RYA Yachtmaster Ocean Qualification Passage Gibraltar - Tenerife

Ralf Zwoenitzer, Berlin, Germany

May-October 2018

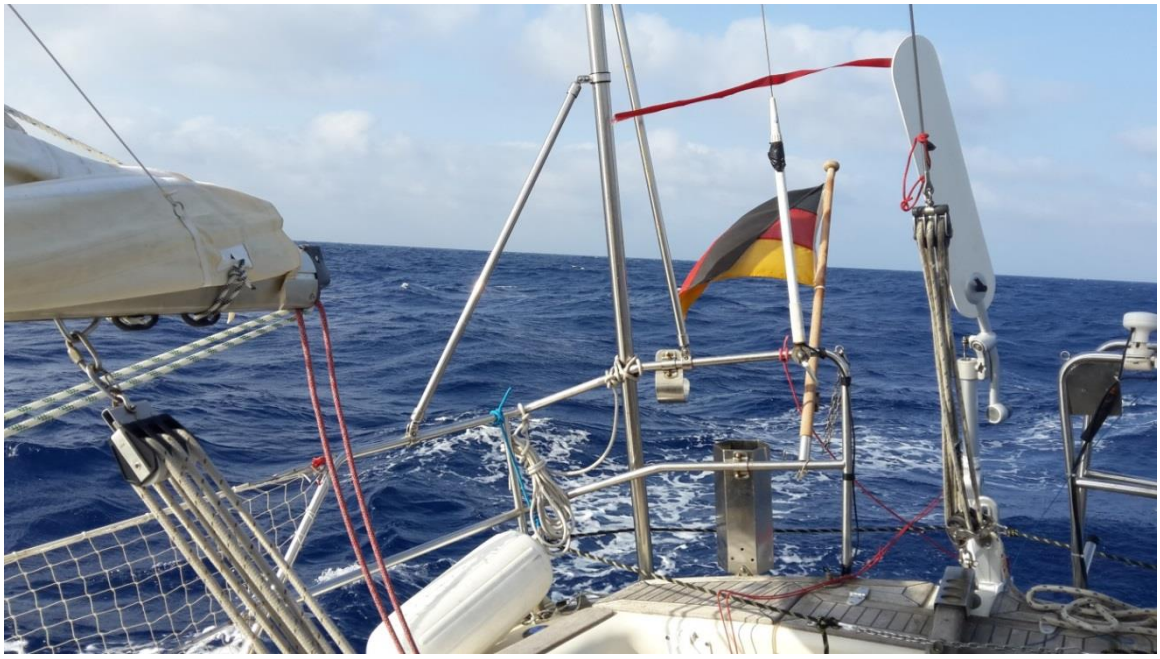


Image 1 Preventer for both sides, a rock solid wind vane and long waves from astern on the run–Atlantic.

Summary

Vessel	“Nica”, a Comfortina 32, build 1983
Call Sign	DG 5341
MMSI	211 374 050
Owner	Hartmut Neuber, Munich
Skipper	Ralf Zwoenitzer, Berlin
Crew	Two of us, no passengers

Route (planned)

Passage	Barcelona (Spain) via Gibraltar to Canary Islands	
Departure	12th August 2018	
Arrival	30th August 2018	
Leg 1	Barcelona to Gibraltar	550 nm, duration 8 days
Days of	2 days in Gibraltar	
Leg 2	Gibraltar to Tenerife	720 nm, duration 8 days
Reserve	2 days	

Route (sailed)

Passage	Gibraltar to Canary Islands (Tenerife)	
Departure	26th September 2018	
Arrival	2nd October 2018	
Planned	Gibraltar to Tenerife	720 nm, duration 8 days, Reserve 2 days
Sailed	Gibraltar to Tenerife	770 nm, duration 7 days, Reserve 3 days

Versioning

Revision	Date	Purpose	Resp.
1.0	20.6.2018	Initial Revision	RZ
1.1	25.6.2018	added some ice and books, corrected a view typos	RZ
1.2	02.07.2018	added electric power, forms added	RZ
1.3	14.07.2018	clarified water, added victualing	RZ
2.0	21.08.2018	new planning after engine breakdown	RZ
2.1	06.10.2018	add logs, maps and documents	RZ
2.2	12.10.2018	removed the med	RZ
2.3	08.02.2019	Added Appendix B	RZ

Table 1 Versioning of document.

Shortcuts

RYA Prerequisites Page 10
Risk Analysis of Nica Page 12
Piloting out of Gibraltar and through the strait of Gibraltar Page 20
Summary and table of celestial sights Page 38
Discussion Page 93
Appendix B – News from the new world Page 107

Content

Summary 2
Route (planned) 2
Route (sailed) 2
Versioning 2
Shortcuts 2

CONTENT 3

PREFACE 4

Plan B 4
Annotation 5
Disclaimer 5

APPRAISAL 6

Development 6
Rough Plan 6

PASSAGE 8

Basics 8
RYA Prerequisites 10
Weather 10

VESSEL 11

Risk Analysis 12
Improvements 14

PASSAGE PLANNING 16

General 16
Piloting out of Gibraltar 20
Passage to Tenerife 23
Piloting into Santa Cruz de Tenerife 33

DOCUMENTATION 38

Summary 38
Day 1 – 26.09.2018 40
Day 2 – 27.09.2018 43
Day 3 – 28.09.2018 52
Day 4 – 29.09.2018 58
Day 5 – 30.09.2018 66
Day 6 – 01.10.2018 72
Day 7 – 02.10.2018 80

DISCUSSION 93

FORMS 95

IMAGES 100

TABLES 102

LITERATURE 103

WEB Links 103
Books and Articles 103

APPENDICES 104

Appendix A - Out Take - Piloting into Gibraltar 104
Appendix B – News of the world 107

Preface

Plan B

Originally the passage was planned for two legs from Barcelona to Gibraltar and then to Tenerife in August. One day before departure we realized that the shipyard that was ordered to overhaul Nica had not done what they were told. They got three weeks time to install a couple of equipment, clean the tank and do the engine maintenance needed. Nothing was done one week prior to departure. The installation was caught up hectically within two days and the engine filters and oil changed without regard to the rest of it.

On the first trip thereafter, the bilge spilled over oily water and the engine overheats. Obviously someone filled diesel in an unmounted tank. To conceal about that, they put lots of water in the hull to spoil out the oil. Unfortunately all apertures and overflows seemed to be blocked with 30 year old dirt and the floor boards were glued in, so no satisfying cleaning was possible.

When the hull heeled the first time part of the mess found its way into the bilge. We needed days to get everything out and to investigate what might have happened. Engine overheating was initiated by blocked coolant channels. Another technician first disassembled, cleaned and replaced parts of the secondary circuit, just to find out that it still overheats. Inside the water pump we found small crumbs of red coolant repair fabric that can be poured inside the system to block small leaks when setting. Those liquids are known to put problems on hold at best but in an old engine with deposited coolant channels they cause an infarct by jamming the last remaining small tubes.

Image 2 Bilge with oily water - nobody wants to see this.

We did not know who exactly was responsible for this disastrous mess, but we brought in a clean boat with a running engine and out came an impeded vessel stinking of diesel. Spaniards say “la culpa es negra”, the blame is black or responsibility is for the others. Everybody involved was not accessible any more. So the only way out was a complete engine maintenance in another shipyard that needed four weeks over all. Flights and schedule had to be changed and the passage was postponed to end of September. The owner drove the boat to Gibraltar himself in short daily trips and due to time issues my job was reduced to the original leg 2 from Gibraltar to Tenerife.

Annotation

Any time zones and zone times within this document are noted as follows:

- Time zones and differences in British notation are noted with ‘UT’ and two digits (UT-01 for CET 7,5°E to 22,5°E) – means UTC is one hour less than zone time.
- Time zones and differences in European notation are noted with ‘UTC’ and one digit (UTC+1 for CET 7,5°E to 22,5°E) – means zone time is one hour more than UTC
- All tables are noted in local time (LT) without DST (Reeds notation). Mentioned are hourly differences to get daylight saving time if effective at the questionable date (DST)
- All courses and bearings are true values as far as not stated otherwise.
- For all computations West or South values are counted negative (also deviation and variation), North and East values are counted positive. This is the European way of calculating *Courses to Steer* or *Estimated Positions* which will result in the same courses and angles as in Britain, but with different definitions of turning directions.

Disclaimer

Appraisal

Development

Owner of Nica is Hartmut Neuber, a German theater actor, who planned a one-year-off on a sail boat, cruising the northern Atlantic single handed from late 2018 to 2019. He joined with me the crew on a North Sea passage from Goeteborg to Bergen in 2016 when I co-skippered a 48" Bavaria. This trip was my qualification passage for the "German Ocean" License Sporthochseeschifferschein (SHS).

This journey was one piece of preparation he carried out for his adventure. He is qualified with a German Sportkuestenschifferschein (SKS), comparable to an RYA YM Costal. He additionally completed a class in celestial navigation und prepared himself with a huge pile of books on cruising. Shortly after this he purchased Nica and I offered help and support by consulting, refitting and training before he would set off in autumn 2018.

In return for this, we agreed on me skippering the first two legs to the Canary Islands together with him. Purpose of this passage is mainly a last training and support to help him with his decision if he should continue with a single handed ocean crossing. Besides this, the passage should count as my qualification passage for the RYA YM Ocean scheduled for winter 2018.

Rough Plan

We started with a rough plan, dividing his year into three parts:

1. Crossing the Atlantic - From Barcelona into the leeward islands (August-September 2018 to Tenerife and from December/January 2018/2019 the crossing)
2. The Sabbatical - From the leeward islands somewhere to the north (Dominican Republic or Bahamas) (January-May 2019), from where to start part three
3. Back to Europe (hopefully) – Bermuda, Azores, Portugal, Netherlands (May-July 2019)

The final destination was not fixed, so the plan ends at Den Helder for now. The last leg north to the Netherlands is treated as optional.

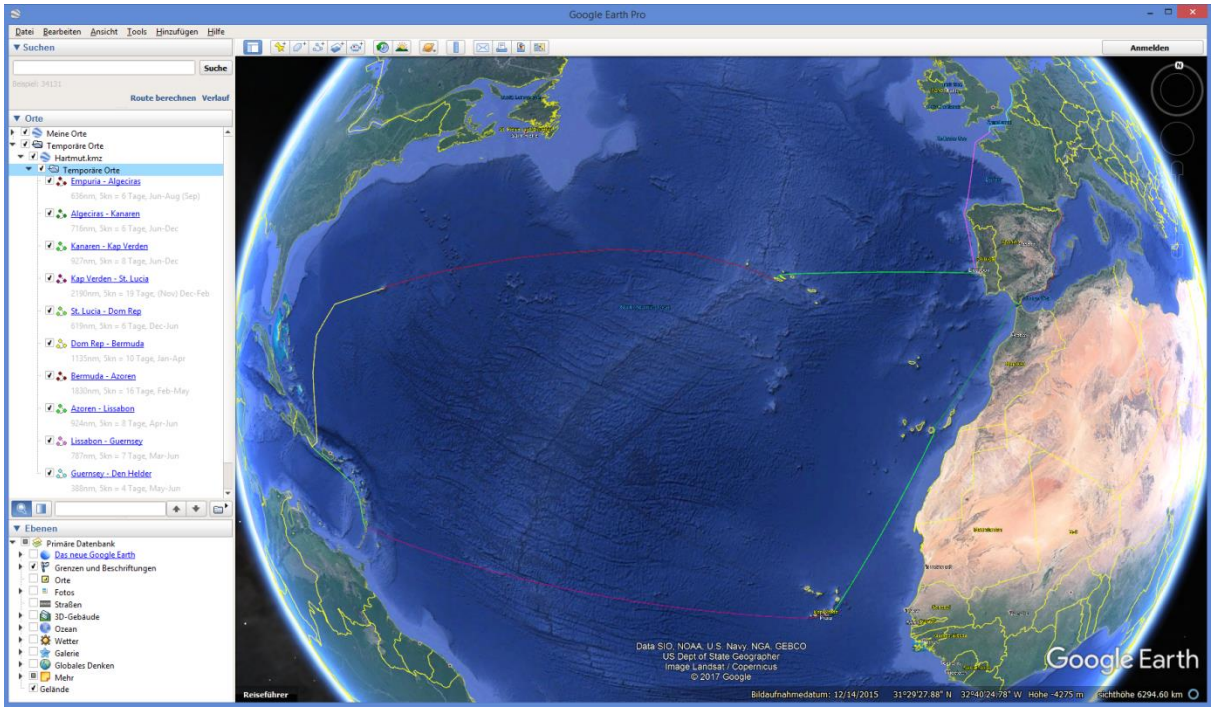


Image 3 shows the complete passage round the Atlantic Ocean.

We detailed the plan with a risk analysis (see below) and the resulting tasks, a never ending list of repairs, renewals und improvements that is beyond the scope of this paper. The owner started the things to do by making two appointments with the local shipyard, ordering the works that were too sophisticated to be done with our home improvement knowledge. However

electrical installations inside the hull were not ordered, since I once had a sound education for this. Those two dates gave the skeleton for all other maintenance and preparations. Between August 2017 and May 2018 we organized three single weeks for those tasks.

This paper should cover the qualifying passage only, but it comes with the nature of such an intensive preparation, that more information might be given than this. E.g. I decided not to reduce risk analysis to the first two legs but for the complete circle, since it is a valuable task and shows qualification required either.

The complete journey is planned for one year. The second leg from Gibraltar to Tenerife is subject to this qualification passage.

Nica was far beyond being ready for such an adventure. She needed a nearly complete refit during the last year before departure in August 2018. So she stayed in her slot in Empuriabrava and we planned to prepare her in a couple of trips to Spain.

The budget of the complete trip was limited. The owner put up a plan of all equipage or maintenance to be done and reserved a reasonable amount for unplanned costs. This turned out to be a very good scheme to always be informed about the state of such a project.

A big point in appraisal is family relations. All relatives of us support this adventure, which is very important, since investments are time and money that might be missing elsewhere.

The main purpose of this passage will be the proof of concept before the owner would continue with a single handed ocean crossing. The crew will be only the two of us. Me as skipper, owner as mate.

During the passage all single handed maneuvers we prepared during the last half year shall be drilled again and MOB with and without engine will be refreshed.

Passage

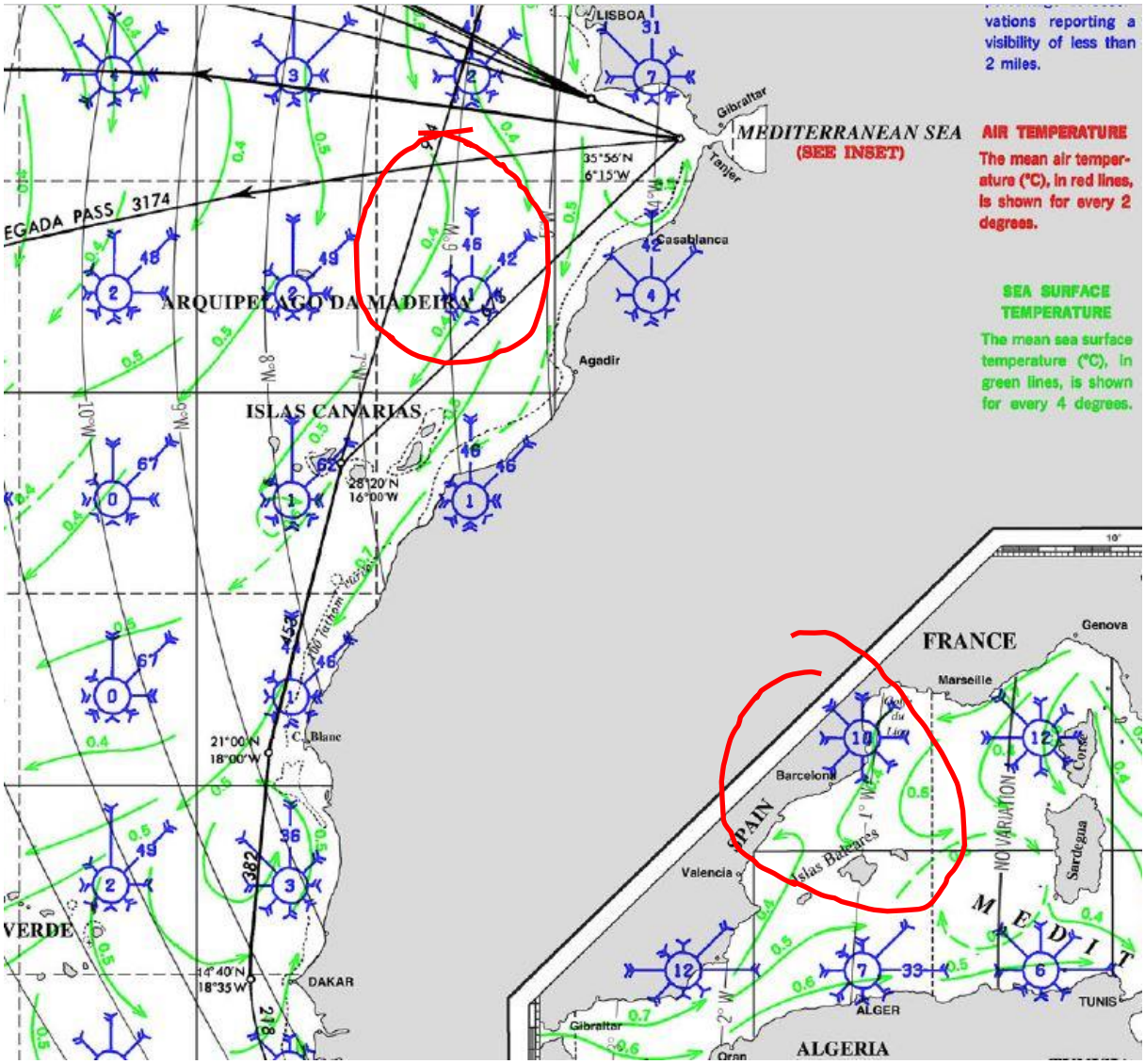


Image 4 Pilot chart of for the area of passage. Two wind roses marked for the Spanish coast and the NE Passat region off the African coast. For details see Passage Planning below.

