Skate should Abort/Out before DOR (Desired Out Range) whereas Short Skate should leave before MAR (Minimum Abort Range).
Out and Abort have similar meaning but Abort is a high-G, maximum performance turn.

> *Spectre 1-2 [Aft] ► Spectre 1-2, timeout, trail man, Group north.*

> *Spectre 1-1 [Aft] ► Spectre, Abort right;*
> *Spectre 1-1 [Fwd] ► Heading 63;*
> *Spectre 1-1 [Aft] ► Spectre 1-1, timeout, lead man, Group north.*

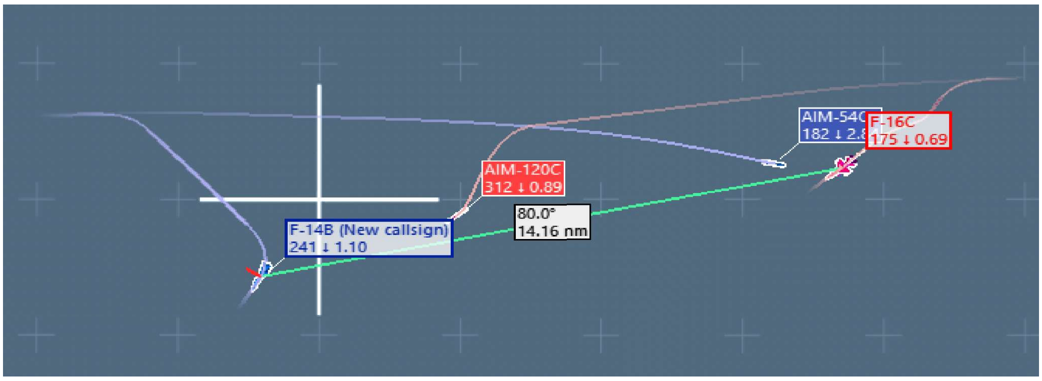

Figure 293: "Short Skate" AIM-54 launch.

9.7.12 SIMPLIFIED TIMELINE, FLOW AND RANGES: DATASHEET

This is how the simplified Timeline appears when applied to DCS' F-14 scenario. Ranges may vary according to a wide number of parameters (such as the mission task, payload, fuel status and so on).

Please note that I haven't drawn the flow post Launch and Decide.

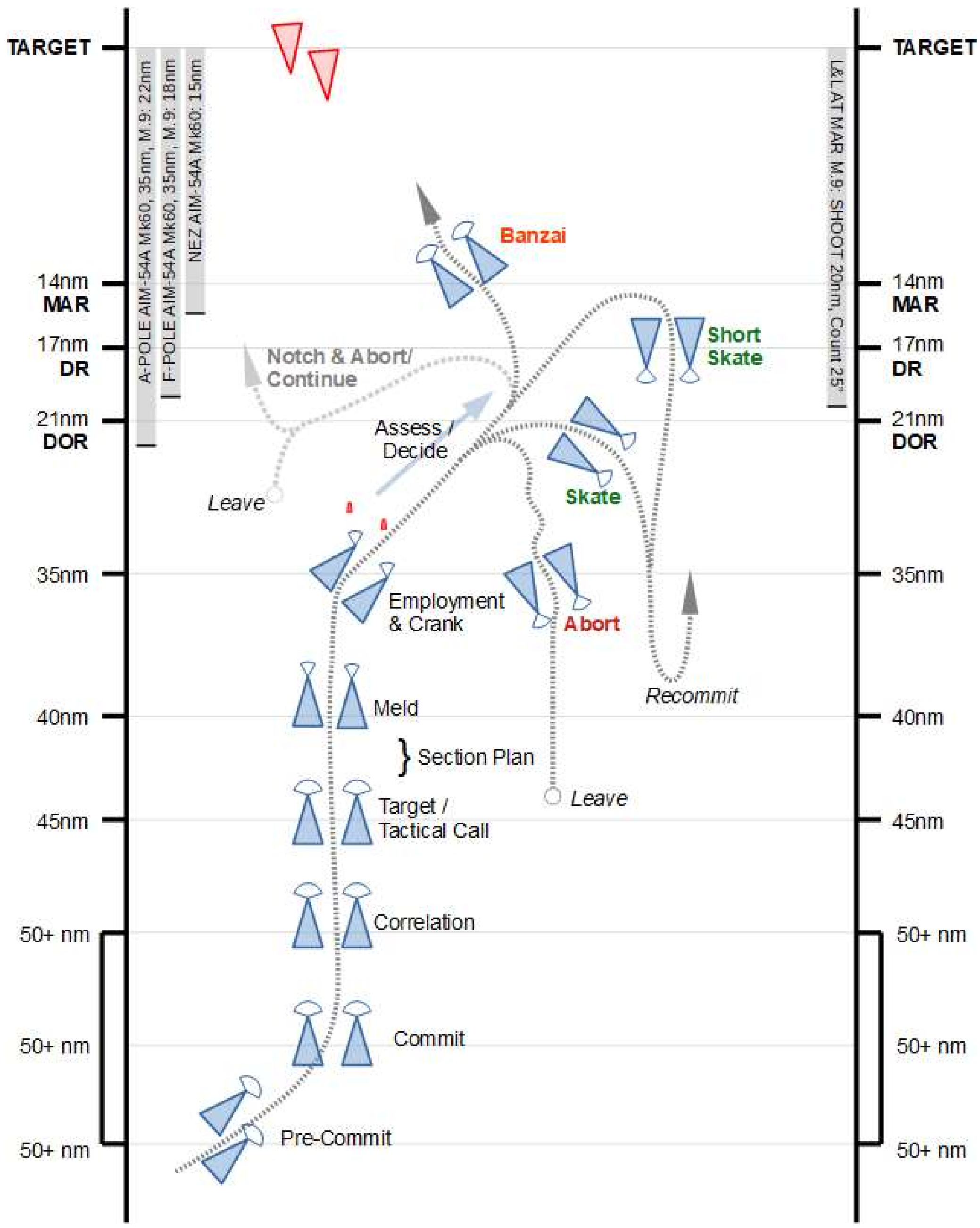

Figure 294: Simplified Timeline – Datasheet.

9.7.13 POST DECIDE: WHAT HAPPENS NEXT?

Unless the Section opted for L&D then Merge, they should be leaving either using Out or Abort. When the Section is leaving, it follows a series of manoeuvres defined to ensure the safety of the aircraft and the crew. By Resetting, the Section should:

- turn hard, placing the target Cold at TA>50°;
- monitor for 5” if range > 20nm, 10” if range <20nm;
- execute high-performance turn to place the target at the Section 6’, then unload and extend. Set Buster to obtain SPDSection ≥ SPDTarget + 0.1 IMN (Indicated Mach Number). Radar should be set to SRR;

- direct the Controller to monitor the previously targeted Group.

> *Spectre 1-1 [Aft] ► Spectre, Reset South, Darkstar Monitor Group.*

If the former target later matches the Commit Criteria, the Section can Commit on it again. CNATRA P-825 suggests that, in case of Abort and having the target at the Section's 6', and in order to Employ again following the doctrinal Timeline, a spacing of 30nm should be adopted (2nm to turn in and 3nm to gain SA before Meld range).

The ranges I proposed for the F-14 are much longer (Meld: 40nm, Employment: 35nm) but such ranges can be even too wide, depending on the situation. Following some tests (but ultimately depending on a number of parameters), the F-14 firing an AIM-54 can Employ at 30nm and leave at DOR as the missile goes Pitbull. Then, if Skating, can Reset to 40nm and turn, assess and build SA whilst turning, Meld at 35nm and Employ again at 30nm, fundamentally creating a sort of an "Employment ring". This situation can continue until, for example, the target meets the Drop Criteria or the flow turns into L&D.

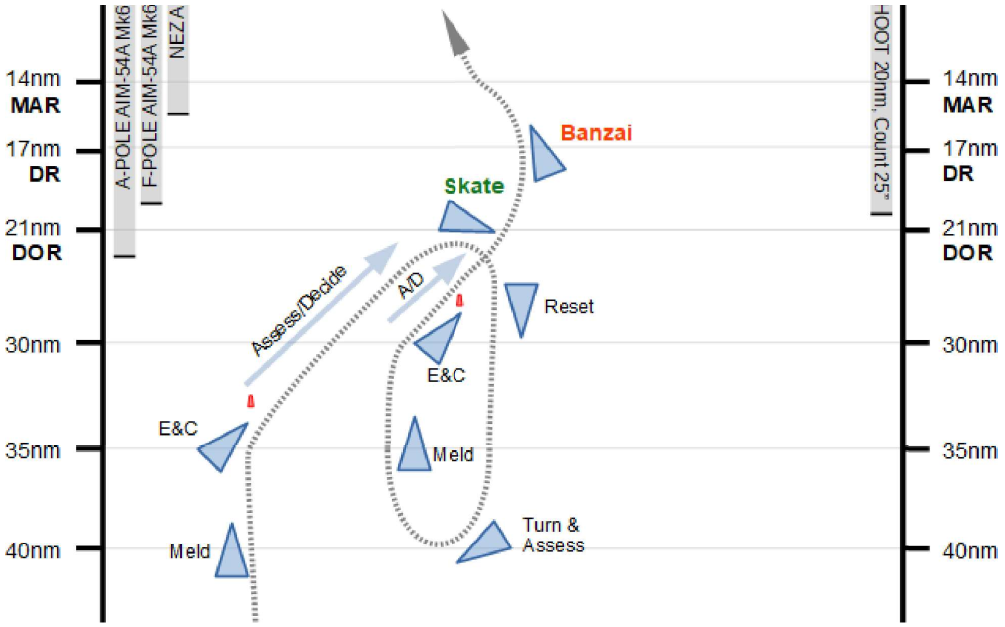

Figure 295: Engagement flow: Reset and Recommit.

Another outcome of the first employment is much simpler and immediate if the range and the situation does not allow for a prolonged manoeuvre: Reset the radar (SRR), Assess Spikes and Turn In. At that point the Leader Employs on any Leaker in the scanned area.

Executing Banzai rather than Short Skate depends on the AMR satisfied and the Abort criteria met.

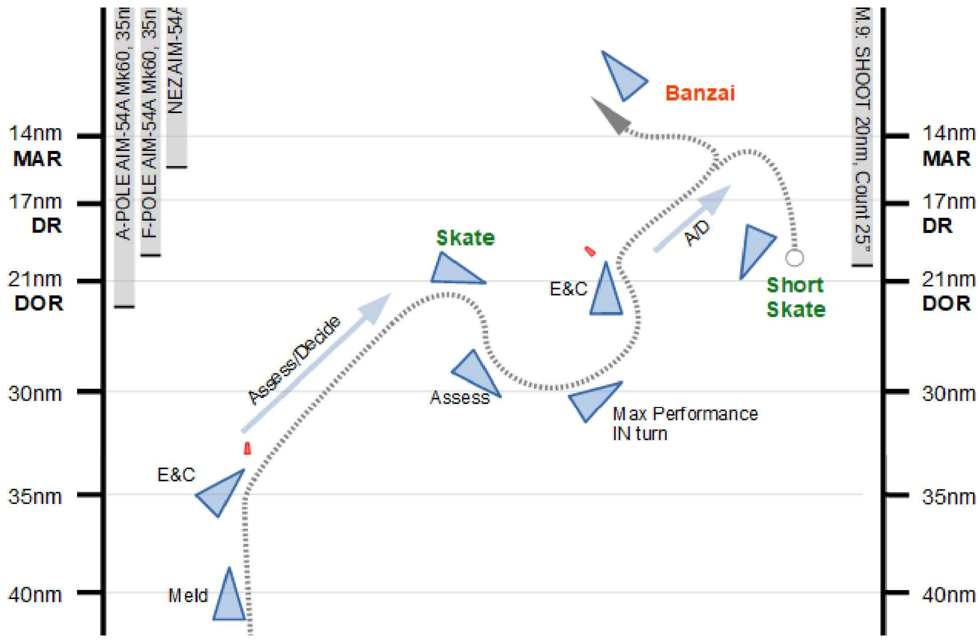

Figure 296: Engagement flow: Assess and Turn In.

The two above are just examples. The point is understanding that there are options: **the ultimate goal is being able to see them, assess the situation, evaluate the options and execute them.**

9.8 SIMPLIFIED INTERCEPT

I put together a short video related to this article, as seeing the procedure from the point of view of the RIO makes it easier to understand.
You can find the video on YouTube, here.

9.8.1 BACKGROUND AND CONTEXT

After discussing Drift, TA, ATA and related concepts I had an interesting conversation about the possibility of using these concepts to perform an intercept, without spending a lengthy amount of time studying the Intercept Geometry. In particular, how they can help to understand and improve the performance in a BVR scenario. A pattern I noticed: new players especially have the tendency of putting the target on the nose, go **pure pursuit**, and chase the squirrel. This often leads, however, to the non-ideal situation of having the target drifting hard, the missile employed has to correct its trajectory and, by doing so, it bleeds a lot of energy.

This simplified intercept takes advantage of the benefits brought by the Collision Course over a simpler Pure Pursuit, mentioning the cues and the functions available to immediately set up such course.

TOOLS AND FUNCTIONS

The following are three useful means to identify and achieve a collision setup.

- *TID in Aircraft Stabilized mode*. Discussed in Chapter 6.3.3 , Collision Course is achieved when the vector points towards the F-14 symbol at the bottom-centre of the display;
- *DDD in Pulse mode*. Discussed in Chapter 6.2.4 , a successful Collision Course is recognizable by the lack of Drift;
- *Collision Steering* function. A handy function that, technically, should solve most of our issues. Unfortunately at the moment it seems inconsistent but, even when fixed and working, it has a couple of drawbacks:
    - if used in STT, this mode can alert the target of our intentions;
    - if used in TWSA (Track-While-Scan Auto), it suffers due to the number of ghost tracks that can confuse the calculation of the centroid, on top of the WCS itself that tries to include as many non-friendly contacts as possible.
    - on the other hand, when used correctly, it will absolve the RIO of having to track collision

This function can be activated by means of a dedicated button placed on the right of the TID.

