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Ground Controlled Approach (GCA) basics

All following explanations and examples are for Sochi aerodrome.

The GCA procedure is used primarily by military approach units. Its equipment, radar antennas and the building with the control room, are located at the aerodrome. The advantage of a GCA is, that the aircraft needs no special equipment to use the GCA service. The normal equipment like a radio, ADI, Altimeter, VSI, Speedometer and a compass are sufficient. Whereby, the instruments must fulfill a certain level of precision to be licensed for use in IMC. Even the pilot needs an IFR rating. All information the radar needs are energy reflections measurement produced by a ground antenna and being reflected by the aircraft's body.

GCA patter layout

The radar traffic pattern consists of the following named legs:

- Upwind
- Crosswind
- Downwind
- Base
- Dog leg
- Final

Compared to a visual traffic pattern there is one additional leg called 'Dog Leg'. This leg is used to simplify the turn to the final. Otherwise, the controller would have to deal with a 90° turn to the final, which is hard to predict.

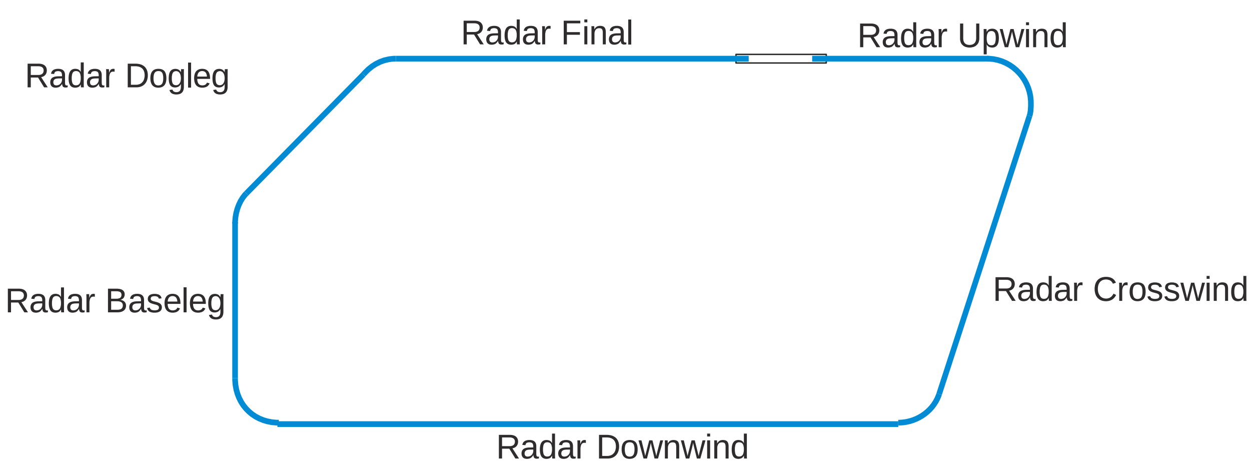

Figure 1 GCA pattern

The entire GCA pattern is precisely calculated and measured out to ensure an obstacle free airspace at and above the published altitudes. For Sochi the following altitudes apply:

Downwind	2100 feet MSL
Base/Dogleg	1800 feet MSL
Final	1800 feet MSL, start of descend 5.3 NM from touchdown.

Standards A-10C

The maximum speed used below FL 100 is	250 KIAS
Speed on downwind is	220 KIAS
Speed on base/dogleg is	170 KIAS
Speed on final (level flight)	170 KIAS
Speed 1 NM before final descend, reduce to	150 KIAS
Speed during final descend	150 KIAS

All turns (except small corrections) have an AOB of 30°

Preparation of approach

To simplify the frequency setting in IMC, the pilot should use preset frequencies. He should prepare

Channel 17	local terminal approach
Channel 16	local GCA
Channel 15	local PAR
Channel 14	local tower

This configuration ensures, that a frequency change in sequence is only one step counter clockwise with the channel selector.

The local altimeter setting is given by the GCA controller and must be acknowledged by the pilot.

The transponder has to be set to NORMAL. On request by ATC, the transponder has to be configured with the given squawk.

Aircraft control in IMC

Because of missing visual information, the pilot has to trust the instruments. A continuous watch circuit has to be executed:

- Horizon

- Altitude
- Vertical Speed
- Horizontal Speed
- Compass

A good trim of the control surfaces is essential. Trim must be executed as soon as speed or altitude changes. If trim is neglected, you will experience some surprises with your attitude if you are busy with setting switches or frequencies..

Normal IFR approach sequence

The approach starts normally with approach or terminal control. This approach unit serves one or more aerodromes and guides the aircraft to a transfer point from which on, the corresponding GCA unit takes over control. GCA is only an executive division. The responsibility of the airspace in IMC is all the time with Terminal Control as higher authority. Therefore, the approach clearance is given by Terminal Control, before the aircraft is transferred to GCA. A clearance is a legally obliged contract between the controller and the pilot with all consequences.

Terminal Control:

The aircraft is short off the transfer point to GCA. This is a position 10 to 20 NM anywhere around the target aerodrome. Terminal control took care, that the airspace between the aerodrome and the aircraft is clear of other traffic:

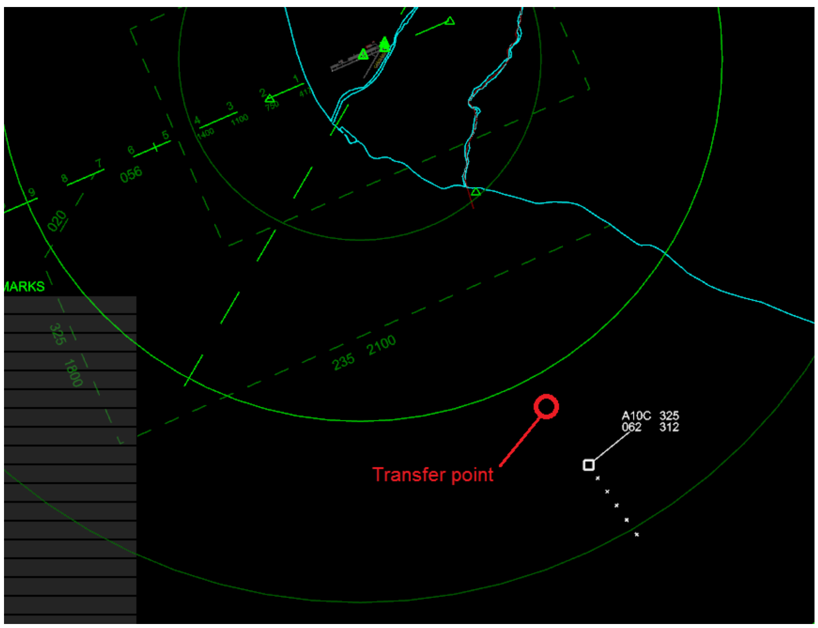

Figure 2 Transfer Point

Black Sea radar:

"GF66 are you ready to copy the clearance?"

Pilot:

"GF66 is ready to copy"

Black Sea radar:

"ATC clears GF66 for a right hand precision approach into Sochi, runway 06. Initial approach altitude will be 3000 feet,Squawk 4250, frequency for Sochi radar will be 251.0 MHz. Read back".

Pilot:

“GF66 is cleard for a right right hand precision approach into Sochi, runway 06. Initial altitude 3000 feet,Squawk is 4250, frequency 251.0”.

Black Sea radar:

“GF66, read back correct, descend altitude 3000ft, contact Sochi radar on 251.0 Mhz.”

Pilot:

“GF66 roger, switching frequency 251.0, good bye”

Black Sea radar:

“Good bye”

GCA control:

Since the pilot flies a home base aircraft out of Sochi, the UHF presets contain already all important frequencies for the approach. The communication with ‘Black Sea’ was on channel 17 (317.5 Mhz). Now he needs only to turn the channel selector one notch counterclockwise to channel 16. He is now on the right ASR frequency of 251.0 MHz.

Identification

Pilot:

“Sochi radar from GF66”

Sochi radar:

“GF66 loud and clear, for identification squawk 4250 ident”

Pilot:

“Roger, 4250 ident”

The pilot pushes the ident switch at the APX72 short forward. This initiates a blinking head symbol on the radar screen for 30 second. The blinking starts with the next radar sweep touching the aircraft. Before the controller is allowed to provide guidance to an aircraft, he must identify the aircraft uniquely. This shall avoid to provide vectoring to the wrong aircraft accidently.