Ice will be no problem on the first part of the journey. Pilot charts show the Mean Maximum Iceberg Limit far away from route of this qualification passage. However care must be taken on the following way back to Europe between May and August. If this passage would start from the US East coast anywhere north of Cape Hatteras following the gulf stream, it would cross a possible iceberg area between 045°W and 050°W. Ice warnings must be regarded carefully then.

Basics

~~The passage starts at Barcelona for the Canary Islands with one stop in Gibraltar. Departure might be somewhere near Barcelona. El Masnou, Mataro or Port Ginesta, see below for possible departures.~~

The passage starts at Gibraltar or somewhere at the coast shortly before.

Average speed for the vessel is estimated with 4 kts. In the Mediterranean a counter current of 0,5kt may reduce SoG, more over the winds are unreliable and there is a 10% chance of calms. The course will thus follow the coastline and two extra days are added to the duration. When in the NE Passat off the African coast, fair winds shall support a nice journey with a 0,4-0,6kt Canary Current on the stern, hopefully.

Schedule Standard

Under normal circumstances this could be a real schedule:

~~Departure~~	~~Barcelona (Spain)~~	~~at 12th August 2018~~
~~Leg1~~	~~Barcelona to Gibraltar 550nm needs 8 days~~	~~until 19th August 2018~~
~~Days off~~	~~in Gibraltar 2 days~~	~~until 21th August 2018~~
~~Leg 2~~	~~Gibraltar to Tenerife 720nm needs 8 days~~	~~until 29th August 2018~~
~~Arrival~~	~~29.8. at Tenerife with two reserve days~~	~~until 31th August 2018~~
Departure	Gibraltar	at 26th Sept. 2018
Leg	Gibraltar to Tenerife 720nm needs 8 days	until 3rd Oct. 2018
Arrival	Two reserve days	at 5th of October latest

Schedule Emergency

This chapter is left in the document for clarification only. When the engine repair starts, all dates where already missed.

In the unlikely case of major delays at the beginning, this could be an emergency schedule using all reserve days and with only one day off. The last possible departure is calculated backwards for two different average speeds, 4 and 5 knots. The place of departure is put 70 nm north of Barcelona to Palamos increasing the passage in the Med up to 620nm.

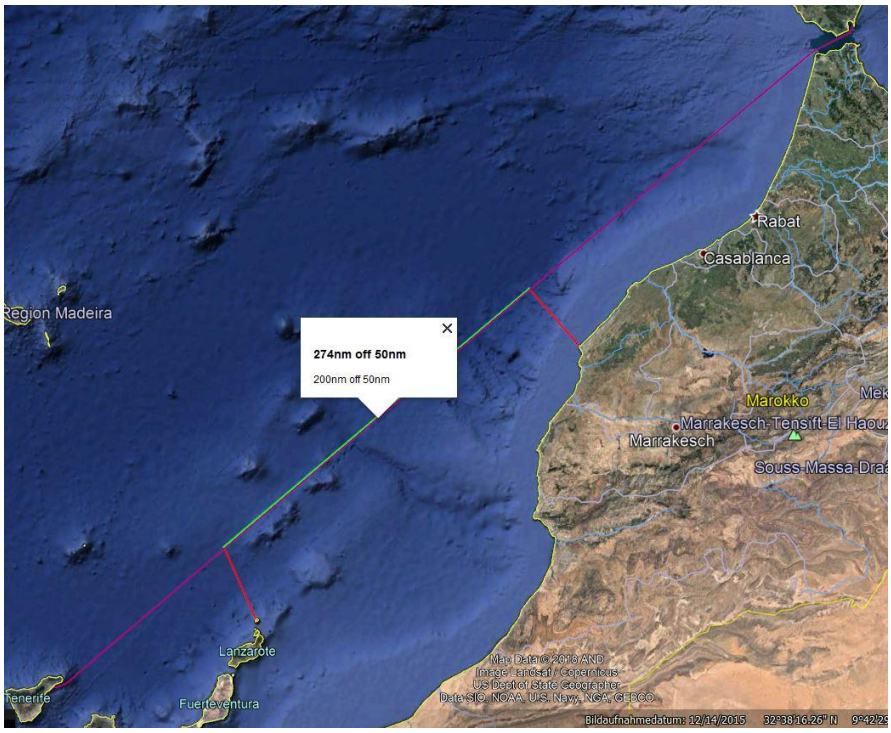
Average speed 4 kt

Latest departure in Tenerife to not miss the plane back home	31.8. 10:00 UTC+1
Latest departure for Gibraltar to Tenerife (720nm = 180hr = 7,5d)	23.8. 22:00 UTC+1
Latest departure for Gibraltar to Tenerife corrected for wait and ZT	23.8. 03:30 UTC+1
Latest departure for Palamos to Gibraltar (620nm = 155hr = 6,5d)	**16.8. 16:30 UTC+2**

Average speed 5 kt

Latest departure in Tenerife to not miss the plane back home	31.8. 10:00 UTC+1
Latest departure for Gibraltar to Tenerife (720nm = 144hr = 6d)	25.8. 10:00 UTC+1
Latest departure for Gibraltar to Tenerife corrected for wait and ZT	25.8. 05:30 UTC+1
Latest departure for Palamos to Gibraltar (620nm = 124hr = 5,2d)	**20.8. 01:30 UTC+2**

RYA Prerequisites



This passage would fulfill the pre-requisites of the RYA Yachtmaster Ocean exam. The passage is in tidal waters, needs for sure more than 4 days (96 hours), reaches over 600 miles direct way and will maintain a distance from land of more than 50 miles for 274nm (see green line).

Image 5 The distances of the passage: 720nm complete distance (purple), 274nm more than 50nm off the African cost and any island (green). 50nm distances in red.

To perform the celestial sights required for the YM Ocean a journey without the use of electronic navigational aids would be the best. Estimated points will be calculated by dead reckoning the log entries with course and distance. The sights performed will be used to get the observed positions for correction. As skipper I decide this will not be enough. So we conclude to let the owner supervise the GPS while I will (try to) do the complete navigation without the knowledge of the GPS positions. The owner will then compare my fixes with the reality and inform me about any position error exceeding 5nm.

Weather

Main sources of weather information will be the following

WEB

Passage Weather with detailed Windinformation:
https://www.passageweather.com/

German Weather service delivers charts down to the canaries:
http://www.dwd.de/DE/fachnutzer/schifffahrt/schifffahrt_node.html

Spanish Weather Service at http://meteonav.aemet.es

And they even offer a planning tool:
http://meteonav.aemet.es/MeteoNav/MeteoNav_en.html

(Later on the way to Netherlands: https://www.metoffice.gov.uk/public/weather/marine)

VHF

See: Admiralty List of Radio Signals, Vol 3, Part 1 or 2

Navtex

Nica is equipped with a “Target Navtex Pro- Plus” by Nasa Marine.

Satellite

Iridium Go in combination with the weather app “Predict Wind”.

Vessel

The *Comfortina 32* was built between 1968 and 1998 appr. 800 times. It is a 7/8 rigged 32 feet sloop with 5t displacement. She offers great stability with an AVS above 140° and is reliable in sailing all courses. Her tiller steering inside a closed cockpit along with its sail drive makes it a perfect choice for a long single handed journey.

She was owned by an elderly couple that stopped sailing in 2016. Up to then they used the boat as a day sailer, located in the Mediterranean Empuriabrava at the north east coast of Spain. They were the first owners and maintained her exemplary, although rig and ropes are original from the 80s and far beyond their life time.

The Volvo Penta engine was never overhauled and no engine hours were counted or logged, but the review by look and sound gave calming results. No leakage, no abnormal noises, no exhaustive smoke even when cold and started after a longer break. It starts at least with the second attempt und runs smooth and reliable then.

The basic installations were state of the art in the 80s, but today many things has to be replaced, renewed or even installed. Other objects of safety or luxury could not be realized, since room and money were far from endless.

Example given the bow anchor, a well sized Bruce, was attached with a short chain and a long rope. Clearly ok for the 80s, nowadays and especially for single handed travel in the Caribbean, a complete stainless chain along with an electrical windlass is needed for security reasons.

A hot water heater on the other hand, could not be installed due to missing room. Same applies to a heating, which clearly influences the possible passages to the regions where heating is not of serious need.

Make	COMFORTBÅTAR AB in Arvika, Sweden	
Model	Comfortina 32	
Build	1983	
LOA	9,5m	32”
Draught	1,7m	5,6”
Breadth	3,3m	10,8”
Mast	14,2m	46,6”
Mainsail	27m²	290ft²
Genua I	33m²	355ft²
Genua III	23m²	248ft²
Try Sail	m²	ft²
Storm Jib	m²	ft²
Displacement	4,9t	
Keel	2t	
Water	100l	
Fuel	60l	
Holding tank	60l	
Engine	Volvo Penta	
Model	2002 / 120S-B (C)	
Eng.No.		
Type	sail drive	
Power	13,3kW	18hp

Image 6 Comfortina 32 “Nica” in Spain, January 2018, still with lots of room for improvements.

Image 7 Nicas lateral plan, a fin keel with sail drive and a spade rudder protected by a small skeg.

Risk Analysis

To assess the risk situation and the actions to be taken a risk analysis were prepared. It is based on the following risk severity matrix.

Risk Severity Matrix

Likelihood	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Critical
Almost Certain 5	Moderate	High	Extreme	Extreme	Extreme
Likely 4	Moderate	Moderate	High	Extreme	Extreme
Possible 3	Low	Moderate	Moderate	High	Extreme
Unlikely 2	Low	Low	Moderate	High	High
Rare 1	Low	Low	Low	Moderate	Moderate

Consequence

Image 8 Risk severity matrix used.

All hazards were identified before planning starts in 2017. Likelihoods and consequences were evaluated to decide which actions will be needed. Improvements take place until August 2018.

Hazard	Likelihood	Consequence	Severity	Action	Result
General ship malfunciton	1 rare	3 Moderate	Low	None - Vessel is not new but in good shape	Low
Get in trouble with Neptune	3 possible	4 major	High	Purchased a bottle of rum Zacapa to sacrifice	Low
Log and depth sounder inaccurate	5 almost certain	3 Moderate	Moderate	Devices replaced with new modern ones	Low
Lines in rudder or prop	3 possible	3 moderate	Moderate	None – Must be accepted, be prepared!	Moderate
Malfunction of sails and rig in heavy weather	3 possible	5 critical	Extreme	Sails checked, storm jib and try sail added und training performed, additional steel jib halyard installed	Low
Malfunction of ropes	5 almost certain	3 moderate	Extreme	Very bad constitution, replaced all ropes	Low
Malfunction of electrical autopilot	4 likely	3 moderate	High	Windvane installed	Low
Electrical problems due to age of installation	4 likely	2 minor	Moderate	Checked wiring completely, removed home improvements of previous owner	Low
Fire from non-fused circuits	3 possible	5 critical	Extreme	Reorganized and added fuses and switches	Moderate
Accident due to be overlooked	3 possible	5 critical	Extreme	Radar Reflector mounted, Active AIS installed, Tricolor installed	Moderate
Fatality in case of abandoning vessel	4 likely	5 critical	Extreme	Life raft was 15 yrs. out of date, replaced, EPIRB installed, Handheld VHF purchased	Moderate
Drowning	2 unlikely	5 critical	High	In date proofed life vests for crew plus reserve, life lines around the deck	Low
Ingress of water	3 possible	5 critical	Extreme	Bilge alarm installed on independent circuit, electrical bilge pump with crocodile clamps, moveable where needed, double system for redundancy, Doubled anything else important (buckets, plugs, lamps, etc.)	Low
Gas leakage	2 unlikely	4 major	High	Installation checked, remote switch at bottle	Low

				reactivated	
Fire on board out of control	2 unlikely	5 critical	High	Two extinguishers were out of date, three additional extinguishers (one CO2) and fire blanket in pantry purchased	Low
Engine overheats	3 possible	3 moderate	Moderate	Primary cooling circuit leaked, deaerator replaced	Low
Engine malfunction	3 possible	3 moderate	Moderate	Maintenance ad tank cleaning before departure, doubled belts, impeller and filters, tools checked complete and sufficient	Low
Anchor slipping or wearing through	3 possible	4 major	High	Improvement (see below)	Low
Communication problems in distress	4 likely	4 major	Extreme	Communication devices improved (see below)	Low
Run out of electrical energy	4 likely	3 moderate	High	Replaced battery (comfort), silent wind generator installed, LED lights replaced as far as possible, shore power adapters (US) purchased	Low
Run out of water (inedible water)	3 possible	4 major	High	Two tanks checked, rinsed and cleaned.	Low

Table 2 shows all hazards identified with its severity resulting from combined likelihood and consequence. Result shows the new assessment after actions taken or changes applied.

Improvements

Further improvements were made without explicit risk analysis.

Single handed training

The owner is aware of the fact that its official qualification may not be enough for the arising challenges, but he compensates for that with great personal initiative. He sailed his journey virtually one year before following weather reports and see states. Additional theory lectures were added as required on legal topics (declaring in, stowaways, piracy, ship's protest).

Training covers all aspects of single handed ocean cruising. Every maneuver was trained with regard to being alone. Most of them are based on heave to. Windvane handling was drilled under different circumstances. Unfortunately, there was no heavy weather training possible prior to departure. So setting the storm sails was the only preparation possible.

Two days training of casting off and berthing single handed as well as anchor maneuvers where performed. Line handling was one major topic, since risk analysis showed that lines in rudder or prop could not be affected positively otherwise.

Reefs

The reef system was optimized to single hand operation without installing a single line system. Reef #1 and #2 are inside the boom as before, #3 is an external rope. Reef #2 can be set completely out of the cockpit, since the spinnaker downhaul was abused for pulling down its cringle at the mast.

Communication

The VHF has a build in GPS, both were checked. The device was attached to an independent circuit to the battery with own fuse and switch. Thus it will be independent from the main power switch. The same circuit is source for the external VHF antenna, which is an active one since it could not be installed on mast head. The VHF emergency antenna is a loop wire that could be hoisted in the mast.

The ancient LF/MF “Sailor” was removed and replaced by an Iridium satellite telephone connected to the tablet. A handheld VHF is the last backup und assures communication once in the life raft.

The old Sony SW radio receiver was replaced by a new Tecsun PL-880 SW SSB receiver. It has an external antenna which is an active wire loop with 50cm diameter that could be pulled up the mast.

Image 9 Navigation table of Nica after improvements.

Gas

Nica is equipped with a standard gas installation, one bottle in the back, a gimbal oven, second valve inside before the tube. Blue camping gas is used instead of grey propane. Those bottles are smaller with less pressure, but they might not be replaced elsewhere around the Atlantic but in Europe. So reserves must be stored. An electrical gas valve was installed but not used. It was checked, reactivated and worked well after that.

Anchors

The Bruce anchor at the bow was equipped with a very short chain, an ancient rope and no windlass. This is indeed not what you need in the West Indies. An electrical windlass was installed and 30m of stainless chain. This might be extended by 20m of rope occasionally.

A second anchor at the stern is a small Grapnel, also ok for use with tender.

Tender

Important for the Caribbean sea as well is a tender. There was none, so an inflatable dinghy was purchased, without engine, only rudders, they are less sensitive for failure.

Passage Planning

General

Hazards on Route

There are no explicit hazards like obstructions or races, but leaving the Mediterranean through Gibraltar is for sure a kind of hazard for itself. Wind, current and the caps rule the passage.

The long trip to the Canary Islands on a small boat from the last century is another point that efforts special care and not least there often are extreme weather conditions between the Canary Islands due to their special geological circumstances in the Atlantic Ocean influenced by the NE Trade Winds.

Tidal Gates

The only tidal gate is the Strait of Gibraltar. Inside the Med there are no significant tides but a couple of currents turning in the Alboran Sea. They may result in a counter current of less than 1 kt. The currents in the Canary Islands are of no major concern, because streams and heights are negligible.

Weather and currents on passage

Strait of Gibraltar – Not the wind rules, the current does. A special pilotage out of Gibraltar is needed.

Atlantic Ocean – NE Trade winds should get us easy to south west. Rarely W or even SW can occur for a couple of days. We will see and decide between two major courses.

In the Canary Islands local weather systems and cap effects are more of a concern. Out there in the Atlantic a sailor's gale is more common than exception. Squalls of 8 are not rare at all.

Water

The vessel has two separate water tanks, with 100l fresh water in sum. One tank is stainless steel with a capacity of 60l, the other one is a bubble tank filling with 40l.

During the qualification passage no leg will need more than 8 days. Let's calculate pessimistic only 80l can be pulled out of the tanks, then this would be 5l per day per person, which is clearly enough to not die (Mister Bönd ;-).

Image 10 Water for the Atlantic.

Besides this a minimum of 3l canned water per person and day should be provisioned. This would be 60l or 40 bottles of 1,5l water for 10 days. Reprovisioning in Gibraltar will be needed on request. Emergency: In case of water shortage a harbor can be reached within 1 or 2 days.

Crossing the Atlantic is completely different:

Water consumption must be planned for pessimistic 38 days. One person needs an absolute minimum of 3l water for drinking a day, this makes 114l (or 76 1,5l bottles) to be provisioned single handed.

For living (cooking, washing, shower), 5l to 10l a day would be really comfortable. This would make a total of 190l to 380l or additional 110l to 300l in canisters resulting in 6 to 15 canisters

each 20l.). So a minimum of 6 canisters 20l each must be provisioned for the Atlantic crossing, the more the good.

Image 11 Provisioning for two and 14 days.

Victualing

Not a real problem for two male instead of a complete crew with their demands. Canned food, longtime bread with sausages in glasses for 10 days and vitamin C pills against scurvy will be enough. Without fresh things nothing can go to waste.

A complete list of victualing will be appended before departure, when we know what was on sale in the market.

Electric Power

Any book on cruising deals with the problems of electrical power more or less successful. All end up with “depends on the case”. So here it is.

Question one: How much electrical power is needed?
Question two: How long will the battery last before it has to be recharged?
Question three: Which strategy might improve the situation?

Power usage

The amount of electrical energy needed is the energy volume [Wh]. It is the sum of all powers [W] times the duration [h] each device is switched on. Power is Voltage [V] times Current [A], any of the books explains this. Voltage will be assumed as 12V although it varies with the capacity of the batteries and 12V is already really low.

The power consumption [W] of the devices aboard are either measured (like at the fridge with a normal multimeter), taken from the manuals (B&G chart plotter), written on the device (lights) or they are a good guess from the books (VHF, led lights).