9.8.2 PURE PURSUIT OBSESSION

Before diving into the geometry, a parenthesis about the most common "road" used to close the distance between the fighter and the target, especially by new players: Pure Pursuit.

New players especially have the tendency of using the pure pursuit almost constantly. Generally speaking, out of the three typical pursuit techniques (Lead, Pure, Lag) it is probably the one that works more often and it is simpler to set up and control: lock a target, place it in the middle of the HUD and follow it to the bitter end. But how does flying a pure pursuit impacts the intercept?

In primis it is not a cutoff. Therefore, if the target is a bomber or an AG aircraft, by the time we reach it, it may be too late as we are not placing the fighter between the hostile and its target, rather "spectating" as we get closer. It also has the tendency of placing the fighter towards a TA equal to beam or flank if the initial TA is greater than 30°-35° (the SR is another important parameter).

9.8.3 THE "CASUAL" INTERCEPT

By means of the concepts discussed so far we can come up with an incredibly simple intercept procedure that requires nothing more than a glance at the TID. Let's start with a simple scenario, the same often used to introduce the intercept geometry (such as in the ubiquitous CNATRA P-825): the fighter and the target fly co-speed and co-altitude.

Therefore, the necessary steps are:

- Match altitude;
- Match speed;
- Manoeuvre to have TA = ATA;

And the objectives are:

- Monitor drift;
- Manoeuvre to have the Vector in TID AS pointing towards the F-14.

This allows you to fly until you "run into" the target (as per definition of collision course) or get close enough to VID or turn behind the target.

Each of the required parameters can be adjusted in just a few seconds.

- **Matching Altitude**
  This is very straightforward, the only parameter that may have an effect is the QNH (unless the intercept happens at ground level where masking or collision can be factors).
- **Matching Speed**
  Altitude and Speed can be obtained from the TID. Target's speed can be provided by the controller (although usually by means of brevities). If GS is what you have, remember that the ECMD provides TAS and GS.
- **TA = ATA**
  When flying co-speed and co-altitude, the modules of the Target Aspect Angle and the Antenna Train Angle are equal. Thanks to the TID AS, there is no need of any calculation, what matters is where the target is presented on the TID. In fact, when the Vector points towards the F-14, the drift is null and collision course is achieved.

9.8.4 PRACTICAL EXAMPLES

Figure 297: Simplified intercept: Initial situation.

Figure 298: Simplified intercept: Vector points towards the F-14.

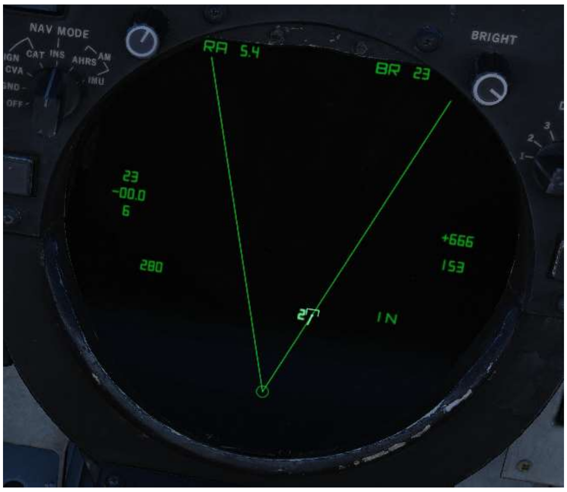

Figure 299: Simplified intercept: Getting closer.

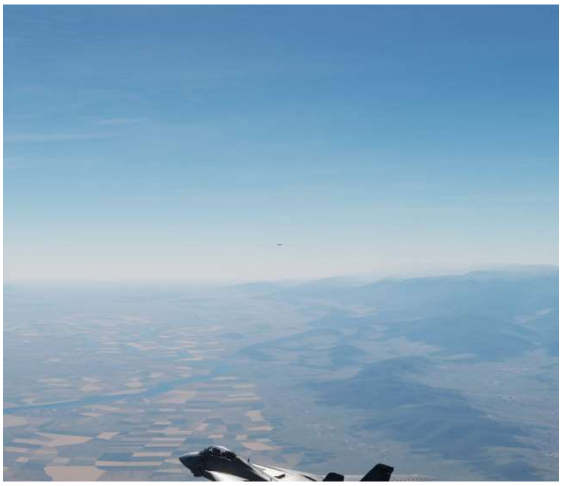
Figure 300: Simplified intercept: Tally on target.

This is not a precise intercept as my F-14 flew about 1.5nm in front of the target, as Iceman does not allow fine adjustments in terms of degrees. Nevertheless, it shows how the collision can be achieved in a very simple means even by now knowing much on the matter (so, no evaluations of TA, Cut, DGT/HCA and so on).

Figure 301: Simplified Intercept: TacView evaluation.

I highlighted the corrections. The original heading is in red, green for the first correction, light blue for the second and yellow for the final heading.

Note how the corrections were less pronounced the more I got closer to a satisfying picture on the TID. Without going a bit deeper into the intercept geometry this is the simplest way to reach our objective.

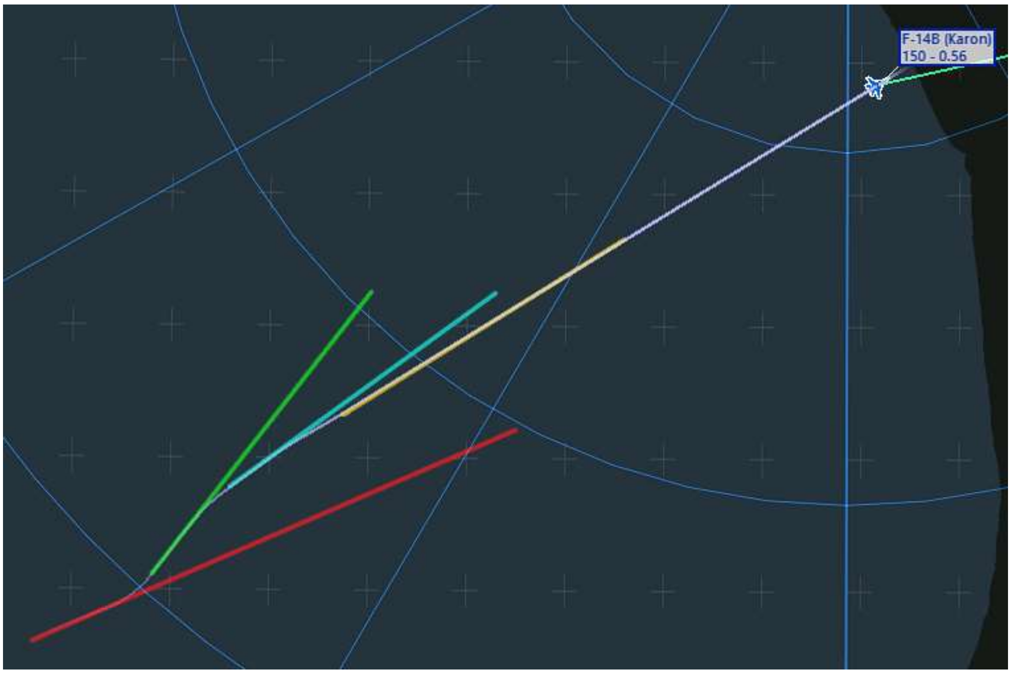

Figure 302: Simplified intercept: heading corrections.

9.8.5 COLLISION TO EMPLOYMENT: DOES IT HELP?

The elephant in the room is whether this intercept satisfies the requirement of achieving a positional advantage, which usually means firing a missile with decent PK on top of other things. Let's review the fist scenario seen above when employing an AIM-7 and an AIM-54.

> Note: High-res versions of the images displayed above are available here.

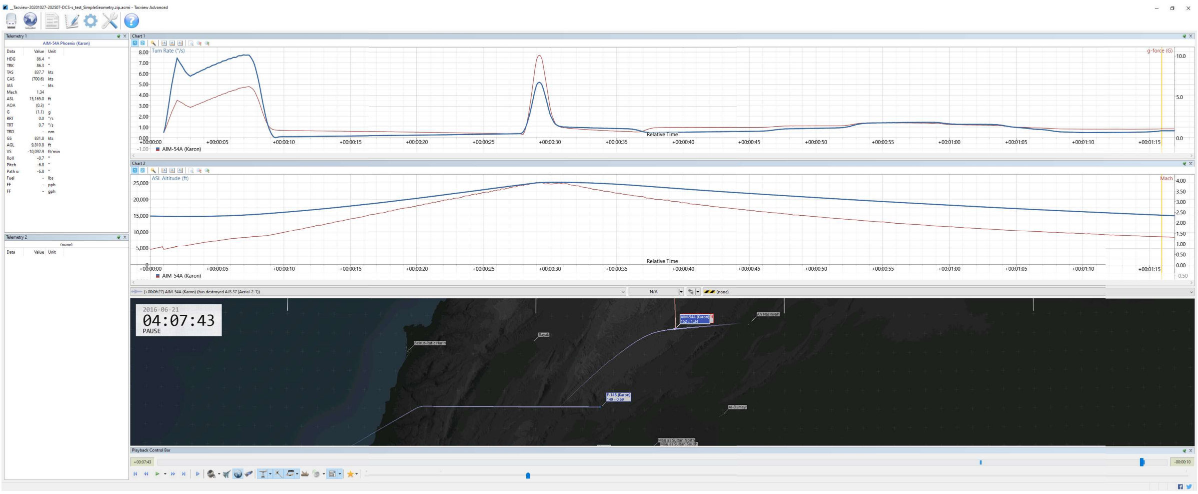

Figure 303: AIM-54A Mk60 launched from CB at 35nm.

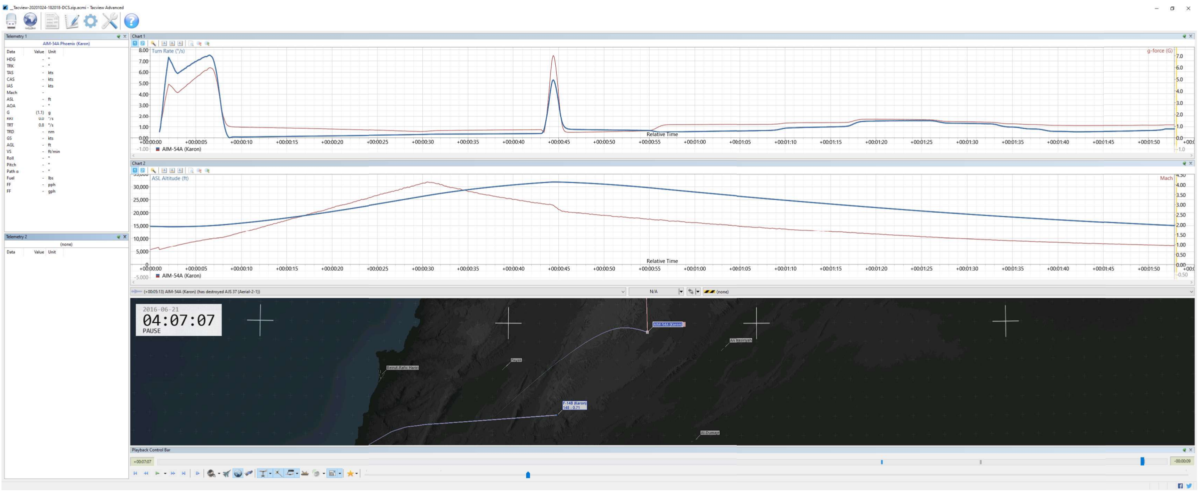

Figure 304: AIM-54A Mk60 launched from CB at 45nm.

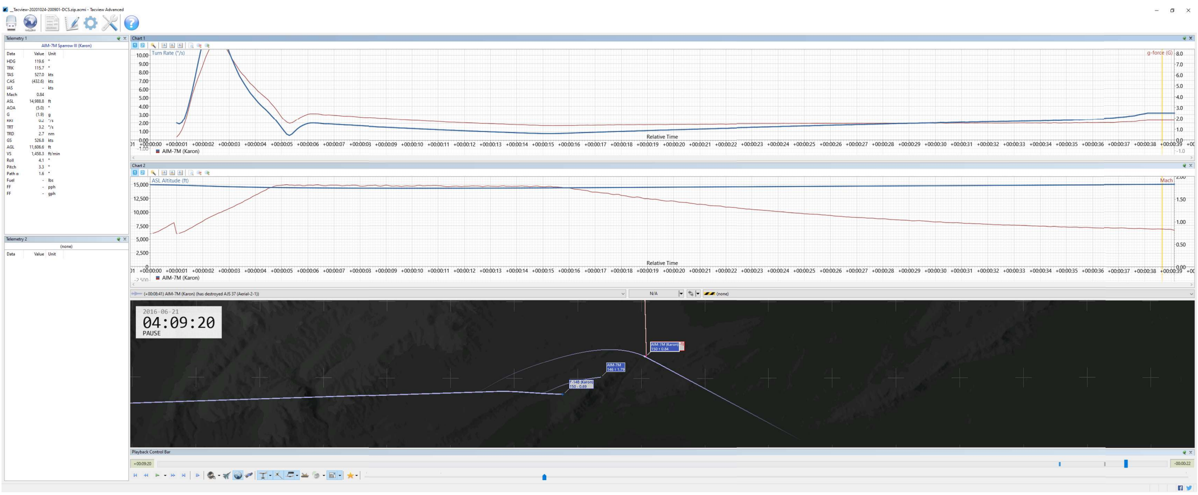

Figure 305: AIM-7M launched from CB.

The answer is… well, not amazing (the scenario flown does not help either). This method in fact does not do anything to achieve an advantage in terms of position: if you happen to have the target with TA ≤ 35° (close to hot), then the missile will be employed in "good" conditions. Otherwise, it may have to perform sustained or hard corrections, which have the tendency of bleeding off a lot of the missile's energy (especially in the case of the AIM-54).

In fact, learning how to manipulate the Lateral Separation and obtaining spatial advantage is probably the hardest (at least initially) yet most interesting aspect of the Intercept Geometry. This does not mean that there is no simpler solution. As we did before, we can use a bit of ingenuity to correct the situation and place the aircraft in a more favourable position for missile employment.