The controller observes the blinking target and informs the pilot:

Sochi radar:

“GF66, you are identified, position 10 NM South East of Sochi in downwind approach”.

Pilot:

“Roger”

Approach information

The controller must deliver three important information blocks to the pilot, which are

Weather information

Sochi radar:

"GF66, Sochi weather, observation at 11:52 Z, wind 040 at 10, visibility 1000m in rain, cloud condition 250 overcast, altimeter 29.65, temperature 15 C, dew point 14 C, color state amber, forecast amber, runway wet, braking action medium".

Pilot:

"Roger, 29.65"

The pilot must read back the altimeter setting, all the time he receives one.

Lost com procedure

Now the controller will provide the "Plan B" information for lost communication and a probable missed approach.

Sochi radar:

"GF66, if no transmission received for 1 minute in the pattern or 10 seconds on final contact Black Sea Approach on 317.5. If negative contact, proceed on heading 230 out bound Sochi. At DME 12, intercept Sochi ILS localizer for RWY 06 and start an ILS approach without delay."

Pilot:

"GF66, Roger"

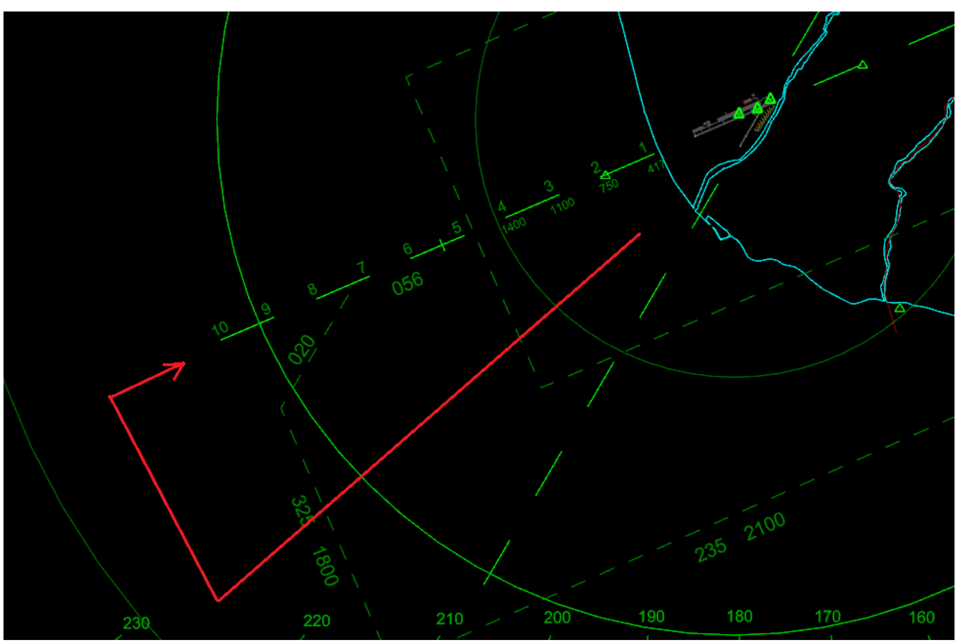

Figure 3 Lost Communication

Missed Approach Procedure

A missed approach procedure is the situation, if the pilot has no visual contact to the runway or the approach lighting system, when he passes the GCA minimum. The standard minima for a precision approach is a minimum ceiling of 200 ft ground and a visibility of 800 m. This is pretty close to the touchdown. Therefore it is important to start the missed approach immediately on advice of the controller or if the pilot has passed the GCA minimum without visual contact to the runway environment. There is no time in this situation to explain to the pilot, what he has to do. Therefore, the procedure is delivered in advance. The procedure shall ensure that even a quick situation change guides the aircraft save separated to other traffic, back into the traffic pattern. A missed approach procedure must not be mixed up with a ”go around”. A go around is a last chance procedure, mainly used in VMC, if other factors than a ceiling and visibility, prevent the aircraft from landing.

Sochi radar:

“GF66, in case of missed approach, climb on runway heading to altitude 1000 ft, then turn right heading 145, continue climb to altitude 2100ft, contact Sochi radar on channel 16”.

The pilot must read back the procedure. It is handled like a clearance.

Pilot:

“GF66 roger, climbing on runway heading to altitude 1000 ft, then turning right heading 145, continue climb to altitude 2100ft, contact Sochi radar on channel 16.

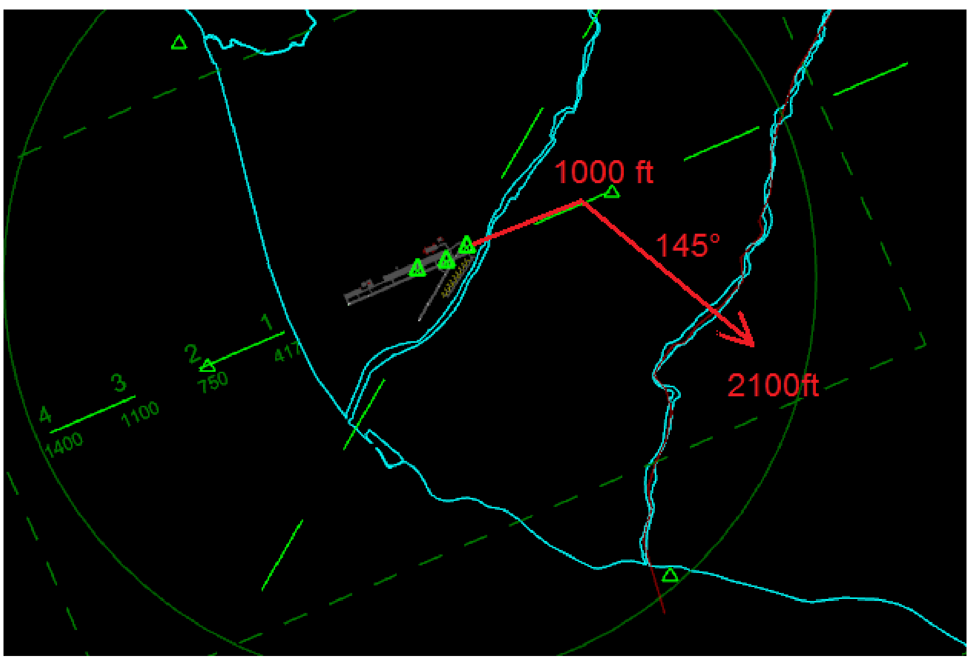

Figure 4 Missed approach

GCA Downwind

The aircraft is in 3000 ft at a speed of 250 KIAS. The controller will prepare the turn to downwind by informing the pilot:

Sochi Radar:

"GF66, you are 8 NM SOUTH EAST of Sochi, standby for downwind turn short."

Pilot:

"Roger"

This information is important because the pilot must reduce the speed right in time to be on downwind with 220 KIAS. All speeds in the radar pattern should be standardized for all participants of the same aircraft type. The controller builds his traffic planning on these standards. This includes even, that all turn shall be executed with 30° AOB.

Sochi radar:

"GF66, for radar downwind turn left heading 235, descend altitude 2100ft, when straight and level, perform initial cockpit check.".