Hours a day means the duration this device typically runs each day, calculated for an average across the whole journey. Daily energy is the key value of consumption, giving the energy volume [W * h] per day, that has to be replaced by any of the possible energy sources, or that might improve the energy strategy by not being used.

Usage	Power	Hours a day	Daily energy	Comment	Min. usage	Mer ** 1h
Instruments and log	15 W	24	360 Wh		Yes	1,5
Weatherdoc AIS	4 W	24	96 Wh	max.	Yes	0,4
Navtex	2 W	24	48 Wh	max.	Yes	0,2
Autohelm	40 W	24	960 Wh	average	No	4
VHF	10 W	24	240 Wh	standby	Yes	1
Chart Plotter (without radar)	10 W	24	240 Wh		No	1
Fridge	36 W	24	864 Wh		No	3,6
Compass and instruments light	5 W	11	55 Wh		Yes	0,5
Cabin lights (led)	5 W	11	55 Wh		Yes	0,5
Nav lights (conventional)	30 W	11	330 Wh	Either …	No	3
Nav lights (tricolor led)	2 W	11	22 Wh	… or	Yes	0,2
Full energy consumption (conventional)			3248 Wh			
Minimum energy consumption (tricolor led)			876 Wh			

Table 3 shows the approx. power consumption of Nica. (** for Mer see energy strategies below)

E.g. the fridge pulls an average current of 3A (max of 7A for a third of an hour, depending on the outside temperature and the usage). This is an average power of 36W running a complete 24h giving an energy consumption of 864Wh per day.

Under normal circumstances not all devices will be powered up. The electrical autohelm is a backup system for the wind vane, chart plotter is not needed on the ocean when navigating celestial (or at least a couple of minutes a day) and the fridge needs not cooling non existing beer reserves after day three.

So two scenarios are calculated: Full energy mode with all devices powered up and the minimum energy consumption, counting only those devices marked in the equally named column.

In full usage mode (with fridge, chart plotter and electrical autohelm), the boat needs 3,2 kWh per day. At home worth 2 €* but much more valuable at sea. In normal minimum mode this reduces to 876Wh. So what is the currency at sea? It is the cost (in diesel or time) needed to replace this consumption with each recharge.

* € = Euro: Monetary currency used in the majority of European countries living with the same zone time.

Battery capacity

The engine starter battery is completely omitted in all calculations. Only a single service (or comfort) battery is installed providing a nominal capacity of 100Ah with 60% efficiency there are 60Ah remaining, times 12V it has an energy volume of 720Wh. This is nearly the minimum energy consumption, which means that the battery would last for nearly one day in minimum mode. Much worse in full mode: more than four times a day the battery would be dis- and recharged with all devices powered up.

Energy sources at sea

The engine alternator is specified in the manual with max. 50A charging current and 700W power, which should be the mechanical power used to drive it, but not the electrical power at the output. This can be calculated by 12V * 50A = 600W. This means, running the engine for one hour will charge the battery with 600Wh energy volume. Trivial calculation leads to 72 minutes engine run is needed for one recharge. To produce the energy volume needed for the minimum power consumption, it must run 1,5 hours a day.

The Silent Wind Generator 400+ has a nominal power output of 420W. Because of a great dependency on wind force and the questionable truth of the word “silent”, an average of 300W output is assumed. By a huge coincidence this is exactly half the energy output of the engine running. So running time of the engine just has to be doubled with the wind generator running alone: 144 Minutes for one recharge of the service battery and three hours for a minimum energy day.

Energy strategies

A simple new currency can be introduced: “minutes needed to run the engine, for each device being switched on for one hour” or “minutes needed to run the wind generator for each device being switched on for one hour”.

Example: 1 hour of chart plotter needs 10Wh (10W * 1h). With 600W engine charging, cost of this plotter hour is 10Wh / 600W * 60 Minutes = 1 Mer (minute of engine run), or with the exchange rate for the wind generator mentioned above 2 Mgr (minutes of generator run).

Again absolutely fortunately there is a quite simple relationship between the power consumption of a device and it’s Mer [minutes]: simply one tenth of the power [W]. The Mer values are mentioned in the rightmost column in the table above. Mgr is one fifth of power, still much simpler then British weights.

Sum up all of it means:

Mer summed up for all minimum devices is 4,2. For a complete day (Mer * 24) it gives 103 minutes of engine run per day or 206 minutes of the wind generator.

The full equipment sums up to 15,9 Mer (or 31,8 Mgr), for a complete day this means 6,5 hours of engine run or 13 hours of wind generator.

- No sum is greater than 60, which are good news, because it means engine or generator delivers enough energy to recharge the batteries at all.

- If the generator delivers real 300W, this might even be enough for fridge.
- In case the wind generator does not, the energy consumption must be reduced to the minimum and the engine run for 1 or 2 hours a day.
- The use of a tricolor led is absolutely recommended, it saves 30 minutes of engine run a day. (But off course it must be approved by Q.)

Electrical windlass was not mentioned since it has allowed to be operated with engine running only. Miscellaneous devices like phone charging are also not calculated, because all other devices were counted pessimistic and there would be enough overhead for this. After all the boat has a good energy balance, that simply has to be monitored. Watching the voltage twice a day and establishing a daily engine run before the evening watch will completely do it.

Mobile Energy

Other important points in energy strategy are the mobile devices like flashlight, cell phone, satellite phone or handheld VHF. All of them are available with accumulators instead of one way batteries. Recharging is preferred whenever possible and only a single reserve pack of AAA and AA batteries are on board.

In contrast great value is put to the kind accus are provided with their energy. Fortunately days with one charger for each device are history. Whenever a device can be recharged with an android USB charger, it is purchased. This increases security tremendously by redundant crossover usage as well as the possible sources from 5V outlet to a laptop connector.

If a proprietary power connector can't be avoided, sufficient electric stuff is in the tool box to reconnect the plug to another charger in case of emergency. In addition a universal multi-voltage charger with several connectors is on board. For the few devices that need a moderate 220V AC current, a small inverter is also available.

Fuel

The Volvo Penta installed has 18hp and an estimated fuel consumption of 1,5 l. per hour (pessimistic guess for playing at sure). Capacity of fuel tank is 60l, that gives 40 hours of a cruising speed with 4 kts., resulting in an engine distance of 160nm. For the first two legs this would be sufficient, since distance to Africa or Europe is not more than 80 - 120nm.

For a 3000 mile Atlantic crossing this is clearly not enough. Given 31 days on the water with a not working wind generator, lamps and VHF would need 1,5 hour of engine running each day. This would be 46 hours or more than the complete fuel capacity.

The averaged possibility for calms along the route from Canaries to the Caribbean in December is 2%, which would roughly be one of the 31 days. Let's say double the risk (4%) and calculated one extra week (38 days over all) it would be 1,5 days cruising through the calm. 36 hours with 1,5l each are 54l for cruising and 57l for battery charging, giving a total amount of 111 liter for the crossing.

All canisters are heavy and difficult to handle. They should not contain more than 20 l. each. Thus three of them would make a good reserve, with the tank fueled up.

Paper Navigation

The following paper charts are used:

1. NV ES 3 – Spain No. 3 chart atlas from Cabo San Antonio to Gibraltar. Scale from 1.750.000 to 5.000
2. BA 3132 and 3133 - Two charts 1.250.000 covering the direct passage from Gibraltar to Tenerife.
3. NV ATL3 – Atlantic No. 3 chart atlas from Azores to Cap Verde including Madeira and Canary Islands. Scale from 1.750.000 down to 7.500

Electronic Navigation

First option is a complete set of NV raster charts electronically on a tablet computer and as paper version.

Second option: Additionally B&G plotter (Zeus), mainly to display the AIS output via an RS422 interface. Instructions to get OpenSeaMap for B&G in AT5 (Atlas V12) Format:

https://wiki.openstreetmap.org/wiki/DE:AT5-OpenSeaMap-Chart_for_Lowrance_Simrad_B&G

OpenSeaMap charts needed:

- South Europe (Spain / Portugal)
- West Europe (France / Engl. Channel)
- Africa (Canaries)
- Central America (Caribbean)
- US South (Florida to Virginia)

Third option is a Garmin handheld GPSmap 78s device with OpenSeaMap vector charts. Format is Garmin OpenSeaMap (UTF-8). A special configured chart was generated from https://extract.bbbike.org/?format=garmin-oseam.zip with a size of 435MB, covering the complete qualification passage.

Documentation

Main documentation tool will be the tracks recorded by Garmin GPSmap 78s. They can be stored every day and examined later in detail for any assessment. The new device read and write the open domain .GPX format, an XML based data format to store any GPS related information (waypoints, tracks or routes).

Google Earth software writes an own format *.kml which is also XML based and can be translated to and from GPX with the GPSbabel software. Along with the interchangeable formats for maps (open sea map, navionics) planning and documentation is possible in many software systems on nearly any device.

Terrestrial Navigation

Terrestrial Navigation is the cornerstone of navigation. It is used any time enough landmarks are visible. Celestial navigation is done whenever possible too, checked by terrestrial values. A Steiner glasses with compass and light. Portland plotter and standard navigation tools along with the NV paper charts are used. That's all that might be needed. Plotting is performed within the paper charts and the results of both are transformed to the log.

Celestial Navigation

A Davis Mark 15 Sextant, which is the least valuable sextant that might be taken for serious, is used. A current nautical almanac and a printed version of Pub.249 Vol.1 for selected stars are present. Volumes 2 and 3 of Pub.249 as well as all six volumes of Pub 229 are available as PDF files in a laptop. Sight reduction for sun, moon and planets are calculated with a scientific calculator. As backup device a laptop with the free software Nautic Tools (http://www.nautictools.de) may be used in case of uncertainty. Most of all, it contains an electronic star finder, endless ephemerides and is designed like a Swiss army knife.

Time

Time is measured with a Casio GW-2310. This is a G-Shock clock, solar driven and with automatic time signal receiver in all time zones. Its accuracy is absolutely sufficient for our ten days without time signal to always have the UTC on the second without watch management in the log.

Piloting out of Gibraltar

- Time zone in Gibraltar UT-01 (CET), subtract 1h from local Standard Time for UTC
- Zonetime is UTC+1, add 1h to UTC for local Standard Time.
- Up to end of October DST is effective with UTC+2 (CEST).

All tables are given in ZT (UTC+1), so add 1h for local DST.

The complete Strait of Gibraltar is subject to an E/W-going current and tidal stream. The maximum rates of current in each direction which may be expected are about 2-3 knots in the W-going direction and about 4-7 knots in the E-going direction. In the central area the tidal streams set in the direction of axis of the strait, but near the land they follow the direction of the coast.

In the northern part, approx. 1-2 nm off the coast, the W-going 1-2kt current is setting from HW+3 Gibraltar to HW-3. Some 3nm further south, the current slacks HW+6 to W reaching 3kt. and at HW Gibraltar to E. So it is favorable for leaving the Med for another 3 hours more (HW+3 to next HW), as long as one increase the distance to the Spanish coast before HW-3.

Additionally overfalls and eddies may occur at time of strongest currents around salient points like caps (Europe Point at the S-tip of Gibraltar or Ponta del Carnero or Cap Spartel the NW-tip

if Africa). It is advisable to maintain proper distance and to pass those points at slack, whenever possible.

Tidal Races may occur south of Tarifa at Punto Marroqui. As long as the weather is not heavy, maintain proper distance to shore (1-2nm).

Way out (or through in this case)

This is the route out of the Bay of Gibraltar, from any of the four marinas, along of 7 waypoints (0-6). It is absolutely important to avoid the 4 knots counter current and to follow the time table below. Its times are given relatively to HW Gibraltar.

- → Leave Gibraltar at HW+2 to reach WP1 at slack (until HW+3)
- → Stay in the N part of the strait for 2-3 hours up to WP3 (until HW+5)
- → At WP4, after another 1,5-2 hours (up to HW-4), the W-going current is prolonged by another 3 hours, because the distance to the coast increases now.
- → Proceed with this current for another 2 hours (until HW-2) until Cap Spartel bears south (WP5).
- → Turn to SW for 2-3 hours (until HW+1), cross between the two TSS. Beware of traffic! On the way to WP6 the current is W-going at the beginning but it is weaker than in the E part of the strait. Although it will slack and turn to E which might compensate the currents influence. A course to steer would be useless, because of the lack of exact streaming information. A proper bearing with more often fixes shall safe the way.

WP	Position	Time	Log	Course	Dist	
WP0	FWM in Bahia de Algeciras	00:00	0	184°T	5nm	
WP1	E of ECM 0,9nm & 311° to Punta del Camero	01:15	5	230°T	3,6	Beware of La Perla to Stb
WP2	1nm S of Punta del Acebuche, Punto Marroqui bears 255°	02:00	8,6	250°T	7,6	Beware of TSS on Port
WP3	1nm S of Punto Marroqui, Capo Trafalger Bears 300° (D 23nm???)	0400	16,2	270°T	6,9	Beware of wrecks and obstr. at Stb
WP4	0,7nm N of NW corner of TSS, Punto Marroqui bears 077°, Cap Spartel bears 217° (D 14nm)	0630	23,1	270°T	8,7	
WP5	Halfway between the two TSS at their northern edges, Punto Marroqui bears 084° (D 16nm), Cap Spartel bears 178° (D 11nm)	0830	31,8	220°T	14	Beware of traffic between the two TSS, beware of tidal streams
WP6	10nm W of Cap Spartel	1200	45,8	Passage to the Canaries		far enough out to avoid eddies and overfalls before the cap (200m depth)

Table 4 shows a generalized way out of Gibraltar to a point south of the TSSs and W of the African coast.

Image 12 Route out of Gibraltar, length 47nm to WP6, which will be the start of the passage to Tenerife.

Dawn and Dusk at Gibraltar

Arrival at Gibraltar is scheduled for the 19.8.2018. Latitude of Gibraltar is 36°N.

This table was changed from 19.8. to 26.9. with V2.0 for the new plan. Source was https://www.timeanddate.com/sun/gibraltar/gibraltar?month=9&year=2018.

UTC+1	Nautical	Civil	Sunrise	Sunset	Civil	Nautical
26.9.2018	06:16	06:46	07:12	19:12	19:38	20:07
27.9.2018	06:17	06:47	07:13	19:11	19:36	20:06
28.9.2018	06:18	06:48	07:14	19:09	19:35	20:04

Table 5 Twilights in Gibraltar.

Table shows the nautical and civil twilight at dawn and dusk as well as sunrise and sunset for the three days expected to be of interest for Gibraltar. As expected, there is not much change in September at Lat 36°N. Times are not local time, add 1h for DST.

Tidal Information Gibraltar and possible Departures

Leaving Gibraltar is scheduled for 26.9.2018. Putting all information together the following departures may work.

This table was changed from 19.8. to 26.9. with V2.0 for the new plan. Source was http://marine.meteoconsult.co.uk/marine-weather-forecast/tide-times-gibraltar-9-1.php.

Age of Tides is Springs to 50% Neaps for the date range 26.9.2018 to 28.9.2018.

UTC+1	HW	Departure (HW+2h)	WP3 (Dep. +4h)	WP6 (Dep. +7,5h)	Civil Twilight is where?
26.9.2018 HW1 *	0331	0531	0931	1231	Dawn 1h after departure
26.9.2018 HW2	1545	1745	2145	0115	Dusk at WP2
27.9.2018 HW1 *	0405	0605	1005	1335	Dawn at departure
27.9.2018 HW2	1619	1819	2219	0149	Dusk at WP1
28.9.2018 HW1 *	0441	0641	1041	1421	Dawn 0,5h before dep.

28.9.2018 HW2	1655	1855	2255	0225	Dusk 0,5h after dep.
30.9.2018 HW1 *	0520	0720	1120	1450	Dawn 1h before dep.

Table 6 Possible departures from Gibraltar.
* Favorable departures are with dawn around departure. Times are not local time, add 1h for DST.

Table shows the times of possible departures from Gibraltar and the corresponding arrivals at WP3 (Tarifa) and WP6 (of Africa). Column “Civil” gives the approx. position of the civil dawn or dusk twilight. It can clearly be seen that a departure in the evening is not a good idea since daylight will fade away almost immediately. Departure in the morning instead will raise daylight before the critical waypoints are reached.

Passage to Tenerife

Great Circle Navigation

First a great circle route is calculated from the western end of the strait of Gibraltar to the north eastern tip of Tenerife. Then these values are compared to the Rhumb Line Course.

WP	Lat	Lon	Course	Dist [nm]	Coment
GC1	35°48,4’N	006°01,7’W	232°	677	WP6 SW Strait of Gibraltar
GC2	35°14,5’N	007°W	232	622	
GC3	34°35,2’N	008°W	231	559	
GC4	33°54,8’N	009°W	231	495	Closest to Maroc.
GC5	33°13,3’N	010°W	230	430	
GC6	32°30,7’N	011°W	230	364	
GC7	31°46,8’N	012°W	229	297	
GC8	31°01,8’N	013°W	229	229	
GC9	30°15,6’N	014°W	228	160	
GC10	29°28,2’N	015°W	227	90	
GC11	28°39,6’N	016°W	227	18	North East tip of Tenerife
GC12	28°27,3’N	016°14,9’W	227°	0	St.Cruz, Tenerife

Table 7 Great circle route

Table Great Circle Navigation shows all points and courses of the great circle route of the passage from Gibraltar to Tenerife for each integer longitude.

Comparison of Great Circle (GC) to Rhumb Line (RL)

GC Distance	677,4 nm
RL Distance	677,6 nm
GC Initial Course	232°
GC Final Course	227°
RL Course	229,4°

It can clearly be seen, that the GC has no significant advantage compared to the Rhumb Line, because the distance is to short. However we will take the table above as a good list of waypoints for the main route. The real passage will clearly be dominated by current, wind and weather than by any great circle.