9.8.6 DETERMINING THE TARGET ASPECT

In primis let's clarify what the ideal situation is, from the point of view of the missile: the missile, in fact, performs better as the TA tends to zero as no corrections are required. On the other hand, creating a spatial offset is always recommended as manoeuvring space = options, and options are good. For the sake of this test, let's say that we want to employ with TA close to the "Hot boundary", therefore 30°TA, or 150°AA.

This leads to two other questions:

1. How is the TA determined?

There are a number of answers to this question, even Maths work but the simplest are:

- Bearing Distance Heading Indicator (BDHI);
- Eyeballing by means of the TID GS;
- Asking the controller.

2. How can the TA be manipulated, in a simple manner?

As for the previous question, there are a number of solutions, but the simplest is probably cranking: therefore, placing the targets on the gimbal limits (therefore in the Hot side of the TID AS) and keeping it there until the TA satisfies our requirements. This is not always applicable of course, as it depends on the scenario, but usually it works quite well and it is simple to achieve, with the benefit of maintaining SA on the target. If necessary the target can be even placed at 5-7 o'clock to further increase the impact on the TA but it can be a dangerous game as the fighter loses SA of the target.

9.8.7 AN APPROXIMATIVE SOLUTION

The approach just discussed is similar to the one used during the transition between BVR and WVR, but at a greater distance.

The following two examples show the AIM-54A Mk60 fired at 35nm and 45nm:

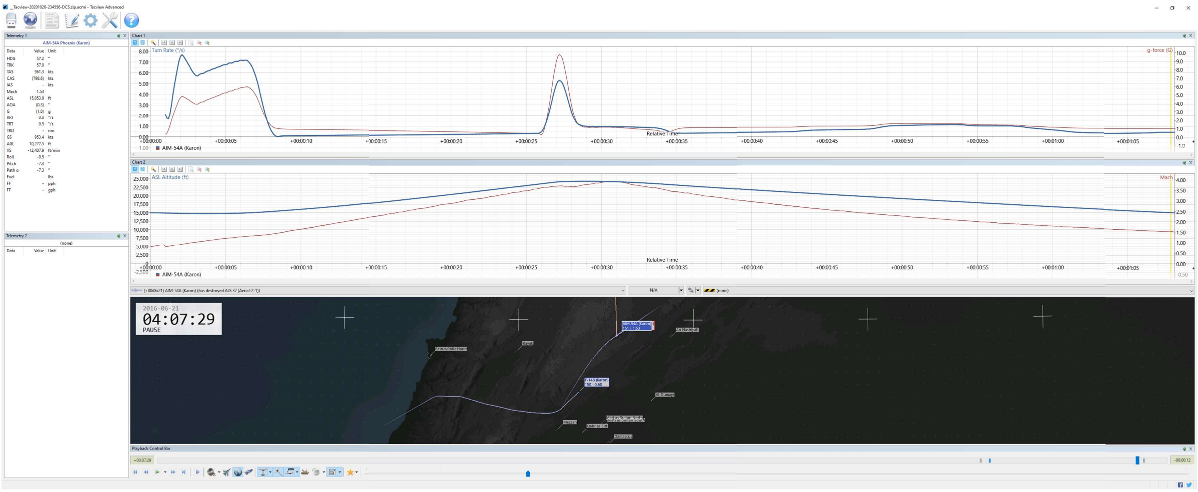

Figure 306: AIM-54A Mk60 launched post crank at 35nm.

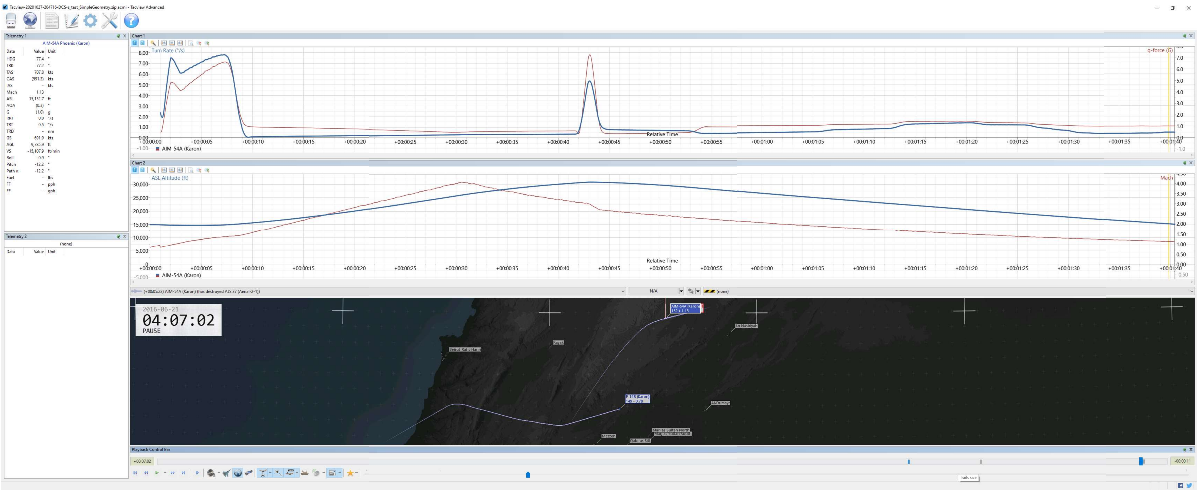

Figure 307: AIM-54A Mk60 launched post crank at 45nm.

How much energy has the missile gained? Since there was little time to manoeuvre in an optimal position (and reducing the TA even more), due to the distance and speed of the target, not much. The missile hits the target whilst flying only M.3 faster. Interestingly, the missiles employed post-crank have reached the target a few seconds sooner, which is also important as the missile has to be sustained until pitbull.

The outcome can be improved by, for example, going Gate (in these examples I accelerated during the crank but decelerated prior to employment to minimize the impact of the energy on the results). Another means is having a human pilot, as Iceman turns in literally ages, wasting time and space.

9.8.8 PURE PURSUIT: OBSERVATIONS

Out of curiosity, I also replicated this scenario using a Pure pursuit right from the start. The outcome is definitely unexpected: I had issues as the contact was notching the AWG-9 first, then the AIM-54 as well. I also tried by means of PSTT to minimize the problem, but PSTT does not control the loft, severely impacting the performance over greater distances.

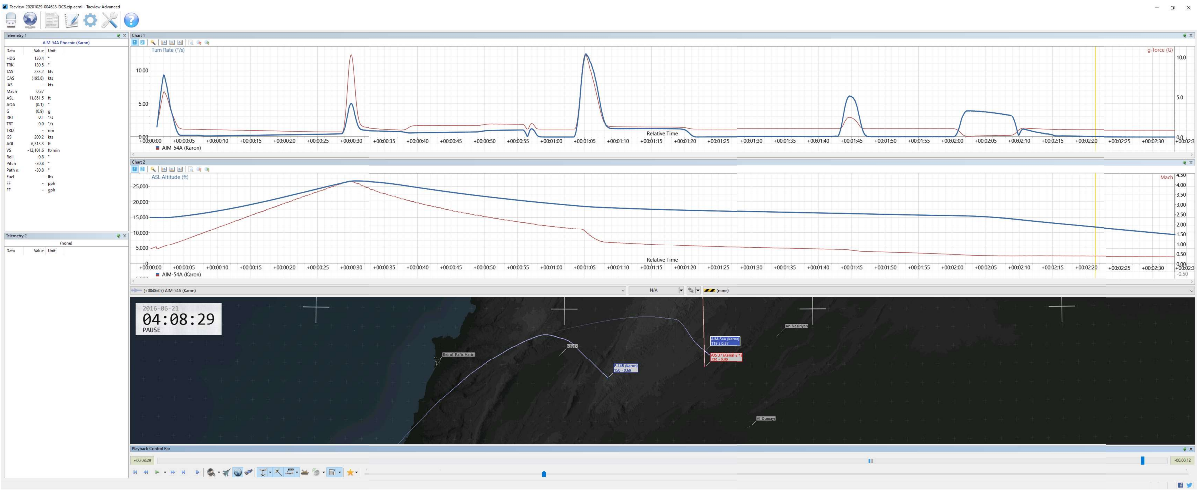

Figure 308: AIM-54A Mk60 launched following pure pursuit at 35nm.

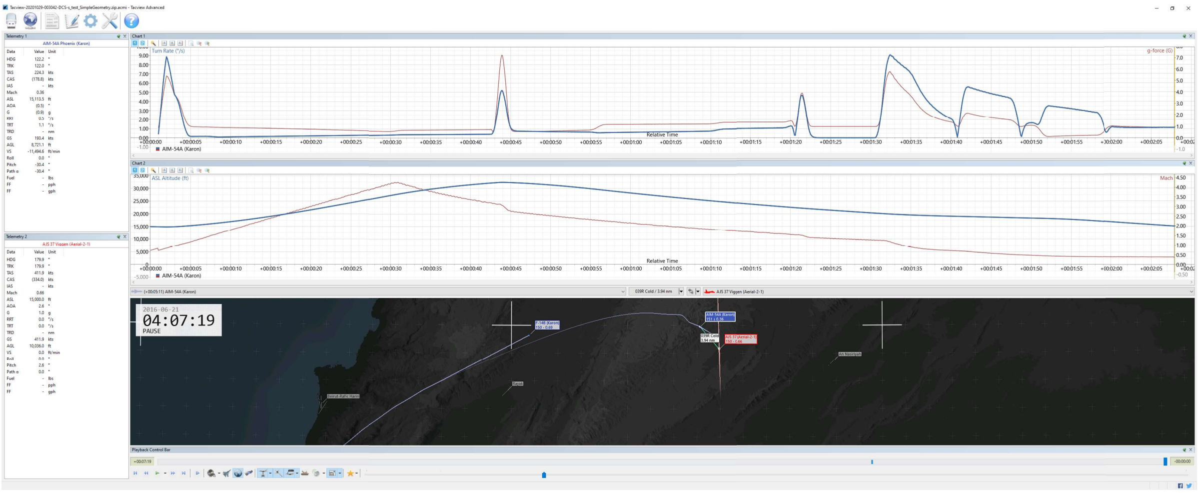

Figure 309: AIM-54A Mk60 launched following pure pursuit at 45nm.

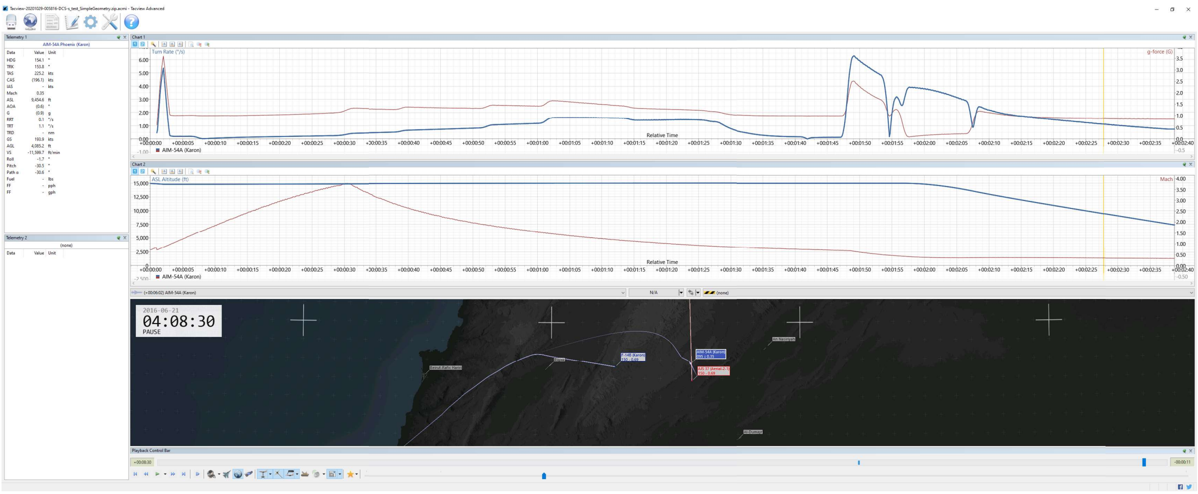

Figure 310: AIM-54A Mk60 launched following pure pursuit at 35nm (STT lock).

I run a couple of additional tests and the results either match the performance of the Collision (as TA tends to zero) or a straight out worse (especially as TA > 45°). It does make sense if you think about it: collision "cuts" the flight path of the target, pure follows the target but, in order to do so, it requires constant corrections as the target is constantly drifting.

This last image is the comparison between the three employments:

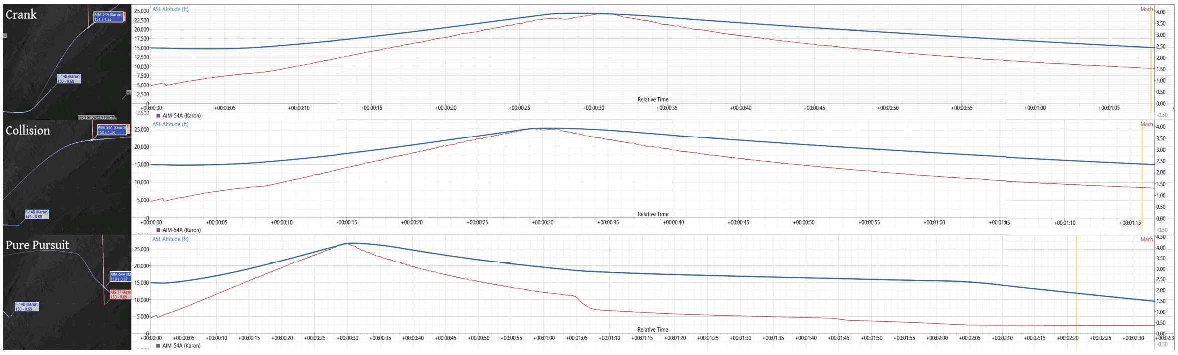

Figure 311: AIM-54A Mk60 at 35nm: "Crank" vs Collision vs Pure pursuit.

Interesting, isn't it?