Pilot:

"Left 235, leaving 3000 for 2100 ft"

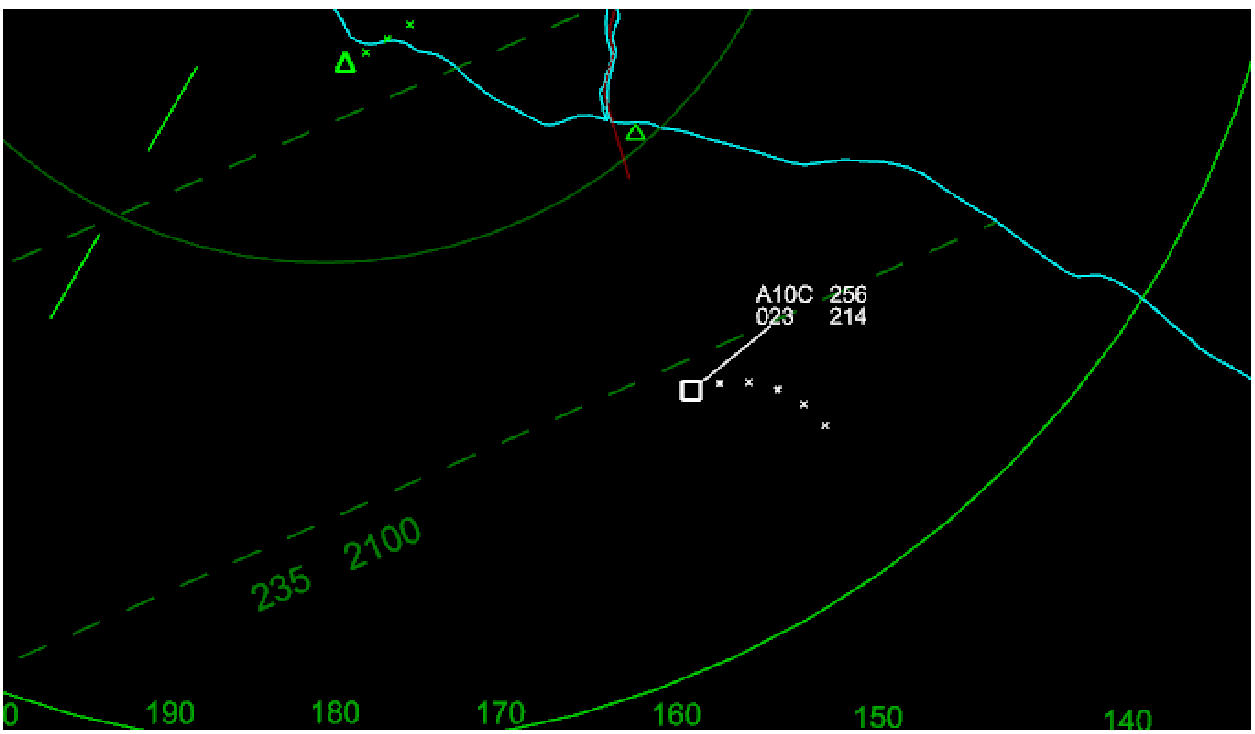

Figure 5 Downwind Turn

The initial cockpit check is a reminder for the pilot to configure his aircraft for a radar precision approach. The controller expects the pilot to be on speed 220 KIAS from this position on.

On downwind, there is nothing important left. An exception would be a traffic information. As it can be seen in the image above, there is a SSR target at the upper border, on converting course to the controlled traffic. If the altitude cannot be determined, the controller would state:

Sochi Radar:

"GF66, there is an unidentified target in your 2 o'clock position, range 5 miles, going South West bound, altitude unknown".

If the pilot feels uncomfortable, he could request 'avoiding action' . Then the controller would vector the aircraft so, as to be clear of the traffic. In any case, if the situation is solved, the controller must inform the pilot with: "GF66, you are clear of traffic".

To fill the time, and to avoid a lost communication situation, the controller will inform the pilot of his current position:

Sochi radar:

"GF66, your position 8 NM South of Sochi on downwind."

Pilot:

"Roger"

GCA base leg

Right in time, before the aircraft reaches the base leg, the controller informs the pilot about the coming base leg turn:

Sochi radar:

"GF66, standby for base turn short."

Pilot:

"Roger"

When the turn point is arrived. The controller will deliver the base turn vector. Most of the aerodromes have a different altitude for the base leg, compared to the downwind leg. This is normally the obstacle situation around the aerodrome. On downwind, an altitude of 1000ft above the highest obstacle in a calculated airspace is required. The base leg has the same requirements, but is located so as to maintain the obstacle clearance at lower altitudes.

Sochi radar:

“GF66, for GCA base turn right heading 325, descend altitude 1800 ft, if straight and level, perform final cockpit check, report gear down and locked.”

Pilot:

“Right 325, leaving 2100ft for 1800ft”

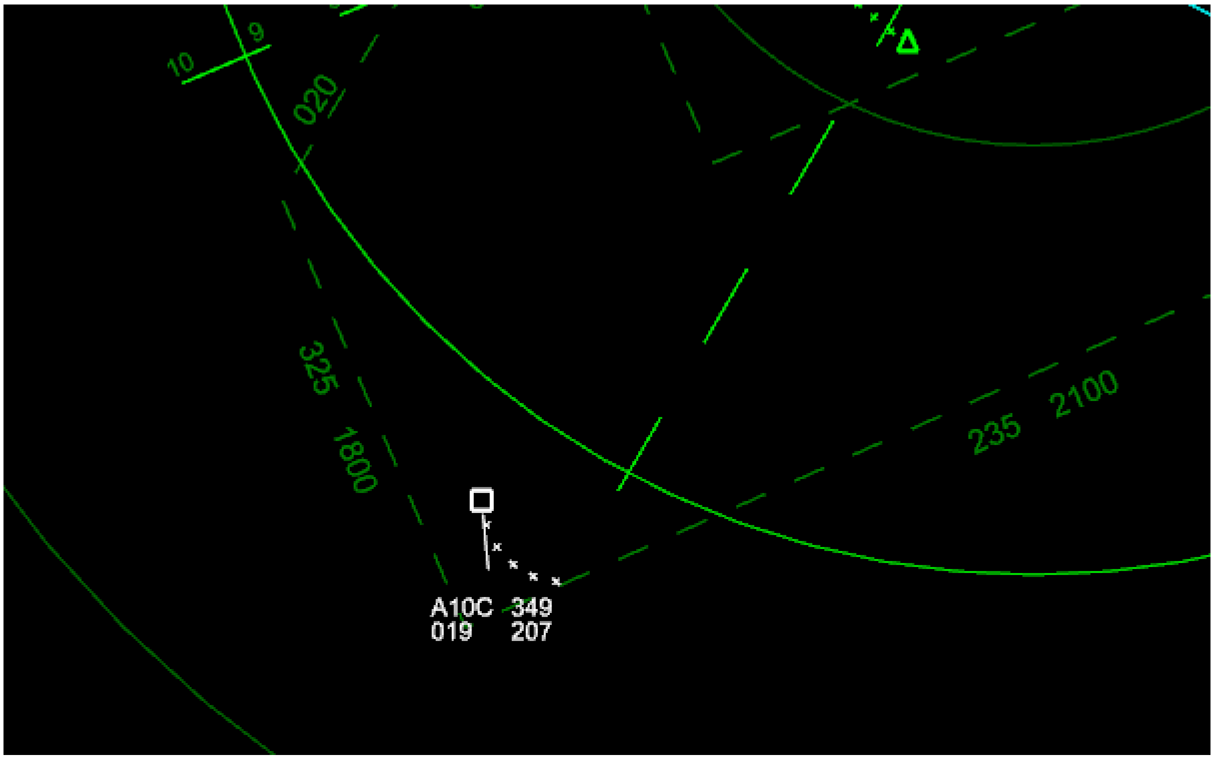

Figure 6 Base Turn

The final cockpit check is the reminder to configure the aircraft for the final approach. At the location shown in the image above, the pilot will reduce to 170 KIAS, lower the gear and sets the flaps according to the speed. He will trim the aircraft so as to hold the aircraft at level with gear and flaps down. He reports:

Pilot:

“GF66, is at 1800 ft, gear is down and locked”.

Like on the downwind, there will be random position reports to the pilot to fill the 1 minute time gap.

GCA dog leg

In difference to a visual pattern, the controller uses a dog leg before he turns the aircraft on final course. The dogleg reduces the angle between the aircraft’s heading and the final track. As smaller the angel as more precise is the rollout on final. Or vice versa, if the controller would use a 90 degree turn to the final, the estimation for the start of turn becomes complicated.