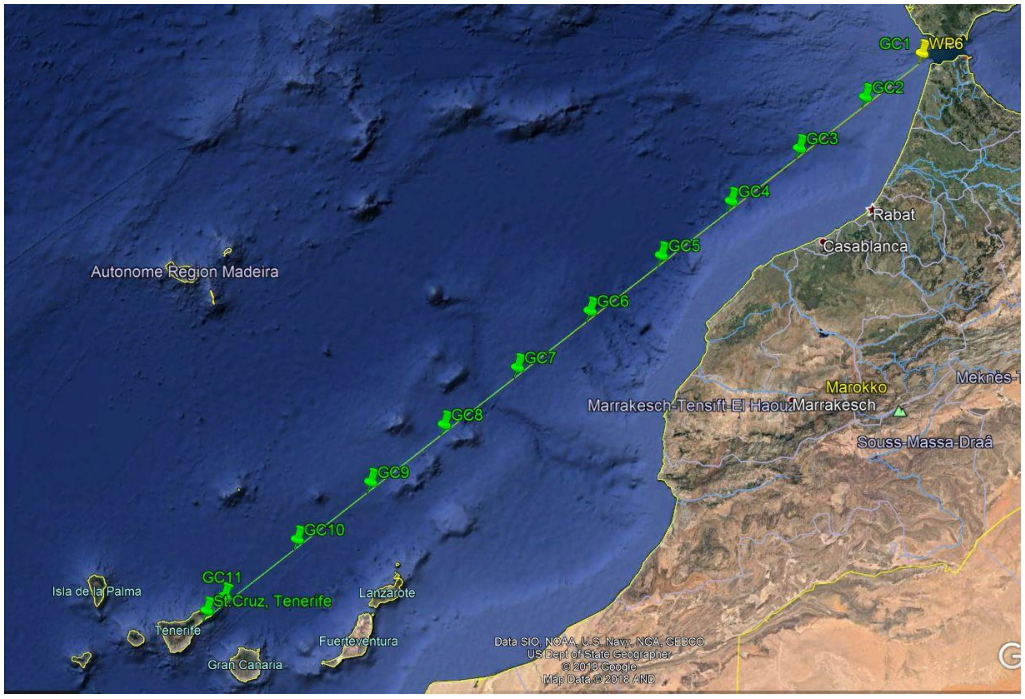


Image 13 Great circle route (green) compared to Rhumb Line route, no significant difference.

Dusk and Dawn on the Atlantic

Travelling with a considerable N/S difference, the times of sun change significantly. Since the track is a straight great circle, the six scheduled days between the two dates 26.9. and 3.10. can be interpolated linearly.

UTC	Nautical	Civil	Sunrise	Sunset	Civil	Nautical	Position / Log
26.9.2018	05:16	05:46	06:12	18:12	18:38	19:07	96 (Gibraltar)
27.9.2018	05:23	05:53	06:19	18:17	18:43	19:12	192
28.9.2018	05:30	06:00	06:26	18:23	18:48	19:17	288
29.9.2018	05:37	06:07	06:32	18:28	18:53	19:22	384
30.9.2018	05:45	06:14	06:39	18:33	18:57	19:26	480
01.10.2018	05:52	06:21	06:46	18:38	19:02	19:31	576
02.10.2018	05:59	06:28	06:53	18:43	18:07	19:35	672
03.10.2018	06:07	06:35	06:59	18:48	19:12	19:39	720 (Tenerife)
04.10.2018	06:08	06:35	06:59	18:47	19:11	19:38	720 (Tenerife)

Table 8 shows the linear interpolated times for rise, set and twilights of sun on the proposed route.

The daily differences are 7 minutes for dawn, 6 minutes for rise, 5 for set and 4 minutes for dusk. Times are in UTC, add 1h for local time (WEST) at destination.

Watch System

The traditional watch system as used for centuries in the Royal Navy is the simplest one to use in a 2-section 2-crew. This system swaps watches every night due to the divided dog watch (2 times 2 hours).

Watch / Day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
20-00 first	A	B	A	B	A	B	A	B	A	B	A	B
00-04 middle	B	A	B	A	B	A	B	A	B	A	B	A
04-08 morning	A	B	A	B	A	B	A	B	A	B	A	B

08-12 forenoon	B	A	B	A	B	A	B	A	B	A	B	A
12-16 afternoon	A	B	A	B	A	B	A	B	A	B	A	B
16-18 dog 1	B	A	B	A	B	A	B	A	B	A	B	A
18-20 dog 2	A	B	A	B	A	B	A	B	A	B	A	B

Table 9 4 hour watch system for two.

A :_____ B : _____

The same principle could be done with six hours:

Watch / Day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
18-00 first	A	B	A	B	A	B	A	B	A	B	A	B
00-06 middle	B	A	B	A	B	A	B	A	B	A	B	A
06-12 morning	A	B	A	B	A	B	A	B	A	B	A	B
12-15 dog 1	B	A	B	A	B	A	B	A	B	A	B	A
15-18 dog 2	A	B	A	B	A	B	A	B	A	B	A	B

Table 10 8 hour watch system for two.

A :_____ B : _____

Both systems are alternating but can simply be equalized by putting together the two dog watches. Another variation might by an asynchronization like the one-in-two system with longer night watches.

All other systems are like them discussing a scheme in Ocean's Eleven: doesn't work and we are too few. Three hour system has to short free watches with two sections. Other systems are based on three sections or more crew members per section.

Passage Plan for the Atlantic

Following four images show the passage plan used for real navigation.

Passage Plan (days) Route Gib - Tenerife Yacht Nº CA

Passage General

From (Location) Gibraltar (La Linea) 36°09,5'N 005°21,7'W	Date 26.9.2018 06:30	UTC +/- +2 CEST	Ctrl (VHF/~~Cell~~) 12/71 QHM 06/08 CG/Cust (VHF/~~Cell~~) 14 Marina (VHF/~~Cell~~) 09
Towards (Destination) St. Cruz de Tenerife 28°27,3'N 016°19,4'W	Date 3.10.2018 18:00	UTC +/- +1 DST	Ctrl (VHF/Cell) CG/Cust (VHF/Cell) Marina (VHF/~~Cell~~) 09
Master Ralf Zwoenitzer RYA YM offshore ce.	Mate H. Neuber SKS		Crew —

Sunrise (local time)	Sunset (local time)	Moonrise (local time)	Moonset (local time)
Departure 08:12 Arrival 07:59	Departure 20:12 Arrival 19:47	Departure Arrival	~~Departure~~ Arrival

Passage Details

LOA (m)	Draught (m)	Air Draught (m)	Speed (kn)	Misc. Depth sounder reference, etc.
9,5m	1,7	14,2	4	

Distance (nm)	Duration (hh:mm)	Departure (Date / local time)	Arrival (ETA Date / local time)
720	180:00 (7,5d)	26.9.2018 ~~06~~30	03.10.2018 17:30

Comments

Passage Weather

Origin	From (Date/ Time UTC)	~~Visibility~~ Area	Wind (Direction & speed Bft)	Percipitation	Sea (height m)
NAVTEX	26.9.18 00:00	Gibraltar	E 6-7, backing later to NNE 3-4	none	rough moderate
— " —	"	Casablanca	~~N~~E 3-4	none	slight smooth
Predict Wind	"	GC1-GC6	NNE 2-4	showers	slight smooth

Tide Information

Standard Port / Secondary Port	~~H~~W1		_W1		~~H~~W2		_W2	
Gibraltar 26.9.18	Time (lt) 0431	HoT (m)	Time (lt)	HoT (m)	Time (lt) 1645	HoT (m)	Time (lt)	HoT (m)
	Age		MRSp		MRNp			
Gibraltar 27.9.18	Time (lt) 0505	HoT (m)	Time (lt)	HoT (m)	Time (lt) 1719	HoT (m)	Time (lt)	HoT (m)
	Age		MRSp		MRNp			
	Time (lt)	HoT (m)	Time (lt)	HoT (m)	Time (lt)	HoT (m)	Time (lt)	HoT (m)
	Age		MRSp		MRNp			

Tidal Gates

Position	Time Range (lt)	Tidal Range (m / kn)	Favour. / Critical
Gibraltar (La Linea)	26.9. 0630-0730		Fav. leave!
— " —	26.9. 1845-1945		— " —

Date 25.9.18 Master (Signature) _____ Passage Plan Zwoenitzer - V1.5 - Page 1

Image 14 Passage Plan Page 1

Passage Plan (days) Route Gib - Tenerife Yacht MICA

Charts needed

Name / Number	Needed at wp / pos	Content / Area	Scale
NVES3-C6	WP0	Gibraltar to Baie Betoya	350.000
NVES3-C9A	WP0-2	Approach to Gibraltar	40.000
NVES3-C9B	WP2-WP6	Gibraltar	15.000
BA 3138	GC1 - GC6	Gibraltar to Madeira	1.750.000
BA 3139	GC5 - GC11	Casablanca to Islas Canarias	1.750.000
NVATL3-C17	TF1	Canary Islands - Middle	300.000
NVATL3-C17A	TF2	Canary Islands - St. Cruz	75.000

Dangers on route

Name / Waypoint	Position	Description	Avoidance
Gibraltar	Strait	Com. Traffic	Follow WP2→WP6
"	" West	Heavy Sea when leaving Med	Maintain a course of 220°.
Tenerife	NE Hug	Gusts, Cap Effet	Dist > 5 nm.

Harbours of refuge

Name	Available from wp / pos	Position (FWM)	Further Information
Rabat	GC1 - GC3	34°01.7'N 006°49.3'W	Marina
Safi	GC4 - GC5	32°18.9'N 009°15.3'W	Harbour
Agadir	GC6 - GC7	30°24.8'N 009°37.9'W	Harbour
Arrecife	GC8 - GC9	28°57.5'N 013°31.8'W	Marina, Lanzarote

List of lights

Waypoint	Name	Type	Characteristic
Pt. Europe	Gibraltar		Iso W 10s. 18M
Punta Cires	Punta Cires		Fl(3)W 10. 18M
GC1	Tanger Boukhalf		Fl W 12s. 25M
GC3	Rabat		Oc(2)W 6s. 31m 16M
GC4	Casablanca	Tower	UQ(2) W 11s. 80m 17M
GC5	Safi		Oc(4) W 12. 18M
GC7	Agadir		Fl. 3s. 36m 17M
GC9	Punta del Sada (Lanzarote)		Fl W 3s. 12M
GC11	Punta de Anaga (Tenerife)		Fl(2+1)W 30s. 247m 21M
TF2	St. Cruz	Harbour	Fl(3) G 9s. 9M

Checks	Engine	Bilge	Fuel	Water	Electrics	Nav	VHF	Cust.	
Crew									

Date 25.9.18 Master (Signature) _____ Passage Plan Zwoenitzer - V1.5 - Page 2

Image 15 Passage Plan Page 2

Passage Plan (days) Route Gib - Tenerife Yacht NiCA

Route			Leg (to reach WP)		Tidal stream			
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
WP0	From Bahia de Algeciras		255	1,7				
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
				5°W			0630	26.9.
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
WP1	0,9/311° to Punta del Carnero ECM		184	5				
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
				5°W			0745	26.9.
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
WP2	S of Punta del Acebuche		230	3,6		250	1	
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
Punta Marroquí b. 255°				5°W			0830	26.9.
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
WP3	S of Punto Marroquí		250	7,6		260	2	
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
Capo Trafalgar b. 300°				5°W			1030	26.9.
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
WP4	35°59'N 005°45'W		270°	6,9		270	3	
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
Punto Marroquí b. 077°				5°W			1300	26.9.
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
WP5	35°59'N 005°55,6'W		270	8,7		270	2	
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
Cap Spartel bears 178°				5°W			1500	26.9.
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
WP6 GC1	35°48,4'N 006° 01,7'W		220	14		250	1	
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
				5°W			1830	26.9.
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC2	35°14.5'N 007°W		232	(67)		230	0,6	
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
				5°W				
Waypoint / Position (Lat/Lon or Brg/Dist)		CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC3	34°35,2'N 008°W		232	(622)		230	0,6	
Danger / Comment		LW °	TC °	Var°	MC °	SoG kt	ETA lt	
				5°W				
Sum					**Distance through water**			

Date 25.9.18 Master (Signature) _____ Passage Plan Zwoenitzer - V1.5 - Page 3

Image 16 Passage Plan Page 3

Passage Plan (days) Route G's - Tenerife Yacht N°4

Route			Leg (to reach WP)		Tidal stream			
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC4 33°54.8'N 009°W		231	(559)		230	0,6	
Danger / Comment	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC5 33°13.3'N 010°W		231	(491)		230	0,6	
Danger / Comment	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC6 32°30.1'N 011°W		230	(430)		230	0,6	
Danger / Comment	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC7 31°46.8'N 012°W		230	(364)		230	0,6	
Danger / Comment	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC8 31°01.8'N 013°W		229	(297)		230	0,6	
Danger / Comment	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC9 30°15.6'N 014°W		229	(229)		230	0,6	
Danger / Comment	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC10 29°28.2'N 015°W		228	(160)		230	0,6	
Danger / Comment	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
GC11 28° 39.6'N 16°W		227	(90)		230	0,6	
Danger / Comment TSS Tenerife at 28°38,3'N 015°46,6'W	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Waypoint / Position (Lat/Lon or Brg/Dist)	CD m	CoG °	DoG nm	ΔHW	TD (°)	TS (kn)	TW °
TF1 SE of Pd. Antequera		215	10,5		270	1,5	
TF2 St. Cruz de Tenerife		241	8,4				
Danger / Comment 28°27.3'N 016°14.9'W	LW °	TC °	Var° 5°W	MC °	SoG kt	ETA lt	
Sum			**Distance through water**				

Date 25.9.18 Master (Signature) _____ Passage Plan Zwoenitzer - V1.5 - Page 4

Image 17 Passage Plan Page 4

Harbors of refuge in the Atlantic

In opposite to the Mediterranean harbors of refuge in the Atlantic are quite rare. None of them are what we would call a marina but simple harbors for industrial or fishing purpose. So the west coast of Africa might also be omitted. Morocco is one of the more reliable African states, but somewhere in the dessert it might be doubtful if it is a refuge at all. The only real marina might be the one in the capitol city of Rabat.

On the other hand African west coast harbors are often closed in strong W-lys due to swell running into their open entrances. All of this leads to a more westerly course (west of the GC line) to get enough reserve when being pushed back to the coast.

In the very rare case of gales from the east, Madeira will be the only refuge.

Name	Latitude	Longitude	Page	Comment
Funchal	32°38,'N	016°54,4'W		Madeira, Marina
Asilah	35°28,4'N	006°02,1'W		
Larache	35°12,15'N	006°09,3'W		
Rabat	34°01,7'W	006°49,3'W		Morocco, Marina
Casablanca	33°37,1'N	007°35,25'W		
Safi	32°18,9'N	009°15,3'W		
Agadir	30°24,8'N	009°37,9'W		
El Quatia	28°28.35'N	011°21,4'W		
Arrecife	28°57,9'N	013°31,8'W		Lanzarote, Marina

Table 11 shows harbors of refuge in the Atlantic part of the passage.

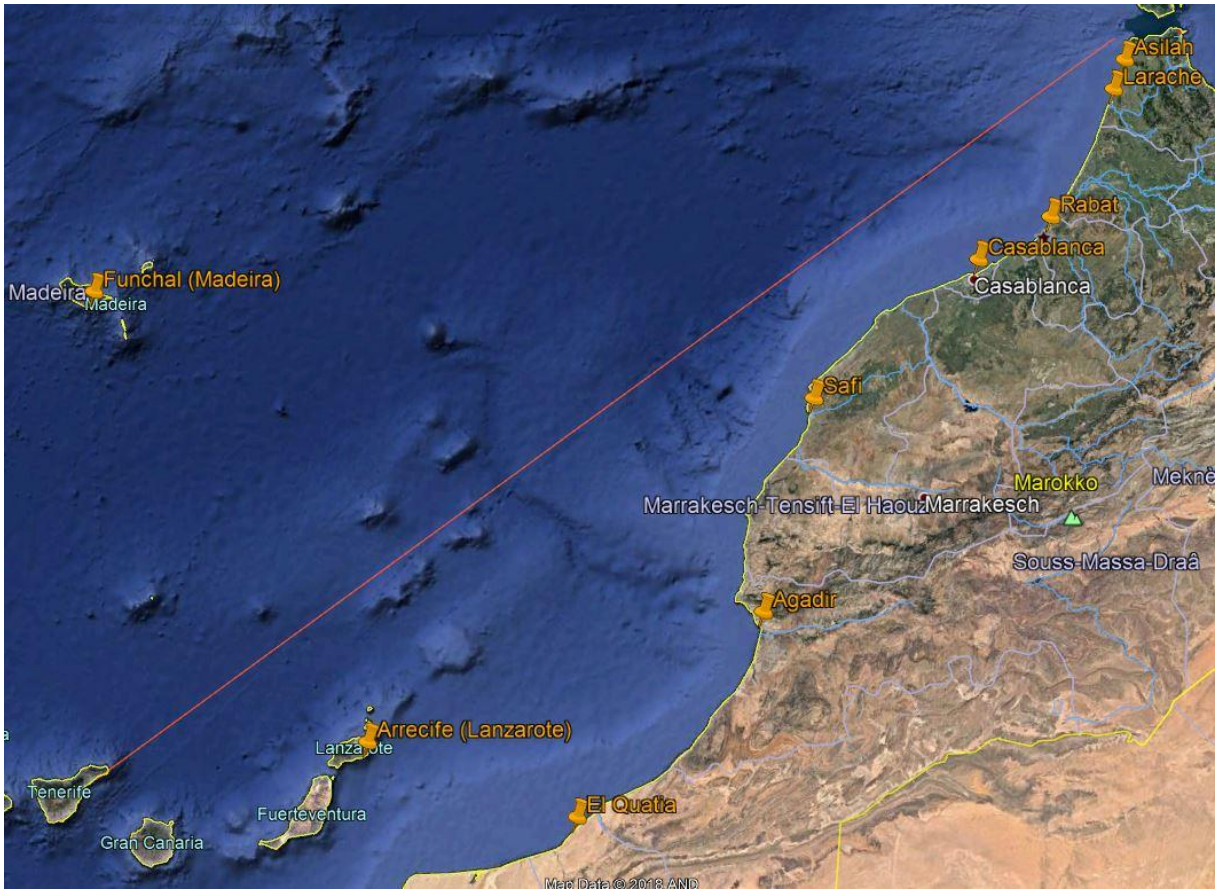


Image 18 Rhumb Line passage through the Atlantic from Gibraltar to Tenerife. Harbors of refuge are shown orange.

List of Lights in the Atlantic

The list of lights at the African coast is just for security reason. The great circle course is the designated route and the passage will try to stay west of this track without any light to be in a visible range.