9.8.9 CONCLUSION

The examples shown above of "Casual" intercept do not provide results as controlled and precise as the actual procedures. You may have noticed in fact how these approaches result into different "impact" angles every time, require numerous adjustments and do not place the fighter in the optimal conditions for a missile employment, not to mention any stern conversion turn.

However, there are some pros in this empirical way of doing the intercept. In primis it is very easy to use: just place the target's vector towards the F-14 in TID AS and that's pretty much it, and this was the main objective of the Challenge. Therefore, it does not require specific, lengthy and detailed study.

It also helps to improve the SA: just consider how AI hostile fighters have the tendency of placing their target on collision; now you can tell if they are placing your aircraft on collision just by glancing at the TID AS.

This procedure has also shown a very simple mean to manipulate the geometry by placing the target at the limits of the radar and accelerating.
Lastly, this is a valid alternative to the common Pure pursuit.

9.9 SIMPLIFIED STERN CONVERSION

Sometimes the fighter is tasked to perform a different operation, such as VID, or the fighter is out of non FOX-2 missiles, and want to improve the odds of an IR missile. Perhaps again, it is simply rejoining a tanker. In these cases, a simple *conversion* towards the rear of the contact will do.

Although the avionics of the F-14 is surprisingly intuitive, the immediate drawback of this technique when compared to the Simplified Intercept is the lack of “no-brainer”, “point-here-and-go” indications. However, the TID in AS mode provides all the necessary tools to obtain the information the crew needs to approximate the manoeuvre.

A rough gameplan is the following:

1. the distance of the target can be approximated via the TID or DDD, down to ~10nm SR;
2. the fighter manoeuvres to adjust the approach, placing the target in a favourable position before the beginning of the conversion;
3. the fighter turns to zero Cut;
4. the crew estimates the lateral separation, to gauge how hard the turn will be;
5. the fighter turns into the target, with a “*steady up*” in the target’s rear quarter.

9.9.1 DISTANCE AND ANGLES APPROXIMATION

The TID in AS mode tells the Radar Intercept Officer where the target will be in the near future, from the perspective of the F-14. Details such as the hooked contact’s range are provided by the two readout lines on the display, or can be eyeballed.

The idea is manoeuvring to place the target at 12-13 nm in an area half-left or half-right from the fighter’s perspective. The TID BR readout will show something close to 315-320 if the target is on the left of the nose, and 40-45 if the target is on the right of the nose. This is a basic operation to perform using the LAUNCH ZONE option in the TID Control Panel to make the vector longer and more visible.

By setting the radar to ±40°, the position we want to place the contact is even more easily identifiable. However, for newer or Jester-stuck players, TWS Auto is sometimes preferable (eventually you will probably use it less often, as TWS Manual offers more control). TWS Auto, as the name suggests, automatically adjusts the radar parameters, thus proposing a narrower and taller scan volume (4B ±20°). For this reason, I left the radar doing its things in this example.

Figure 312: Simplified stern conversion - Scenario.

In this specific case, the target is almost on collision course already, thus the required correction is less dramatic than other cases.
The WCS is automatically setting the TWS Auto to 4B ±20°.

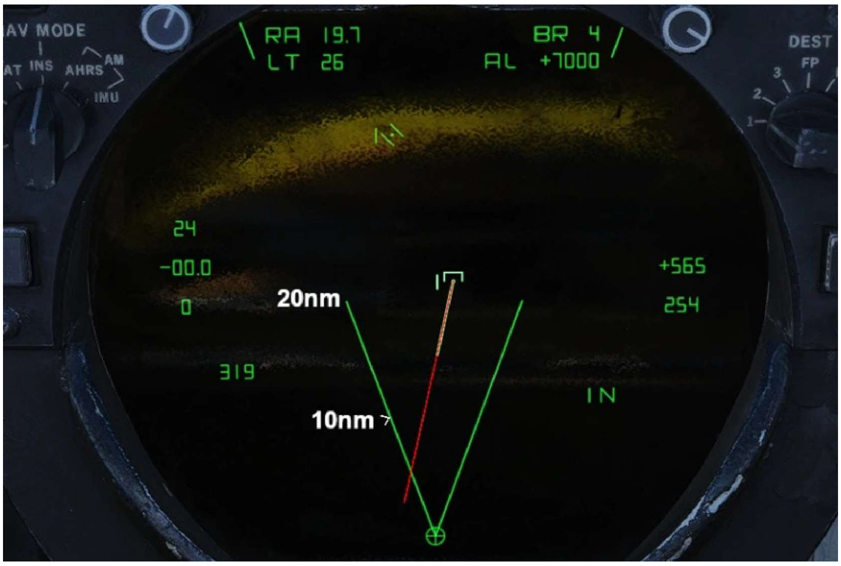

Figure 313: Simplified stern conversion - Contact at 20nm.

9.9.2 ZERO CUT

The next step is achieving Zero Cut at about 10nm, at an angle similar to the one described above.
The Cut concept is described in the Intercept Geometry study (see Chapter 5.2). If you are new to it, or it sounds too complex, consider that the fighter's goal is to fly towards the reciprocal of the contact. For example, if the contact is flying due South (180°), then the fighter will fly due North (360°).

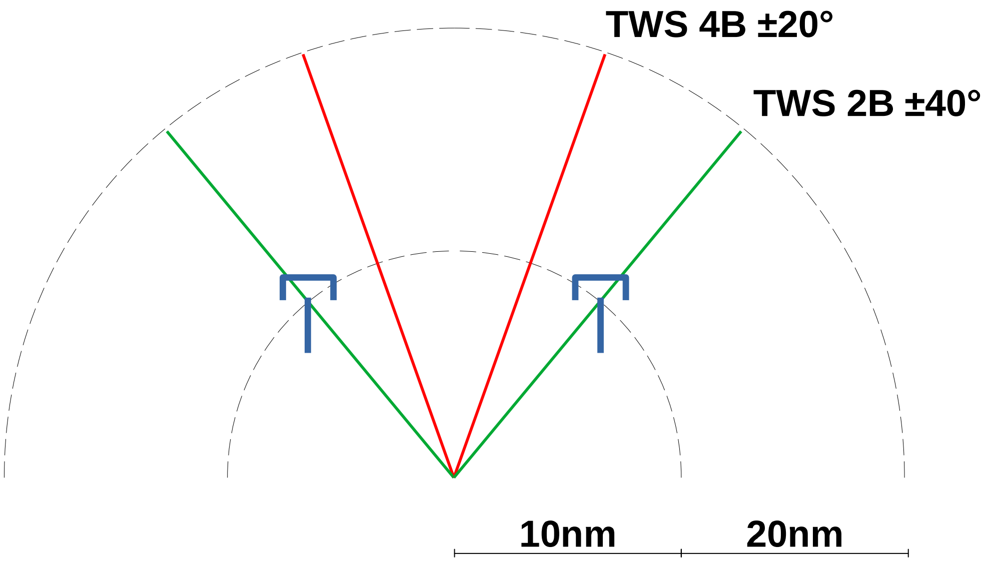

Figure 314: Simplified stern conversion – Zero Cut, TWS wide and narrow on the Tactical Information Display in Aircraft Stabilised mode.

The following image illustrates how the situation above would appear from a god's eye point of view:

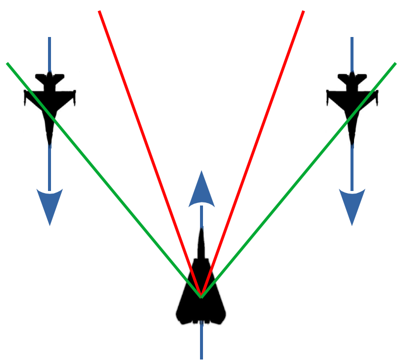

Figure 315: Figure 280: Simplified stern conversion – Zero Cut, TWS wide and narrow in "real life".

Glimpse of the Future
After the heavily simplified approaches to Timeline, Intercept and Conversion, diving into the study of the Intercept Geometry is strongly recommended.
Albeit more complex, it will answer questions many common questions. For example, the reason we want the contact to be at 10 nm, about 40° left or right, is to satisfy the requirement of Lateral Separation for a textbook stern conversion turn: the LS is calculated as TA * SR * 100, and it should be equal to 40,000ft if the textbook definition is followed. The parameters mentioned above are close to the required 40,000ft of LS at 10nm.
By flying Zero Cut, the Lateral Separation is "locked" through the rest of the intercept, although the angles (TA and ATA) are changing. Thus, the plan is to capture the desired Lateral Separation right before proceeding to turn towards the target's Rear Quarter.

In order to place the contact in the desired position, start the turn to the Reciprocal Heading before hitting 10nm; at about 12-13nm usually works. Otherwise, the manoeuvre may be completed well within the 10nm mark.
Note that if TA is particularly high, the turn to zero cut may be quite hard. This is the main drawback of a technique that relies on visual approximations rather than maths. A more thorough approach, using the fundamentals of the Intercept Geometry, corrects this situation before approaching the conversion turn.

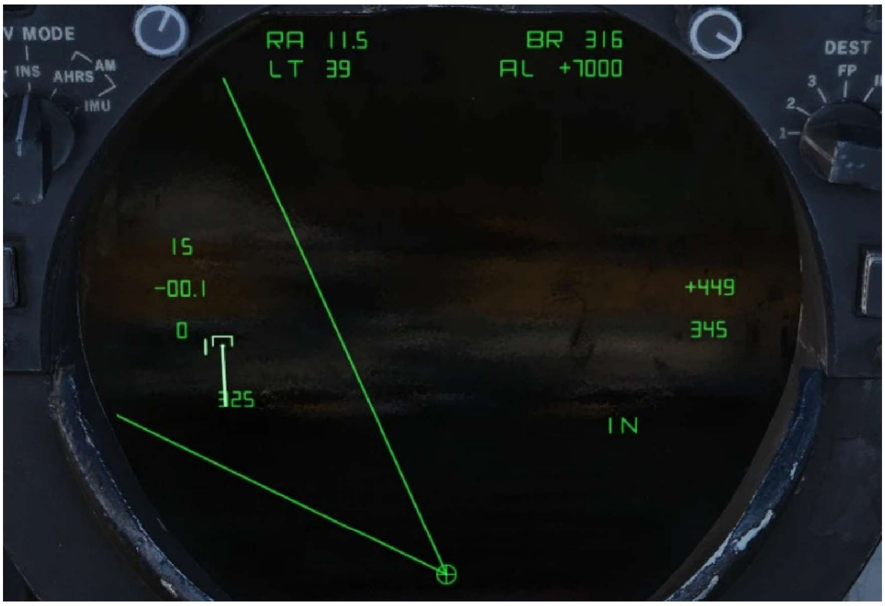

Figure 316: Simplified stern conversion - Contact at 10nm, zero cut.

Figure 316 shows the situation before the conversion turn. Textbook-wise, the amount of lateral separation is excessive (44,850ft rather than 40,000ft), but for this simplified approach it will do.

A quick means to gauge if the conversion has to be hotter or colder is the value of the Target Aspect (or the Antenna Train Angle, present on the DDD as well). Without going too much into the details, the key value is 40 L/R at 10nm. If it is greater, then the pilot has to turn harder towards the contact. Vice versa, if less than 40°, the pilot should slightly ease off the manoeuvre.

9.9.3 THE CONVERSION TURN

The radar track may be lost during the last few seconds before the conversion turn. However, if the parameters (sort of) match the intended values, the turn becomes a classic "easy-to-hard": the turn starts quite "easy", then, halfway through the turn, the ratio increases, and it is eventually adjusted as soon as Tally is called.

The pilot must be cautious and practice the turn; otherwise there is a concrete of pulling too hard. If the error occurs in the initial half of the manoeuvre, the result can be an overshot, or a rollout parallel to the target, rather than in its rear quarter.

Figure 317: Simplified stern conversion - Tally!

In this example, I used TWS Auto until the turn, switched to the front seat, flipped the ACM cover and locked the target in VSL LOW almost at the end of the manoeuvre.

It was my very first attempt, with a bit of practice (and a real human RIO in the back seat – I disabled Jester first thing), the precision of the manoeuvre is noticeably increased.

9.9.4 SCENARIO AND TACVIEW

I placed the bogey and the F-14 quite randomly in the recently released South Atlantic Map. As expected, the geometry displayed by the TID in AS mode does not match the map.

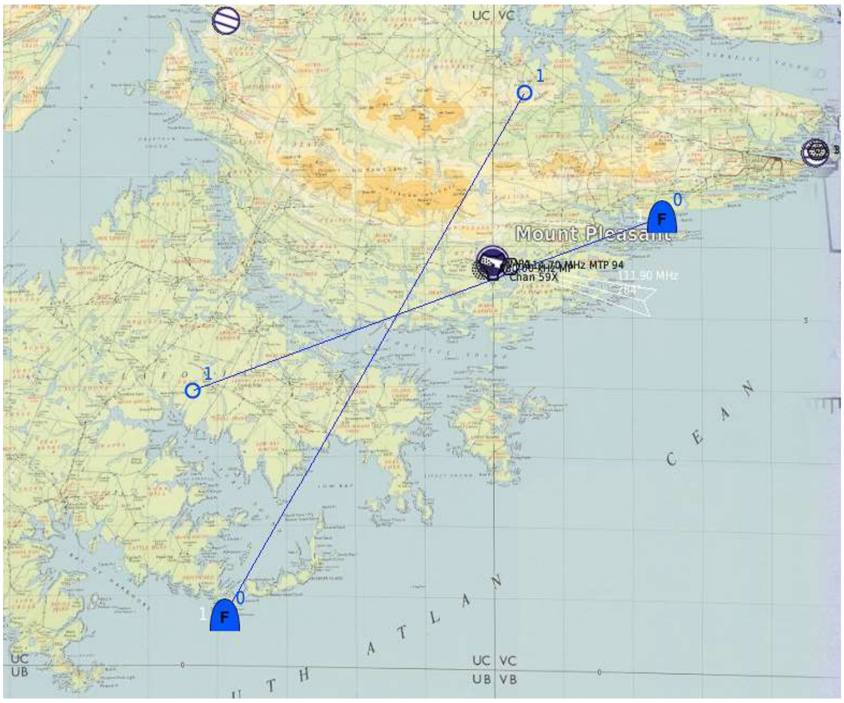

Figure 318: Simplified stern conversion - Scenario in the DCS Editor.