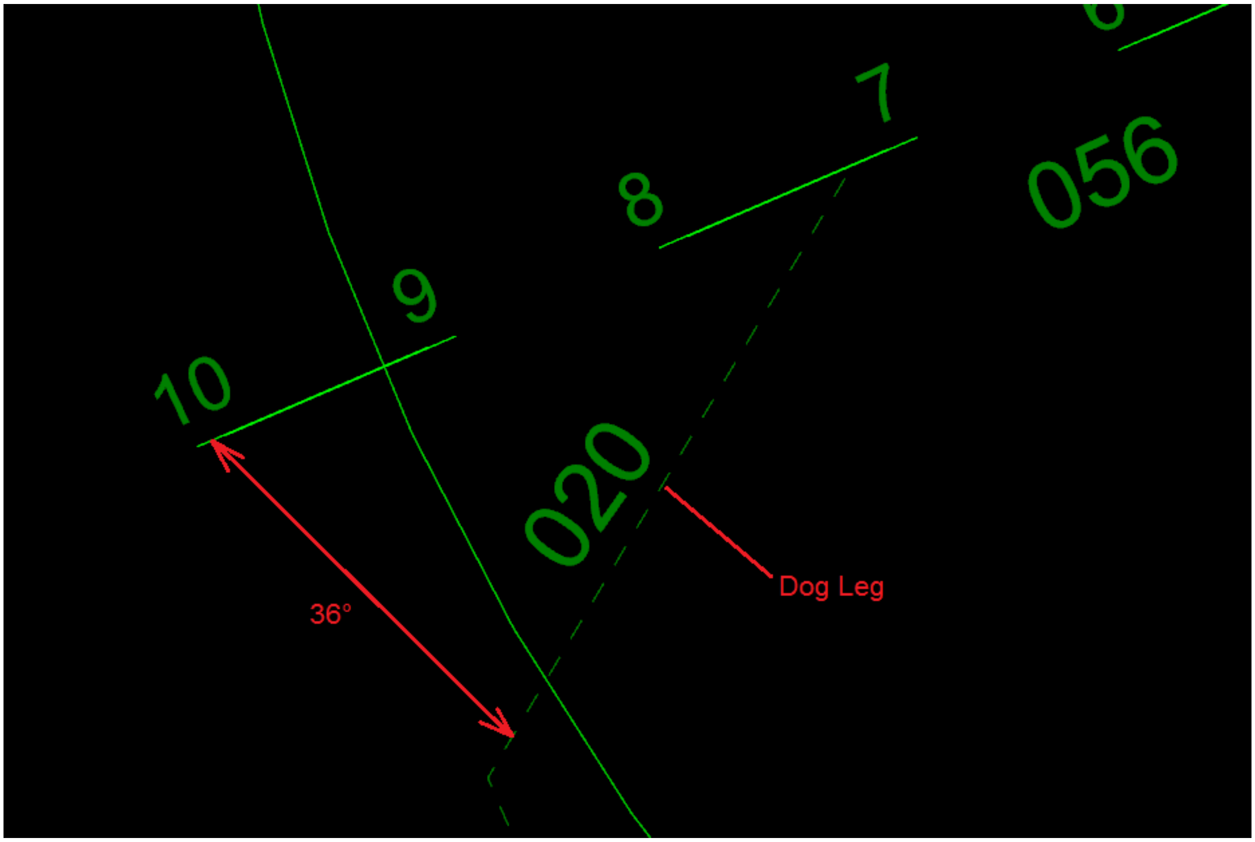

Figure 7 Dog Leg Angle

Sochi radar:

"GF66, for GCA dogleg turn right heading 020 at altitude 1800ft"

Pilot:

"Right 020 at 1800".

Now the pilot will slowly reduce to 150 KIAS as speed for the final descend. The Controller will give a warning for the final turn right in time.

Level on GCA Final

It depends on the traffic situation, when the aircraft will be transferred to the final controller. The controller will even keep in mind, that this is in conjunction with a frequency change. He will never advice a frequency change during a turn because of a possible vertigo situation for the pilot. The vertigo is caused if a pilot looks down to the consoles to find the switches for the frequency setting. The gravity is overridden by the centripetal forces caused by the turn. He easily loses the orientation which can lead into steep uncontrolled descend. Two measures shall avoid such a situation:

- Controller: Do not order a frequency change during turns.

- Pilot: Prepare the radio box with preset frequencies which need no visual contact to the equipment.

Sochi Radar:

"GF66, for final turn right heading 056 at altitude 1800ft. When straight, contact Sochi Final on channel 15".

Pilot:

"Right 056 at 1800, frequency for final on channel 15".

When the turn is completed:

Pilot:

"GF66, switching to channel 15, good bye".

Sochi radar:

"GF66, roger".

The pilot checks in on channel 15:

Pilot:

"Sochi Final from GF66"

Sochi Final:

"GF66 loud and clear, how me?"

Pilot:

"I read you 5"

Now the final controller explains the communication procedure on final. A final talk down needs a lot of transmissions in a time. Since the transferred aircraft is usually the only aircraft under control, all acknowledgements can be saved. This gives more time for the controller to provide final corrections.

Sochi Final:

"GF66 you are identified, 7 NM on GCA final, do not acknowledge any transmission until requested".

This advice means, that the pilot has to keep silence until the controller explicitly asks for an answer.

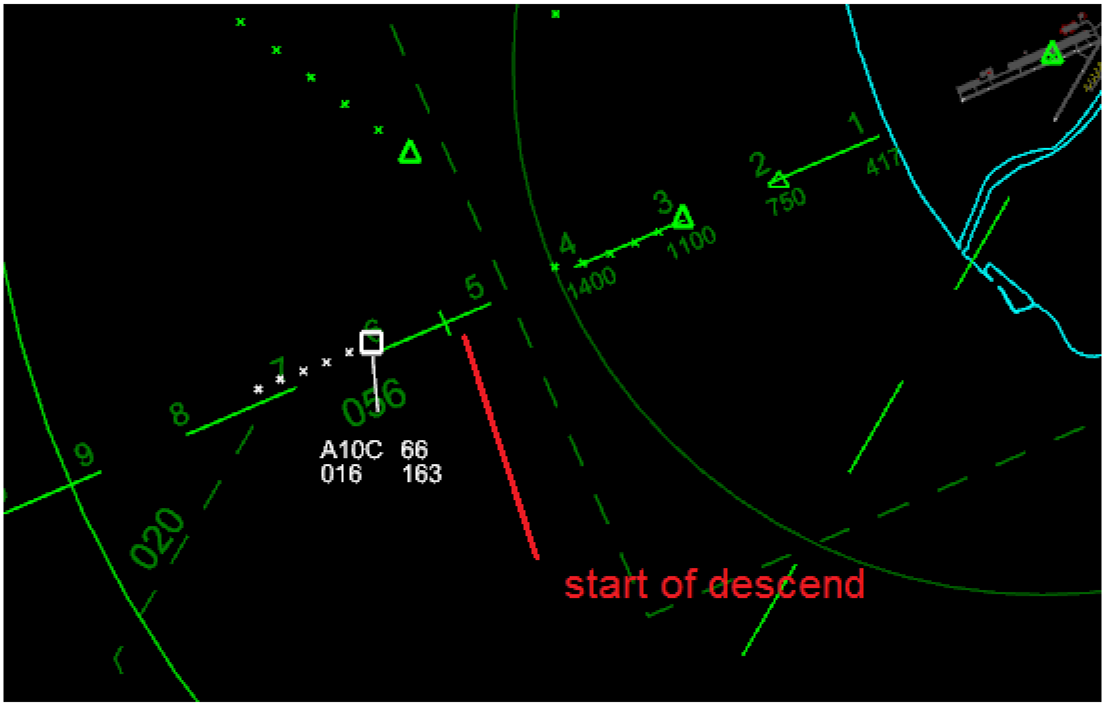

Figure 8 On Final

The aircraft is now stable at 1800 ft. The pilot should now decelerate to 150 KIAS, gear and flaps must be down. If gear or flaps would be set during descend, the descend rate would change immediately and the aircraft needs to be trimmed again.