Name	Latitude	Longitude	Characteristics	Comment
Tanger Boukhalf	35°43,6'N	005°54,9'N	Fl W12s. 25M	Airport
Punta Nadar	35°11,6'N	006°10,1'W	Fl(2)15s.78m 26M	
Kenitra	34°17,5'N	006°36,1'W	Al.Fl(2+1)WG 10s.55m	Airport
Rabat	34°01,9'N	006°50,7'W	Oc(2)6s.31m 16M	
Casablanca 1	33°36,3'N	007°34,75'W	Oc.WR 4s.16/12M	
Casablanca 2	33°33,8'N	007°39,6'W	UQ(2)11s.80m 17M	
Pointe d'Azemmour	33°20,5'N	008°18,2'W	Fl(2)WR 6s.15/11M	
El Jorf Lasfar	33°09,7'N	008°37,7'W	Fl(3)12s.31m 15M	
Beddouza	32°32,4'N	009°16,9'W	Fl(2)10s.65m 22M	
Pointe de la Tour	32°19,85'N	009°16,6'W	Oc(4)W 12s.18M	

Table 12 shows the list of lights in the Atlantic for the first half from Gibraltar to Safi.

Image 19 List of lights in the Atlantic for the first part from Gibraltar to Safi.

Name	Latitude	Longitude	Characteristics	Comment

Cap Hadid	31°41,8'N	009°40,3'W	Fl(2)15s.48m 20M	
Essaouira	31°30,4'N	009°46,5'W	Q.W.12M	
Cap Sim	31°23,8'N	009°49,8'W	Fl(3)15s.103m 21M	
Cap Rhir	30°37,8'N	009°52,9'W	Fl 5s.85m 22M	
Inezgane	30°22,9'N	009°33,35'W	Fl 3s.36m 17M	
Cap d'Aglou	29°40,0'N	009°58,1'W	Fl(2+1)12s.53m 20M	
Bajo Vigia (Sidi fini)	29°22,9'N	010°10,6'W	Fl(3+1)W 25M	
Cap Draa	28°40,5'N	011°07,5'W	Fl(2)12s.87m 25M	
Cabo Nachtigal	28°29,6'N	011°20,5'W	Fl W5s.15M	

Table 13 shows the list of lights in the Atlantic for the second half from Safi to Tenerife.

Name	Latitude	Longitude	Characteristics	Comment
Punta Delgada	29°24,2'N	013°29,3'W	Fl W3s.12M	Alegranza
Faro de Martino	28°45,9'N	013°48,9'W	Fl(2)W15s.14M	Isla de Lobos
La Isleta	28°10,5'N	015°25,15'W	Fl(3+1)120s.249m 31M	Gran Canaria
Punta de Anaga	28°34,9'N	016°08,4'W	Fl(2+4)30s.247m 21M	Tenerife
St. Cruz	28°28,0'N	016°14,5'W	Q(3)10s.9m 5M	Tenerife

Table 14 shows the list of lights in the Canary Islands.

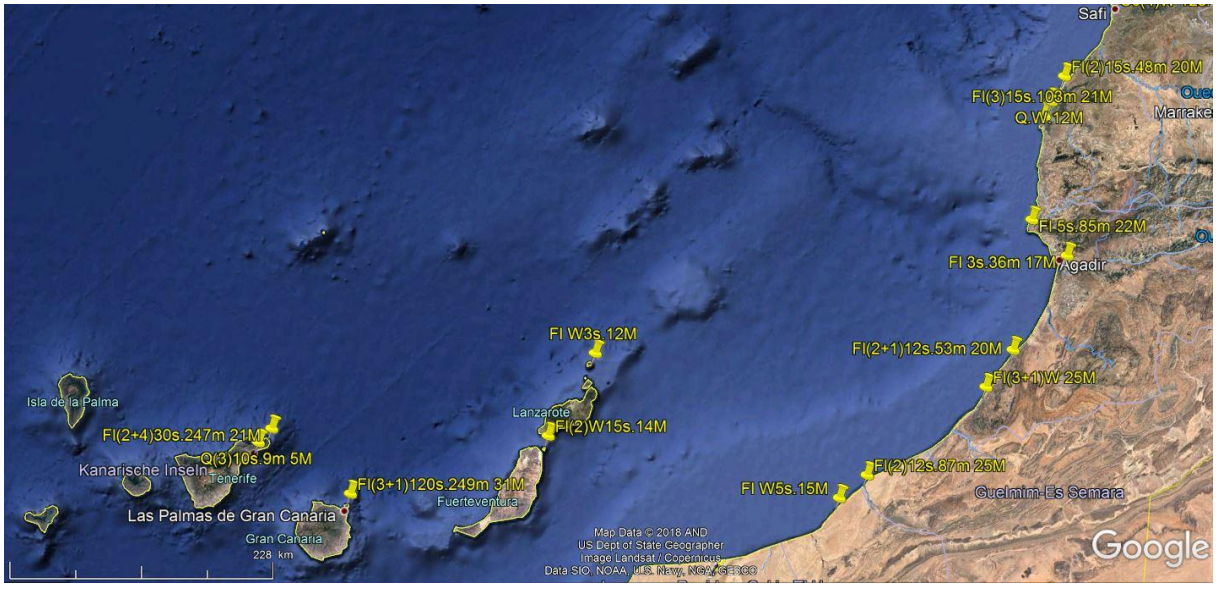


Image 20 List of lights in the Atlantic for the second half from Safi to Tenerife.

Visibility of the lights from the African Coast

To estimate the visibility of lights at the African coast, Casablanca 2 is used since it is the highest light in Morocco:

Visibility = 1,93 * (sqrt(Height of Object [m]) + sqrt(Height of Eyes [m]))

Example Casablanca 2: HoE 2,5m HoO 80m Visibility 20nm Range 17nm

This proofs clearly that none of the lights will be visible on the planned track. Time to reach their ranges could be estimated to 7 to 8 hours on a direct way towards the coast.

Piloting into Santa Cruz de Tenerife

- Time zone in Tenerife UT-00 (WET), subtract 0h from local Standard Time for UTC
- Zonetime is UTC+0, add 0h to UTC for local Standard Time.
- Up to end of October DST is effective with UTC+1 (WEST).

All tables are given in ZT (UTC+0), so add 1h for local DST.

Obviously it would be a good idea to establish UTC+1 as board time as soon as Gibraltar disappears in the back.

The piloting into Tenerife starts at the NW corner of the TSS between Tenerife and Cran Canaria. The WP is at 28°38,3'N 015°46,6'W and bears 260° to Fl(2+4) Punta de Anaga in 20nm distance. Punta de Antequera is in 20nm distance at 070°.

From Tenerife TSS a course of 256° leads within 28nm to the harbor entrance of St Cruz. This marina is a good place for landfall, since it is within walking distance to the pubs and bars of St. Cruz downtown. It is easy to access, well-marked and there are no obstructions that one might not be aware of after 8 days on the water.

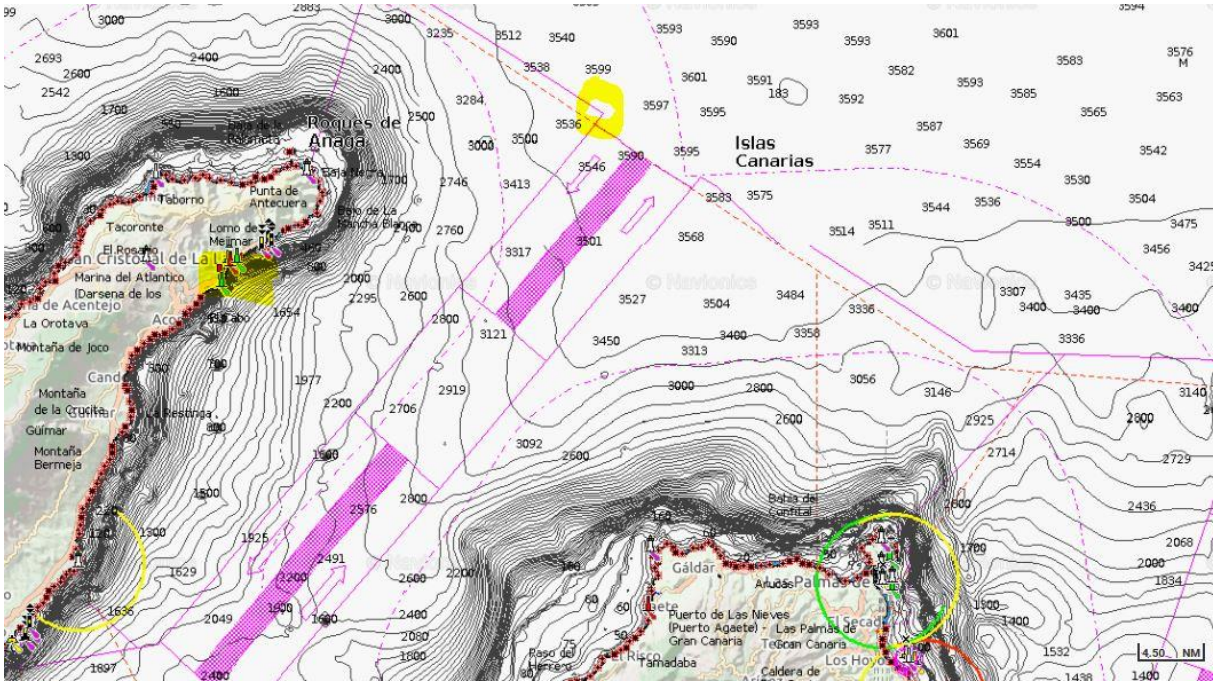


Image 21 Map view shows the NW corner of the TSS (WP Tenerife TSS), marked yellow, from where a course of 256° leads after 28nm to the entrance of St. Cruz. Do always maintain a course greater than 225° from Tenerife TSS to not enter the TSS accidently.

Image 22 Image shows the main approach to St. Cruz beginning at Tenerife TSS with the light of Punta de Anaga Fl(2+4) bearing 260° in 20nm and at day Punta de Antequera in 070° also within 20nm. It shall be at beam stb after 20,5nm on the way to St. Cruz.

Cran Canaria in the bottom right corner will be too far away for terrestrial navigation.

Image 23 Image shows the entrance to St. Cruz Marina at the upper right end of the main harbor (marked yellow).

At night the ECM on the mole reaches 5nm and should be a clear mark. At the upper end, the long moles of three commercial harbors can be seen. The final piloting shall reflect the danger of misleading, especially at night this will be a chain of lights in front of the urban illumination.

Night Approach

For a night approach major lights (3M range and more) and local lights are shown here.

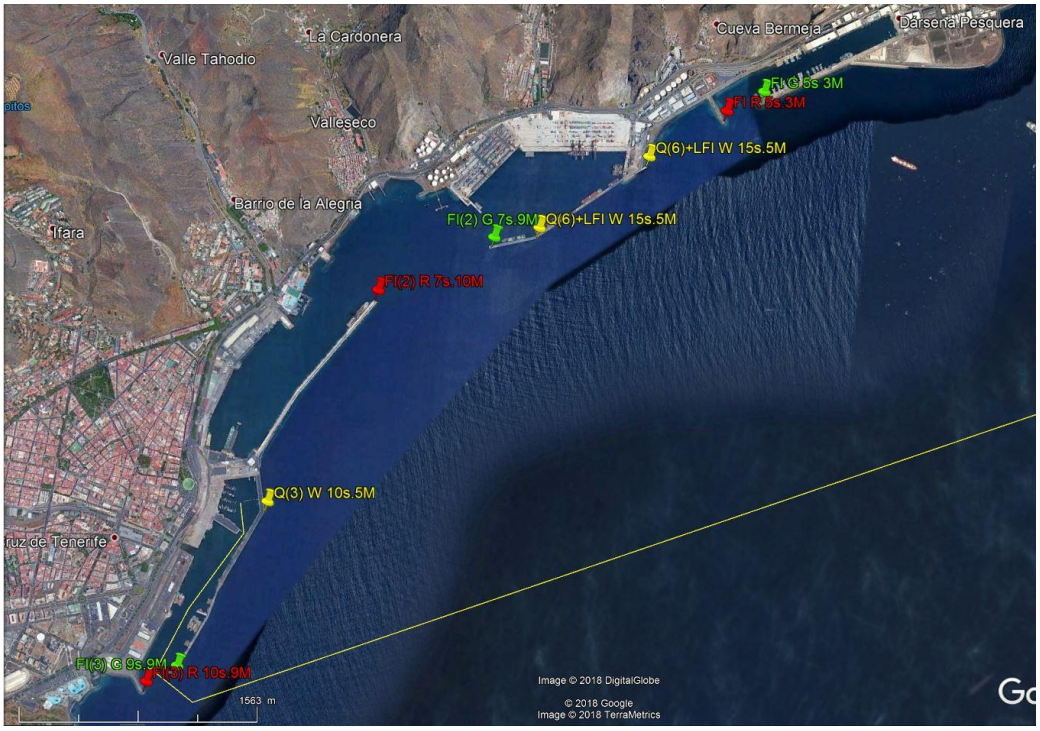


Image 24 shows the complete harbor of St. Cruz de Tenerife.

Shown are major lights only: Upper right corner *Darsena Pesquera* (maybe an option for landfall), upper middle the *container terminal* (not an option at all) with two SCM on its mole, middle left the *Marina Del Real Club Nautico* (members only, maybe at the fuel station) and bottom left our destination *Marina Santa Cruz*.

Image 25 shows all local lights for the approach to the marina.

Care must be taken not to confuse local lights, major lights and urban illumination. In case of uncertainty anchorage is allowed outside the complete mole until daylight.

Image 26 Local lights inside the big northern basin (for orientation only), no arrival planned here.

Dawn and Dusk at Tenerife

Arrival at Tenerife is scheduled for the 03.10.2018. Latitude of St. Cruz is 28°N.

This table was changed from 29.8. to 03.10. with V2.0 for the new plan. Source was https://www.timeanddate.com/sun/spain/santa-cruz?month=10&year=2018.

UTC	Nautical	Civil	Sunrise	Sunset	Civil	Nautical
02.10.2018	06:07	06:34	06:58	18:49	19:13	19:40
03.10.2018	06:07	06:35	06:59	18:48	19:12	19:39
04.10.2018	06:08	06:35	06:59	18:47	19:11	19:38

Table 15 Twilights in St. Cruz de Tenerife.

Table shows the nautical and civil twilight at dawn and dusk as well as sunrise and sunset for the three days expected to be of interest for Tenerife. As in Gibraltar, there is not much change in October at Lat 28°N. Times are not in local time, add 1h to get DST (WEST).

Documentation

This section will cover copies of the logbook, maps, sketches and other documentation like celestial navigation forms. All of this is given to compare the reality to the plan and to proof correctness of all data regarding the passage.

The chapter is organized with the 7 days sailed and shows the log together with recorded tracks. Log was filled in German, important facts will be translated as far as needed. The tracks were recorded with a GPS and besides joining and deleting empty values they are original without any editing.

In addition to those two images, an extract of the sea maps with the dead reckoning and all filled in forms used for celestial navigation are appended and commented.

Summary

Day	Date	Hours	Min Distance from Land	Distance over Ground	Sum
1	26.09.2018	16,5	0nm	103nm	103nm
2	27.09.2018	24	45nm	120nm	223nm
3	28.09.2018	24	41nm	102nm	325nm
4	29.09.2018	24	65nm	103nm	428nm
5	30.09.2018	24	101nm	130nm	558nm
6	01.10.2018	24	51nm	126nm	684nm
7	02.10.2018	18	0nm	86nm	770nm

Table 16 shows the hours and distances run each day.

All celestial sights were used within fixes and compared to their real positions at the time of observation. The sight reductions were calculated with a scientific calculator, however for comparison and to show the ability, the last three fixes were also looked up in the Pub.249 tables and compared to the calculated values.

Day . Sight	Fix	Sight	Position Error
2.1	Compass bearing at true sunrise		0°
2.2 →2.3	27.9. Fix1223	Sun-Run-LAN	10,2nm / 206°
2.3 →2.4	27.9. Fix1604	LAN-Run-Sun	3nm / 056°
2.5	Compass bearing at true sunset		2°E
2.6	27.9. Lat1905	Polaris	17,1’
3.1 →3.2	28.9. Fix1225	Sun-Run-LAN	22nm / 069°
3.2 →3.3	28.9. Fix1454	LAN-Run-Sun	2nm / 087°
4.1 →4.2	29.9. Fix1419	LAN-Run-Sun (with linear interpolation)	6nm / 054°
5.1 →5.2 → 5.3	30.9. Fix1103	Sun-Run-Moon-Run-Sun (with circular interpolation)	5,3nm / 029°
6.1	1.10. Fix0622	Star & Moon (calculated & Pub.249)	3,5nm / 283°
6.2	Compass bearing at true sunset		1°E
6.3	1.10.	Evening stars	Clouds
7.0	2.10.	Morning stars	Clouds
7.1	2.10. Fix1000	Sun & Moon (calculated & Pub.249)	3,6nm / 216°

7.2	2.10. Fix1139	Sun & Moon (calculated & Pub.249)	4,6nm / 259°

Table 17 shows an overview of all celestial sights taken during the passage.