The Tacview track in Figure 319shows the different stages of the intercept and the conversion turn.

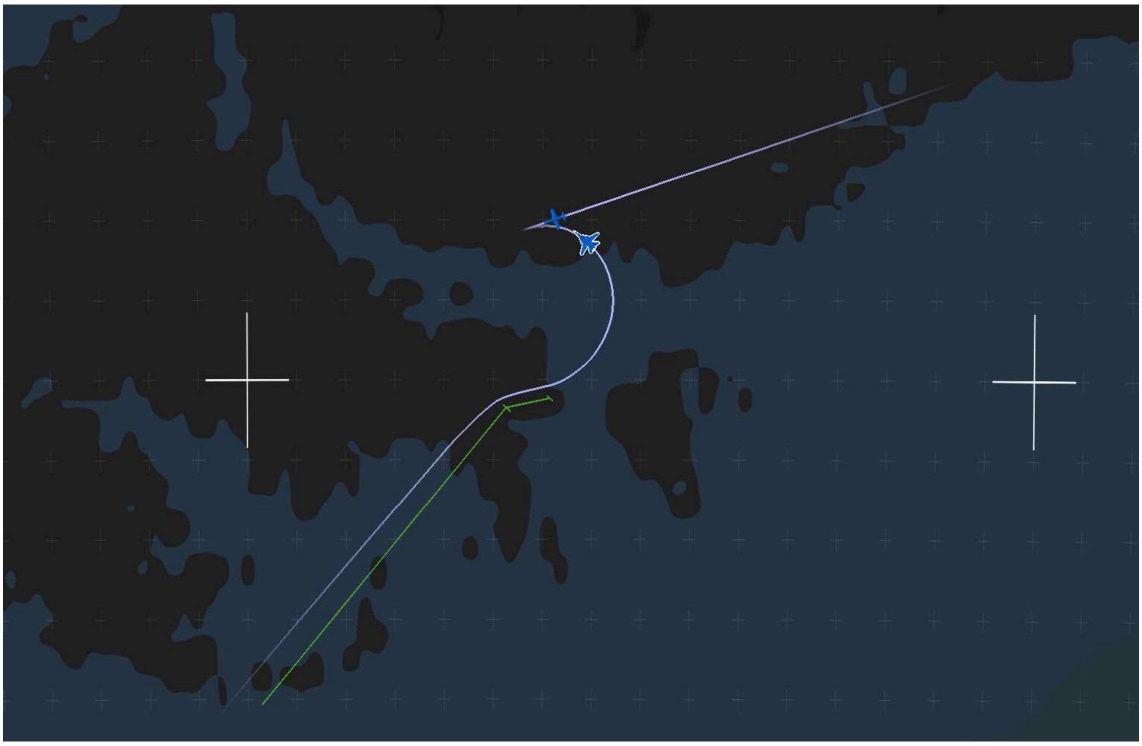

Figure 319: Simplified stern conversion – Tacview, top-down view.

The green line, interpose by the dashes, mark the initial approach and the turn to zero Cut. The conversion is not a precise half-circle, but it starts easy, and it gets progressively harder, with final adjustments post Tally.

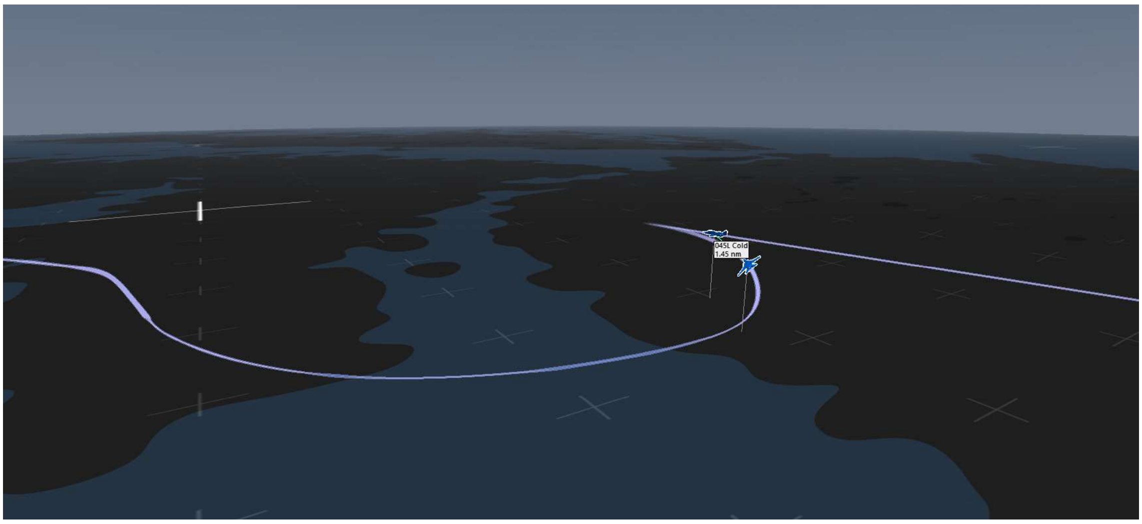

Figure 320: Simplified stern conversion – Tacview, conversion turn.

9.9.5 VIDEO

I recorded a brief video showing how simple the application of this procedure is, starting from the mission editor, down to the conversion into the target's rear-quarter itself.
To open the video, click on the image or on this link.

Figure 321: Video - Simplified Stern Conversion Turn (link).

9.9.6 CONCLUSIONS

The simplified conversion is more of an exercise than a practical manoeuvre, but it can come handy in specific situations. More importantly, it offers a first look at something deeper and more complex than the Simplified Intercept. In fact, it shows how information such as Headings and Angles can be used to manoeuvre the F-14 in a favourable position for an ad hoc task.

9.10 REAL-LIFE EMPLOYMENT RANGES

In an episode of "*10 Percent True*", hosting *James "Puck" Howe*, former CO of the VF-31, the employment range of the AIM-54 were discussed when employed in the F-14D (starting at 15'20").

The most interesting aspect of the discussion is the consideration about the awareness of the target. In fact, Puck mentions how long-range, 60+ nm shot, did not require much to be defeated, and this is consistent with DCS. An early shot at 50nm was easily defeated by the target introducing a 25° offset.

Puck continues, mentioning that in TOPGUN, the usage of the AIM-54 Phoenix was restricted between 30nm to 40nm. They avoided shooting inside 30nm. Post launch, they waited for the target to manoeuvre, expecting former Soviet tactics, then the follow-up employment would be within 20nm.

The range between 20nm to 30nm was considered a "dead-zone" for the AIM-54 Phoenix. The 20nm shot with the Phoenix was, ad verbatim "a great shot", thanks to the motor burning for about 30", and burning all the way to the target.

The idea was shooting them before 30nm, thus before the contact realised it was targeted. Inside the 30nm they probably recognised they were targeted, they would start to manoeuvre sharply, defeating any Phoenix shot in that situation.

In contrast, the AMRAAM had more margin against manoeuvring targets, also thanks to more radar modes to the shooter.

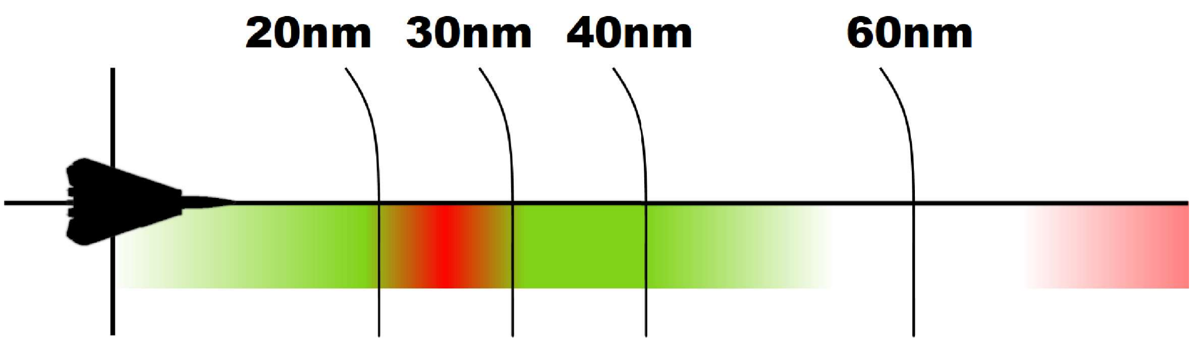

Figure 322: "Puck's" AIM-54 Employment ranges.

10. OPERATIONS IV: INTERCEPT GEOMETRY – A STUDY

The simplified structures presented in Chapter 9, the Timeline and the Intercept there are meant to be used "out-of-the-box", without going to much into the details of the theory beneath. Not everyone is, in fact, interested in long discussions about finer the details necessary to follow the doctrinal explanations.

This Chapter resumes where Chapter Error: Reference source not found left, after the introduction of the fundamental notions related to the Intercept Geometry.

Long Story Short
The study of the Intercept Geometry on FlyAndWire spans from the 50s to the modern intercepts (some articles are still WIP). However, only the chapters relevant to the F-14 will be discussed in this book.
Those include:

- Modern intercepts, based on the P-825/17;
- '2000s intercepts, based on the P-825/02.

Also note that the available documentation is "beginner-level". The notions discussed are introductory. On top of the fact that they are public, this clearly proves that this are hardly techniques used in the front lines. Nevertheless, they provide a good insight to the intercept procedures and help shaping the forma mentis of the virtual Radar Intercept Officer.

10.1 INTRODUCTION

This overview is long and quite detailed. It covers most of the relevant aspects from two versions of the P-825: the most recent, from 2017 and a previous version from 2002. I am not using the version from 2008 since it sits somewhat in-between the two others.

The 2017 version takes advantage of the new avionics used by the T-45 Goshawk, such as the HAFU displayed on the Attack Display. Such indicator shows many important details at a glance, and does not require any mental calculation.

The 2002 versions, which is very similar, content-wise, to an F-4 syllabus from the 70s, is based on the T-39 Sabreliner and pushes heavily on the ability of the RIO to execute Maths quickly and reliably, and commit to memory several tables and information. The different approach makes completely sense, as more automation equals to less attention and stress required from the crew, and more energy dedicated to maintaining Situational Awareness and fulfilling the task of the mission.

OBJECTIVES

The purpose of this study is showing how what has been learnt so far and the new notions can be used in a practical scenario. The goal is not blindly applying the procedures, but rather understanding how the Radar Intercept Officer can manoeuvre his aircraft to obtain an advantage.

For example, the effects of the geometry on the angles and, therefore, to the performance of our own to the hostile's missiles. Not to mention the effects on the avionics and the ability of employing a missile in the first place, due to the huge blind spots affecting the AWG-9.

WHY STUDYING BOTH THE OLD AND THE NEW?

Although the newer doctrine is closer to an F/A-18C Hornet then the F-14 Tomcat, in terms of DCS, it offers finalized and "polished" structures such as the Timeline, that in the older doctrine are either not mentioned, or are not as clear in their presentation.

However, the F-14 has something that makes it unique: it was operative in one of the most interesting periods in terms of air combat, and the doctrine applicable spans since the Vietnam[84] up until the war in Afghanistan. Therefore, there was a time where the AIM-54 was not used against fighters, and here is where concepts such as the Lead Collision become relevant to optimize the performance of an AIM-7; until the era of the Active Radar Homing missiles dominated, and tactics such as Skate became feasible.

Since DCS is a sandbox, each player can choose the time setting and a scenario he prefers, it is worth looking at both sides of the employment history.
If you are wondering why no doctrine preceding the 2000s is included, answer is very simple: the available documentation is extremely similar, both in topics and techniques, to what the P-825/02 covers[85].

84 Source: Wikipedia – American Withdrawal from Saigon (1975).
85 I used a syllabus for the F-4 from 1972 for the comparison.

10.2 TARGET ASPECT AND LATERAL SEPARATION

Out of many concepts related to the Intercept Geometry, the Lateral Separation is probably the most important variable at this stage of our learning process.

The Lateral Separation is calculated as *Target Aspect * Slant Range * 100*, thus it is directly dependant from the value of the Target Aspect, and that's where we start from.

10.2.1 THE TARGET ASPECT

Defined as the bandit's perspective pertinent to the fighter, there are several ways to calculate this variable. Two of the most common can be visualized on the BDHI. However, the RIO should be able to calculate the TA mentally rather than re-creating the scenario on the BDHI every time.

Unfortunately, this is not the only value the RIO has to calculate and monitor and feeling overwhelmed is very easy especially when approaching these concepts for the first time, but practice definitely help (or, at least that's my experience). Eventually, calculating TA and LS becomes a matter of a bunch of seconds:

> *High aircraft speeds bring the two aircraft into close proximity within a maximum of 2 to 3 minutes, and usually less. The RIO must learn to calculate rapidly, and with little error. An error, once made, seldom can be fully corrected within the time remaining to intercept. Rapid closure, numerous calculations, and the need to continually manipulate the radar, essentially prohibit recording calculated values. The RIO must hold the results in his memory as he progresses through the list of operations. The outcome is a high information-processing rate for the RIO's mental processes.*
>
> **NAVTRAEQUIPCEN 71-C-0219-1 P10**

Two formulas are used to calculate the Target Aspect. They are actually identical as both use the BR (or Cut) as the starting point and the BB (or ATA) as the finishing point.

The context in which this formulas are applied is the typical Lead Pursuit where BB, FFP and BFP create the familiar intercept triangle, featuring TA, ATA and DTG as internal angles.

1. **Cut to ATA = TA (L or R)**

   This formula works best on the DDD or other B-scope attack display. Problem is, the TID is not one of them and the information displayed on the DDD are functions of VC in non-Pulse modes, making the drift hard to identify.

2. **BR to BB = TA (L or R)**
   This formula is should be used when the BRAA is passed. It is very simple as the BR is immediate (the documentation stresses the importance of being able to calculate

the BR in a second), then it is just a matter of “moving to” the BB. If no tactical control is available, then BB can be calculated as FH ± ATA (add if ATA Right, subtract if Left).