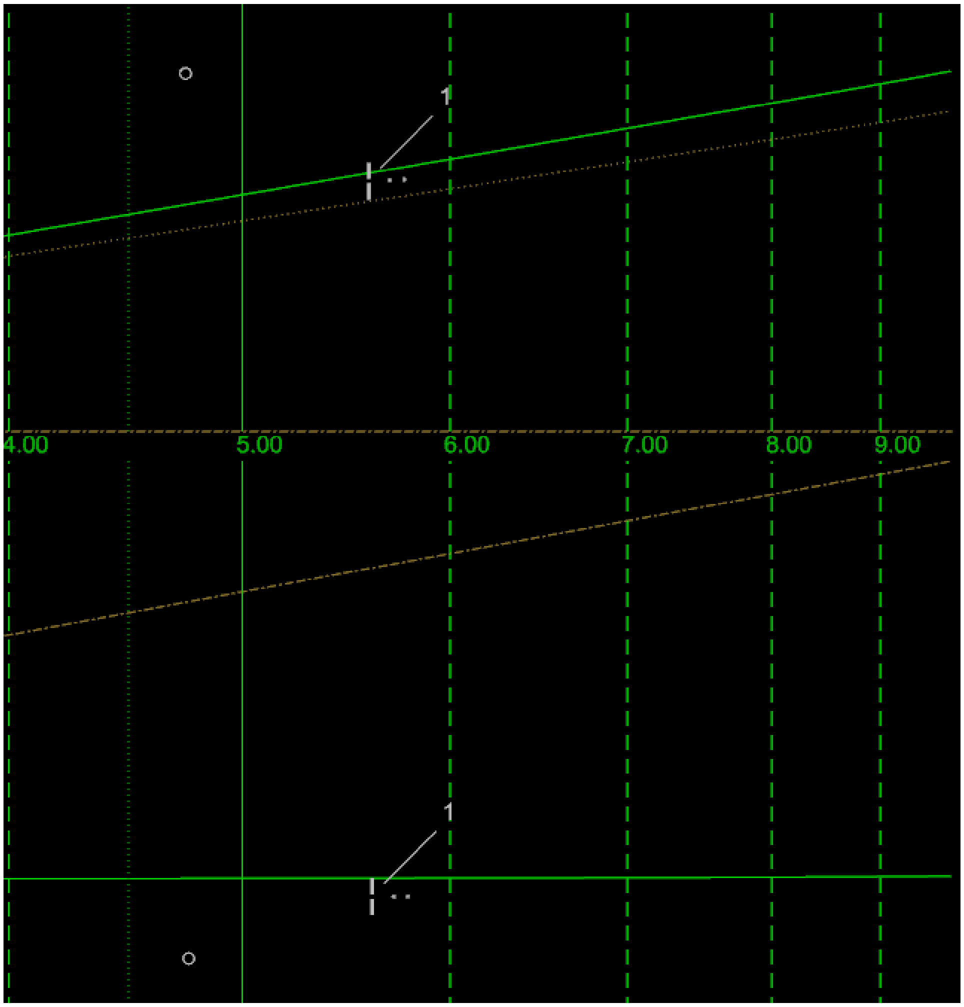

Figure 9 Level flight on final

As it can be seen in the image above, the aircraft is short before to start the descend and the lower part of the image says, that the aircraft is left of centerline.

GCA Final descend

Sochi Final:

"You are coming 5 and a half miles from touch down, left of centerline, stand by for descend short"

The glide path warning is important. The pilot needs to prepare for a new trim configuration.

Sochi Final:

"For final correction turn right heading 060".

"Start descend now, I say again start your normal rate of descend".

To follow the glide path, the pilot uses two methods. If he is equipped with a head up display, he can follow the glide path by setting the pipper onto a 3 degrees position.

Figure 10 3° on HUD

The more precise indication comes from the VSI. At a speed of 150 KIAS the vertical speed for a 3 degrees glide path is 800 ft/min.

Figure 11 VSI 800 ft/min

All corrections from the controller are around this value. The controller will never provide a vertical speed. It is up to the pilot to find the right value.

Final corrections

While horizontal deviations from the centerline can be corrected easily with vectors, vertical corrections are more complicated because the controller cannot fly the aircraft. He will inform the pilot about his relative position to the glide path. The pilot's responsibility is to take the right measure to come back to the glide path. All this requires a standardized instruction set, which leaves no doubt about its logical content.

The following instructions will arrive from the controller during the final descend:

On glide path

The aircraft is on glide path. The pilot should take care, that the vertical speed is at standard for the 3 degrees glide path.

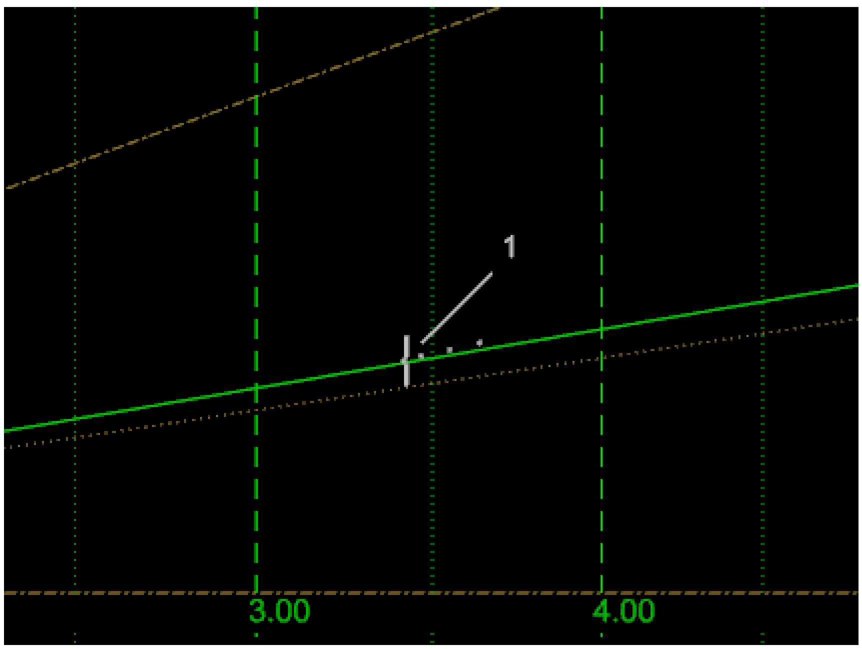

Figure 12 On glide path

Slightly above the glide path

The aircraft is slightly above the glide path. The deviation is not dramatically and should be corrected easily by increasing the descend rate slowly.

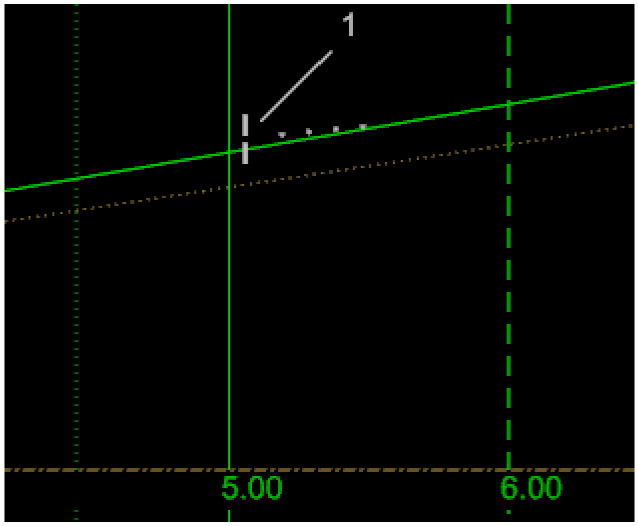

Figure 13 Slightly above

Above the glide path

The aircraft is clear above the glide path. The pilot should increase the descend rate accordingly.

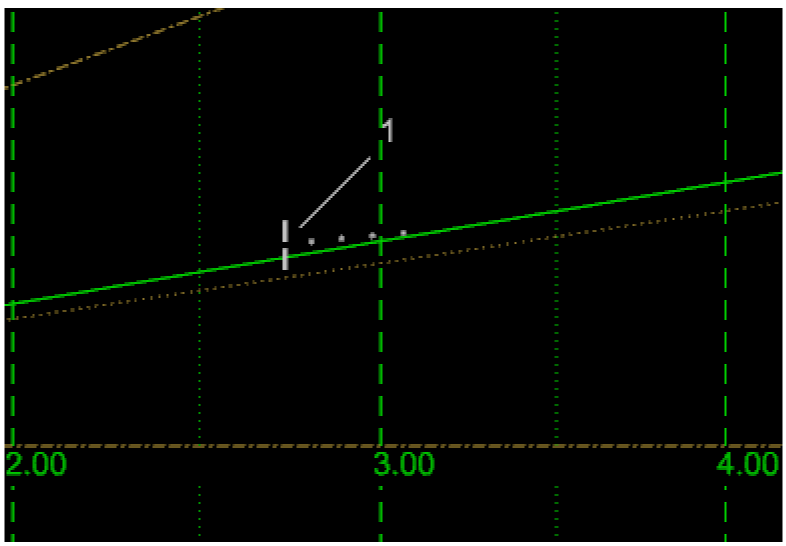

Figure 14 Above glide path

Slightly below the glide path

The aircraft is slightly below the glide path. It is not dangerous but should be corrected carefully.