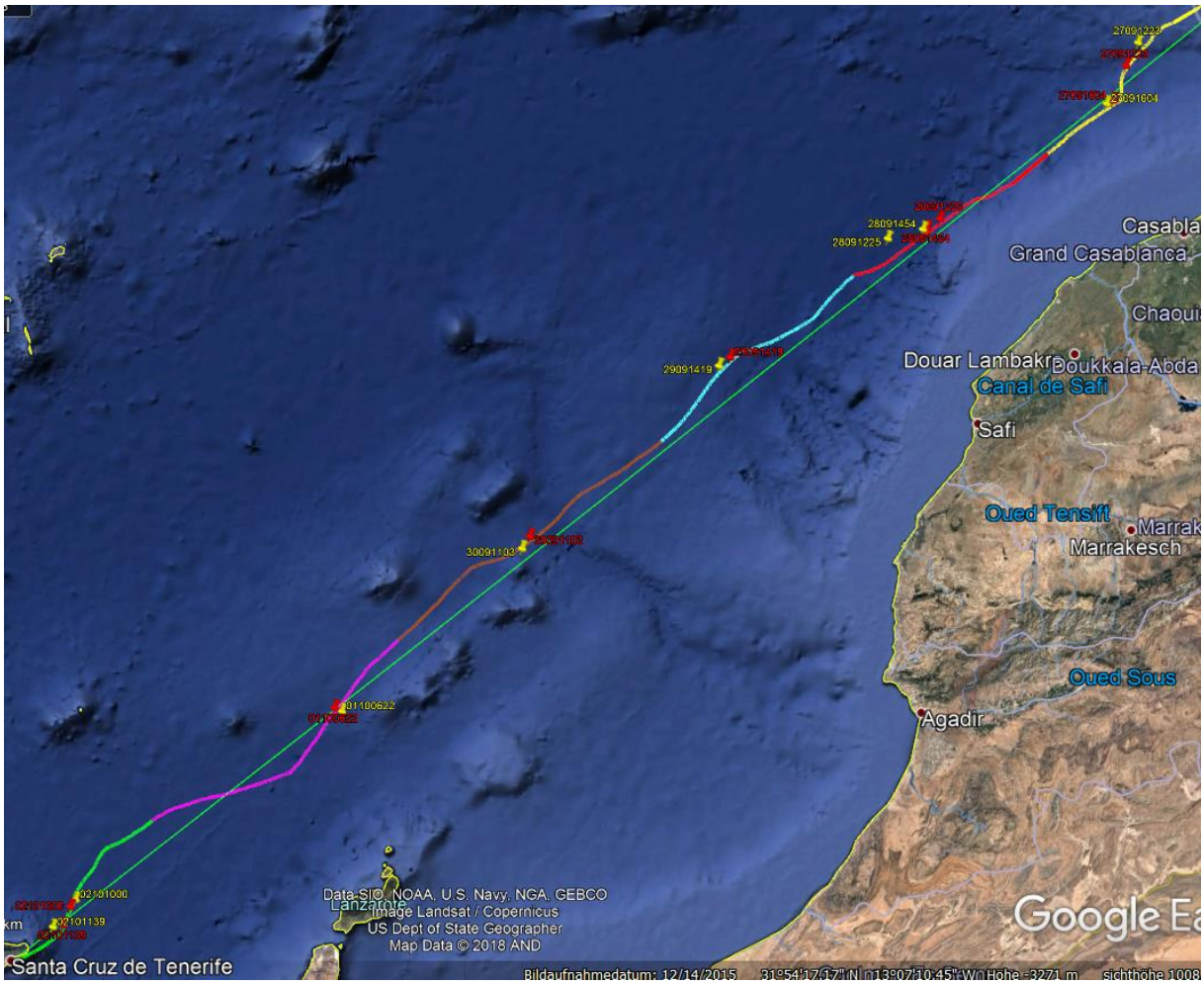


Image 27 showing the complete track from day 2 to day 7 with celestial fixes (yellow) and the according real positions (red).

Day 1 – 26.09.2018

Day 1 Log

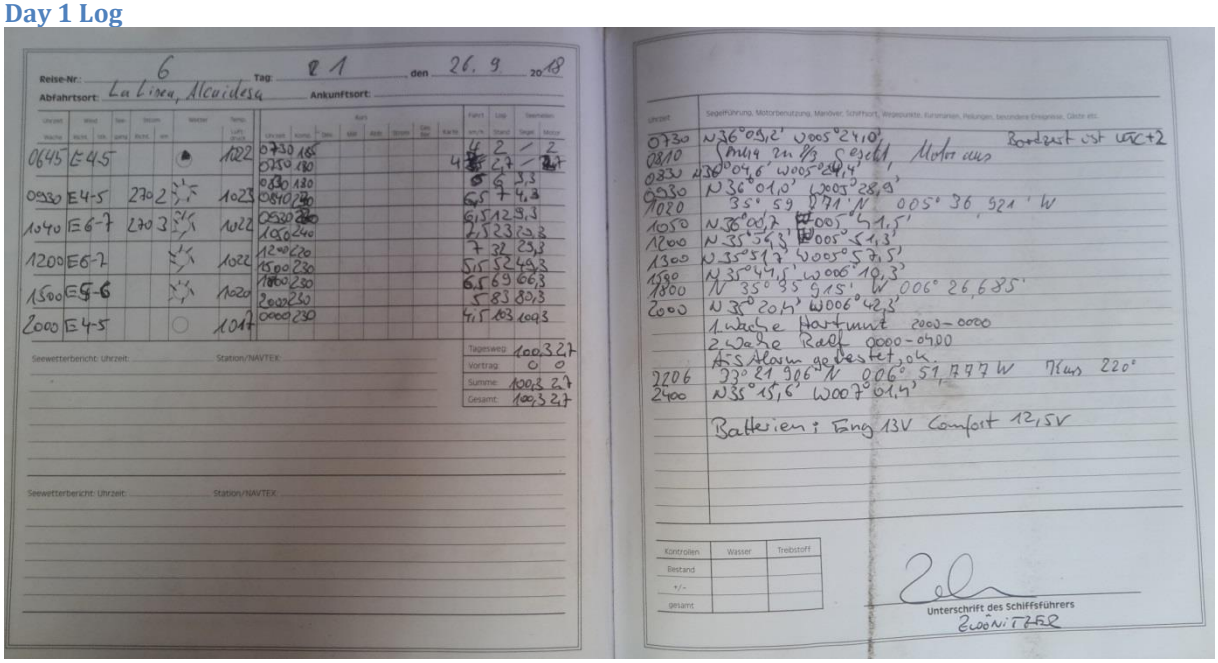


Image 28 Logbook pages 26. September 2018.

Log of day 1: *0730* Boardtime is set to UTC+2 (UT-02), departure, *0810* Headsail 70% out, Engine stop, *2000* 4 hour watch system established, 1.Watch Hartmut, 2. Watch Ralf, AIS Alarm successfully tested (30 minutes before CPA and within 2 nm), *2400* Battery Voltage: Engine 13V Service 12,5V.

Weather forecast was dry but very windy. In the Strait of Gibraltar there were 35-40 kts wind from aft increasing to 45kt in gusts. We passed under a head sail in 3rd reef with 7kt SoG, which is rather fast for Nica. The current set exactly as calculated and so we reached WP6 in record time four hours earlier than estimated (1415BT instead of 1830BT).

The sea was moderate later rough around Capo Tarifa. Crossing seas produce unpleasant waves when entering the Atlantic from the Mediterranean. Everything came from aft, so even with head sail Nica was pushed from one side to the other and we started shifting through the strait to avoid running. Crossing the area between the two major TSS was no problem due to AIS information. Traffic was not very dense but passing at slow speed for hours between chains of metal mountains is like the old arcade game frogger.

Image 29 Leaving Gibraltar shows clearly, why the clouds are moving over the top of the hill.

Day 1 Track

Image 30 Route planned (yellow) and real track (green) out of Gibraltar. WP6 is identical with the first waypoint GC1 on the passage route.

Image 31 Route planned (green thin) and real track (green thick) of day 1. Etmal was 103nm (in 17,5 hours!), distance between GC1 and GC2 is 55nm, max XTE 2,4nm.

Day 1 Navigation

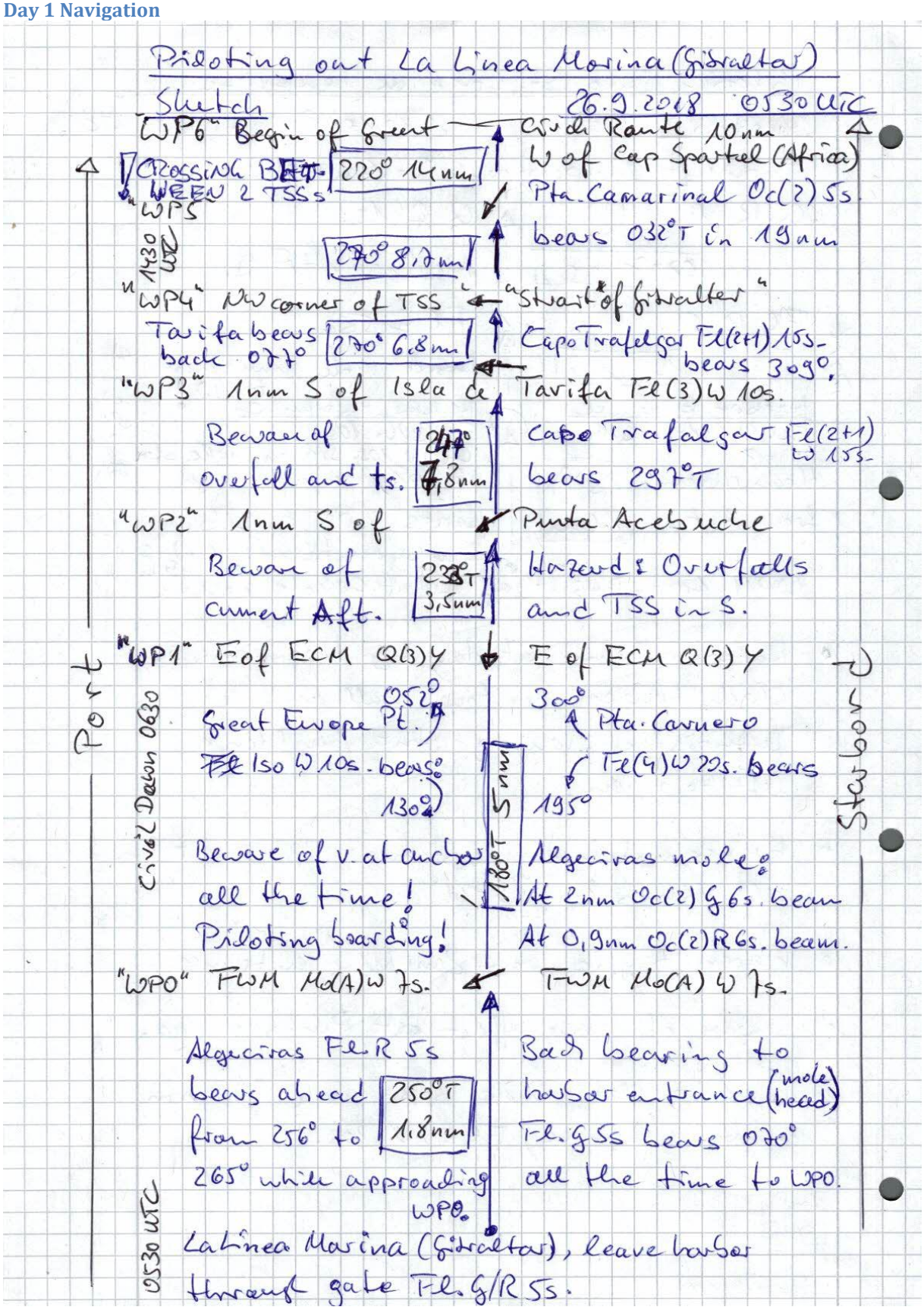


Image 32 Piloting sketch used out of Gibraltar.

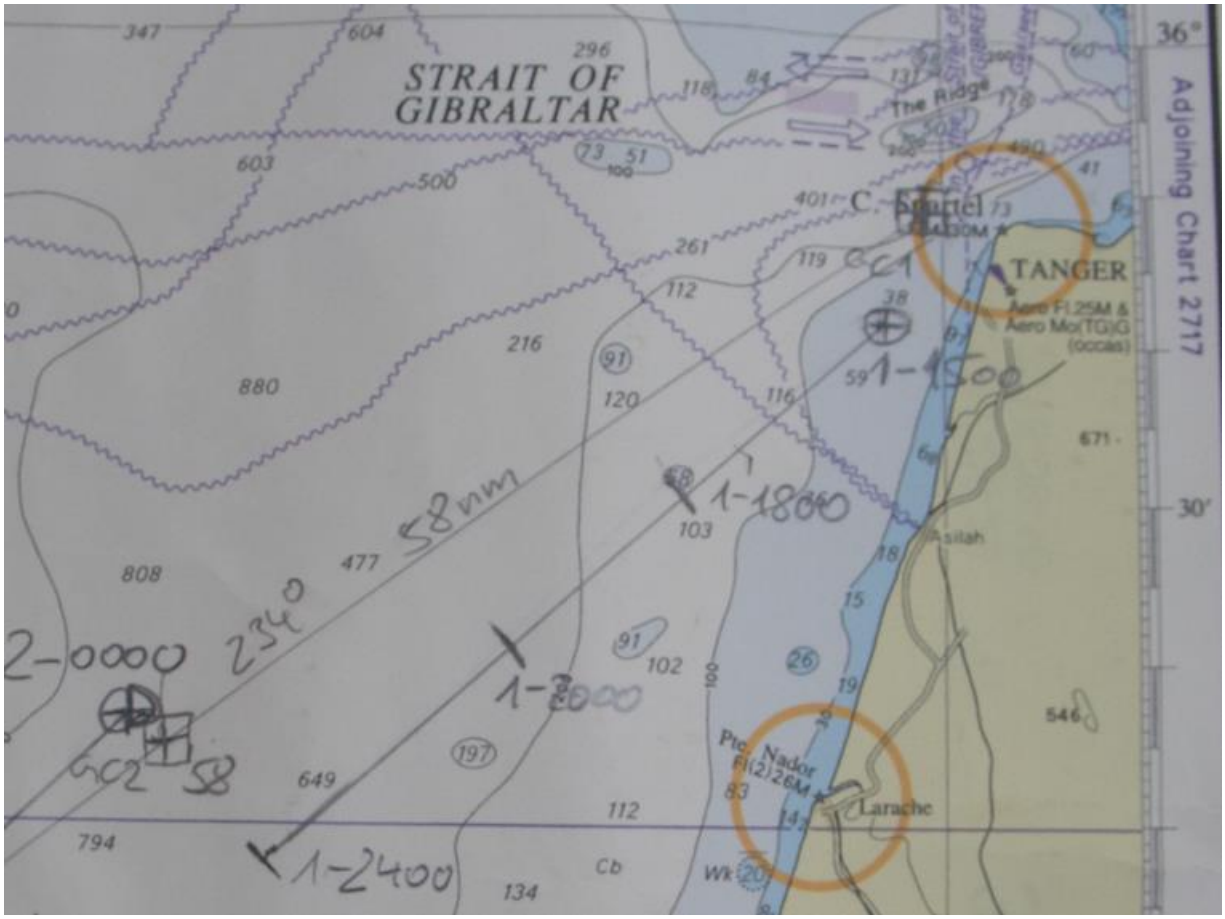


Image 33 Dead reckoning of day 1 starting at 1-1500 BT after passing the strait of Gibraltar.

Day 2 – 27.09.2018

Day 2 Log

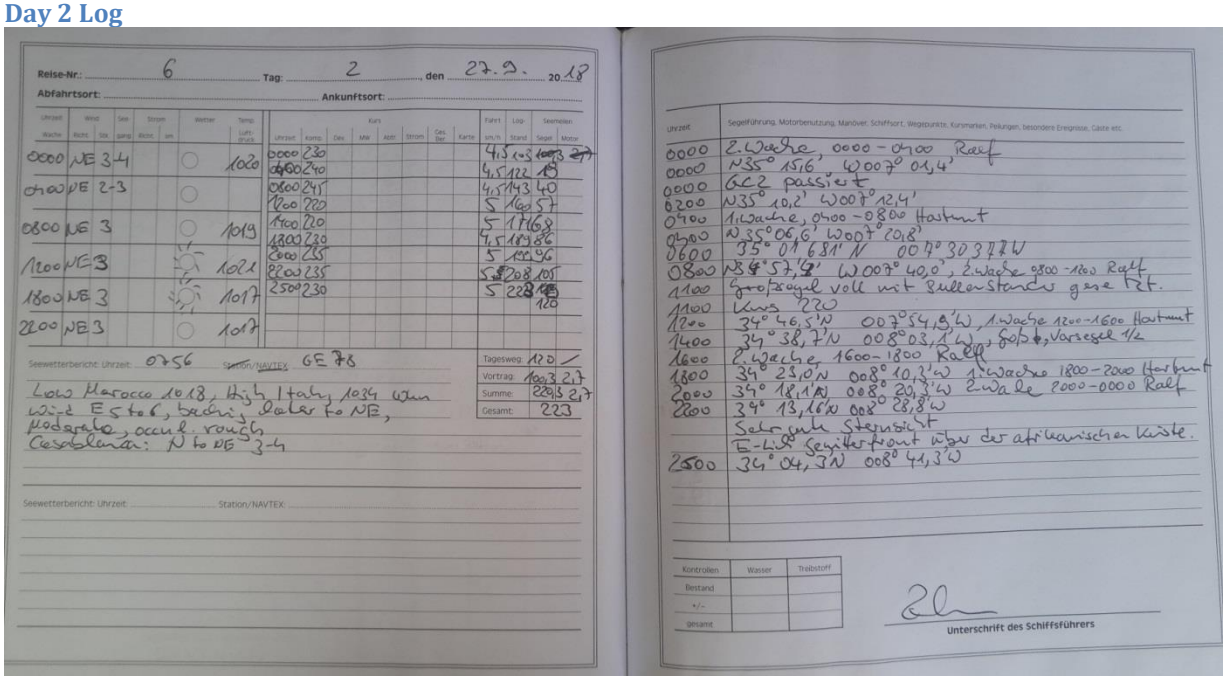


Image 34 Logbook pages 27. September 2018.

Log of day 2: *0000* Passed waypoint GC2, *1100* set mainsail with preventer, *2200* very good sight to the stars, at night lightning in the east over the African coast. *2500* 2. watch extended by one our due to change of board time to UTC+1.