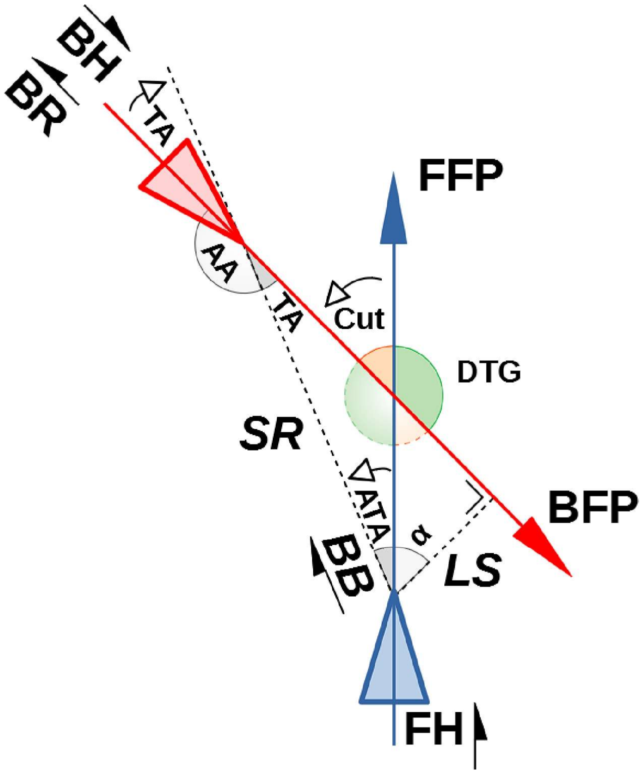

Figure 323: Intercept Geometry: fundamental angles.

What does “to” mean?
“to” is not a mathematical operator of course, it literally means “jumping” between two values, logically measuring the direction as mathematically we would do by means of the modulo.
Consider the application of the second Formula to this scenario:
BR = 355°;
BB = 030°.
The simplest solution is to mentally visualize the BDHI and assess how many degrees there are between BR and BB: 5° from 355° to 360° then 30° more for a total of 35°. This exercise is also useful to visualize the label (Left or Right) of the TA. In this scenario we moved from Left to Right so TA is 35R.
If we invert BR and BB instead, we still have 35°, but we would be moving from 30° to 355°,
therefore from Right to Left. The TA in this case is 35L.
After some practice, this becomes second nature.

At the end of the day, use the procedure you prefer. I usually follow the doctrine and use BR → BB if a controller is available (and therefore BRAA is routinely provided unless “JUDY” is called), otherwise Cut → ATA which is very easy to visualize both mentally and on the BDHI.

The BDHI is invaluable when first approaching the long list of parameters that can affect the geometry, use it!

10.2.2 DETERMINING THE BANDIT RECIPROCAL: THE +2/-2 RULE

This is a simple but useful trick to calculate the BR. The Bandit Reciprocal can be in fact mathematically obtained by using the modulo but when calculating the result in your head, using the modulo may not be the fastest way.

Since ±180° are added depending on the BH, the +2/-2 rule can be effectively used:

If 20° < HDG < 180°: add 2 to the hundreds, subtract 2 from the tens;

If HDG > 190°: subtract 2 from the hundreds, add 2 to the tens.

As you can see, it's simply a more structured way to add or subtract 200 and compensate for the remaining 20 degrees.

Examples:

- HDG 347 → "3" – 2 and "4" + 2. "7" is carried over. Reciprocal: **1 6 7**
- HDG 125 → "1" + 2 and "2" – 2. "5" is carried over. Reciprocal: **3 0 5**
- HDG 220 → "2" – 2 and "2" + 2. "0" is carried over. Reciprocal: **0 4 0**
- HDG 021 → "0" + 2 and "2" – 2. "1" is carried over. Reciprocal: **2 0 1**

Alternative means of calculating the BR are, for example, the already discussed BDHI or memorizing a table with Headings and Reciprocals, similarly to what we all did back at the elementary school.

10.2.3 UNDISCUSSED SCENARIOS

The sources I used and mentioned in Part I take for granted that in this phase the intercept triangle is present and built as usual by ATA, TA and DTG (angles). What if, instead, the standard intercept triangle is not applicable due to how FFP and BFP are oriented?

To answer this question, I put together a bunch of different scenarios and checked whether the formulas can be applied or the geometry changed in such a way that new formulas are required.

Note that I represented Target Aspect, Cut and DTG as per their definition (out of simplicity, in some cases I drew the opposite angle):

- *TA*: the angle between BB and BR;
- *Cut*: the angle between FFP and the BR;
- *Degrees To Go*: the angle between FFP and BFP.

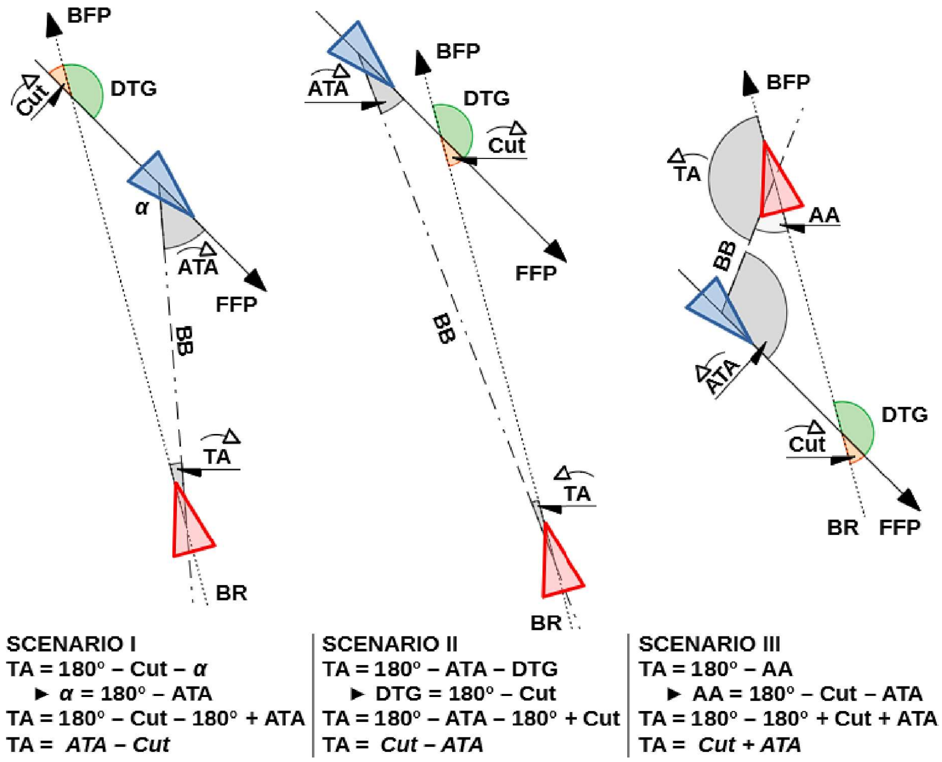

Figure 324: Intercept Geometry: undiscussed scenarios.

As you may have noticed already, the conundrum is understanding where the intersection between FFP and BFP is located: unless fighter and bandit are flying parallel, in fact, the two paths will always intersect at one point.

Scenario II, included for reference, is the standard Lead Pursuit (whether collision course is established, or it does not matter in this context).
Applying the first formula, we find that TA = Cut – ATA.

Scenario I see the BFP intersecting the FFP behind the fighter.

The angles involved are Cut, TA and α, the supplementary angle of the ATA.

TA = 180° – Cut – α

α is equal to: 180° – ATA

Thus: TA = 180° – Cut – 180° + ATA = ATA – Cut

> **Observation I**: although Scenario I and II provide different results Maths-wise, in practical terms there is no difference as the absolute value of the difference is considered when determining the TA.

Scenario III resembles a Lag Pursuit and the usual intercept triangle is again not applicable.
We notice that the triangle's angles are AA, Cut and ATA:

TA = 180° – AA

AA in this case is equal to: 180° – Cut – ATA

Thus: TA = 180° – 180° + Cut + ATA = Cut + ATA

The result is different from the previous scenarios as in this case Cut and ATA are added up rather than subtracted.

Observation II: if Lag Pursuit is established, ATA and Cut are discordant*. This makes understanding the current geometry immediate and can affect how the RIO decides to manage the TA and eventually the Lateral Separation.

*: this is a purely empirical observation. If you find examples where this is not applicable, please let me know!

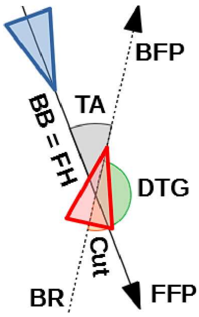

Figure 325: Pure Pursuit.

For completeness' sake, let's have a look at what happens in two more peculiar scenarios:

Scenario IV: Pure Pursuit. Pure pursuit does not often happen during the intercept, but it is the typical case originated by a "Hot-to-Hot" situation, or TA = ATA = 0.

This scenario is quite simple since BB = FH, the simplest solution is using BR → FH.

Observation III: in this scenario, TA = Cut – ATA with ATA = 0, therefore TA = Cut (in fact, the TA is the opposite angle of the Cut).

Note that Pure Pursuit should be maintained by adjusting FH, otherwise the situation falls into either Scenario II or Scenario III.

This scenario can be useful to quickly assess the aspect of the target at the beginning of the BVR Timeline (Point and Assess).

Remember also that the TA does not change instantaneously when the ATA changes.

Scenario V: Parallel Flight. Fighter and bandit can fly following parallel flight paths, therefore DTG = 180° or DTG = 0° depending on the directions:

- When DTG = 0° and FH = BH, the scenario is called True Stern;
- When DTG = 0° and FH ≠ BH , the scenario is called Parallel Stern;
- When DTG = 180° and FH = BR, the scenario is called True Head-On;
- When DTG = 180° and FH ≠ BR , the scenario is called Parallel Head-On.

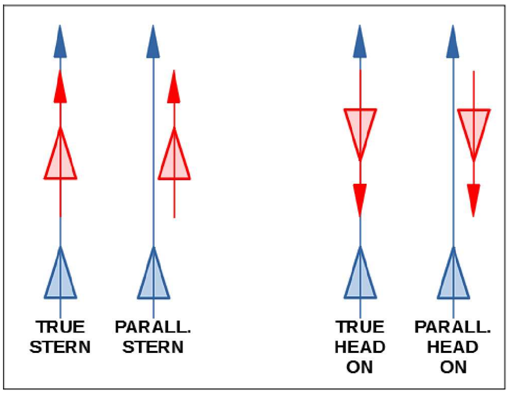

Figure 326: Intercept Geometry: parallel flight.

> Observation IV: no matter the scenario, TA can be always calculated by using Formula 2, BR to BB; whereas the relations between TA, ATA and DTG may change depending on the geometry.

10.2.4 PRACTICAL EXAMPLES

The considerations and observations made so far can help to understand how the TA changes as the intercept progresses, especially in case CB is not established.

Let's now have a look at a few practical examples. I used both Formula 1 (DTG to Cut to TA) and Formula 2 (BR to BB), plus a variant of the first formula skipping the determination of DTG.

Higher resolution images for these examples are available here.

Figure 327: Target Aspect: Example I.

Figure 328: Target Aspect: Example II.

Figure 329: Target Aspect: Example III.

Figure 330: Target Aspect: Example IV.

Figure 331: Target Aspect: Example V.

Figure 332: Target Aspect: Example VI.

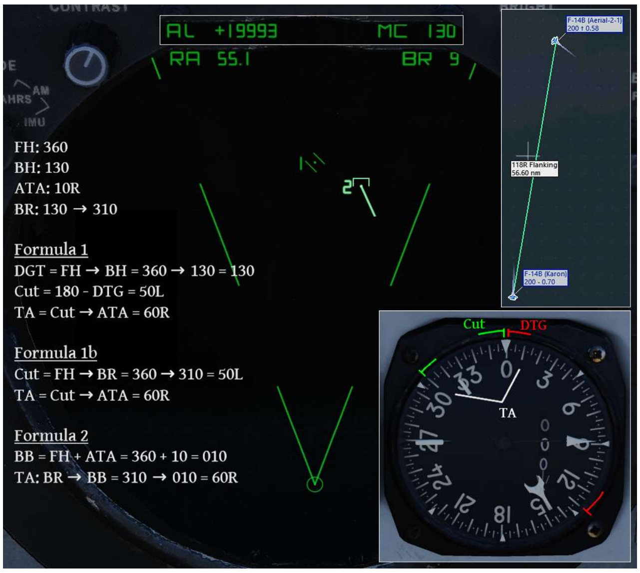

Figure 333: Target Aspect: Example VII.

10.2.5 LATERAL SEPARATION: AXIS MUNDI

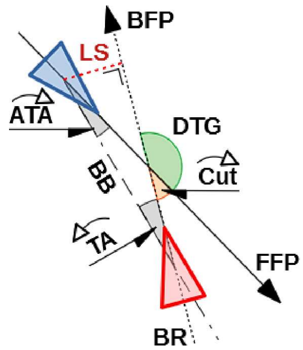

Figure 334: Lateral Separation.

The Lateral Separation (LS), sometimes called Lateral Displacement (LD) is one of the most important concepts of the Intercept Geometry. Defined as the distance from the Fighter Flight Path to the Bandit Flight Path, the LS puts into relation two other fundamental basic concepts: Target Aspect (TA) and Slant Range (SR).

The LS can be expressed in feet of nautical miles, and it is calculated as:

[ft] > LS = TA * SR * 100

[nm] > LS = TA * SR / 60

Besides the geometrical concept, what is the meaning of the lateral separation? Simply put, it expresses the manoeuvring space available to the fighter, in relation to the target.

As mentioned above, the Lateral Separation is drastically affected by the TA: variations of the Antenna Train Angle or the Slant Range do not affect the LS immediately, whereas if the bandit turns and therefore the TA changes, it impacts the LS instantaneously.