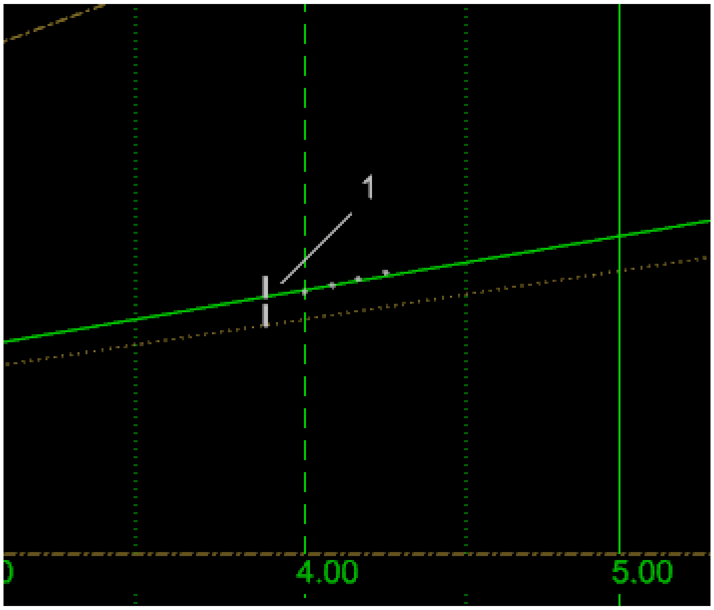

Figure 15 Slightly below glide path

Below the glide path

If the aircraft is more than 2 NM from touchdown, there would be no direct danger but an immediate correction is required.

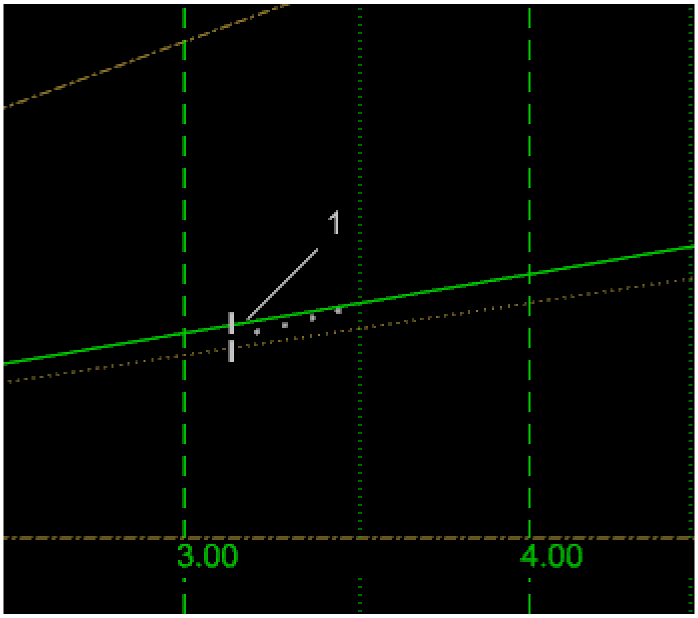

Figure 16 below

Far below the glide path

The aircraft comes close to the safety cursor. This is a line, 1 degree below the glide path line on the PAR screen. Immediate action is required.

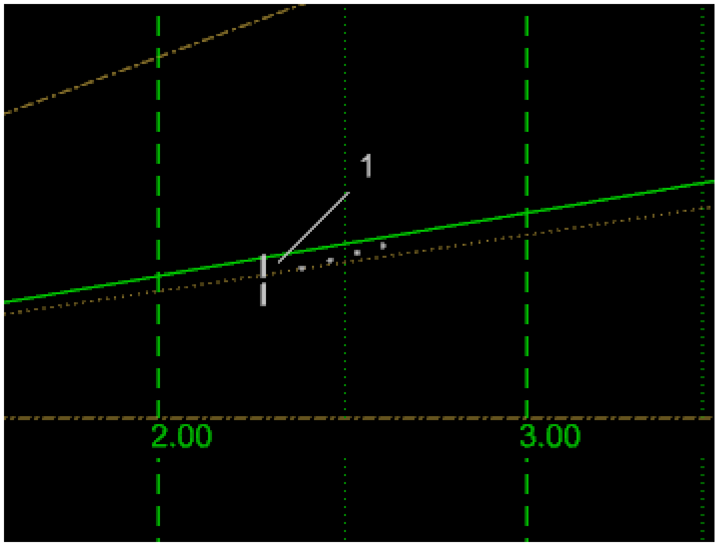

Figure 17 Far below

Dangerous below the glide path

The aircraft is below the safety cursor. Obstacle clearance is not longer ensured. The pilot is in a dangerous situation which requires immediate climb action. In 80% of all cases there is a technical problem with the aircraft. The controller will add the order to perform a missed approach.

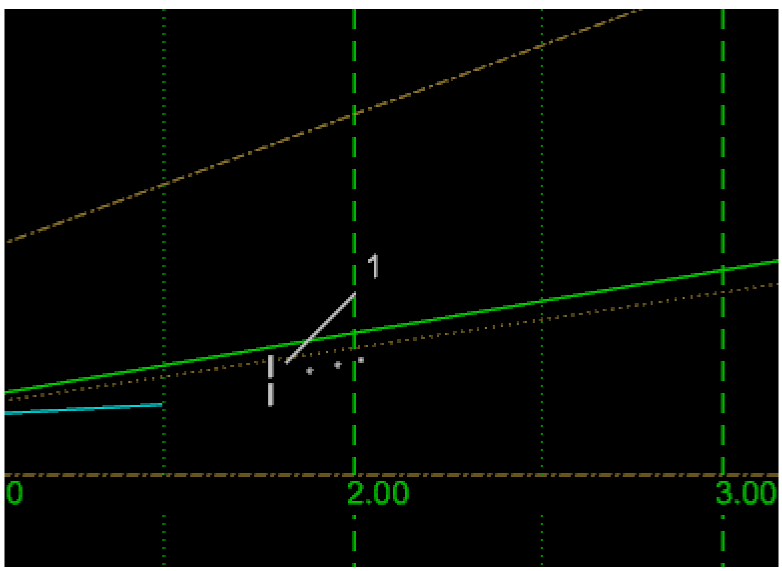

Figure 18Dangerous below

Pull up, pull up

The controller observes the aircraft flying straight into an obstacle. It is the highest danger level.

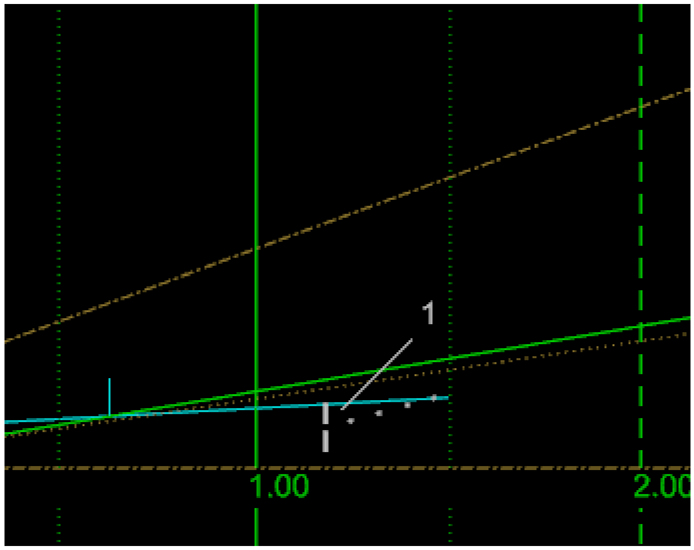

Figure 19Pull up

The clearance

Between 6 NM and 3 NM from touchdown, the controller will issue the clearance to land or whatever type of landing the pilot requested before. The clearance cannot be given by GCA without the approval of the tower. Even if terminal control is responsible for the entire airspace, the aerodrome control tower remains in charge for all ground traffic. The tower is the only unit who can see directly whether the runway is clear of all other traffic and there is no danger for an incoming landing. The clearance must be acknowledged by the pilot.