Day 2 Track

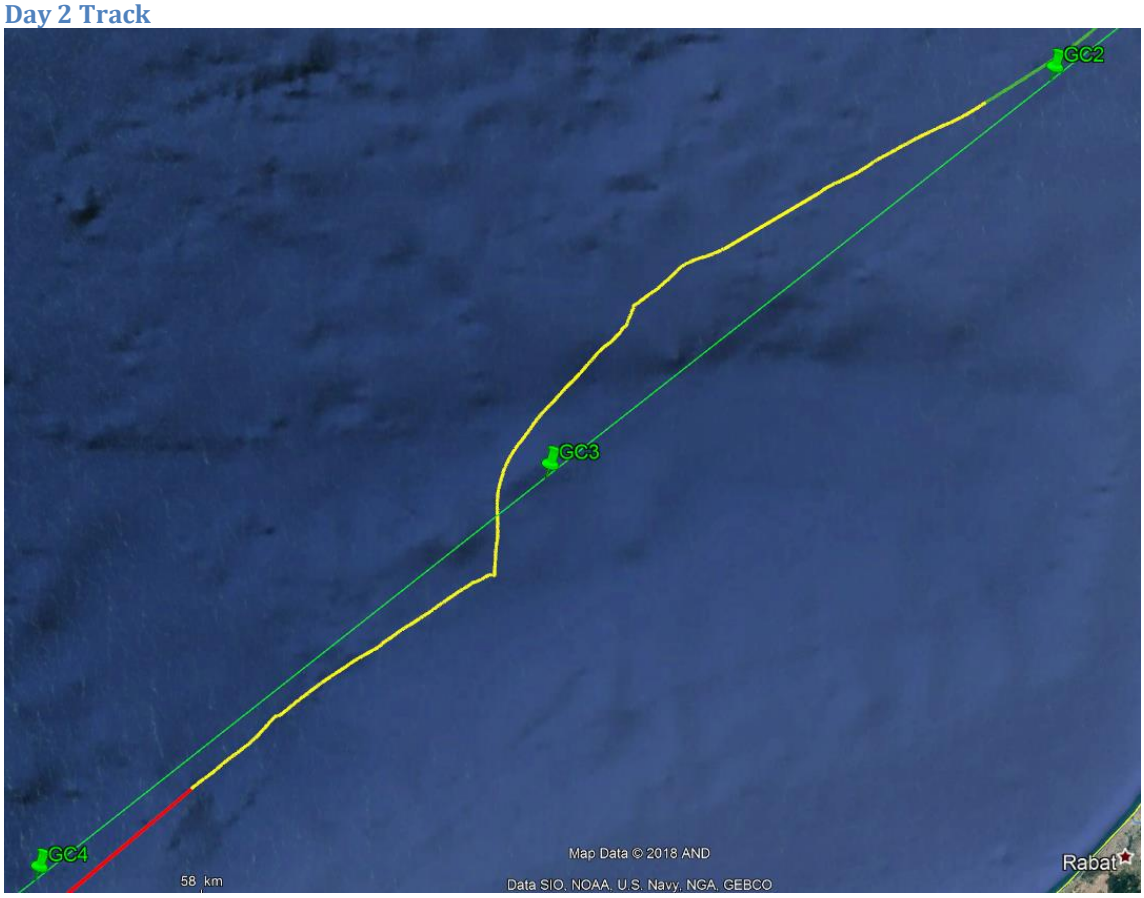


Image 35 Route planned (green) and real track (yellow) of day 2. Etmal was 120nm, distance between GC2 and GC3 is 63nm, max XTE 7,8nm.

Image 36 Dead reckoning of day 2 started at fix 2-0000 with a fix at 1704BT (1604 UTC)

Day 2 Navigation

At day 2 we started sights of celestial navigation. I will discuss the overall results at the end.

Image 37 Celestial navigation at Nica is sophisticated even with “no waves”.

Celestial navigation at Nica is not simple at all. She rolls heavily in any wave and leaning on the main sheet is somehow the only way to not lose the body out of the field of view. The simple sextant Mark15 is another reason for nasty words and major inaccuracy. This will also be a subject to discuss at the end.

2.1) Compass bearing at true sunrise

Since the ships compass is a build in the wall model and without a pelorus, no bearing was possible. So the handbearing compass and the build in one in the Steiner glasses will be checked.

Position 34°56,9’N 007°41,3’W

Sunrise 0551 UTC
λiT 003045
Local 062145 UTC

Sight taken at true sunrise **0626UTC** MC = 235°
Handbearing compass: bearing measured MB = 098°

2.1.a) Simplified version of true sunrise/sunset

1. Az = arccos(sin δ / cos φ)
2. Main direction of Az is from declination
3. Sub direction is E at sunrise and W at sunset.

δ = 01° 37,4’S Unt = 1,0’S
Vb = + 0,4’
δ = 01° 37,8’S

Az = arccos(sin(01°37,8’) / cos(35°)) = S86,8°E = 180° - 86,8° = 93,2°

AZ 93° MB + Dev + Var = Az Dev = Az – Var – MB = 93 + 5 – 98 = 0° = 0°

2.1.b) Standard calculation of Az

See “True Sunrise” in column 1 of form “General Sight Redution” today: Az = 92°

MB + Dev + Var = Az Dev = Az – Var – MB = 92 + 5 – 98 = -1° = 1°W

2.2) SunSight LL

101419UTC DR-Pos: 34°45,6’N 007°55,9’W IE -24,3’ Log 161 TC 220° Hs 42°54,2’

See “Sun LL” in column 2 of form “General Sight Reduction” today: Az 133,7° 2,9’ A

2.3) Meridian Passage LL

DR-Pos: 34°36,4’N 008°05,3’W

See “Celestial Day Form” today for all values: 122315 UTC Hs 53°39,8’

See “LAN (Sun)” in column 1 of form “Special Sight Reduction” today: φ_{1223} = 34°46,6’N
(The owner informed me, this differs from real latitude by nearly 10 nm, there must be a reason for this error.)

Fix_{1223} from Sun-Run-LAN plotted in form “Celestial Plotting Form B” today:
Fix_{1223}: 34°46,6’N 007°58,1’W
Pos_{1223} 34°37,2’N 008°04,3’W
The owner informed me about the difference of 10,2nm / 206°, as could be expected by the LAN error, obviously there is room for improvement. The error might be resulting from the mistake made at the LAN at 1223, but all calculations were correct. It must be something with measurement of height. When I continued with the next Sun LL at 1604, a massive difference in the IE could be observed (> 10’). There seems to a systematic mistake. So I reduced the IE of the LAN_{1223} and repeated the calculation, ending up with much better result of 34°36,5’N (0,7’ from the real altitude instead of 10’). So I continued with this corrected LAN_{1223} and decided to keep this in mind. For future measurements I should control IE before and after the sights.

2.4) SunSight LL

160425UTC E-Pos: 34°24,1’N 008°17,9’W IE -7,5’ Log 189 TC 230° Hs 26°56,8’

See “Sun LL” in column 3 of form “General Sight Reduction” today: Az 246,9° 1,9’ A

Fix_{1604} from LAN-Run-Sun plotted in form “Celestial Plotting Form B” today:
Fix_{1604}: 34°21,9’N 008°14,0’W
Pos_{1604} 34°23,6’N 008°10,7’W
This was a difference of 3nm / 056°, we took it as a new fix for BT 1704

2.5) Compass bearing at true sunset

DR-Pos. 34°20’N 008°21,0’W

Sunset 1751 LMT
λiT 003324
Local 182424 UTC

Sight taken at true sunset **1816UTC** MC = 235°
Classes compass, bearing measured MB = 271°

2.5.a) Simplified version of true sunrise/sunset only

δ = 01° 49,1’S Unt = 1,0’S
Vb = + 0,3’
δ = 01° 49,4’S

Az = arccos(sin(01°49,4’) / cos(34°)) = S87,8°W = 180° + 87,8° = 267,8°

AZ 268° MB + Dev + Var = Az Dev = Az – Var – MB = 268 + 5 – 271 = +2° = 2°E

2.6) Polaris

Polaris sight was not used in a fix. The height from the nautical almanac was calculated backward to the expected height at the sextant for comparison with the real height measured.

UTC 190540 DR-Position 34°15,6'N 008°25,0'W Log =194 Az = 0,7° Ho = 33°55,7'

GHA_{Aries}	= 291°30,9'
Incr.	= + 1°25,2'
DRλ.	= - 8°26,0'
LHA_{Aries}	= 284°30,1'

a0	= 1°18,7'
a1	= 0,5'
a2	= 0,9'
aX	= 1°20,1'

φ = Ho -1° + aX
34°15,6' = Ho -1° + 1°20,1'
Ho = 34°15,6' + 1°- 1°20,1' = 33°55,5'

Hs	= 33°59,7' ← This is expected at the sextant…
IE	= 0,0'
Dib	= - 2,8'
Ha	= 33°56,9'
Corr.	= - 1,4'
Ho	= 33°55,5' ← This is the Ho calculated in the last step.

The index error was eliminated by adjusting the horizon mirror.

Hs expected to find Polaris = 33°59,7'
Hs sighted = 33°42,6'

This is again a difference of 17,1', resulting from the inaccurate measurement. The telescope could not be used, because the body disappears out of the small field of view due to the rolling boat. Without the magnification, the small dot could not be placed appropriately on the horizon. I will try again stars, as soon as the waves and clouds will allow me to do.

Celestial Day Form Route GS-Tenerife Date 27.9.2018 Day 2

Time Sync | Error[sec] | ZD (+/- UTC)

	DR-λ 7°41,3'W	Nautical	Dawn Twilight	Civil	Sunrise	Moonrise
Morning	LMT				0551	
	λiT				003045	
	GMT				062145	
Aries	GHA					
	incr.					
	λ					
	LHA					

Morning Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#/IE	WT	Hs	Log
	SUN LL				-24,3'	101419	42°54,2'	161(220°)

LAN Results	DR-λ 8°03,7'W	Meridian Passage	#	WT	Hs	Log
	LMT	1151		121715	53°37,8'	
	λiT	003215		121915	53°38,7'	
	GMT	122315 (142315 BST)		122415	53°39,2'	
	IE	-22,5'		122315	53°39,8'	173
	WT	122315		122515	53°39,1'	
	Hs	53°39,8'		122715	53°38,6'	
	Log	173 (TC 220°)		122915	53°37,6'	

Evening	DR-λ 8°21,0'W	Moonset	Sunset	Civil Dusk Twilight	Nautical
	LMT		1751	1817	1846
	λiT		003324	003324	003324
	GMT		182424	185024	191924
Aries	GHA		276°28,4'	276°28,4'	291°30,9
	incr.		6°07,0'	12°44,6'	7°33,5
	λ		-8°21,0'	-8°21,0'	-8°21,0'
	LHA		274°14,4'	280°52,0'	290°43,4'

Evening Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#/IE	WT	Hs	Log
	SUN LL		?		-7,5'	160425	26°56,3'	189(220°)
	~~Polaris~~		~~33°58,1'~~	~~0,7°~~				
	Polaris		33°59,7'	0,7°	0,0'	190540		194(230°)

Celestial Day Form – Whole Day Sights – V 1.0 - © R. Zwönitzer – www.zwoenitzer.de

Celestial Day Form containing all observations of the day.

	General Sight Reduction	Route G-S-Tenerife	Day 2	
	Body	True Sunrise	SUN LL	SUN LL
Run	Course °			220°
	SoG [kt]			
	Log / Dist [nm]			16
DR	$\Delta\varphi$ = cos(C) * D			-12,3'
	$\Delta\lambda$ = sin(C) * D / cos(φ)			+12,6'
	Lat φ	34°56,9'N	34°45,6'N	34°24,1'N
	Lon λ	007°41,3'W	007°55,9'W	008°17,9'W
Date/Time	**Watch** Err ZD			
	UTC	06 26 24	10 14 19	16 04 25
	Date	27.09.18	27.9.18	27.9.18
Local Hour Angel	**GHA_{body} / $_{Aries}$**	272°14,1'	332°14,9'	62°16,2'
	incr. (m.s.)	6°36,0'	3°34,8'	1°06,3'
	addtl. (v/quant) or SHA_{Star}			
	GHA	278°50,1'	335°49,7'	63°22,5'
	DR λ / a-lon $_{229/249}$	-7°41,3'	-7°55,9'	-8°17,9'
	LHA_{body} / $_{Aries}$	271°08,8'	327°53,8'	55°04,6'
Declination	**Declination** δ (h)	01°37,4'S	01°41,3'S	01°47,1'S
	incr. (d / quant)	+0,4' +1,0	+0,2' +1,5	+0,1' +1,0
	δ	01°37,8'S	01°41,5'S	01°47,2'S
Sextant	**Sextant** Hs		42°54,2'	26°56,8'
	IE (+ off / - on)		-2,3'	-2,5'
	Dib (HE = 2,5 ft / m)		-2,8'	-2,8
	Ha		42°27,1'	26°46,0'
	Corr. all sights		+14,9'	+14,1'
	addtl.(UL moon -30') / HP			
T	Ho		42°42,0'	27°00,1'
	(Hc_{tab} / d / quant) $_{229/249}$			
A	Hc		42°44,9'	27°02,0'
	Δh (Ho-Hc) a =	T A	2,9' T A	1,9' T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA		LHA < 180°	LHA >= 180°
	$\tan Az_r$ = sin LHA / (sin φ * cos LHA – tan δ * cos φ)		< 0 $Az=Az_r+360°$ else $Az=Az_r+180°$	< 0 $Az=Az_r+180°$ else $Az=Az_r$
	Azimut Az	-88+180 = 92°	133,7°	246,9°
	Position Error	**Course** °	**Distance** nm	
	DR φ =		λ =	
	$\Delta\varphi$ =		$\Delta\lambda$ =	
	DR φ =		**λ =**	

Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains all three general sight reductions needed today.

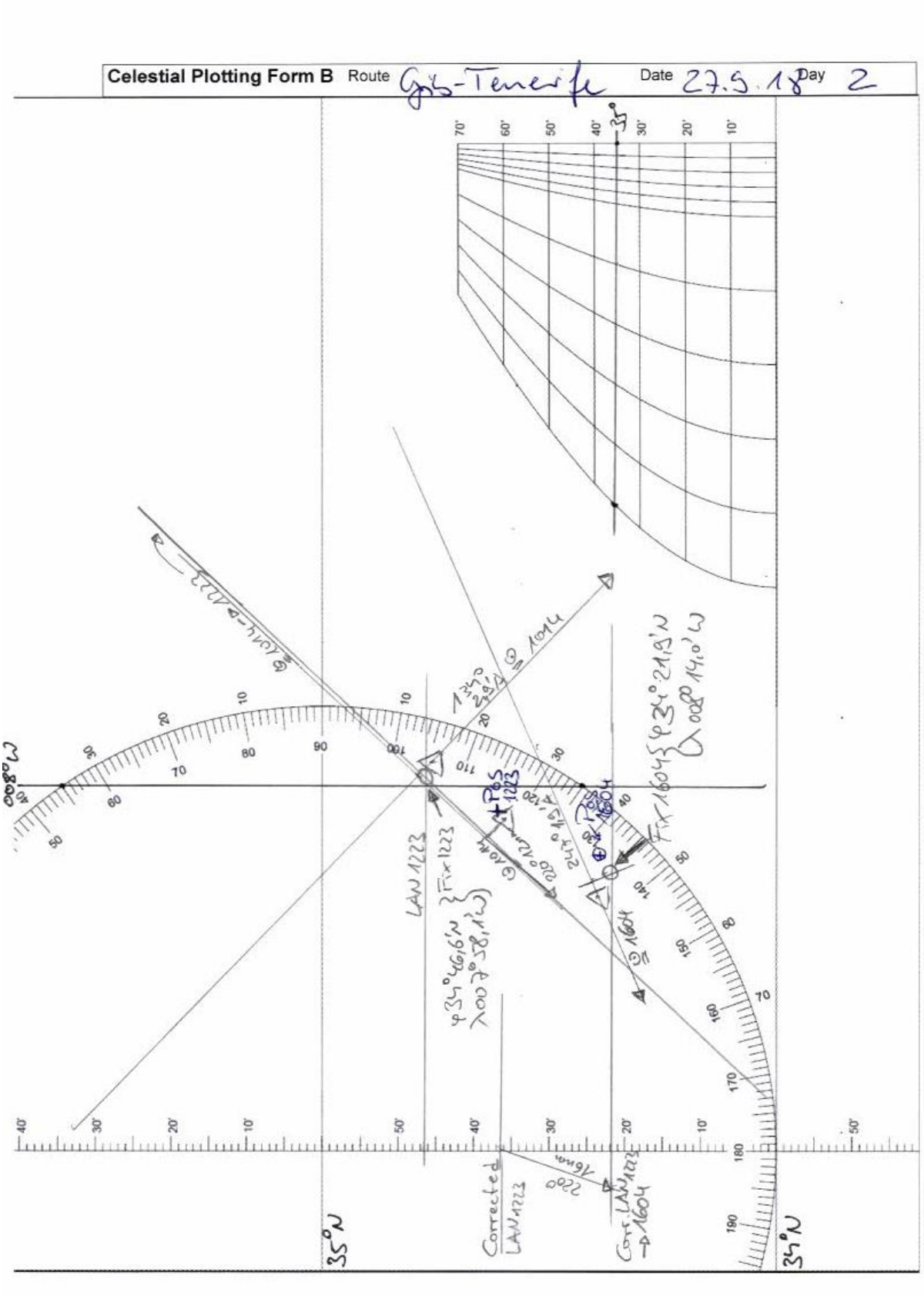
	Special Sight Reduction	Route GC-Tenerife		Day 2
	Body	**LAN (Sun)**	**Body**	**Polaris**
Run	Course °	220°	Course °	
	SoG [kn]		SoG [kn]	
	Log / Dist [nm]	12	**Log / Dist** [nm]	
DR	$\Delta\varphi$ = cos(C) * D	−9,2'	$\Delta\varphi$ = cos(C) * D	
	$\Delta\lambda$ = sin(C) * D / cos(φ)	+9,4'	$\Delta\lambda$ = sin(C) * D * cos(φ)	34°15,6'N
	Lat φ	34°36,4'N	**Lat φ**	008°25,0'W
	Lon λ	008°05,3'W	**Lon λ**	
Date / Time	MerPass (T) LMT	11 51	Watch	
	λiT 003215	12 23 15	Err / ZD	
	UTC	12 23 15	UTC	19 05 40
	Date	27.9.18	Date	27.9.18
Lcl. Hr Angel			**GHA$_{Aries}$**	291°30,9'
			incr. (m.s.)	1°25,2'
			DR λ	−8°26,0'
			LHA$_{Aries}$	284°30,1'
Declination	**Declination** δ (h)	01°43,2'S	a0 (from LHA)	1°18,7'
	incr. (d / quant)	+0,4' +1,0	a1 (from DR φ)	0,5'
	δ	01°43,6'S	a2 (from month)	0,9'
Sextant	**Sextant** Hs	53°39,8'	**Sextant** Hs	33°42,6'
	IE (+ off / - on)	−22,5'	IE (+ off / - on)	0,0'
	Dib (HE = 2,5 ~~ft~~ m)	−2,8'	Dib (HE = 2,5 ~~ft~~ m)	−2,8'
	Ha	53°14,5'	Ha	33°39,8'
	Corr. all sights	15,3'	Corr. all sights	−1,4'
	Ho	53°29,8'	Ho	33°38,4'
	ZD = 90° - Ho (*)	36°39,2'		
	φ = ZD + δ	36°30,2'−1°43,6'=34°46,6'	**φ = Ho−1° + a0 + a1 + a2**	33°58,5'
	Position Error	**Course** °	**Distance** nm	$\Delta\varphi$ = 17,1'
	DR	φ =	λ =	
		$\Delta\varphi$ =	$\Delta\lambda$ =	
	DR	**φ =**	**λ =**	

(*) ZD ist negative if GP is north of DR, positive else.