Consider the following examples:

SR=50nm, TA=35° → LS = 175,000	SR=50nm, TA=35° → LS = 175,000
SR=30nm, TA=35° → LS = 105,000	SR=50nm, TA=10° → LS = 50,000
SR=10nm, TA=35° → LS = 35,000	SR=50nm, TA=0° → LS = 0

It is clear how the Slant Range can't change in a bunch of seconds whereas the Target Aspect can, and by doing so, it drastically affects the Lateral Separation. This effect is fundamental as an aware bandit may try to deny the fighter's intercept by, for example, jinking, turning cold or head-on.

The following sketch further emphasises this concept.

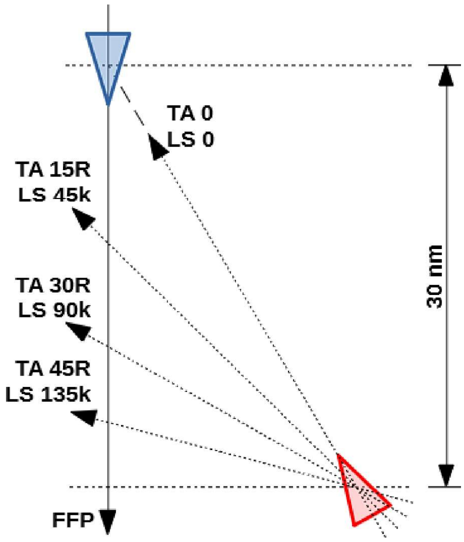

Figure 335: Lateral Separation: "opposite" view.

Since the Lateral Separation describes the turning space available to the fighter, it should be more clear now how important it is and, intuitively, we can foresee already how a big chunk of the Intercept Geometry relies on the ability to manage and manipulate the two components of the LS: Target Aspect and Slant Range.

The “goal” LS and how it is managed change depending on the objectives of the mission, tasking, commit directive from a controller, ROE and VID requirements and so on.

MANAGING LATERAL SEPARATION

Before diving into the doctrinal techniques used to manage the LS, let’s have a quick look at the relation between LS and other actors.

> Notes: each of the sources I used as reference approach the management of Lateral Separation slightly differently, and sometimes set different goals in terms of separation. The rest of the article is based on the P-825/17.
> The following LS management observations are fundamentally a series of applications of the basic concepts of Euclidean geometry and trigonometry.
> The differences and “quirks” pertinent to each technique are discussed in the following parts of the series.
> Note also that the relations are based on the fact that the intercept is co-speed, co-altitude, conditions that rarely happen in DCS. On the other hand, this scenario simplifies the relations and the calculations required to determine collision and LS.

10.2.6 RELATION BETWEEN CUT, DTG, ATA AND LS

The CNATRA P-825 shows how different types of Cut vs Collision affect Lateral Separation and Target Aspect over time.

#	CATEGORY	TYPE OF CUT	LS	TA
1	Cut Into	Cut > Collision	Decreases	Decreases
2	Cut Into	Cut = Collision	Decreases	Unchanged
3	Cut Into	Cut < Collision	Decreases	Increases
4	Cut equal to BR	Cut = 0	Unchanged	Increases
5	Cut Away	Cut Away / Zero Cut	Increases	Increases

The three categories are easily explained: a Cut into decreases the Lateral Separation (BFP and FFP intersect), a Cut away increases the LS (the fighter moves away from the BFP), the Cut equal to BR, maintains LS.

These five relations provide simple means to manipulate the Lateral Separation in order to achieve the desired objective.

The following sketches describe the relations mentioned above:

#1 – Cut Into: Cut greater than Collision

► LS and TA reduced over time

- FFP well in front of the bandit;
- This is the only Cut that reduces TA;
- The bandit is place in the Hot side of the display.

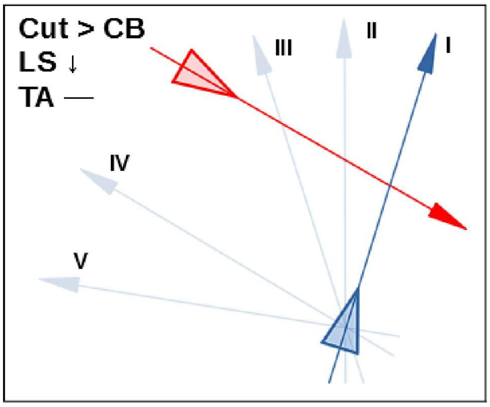

Figure 336: Cut greater than collision.

#2 – Cut Into: Cut equal to Collision

► TA unchanged, LS decreases

- As TA remains unchanged, the LS decreases due to the SR;
- TA = ATA but opposite in sign;
- If co-altitude, the aircraft will (theoretically) collide mid-air;
- This is the most efficient geometry to close with the bandit;
- Bandit's vector in TID AS points towards the F-14.

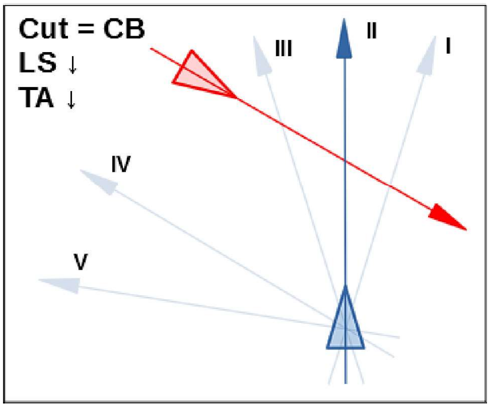

Figure 337: Cut equal to Collision.

#3 – Cut Into: Cut less than Collision

► LS is reduced whilst TA increases

- Pure and Lag pursuit are always less than collision;
- There can be Lead pursuit if within Pure and collision;
- Useful when approaching WVR (if bandit unaware of the fighter);
- The Target is placed in the first part of the Cold side of the TID.

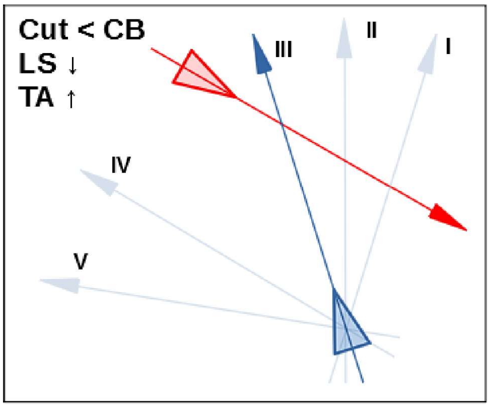

Figure 338: Cut less than collision.

#4 – Cut equal to Bandit Reciprocal

► TA doubles as range halves

- This is not a type of pursuit;
- FFP and BFP are parallel;
- It is the only occasion when the bandit's TID AS vector is perpendicular to the bottom edge of the screen.

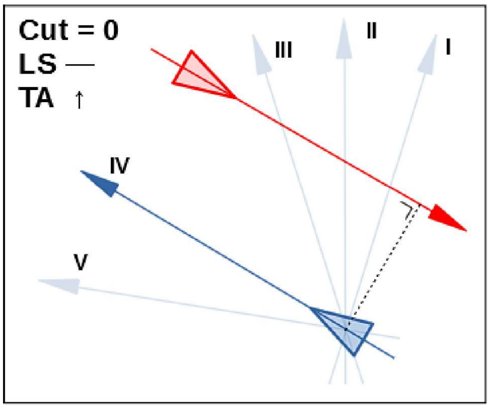

Figure 339: Cut equal to BR.

#5 – Cut Away

► Only way to increase LS

- It is not a type of pursuit (since LS is being generated);
- It is used by the fighter when LS needs to be increased.

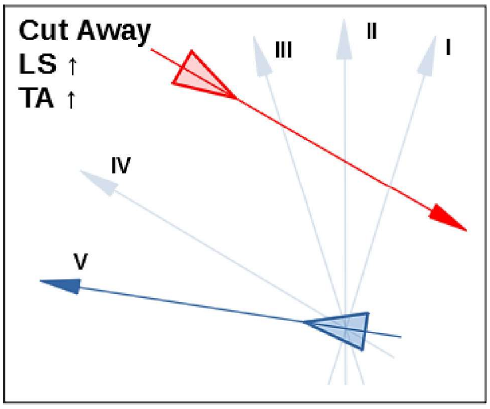

Figure 340: Cut Away.

A FAMILIAR TOOL: TACTICAL INFORMATION DISPLAY IN AIRCRAFT STABILIZED MODE

These considerations are immediately understandable when applied in the scenarios described by the P-825, but what happens on the TID in Aircraft Stabilized mode when the fighter and the bandit are not co-speed?

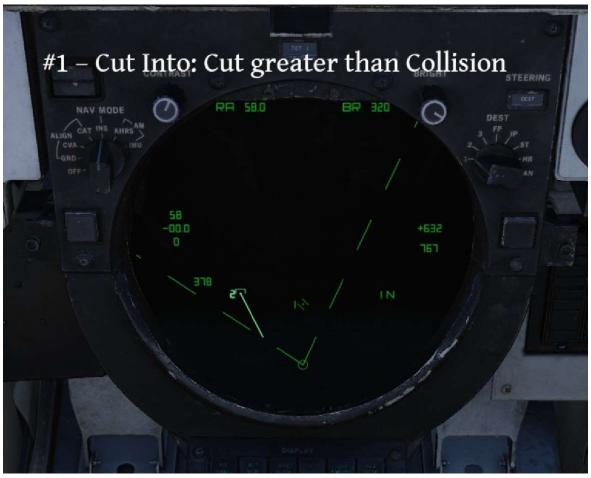

Figure 341: TID: Cut greater than collision.

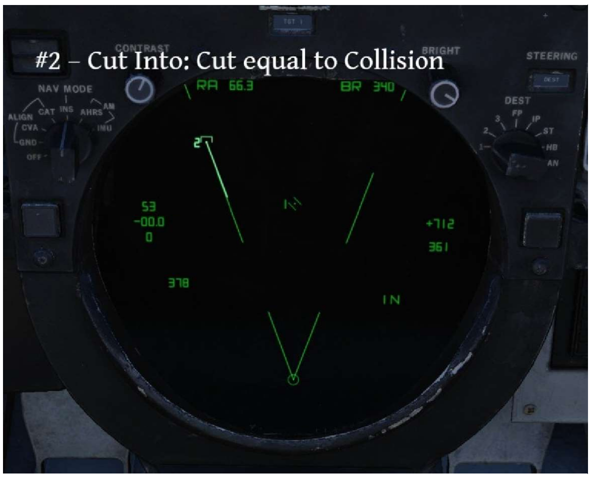

Figure 342: TID: Cut equal to collision.

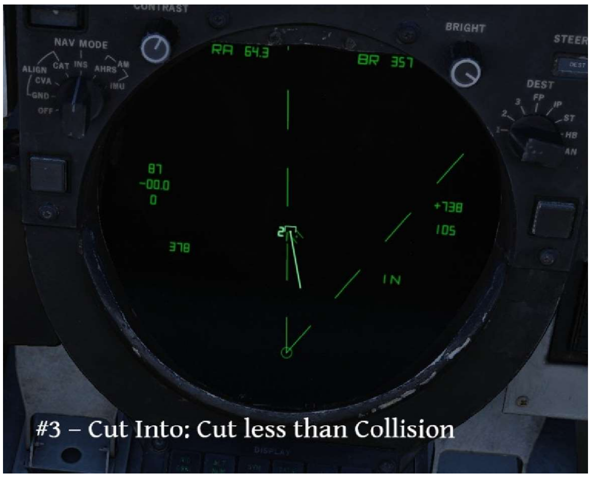

Figure 343: TID: Cut less than collision.

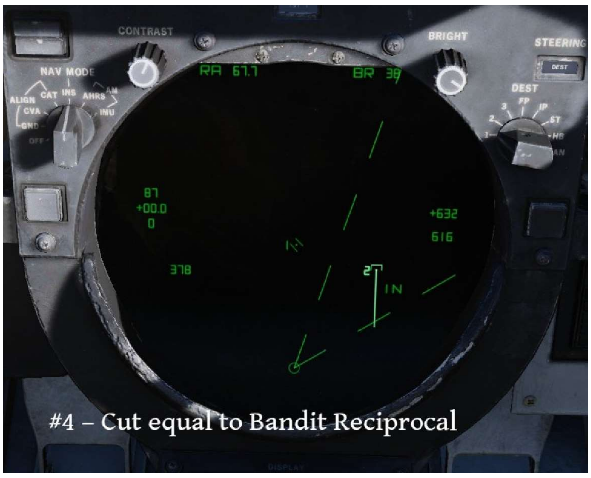

Figure 344: TID: Cut equal to BR.

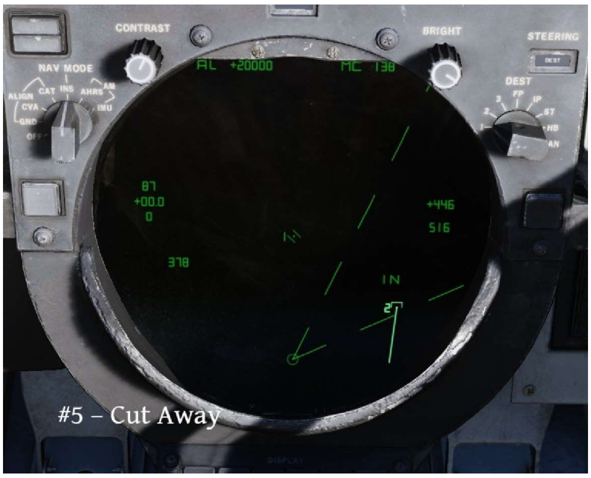

Figure 345: TID: Cut away.

Whist putting together these examples I collected data relative to the TA and the SR after 30” and 60”. I ran the first series of tests with the fighter flying faster than the bandit and then I repeated the test collecting a second series with the aircraft flying co-speed (GS).

Modus operandi. Notes:

- I set up the flight paths from the ME, so they are not perfectly accurate but close enough (ref. collision and FFP = BR);
- The F-14 spawned in exactly the same position every time, I only changed FH and speed;
- Values are taken from TacView, I used RBRG from the target to the fighter as it is more precise (float) than the AA provided (int);
- LS is expressed in a thousand of feet.