Sochi Final:

"GF66, tower cleared you to land, wind 040 at 10, recheck gear and flaps, acknowledge."

Pilot:

"GF66 is cleared to land, gear is down".

Passing the GCA minimum

The GCA minimum is marked on the PAR screen. It marks the position at which the pilot must have the runway environment in sight and a save landing can be executed. If these condition are not met, a missed approach has to be executed.

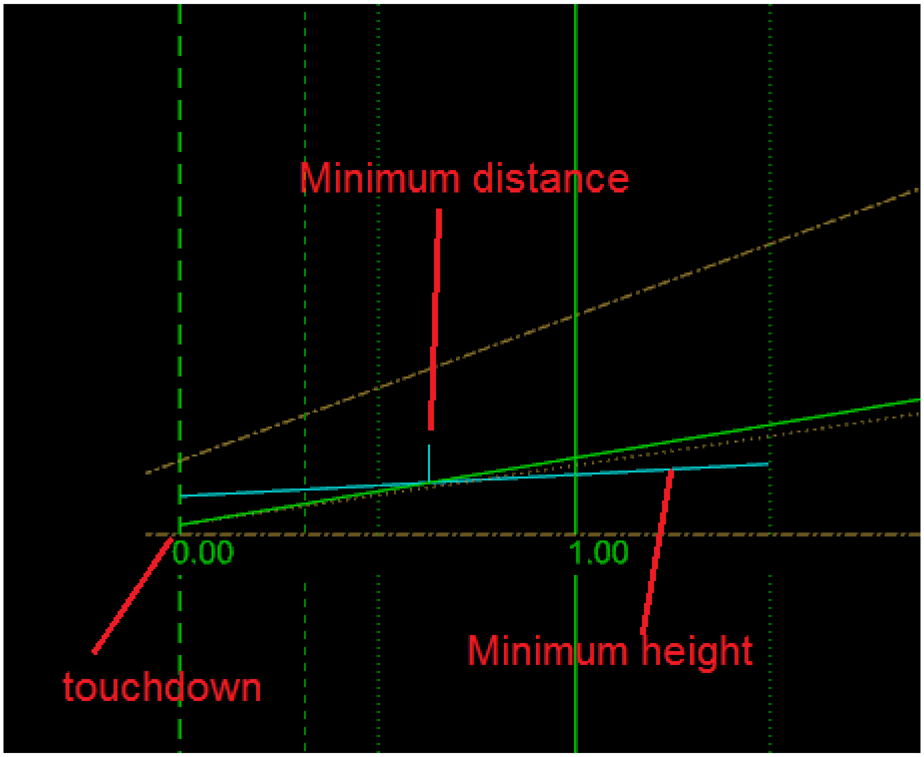

Figure 20Minimum Marker

Sochi Final:

"You are approaching GCA minimum, report field in sight".

Pilot:

"Field in sight",

Sochi Final:

"GF66, take over visually complete your full stop landing. When save on ground, contact tower on channel 14."

IFF SIF control for DCS A10C and UH-1

The control panel for the APX-72 is normally not evaluated by the DCS simulator. Nevertheless, the switch position of the panel can be taken to emulate the entire logic of the APX-72. For the Aries Radar Systems, a IFF/SIF function is important to follow the rules for ATC and GCI.

IFF / SIF APX-72

A Receiver-Transmitter, APX-72 when used with auxiliary equipment, provides automatic radar identification of aircraft or surface vessel to all suitably equipped challenging aircraft, surface ships, and ground facilities within the operational range of the system. The RT-859/APX-72 receives, decodes, and responds to the characteristic interrogations of operational modes 1, 2, 3/A, C and 4. The receiver section operates on a frequency of 1080 megahertz (MHz) and the transmitter section operates on a frequency of 1090 MHz. Specially coded identification of position (1P) and emergency.

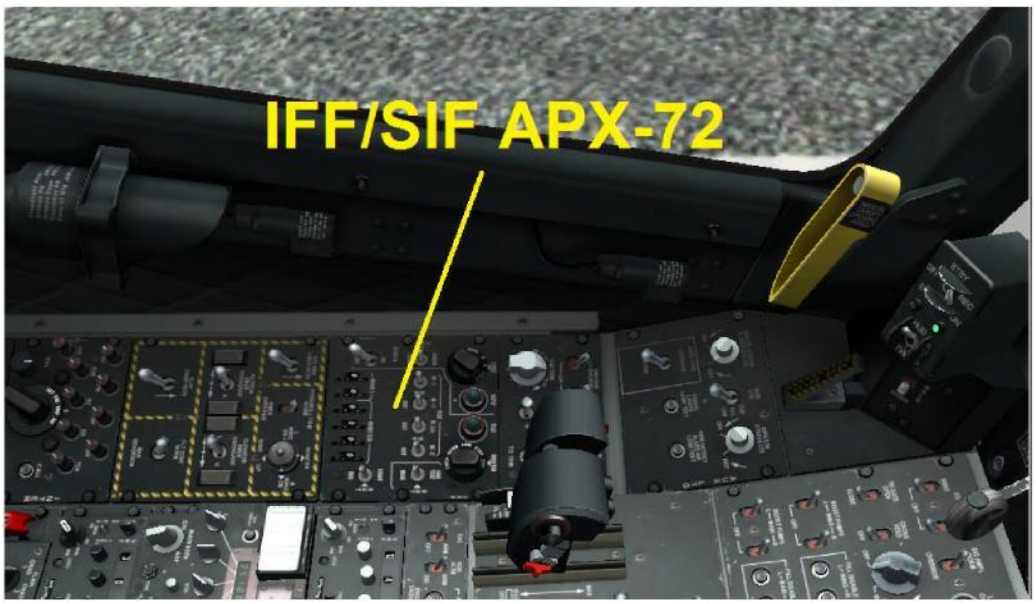

Figure 21A-10C IFF/SIF control panel

For the UH-1 the panel can be found in the mid console:

Figure 22UH-1 IFF/SIF control panel

Panel Description

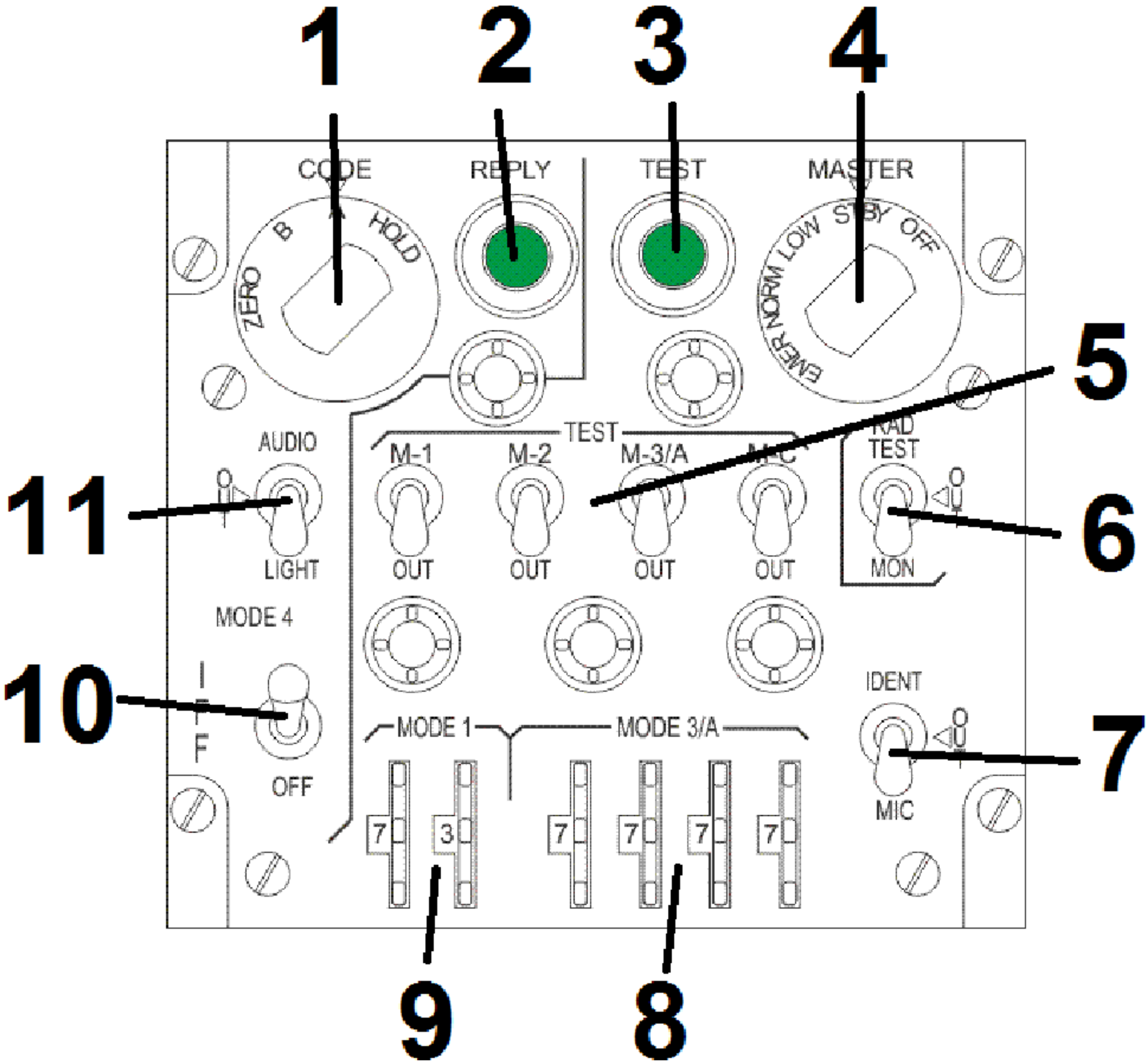

Figure 23C-6280(P)APX layout

Nbr	Control	Position	Function
1	CODE	A	Mode 4 transponder answers only on interrogations which match the code behind [A]. The code is set before the pilot enters the aircraft. The radar antenna transmits the code as interrogation. For the DCS simulation a fixed code is set internally, depending on the coalition selected for the
		B	Mode 4 transponder answers only on interrogations which

			match the code behind [B]. The code is set before the pilot enters the aircraft. The radar antenna transmits the code as interrogation. For the DCS simulation a fixed code is set internally, depending on the coalition selected for the aircraft.
		ZERO	In case of bail out or forced landing in enemy territory, all classified codes can be erased in the mode 4 transponder. The codes cannot be restored during the flight. Therefore it should used caution when handling this turn button. To switch to this position, the turn button must be pulled and then turned. This is necessary to avoid a deletion of all codes accidently.
		HOLD	Function not supported
2	REPLY		If switch 11 is set to light or audio, this control lamp [2] is lit. Provided, the mode 4 function is switched ON, the lamp will go off for 500 ms if the receiver is hit by a interrogator signal and answers on it. This is a useful indication for a pilot to be sure, that a friendly radar sent this interrogation.
3	TEST		Function not supported
4	MASTER	OFF	The entire APX-72 system is switched off
		STBY	The APX-72 is under power but does not answer on any interrogation. This position is useful if it is necessary to strangle all IFF/SIF functions when entering enemy territory. To switch back to full functionality afterwards, it does not require a warm up phase. Even ATC sometimes request to squawk [STBY]. This comes normally on ground during taxi operations.
		LOW	Under certain circumstances it can be necessary to prevent over interrogation by antennas in the surroundings. The receiver sensitivity is lowered so as to respond only to interrogations of a certain power level. The normal interrogation trigger level is between 52 and 67 db. If set to LOW the trigger must be higher than 67 db.
		NORM	This is the normal receiver configuration to respond to interrogations of at least 52 db.
		EMER	Transmits emergency reply signals (7700) to mode 1, 2 or 3/A regardless of mode control settings. This position retains the codes set with the code wheels [8] and/or [9]. On a radar screen, the correlation is not lost because it receives the emergency signal and the manual set code as well.
5	Mode Enable	MID	The switches enable or disable the functionality of modes 1, 2, 3/A , 4 and mode C. The mid position(default) enables the function.
		TEST	Not supported
		OFF	Function suppressed
6	RAD TEST-MON switch		Function not supported
7	IDENT/MIC	IDENT	The transponder adds an IDENT signal to the transponder reply. An observing radar sees a special symbol on the screen for 25 seconds. The special symbol is normally a flashing target symbol.

			ATC uses this function to safely identify an aircraft on the screen. The usage of IDENT is normally requested by ATC with the instruction "Squawk ident.". The switch is spring loaded and moves back to OUT if it is released.
		OUT	No ident signal is sent.
		MIC	If set to MIC, every time the PTT button is pressed, the IDENT function is triggered like with IDENT. The switch holds its position until manually moved back to OUT. This function is not useful because the visual signal on the radar screen may be delayed by the time for one antenna revolution.
8	MODE 3/A		This four rotary wheels define the code for mode 3/A. The code is set by the pilot if a station instructs him "Squawk nnnn", where nnnn is the code to be set. The code digits have a range between 0 and 7 because of the octal style. Therefore 4096 different codes are possible. Mode 3/A is used worldwide on military and civilian side.
9	MODE 1		This rotary wheels set the military code for mode 1. The higher digit can be set between 0 and 7 while the lower digit covers only 0 to 3. So 32 different codes are possible. Mode 1 is mainly used for timed flight operations. The headquarter defines mode 1 settings for specific areas at a given time. The pilot is responsible to set the right code in an area at the right time. Otherwise he will be identified as hostile aircraft.
10	Mode 4	ON	Powers the entire mode 4 functionality. Interrogations are answered only if they match the code selected by rotary switch [1] (CODE).
11	AUDIO/LIGHT	LIGHT	The reply lamp [2] is lit. Every time an interrogation is answered, the light will be switched off for 500 ms.
		OUT	No feedback for interrogation answers. The light remains off.
		AUDIO	The reply lamp [2] is lit. Every time an interrogation is answered, the light will be switched off for 500 ms. In addition, the pilot hears a 'Ping' signal in his headphones.

IFF/SIF remote control panel

Pilot procedures

The usage of the IFF/SIF functionality is bound to specific situation. ATC and GCI expect a standardized usage during aircraft operations. If a working IFF/SIF is available on board, it must be used to support ATC radar service and GCI safety obligations.

Startup

Before powering the APX-72 make sure, that the CODE rotary switch [1] is **not** set to position ZERO!

As soon as the bus is powered at which the APX-72 is connected to the MASTER rotary switch [4] shall be set to **STBY** The system powers up and is ready if the usage is requested by ATC.

If any code was given in advance by AIS or by ATC via radio, it can be set immediately in the STBY condition.

In the real world, the pilot would use the test functions to ensure a proper functionality. In the DCS simulation, test functions are not supported.

Check:

- Mode 1 schedule chart available as briefed.
- CODE rotary switch [1] is set to position 'A'.
- Function switches [5] for mode 3/A and mode C are set on.
- IDENT/MIC switch[7] is in OUT position.
- Codes set in [9] and [8] set as required . If operating on a VFR flight plan, set mode 3/A to the national code for military VFR flight. These codes are different over the world.
- Set the code for mode 1 according to the mode 1 schedule chart.
- Mode 4 switch [10] is OFF.
- AUDIO/LIGHT switch [11] as suitable.
- MASTER rotary switch [4] on STBY.

Taxi procedures

If not otherwise instructed by ATC leave the IFF/SIF equipment on STBY.

Receiving IFR clearance by ATC

One item of the IFR enroute clearance is the mode 3A code to be used when contacting the radar service after takeoff. The code should be set immediately while the equipment remains in STBY configuration if not otherwise instructed by ATC.

Lining up for takeoff

As soon as the aircraft enters a runway for takeoff, MASTER rotary switch [4] must be set to NORM. If the aerodrome is located close to enemy terrain, MODE 4 switch [10] should be set to ON.