These are the results of the first test:

Speed TGT	**300**
Speed F14	**500**

Test	TA30"	SR 30"	TA60"	SR 60"	LS 30"	LS 60"	Δ LS	Δ LS%	Δ TA%	Δ SR%
Greater	36.10	64.93	35.00	59.66	234.40	208.81	-25.59	-10.92%	-3.05%	-8.12%
Collision	37.00	64.20	37.10	58.43	237.54	216.78	-20.76	-8.74%	0.27%	-8.99%
Lesser	38.00	64.10	39.30	57.93	243.58	227.66	-15.92	-6.53%	3.42%	-9.63%
Cut=BR	40.40	65.00	44.10	59.60	262.60	262.84	.24	0.09%	9.16%	-8.31%
Cut Away	41.00	65.88	45.60	61.85	270.11	282.04	11.93	4.42%	11.22%	-6.12%

Figure 346: Different speeds - Test results.

The second test saw both aircraft flying at the same speed:

Speed TGT **300**
Speed F14 **300**

Test	TA30"	SR 30"	TA60"	SR 60"	LS 30"	LS 60"	Δ LS	Δ LS%	Δ TA%	Δ SR%
Greater	36.60	66.63	36.20	63.08	243.87	228.35	-15.52	-6.36%	-1.09%	-5.33%
Collision	36.50	66.23	36.50	62.14	241.74	226.81	-14.93	-6.18%	0.00%	-6.18%
Lesser	38.20	65.66	39.50	61.21	250.82	241.78	-9.04	-3.60%	3.40%	-6.78%
Cut=BR	39.50	66.37	42.20	62.30	262.16	262.91	.74	0.28%	6.84%	-6.13%
Cut Away	40.00	67.04	43.20	63.98	268.16	276.39	8.23	3.07%	8.00%	-4.56%

Figure 347: Same speeds - Test results.

The numbers confirm what stated in the Navy docs but seeing them makes them more understandable (please note that values can change depending on a plethora of factors: fighter GS, bandit GS, FH, BH, etc).

OBSERVATIONS

- Case 1: Cut > CB. In this scenario, both TA and SR decrease over time, and it is the quickest way to reduce LS. The SR does not decrease as much as in the other cases as the FH points almost away from the bandit, rather than towards the bandit itself;
- Case 2: Collision. This is a well-known situation, where the loss of LS is mostly due to the decrease of the SR;
- Case 3: Cut < CB. In this scenario the TA is increasing (eventually the F-14 will fly at the 3/9 of the bandit, rather than on its nose). This reduces the loss of LS caused by the decreasing SR;
- Case 4: Cut = BR. Besides a small error positioning the aircraft, the LS is almost unchanged. There is, in fact, a balance between the decreasing SR and the increasing TA. Moreover, as range halves, the TA doubles. This is an important consequence, since, for example, we can use Cut = BR as a mean to maintain the desired LS until it is time to perform a conversion turn;
- Case 5: Cut Away. This scenario is the simplest to imagine: the F-14 is flying away from the bandit and therefore the ratio at which the TA is generated drastically increases and, at the same time, slows down the SR decrements, resulting in an increase of LS. This manoeuvre can therefore be used ante conversion to generate enough room for the turn.

10.3 MODERN GAMEPLANS

This Chapter introduces the Gameplans used to manipulate the Lateral Separation to allow the F-14 to complete the intercept using manoeuvres such as the Horizontal Stern Conversion Turn.

The primary reference is the CNATRA P-825, reviewed in 2017. This is the most recent version available to the public, hence the title.

10.3.1 HORIZONTAL STERN CONVERSION TURN AND THE 40K FT OF LS GOAL

After the lengthy discussions about the basic concepts related to the Intercept Geometry, we are finally able to put some of those into practice.

The Horizontal Stern Conversion Turn is the final manoeuvre of a basic form of intercept, and it is used to place the fighter in the rear quarter (RQ) of a non-aware or non-manoeuvring target, In LAR for a Short Range Missile (SRM) employment, whilst also enabling the crew to visually identify (VID) the target during the turn (if weather conditions allow so).

It is also a handy means of rejoining a tanker, and a simple way to practice the intercept.

10.3.2 GATES

If Timelines use the range as a means of tracking the progression, the intercept uses "Gates". Gates are sets of SR and TA (and therefore, LS) that the fighter should ideally fly through in order to ensure the correct positioning during the intercept.

For a Horizontal Stern Conversion Turn the last gate is LS = 40,000ft at SR = 10nm (and therefore, TA = 40). This is, in fact, where we want to be prior to turn into the bandit's six o'clock (if you visualize it in your mind, it means behind slightly off to the side, ready to perform a sort of "U Turn" behind the target).

Depending on the status of the bandit, the RIO has to come up with a plan (Gameplan) that eventually satisfies the goal mentioned above.

Revising VC
Albeit intuitive and already discussed in the past, for completeness' sake I set up a quick scenario to determine the difference in terms of VC induced by horizontal offset: two F-14 flying one true head-on, the second parallel head-on towards their relative targets, with 6.5nm (~40,000ft) of Lateral Separation at 20,000ft; every aircraft is flying at 350kts.

True Head-On

1. VC = 700kts at any range, until the last mile, due to imprecision in positioning the aircraft in the editor;

Parallel Head-On

1. VC = 689kts at 37.5 nm (ATA 10)
2. VC = 683kts at 30 nm (ATA 13)

3. VC = 662kts at 20 nm (ATA 19)
4. VC = 540kts at 10 nm (ATA 41)
5. VC = 373kts at 7.5 nm (ATA 62); then the target passed the gimbal limits.

These values should give a good idea of how ATA and VC change depending on the SR.

10.3.3 TARGET ASPECT AND GAMEPLAN

The gameplan adopted primarily depends on the Target Aspect:

- **Low TA: 0 < TA < 15**
  TA < 10 is considered very low and, consequently, the Lateral Separation will be narrow as well. At 30nm and 15° TA, LS is 45,000ft. VC will be close to the sum of the velocities.
- **Medium TA: 15 < TA < 35**
  At 30nm, the LS in this interval stretches between 45,000ft and 105,000ft, the VC down to 450-500kts. In order to meet the 40k goal, the LS must be reduced before the 10nm Gate.
- **High TA: 35 < TA < 45**
  LS is around 120,000ft and the amount of LS to be removed to hit the Gate at 10nm is considerable. VC should be around 480kts.
- **Very High TA: TA > 45**
  This case is extreme, the amount of LS is really substantial, the gameplan aimed to reduce it should be implemented as soon as possible if the fighter wants to meet the 10nm Gate.

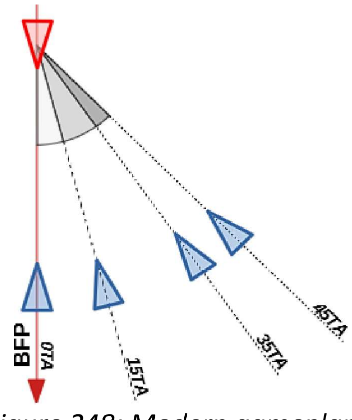

Figure 348: Modern gameplans.

As mentioned before, the P-825/17 uses 40,000 ft of Lateral Separation as the Gate at which the fighter starts the stern conversion turn towards the RQ of the target.

A LS < 40,000ft will result in the fighter exceeding the conversion, ending up at 5 / 7 o'clock of the target.

A LS greater than 40,000ft may satisfy the positioning aspect only on one axis, ergo lagging behind the bandit, but the fighter may be out of the envelope of its weapons due to the additional time and space required to complete the conversion.

The following is a table useful to visualize the LS computations needed to meet the goal of 40k ft of LS all the way down to the last gate at 10nm:

SR\TA	10	15	20	30	40	50	60
50	50,000	75,000	100,000	150,000	200,000	250,000	300,000
45	45,000	67,500	90,000	135,000	180,000	225,000	270,000
40	40,000	60,000	80,000	120,000	160,000	200,000	240,000
35	35,000	52,500	70,000	105,000	140,000	175,000	210,000
30	30,000	45,000	60,000	90,000	120,000	150,000	180,000
25	25,000	37,500	50,000	75,000	100,000	125,000	150,000
20	20,000	30,000	40,000	60,000	80,000	100,000	120,000
15	15,000	22,500	30,000	45,000	60,000	75,000	90,000
10	10,000	15,000	20,000	30,000	40,000	50,000	60,000

Figure 349: Modern gameplans - SR vs TA.

Following this table, the pairs or SR and TA meeting the LS goal are:

1. 15 TA at 30nm;
2. 20 TA at 20nm;
3. 30 TA at 15nm.

This scenario can be visualized very easily: the fact that TA and SR are inversely proportional means that the fighter is “drifting” to the side as it is getting closer to the bandit, thus creating room for the conversion turn. To simplify, imagine a triangle rectangle built by the BFP and the LS as catheti, where the hypotenuse approximates the FFP until the last Gate.

It goes without saying that this is not the scenario we want if the goal is employing an AIM-7 or an AIM-54, as their performance peak vs targets with low TA and high VC. Both conditions are met as the FFP gets closer and closer to the BR and the TA is low (this scenario will be discussed more in-depth later).

An important note: don’t get overly fixated over the LS, especially in an aircraft like the F-14, where approximations and minor imprecisions are intrinsic and expected:

- Creating and maintaining a good level of SA is more important than knowing the exact value of LS at any given moment;
- Task fixation is very dangerous and can easily become saturation. Avoid it!

Practising how to manipulate the TA to increase, decrease or maintain the LS is important and very helpful, especially if you are new to this.

10.3.4 DETAILS OF THE MODERN GAMEPLANS

The following is a quick look at the Gameplans suggested by the P-825/17 to ensure that the gate 40k at 10nm is met. Note that in all these examples the bandit is not aware or "cooperating": it is not jinking, countering the manoeuvres of the fighter or denying LS.

> Sketches: Modus Operandi
> The sketches of the Tactical Information Display in Aircraft Stabilized mode and the Detail Data Display both for Pulse and Pulse Doppler modes are not meant to be extremely precise or to scale.
> In particular, I did not calculate VC as a function of the ATA for the DDD in PD mode: I placed the target image depending on the VC at that moment, compared to the others rather than its value.
> The images depicting the TID AS have a set of dashed lines every 15°, whereas the others represents the settings of the AWG-9 (±10°, ±20°, ±40°, ±65°).
> I plan to put together a video about the gameplans here discussed and other concepts later on.

THE FIRST TURN

When the Simplified BVR Timeline was discussed in Chapter 9.7, I stripped it of as many aspects related to the Geometry as possible. Now it is time to put such parts back, a piece at the time.

Post commit, the fighter turns towards the target (Point and Assess). Point and Assess involves placing the target in the F-14's radar scan zone (on the nose) and determining the Target Aspect, calculating the Lateral Separation and evaluate how to satisfy the goal of 40k ft of LS.

Depending on the TA, the fighter can now turn to generate LS, turn to zero cut to preserve LS or turn to collision to remove undesired LS.

After the first turn and assessing the TA, the RIO decides the next step. There are a number of techniques used to manipulate the LS, the following are described in the P-825/17.

10.3.5 LOW TA / NO LS GAMEPLAN

Having the target dead-on and pointing straight towards the fighter is typical follow-up after a forward-quarter ARH/SARH employment.

The fighter wants to manoeuvre and build LS to meet the usual LS goal of 40k ft at 10nm. Intuitively and thanks to the precedent discussions, we know that turning away from the bandit has the effect of increasing the Target Aspect, and subsequently the Lateral Separation, on top of decreasing the VC (remember the previous part of the series, the "Cut-away").

This plan, named “Kick and Build” takes advantage of these considerations to satisfy the goal.

- The RIO places the contact at 50ATA cold, this builds separation;
- When the goal is met, the fighter turns to the Bandit Reciprocal. This stabilizes and maintains the LS;
- At 10nm, TA is increased to 40.

In other words, the goal is transforming a True Head-On situation into a Parallel Head-On situation.

Notes:

The F-14 can place the target to the gimbal limits if necessary, increasing the 50ATA angle suggested by the P-825/17.

Remembering what was discussed in Chapter 10.2, the first turn is a Cut Away in order to increase LS up to the desired 40,000ft, a further turn to TA to FH = BR to maintain such separation and lastly a turn to Cut < CB (Pure pursuit) to converge at the target’s 6 o’clock.

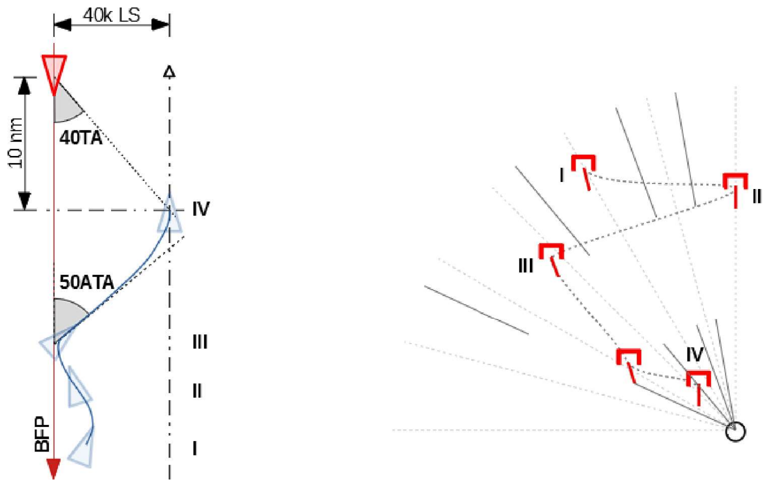

Figure 350: Low TA gameplan – progression.

1. Phase I: Detect and Correlate. The contact appears on the radar, and it is correlated with the controller;
2. Phase II: Point and assess. The fighter places the target on the nose, the amount of LS is determined;
3. Phase III: Turn to place the target at 50 ATA cold, by turning away from the target, LS is generated. The RIO should monitor the drift as the contact may drift out of the radar scan volume;
4. Phase IV: Turn to BR. When the LS goal is met, the RIO commands the pilot to turn to the Bandit Reciprocal. As discussed in the previous parts, this manoeuvre captures the LS.

Note: following gameplans will combine Phase I and Phase II into a single step.