- All S-values get a – sign (are counted negative), alle N-values get a + sign, are treated positive.
- If the body is sigthed in the Northmeridian (observer (DR) is S of body (GP)), the ZD gets a – sign (is treated negative). If the body is sighted in the Southmeridian (observer (DR) is N of body (GP)), ZD gets a + sign (is treated positive).
- If calculated **φ = ZD + δ** is positive, it is a N-latitude, otherwise it is a S-latitude.

Celestial Sight Reduction – special running fixes – V 1.1 - © R. Zwönitzer – www.zwoenitzer.de

Table contains the two special sight reductions needed today.



Plotting sheet for both fixes 1223 and 1604 of today. Real positions are marked blue.

Day 3 – 28.09.2018

Day 3 Log

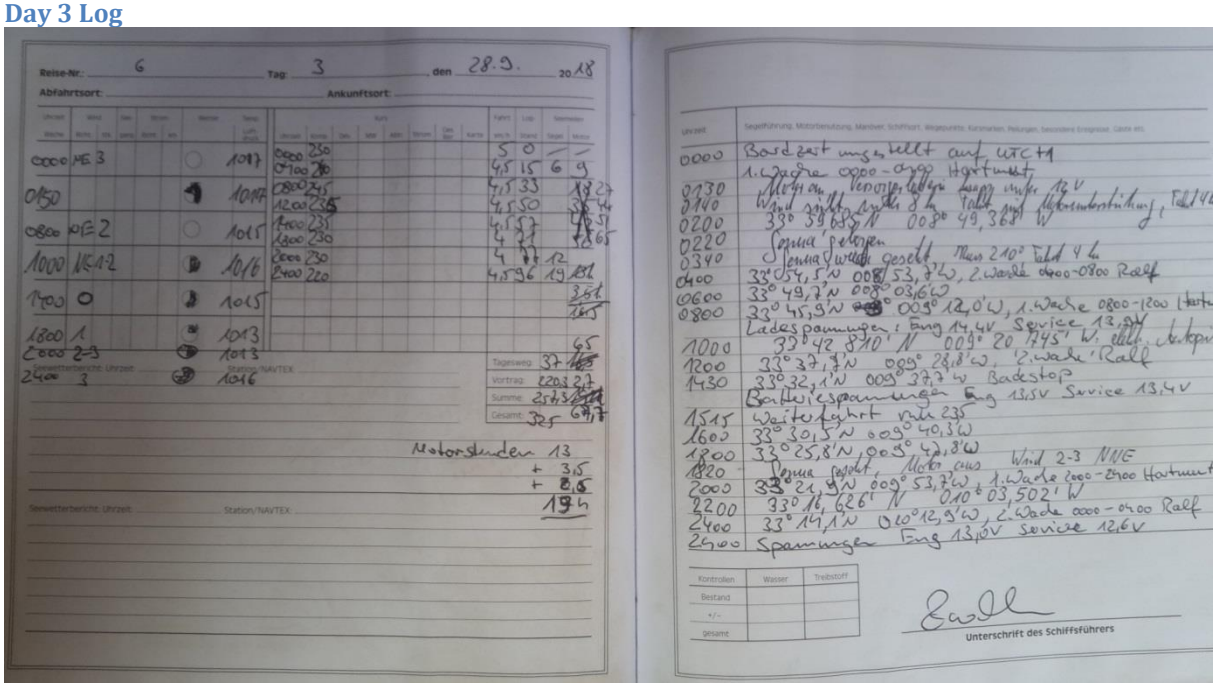


Image 38 Logbook pages 28. September 2018.

Log day 3: *0000* Boardtime set to UTC+1 (UT-01), *0130* Voltage below 12V engine start, *0140* no Wind, PDV, headsail in, *0340* head sail out 4kts, *0800* charging voltages 14,4V/13,9V, *1000* elektr. Autopilot, *1430* stopover for a bath, voltages 13,5V/13,4V, *1515* underway again, *1820* head sail out, engine stop, 2400 voltages 13V/12,6V

Day 3 Track

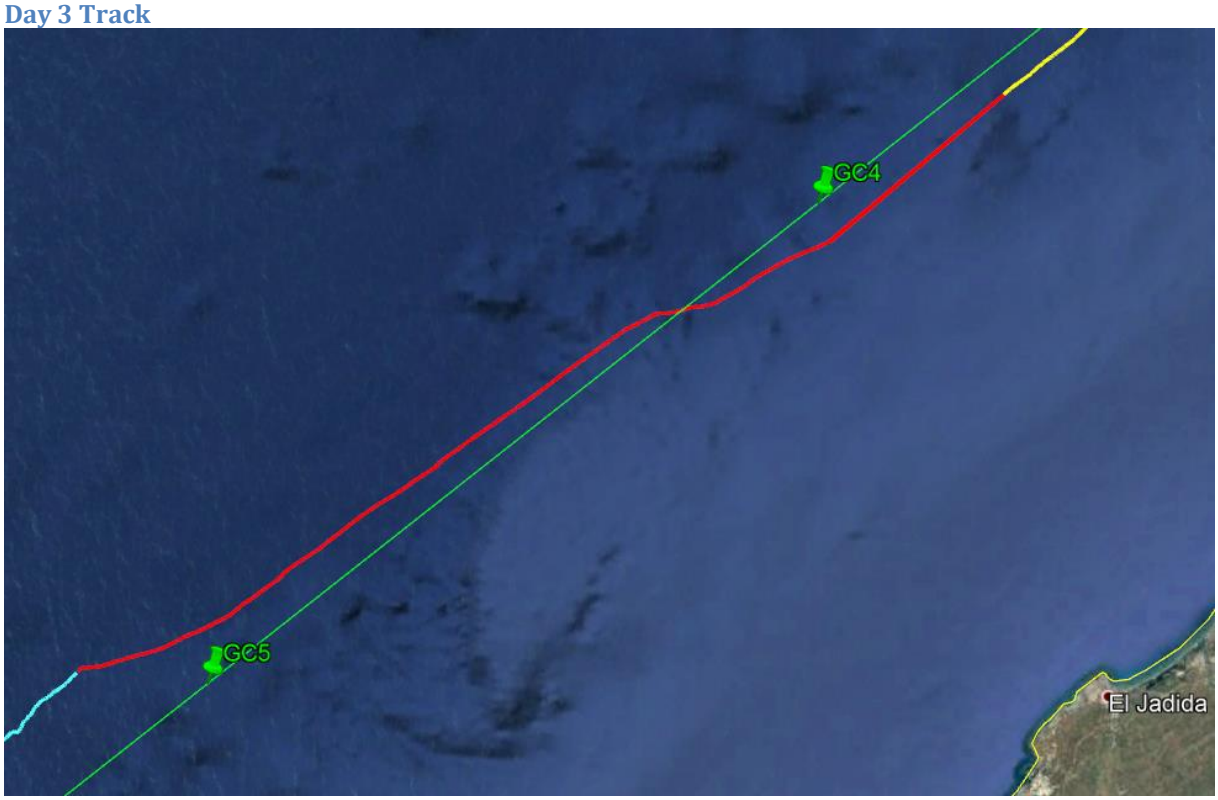


Image 39 Route planned (green) and real track (red) of day 3. Etmal was 102nm, distance between GC4 and GC5 is 65nm, max XTE 7,4nm.

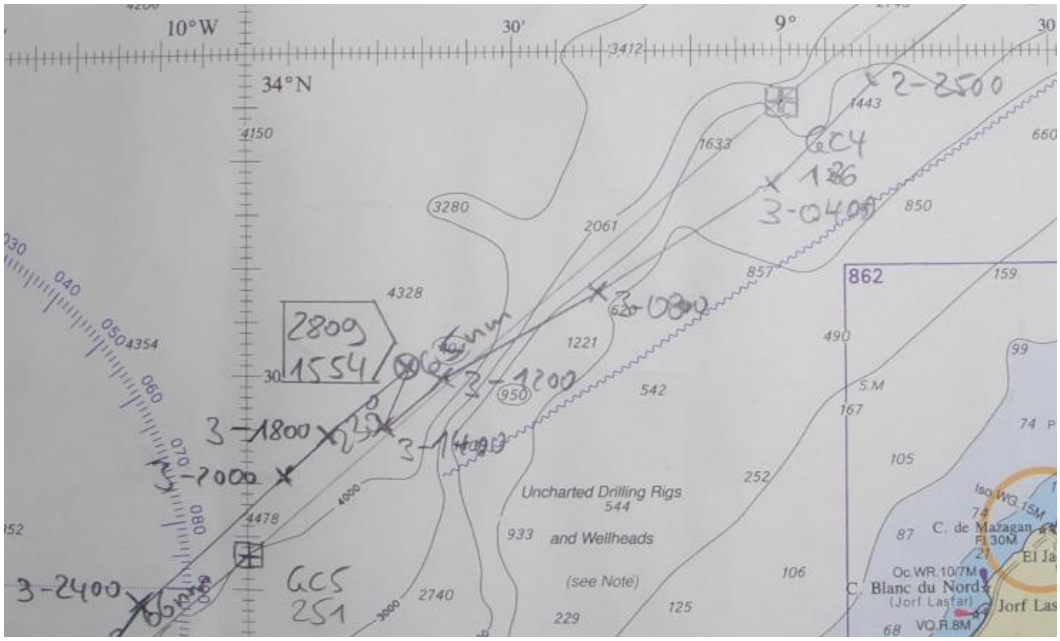


Image 40 Dead reckoning of day 3 started at DR 2-2500 with a fix at 1554BT (1454 UTC)

Day 3 Navigation

3.1) SunSight LL

092940UTC DR-Pos: 33°41,6'N 009°22,7'W IE -24,2' Log 43,2 TC 240° Hs 34°51,8'

See "Sun LL" in column 1 of form "General Sight Reduction" today: Az 121,2° 12,6' A

3.2) Meridian Passage LL

DR-Pos: 33°35,4'N 009°35,6'W

See "Celestial Day Form" today for all values: 122535 UTC Hs 54°08,0'

See "LAN (Sun)" in column 1 of form "Special Sight Reduction" today: φ_{1225} = 33°26,0'N
(This differs from real latitude 33°34,5'N by 8,5nm, same as yesterday, grrr.)

Fix_{1225} from Sun-Run-LAN plotted in form "Celestial Plotting Form B" today:

Fix_{1225}:	33°26,0'N	009°58,5'W
Pos_{1225}	33°34,5'N	009°34,1'W

Again the owner stated this is a difference of 22nm / 069°, as could be expected by the LAN error, obviously there is still room for improvement. The error might be resulting from the mistakes made at the LAN at 1225, but there are more things to correct:

1. The time of LAN was too early, 3 minutes before GMT calculated. There were obviously not enough sights taken. → More of them tomorrow.

2. Following the wrong time, the height measured was too small, it should be 2' more.

3. But most of all, the huge differences in IE are still present, even when approved directly before and after the sights. After a couple of retries I then found out, that the clamp does not always relock exactly between the teeth of the index arc but stays on top of them, even when the drum is adjusted! One light knock at the drum and it snaps in and jumps some multiples of a minute to either side. There is clearly no exact measurement possible with this. From now on the fit of the nose in the arcs teeth must be checked with every sight.

As yesterday I continue with the corrected LAN_{1225}.

3.3) SunSight LL

145445UTC DR-Pos: : 33°31,6'N 009°42,2'W IE 3,0' Log 62,3 TC 235° Hs 40°18,8'

See "Sun LL" in column 2 of form "General Sight Reduction" today: Az 231,0° 0,0'

Fix_{1454} from LAN-Run-Sun plotted in form "Celestial Plotting Form B" today:

Fix_{1454}:	33°30,1'N	009°42,0'W
Pos_{1454}	33°30,6'N	009°40,1'W

This was a difference of 2nm / 087°, the owner was amused. It seemed the error could be detected. The fix was used as new start of DR for BT 1554

Celestial Day Form Route Sib-Tenerife Date 28.9.2018 Day 3

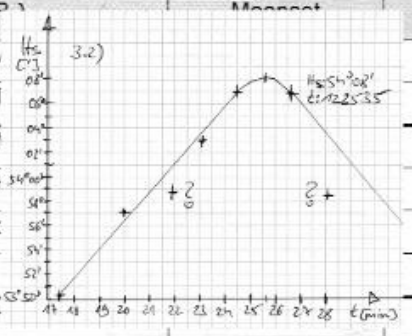
Time Sync | Error[sec] | ZD (+/- UTC)

	DR-λ	Nautical Dawn Twilight	Civil	Sunrise	Moonrise
Morning	LMT				
	λiT				
	GMT				
Aries	GHA				
	incr.				
	λ				
	LHA				

Morning Sights	DR-φ 009°12,7'	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#/IE	WT	Hs	Log
	SUN LL	3.1			-24,2'	092940	34°51,8'	43,2

LAN Results	DR-λ 009° 35,6'	Meridian Passage	#	WT	Hs	Log
	LMT	1151	3.2	122722	53°50,2'	
	λiT	003822		122000	53°57,2'	
	GMT	122922		122150	53°58,8'	
	IE	+6,5'		122310	54°03,0'	55,6
	WT	122535		122432	54°07,0'	(TC 235°)
	Hs	54°08'		122710	54°06,8'	
	Log	55,6		122810	53°58,6'	

Evening	DP	Moonset	Sunset	Civil Dusk Twilight	Nautical
	LM				
	λiT				
	GI				
Aries	GI				
	inc				
	λ				
	LH				



Evening Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#/IE	WT	Hs	Log
	SUN LL	3.3				145945	40°18,8	62,3
								(TC 235°)

Celestial Day Form – Whole Day Sights – V 1.0 - © R. Zwönitzer – www.zwoenitzer.de

Celestial Day Form containing all observations of the day. The LAN sun sight was interpolated by circular interpolation as shown in diagram in the middle.

General Sight Reduction Route S-S-Tenerife Day 3

	Body	SUN LL(3.1)	SUN LL(3.3)
Run	Course °		235°
	SoG [kt]		
	Log / Dist [nm]		6,7
DR	$\Delta\varphi$ = cos(C) * D		-3,8
	$\Delta\lambda$ = sin(C) * D / cos(φ)		+6,6
	Lat φ	33°41,6'N	33°31,6'N
	Lon λ	009°22,7'W	009°42,2'W
Date/Time	**Watch** Err ZD		
	UTC	092940	145445
	Date	28.09.18	28.09.18
Local Hour Angel	**GHA_{body} / $_{Aries}$**	317°19,8'	032°20,8'
	incr. (m.s.)	7°25,0	13°41,3'
	addtl. (v/quant) or SHA_{Star}		
	GHA	324°44,8'	046°02,1'
	DR λ / a-lon $_{229/249}$	-9°22,7'	-9°42,2'
	LHA_{body} / $_{Aries}$	315°22,1'	036°19,9'
Declination	**Declination** δ (h)	02°03,7'S	02°08,5'S
	incr. (d / quant)	+0,5' +1,0	+0,9' +1,0
	δ	02°04,2'S	02°09,4'S
Sextant	**Sextant** Hs	34°51,8'	40°18,8'
	IE (+ off / - on)	-24,2'	+3,0'
	Dib (HE = 2,5 ft / m)	-2,8'	-2,8'
	Ha	34°24,8'	40°19,0'
	Corr. all sights	+14,6'	+14,9'
	addtl.(UL moon -30') / HP		
T	Ho	34°39,4'	40°33,9'
	(Hc_{tab} / d / quant) $_{229/249}$		
A	Hc	34°52,0'	40°33,9'
	Δh (Ho-Hc) a =	12,6' T A	0,0 T A

sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA	LHA < 180°	LHA >= 180°
tan Az_r = sin LHA / (sin φ * cos LHA – tan δ * cos φ)	< 0 Az=Az_r+360° else Az=Az_r+180°	< 0 Az=Az_r+180° else Az=Az_r
Azimut Az	121,2°	231,2°

Position Error	**Course** °	**Distance** nm		
DR	φ =		λ =	
	$\Delta\varphi$ =		$\Delta\lambda$ =	
DR	**φ =**		**λ =**	

Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains both general sight reductions needed today.

	Special Sight Reduction	Route GS-Tenerife	Day 3	
	Body	**LAN (Sun)** (3.2)	**Body**	**Polaris**
Run	Course °	240°	Course °	
	SoG [kn]		SoG [kn]	
	Log / Dist [nm]	12,4	**Log / Dist** [nm]	
DR	Δφ = cos(C) * D	-6,2	Δφ = cos(C) * D	
	Δλ = sin(C) * D / cos(φ)	+12,9	Δλ = sin(C) * D * cos(φ)	
	Lat φ	33°35,4' N	**Lat φ**	
	Lon λ	009°35,6'W	**Lon λ**	
Date / Time	MerPass (T) LMT	1151	Watch	
	λiT 0036 + 000222	003822	Err / ZD	
	UTC	122922	UTC	
	Date	28.9.2018	Date	
Lcl. Hr Angel			**GHA$_{Aries}$**	
			incr. (m.s.)	
			DR λ	
		122535	**LHA$_{Aries}$**	
Declination	**Declination** δ (h)	02°06,6'S	a0 (from LHA)	
	incr. (d / quant)	+ 0,4' +1,0	a1 (from DR φ)	
	δ	02°07,0'S	a2 (from month)	
Sextant	**Sextant** Hs	54°08,0'	**Sextant** Hs	
	IE (+ off / - on)	+6,5'	IE (+ off / - on)	
	Dib (HE = 2,5 ft / m)	-2,8'	Dib (HE = ft / m)	
	Ha	54°11,7'	Ha	
	Corr. all sights	+ 15,3'	Corr. all sights	
	Ho	54°27,0'	Ho	
	ZD = 90° - Ho (*)	35°33,0'		
	φ = ZD + δ	33°26,0'N	**φ = Ho–1° + a0 + a1 + a2**	

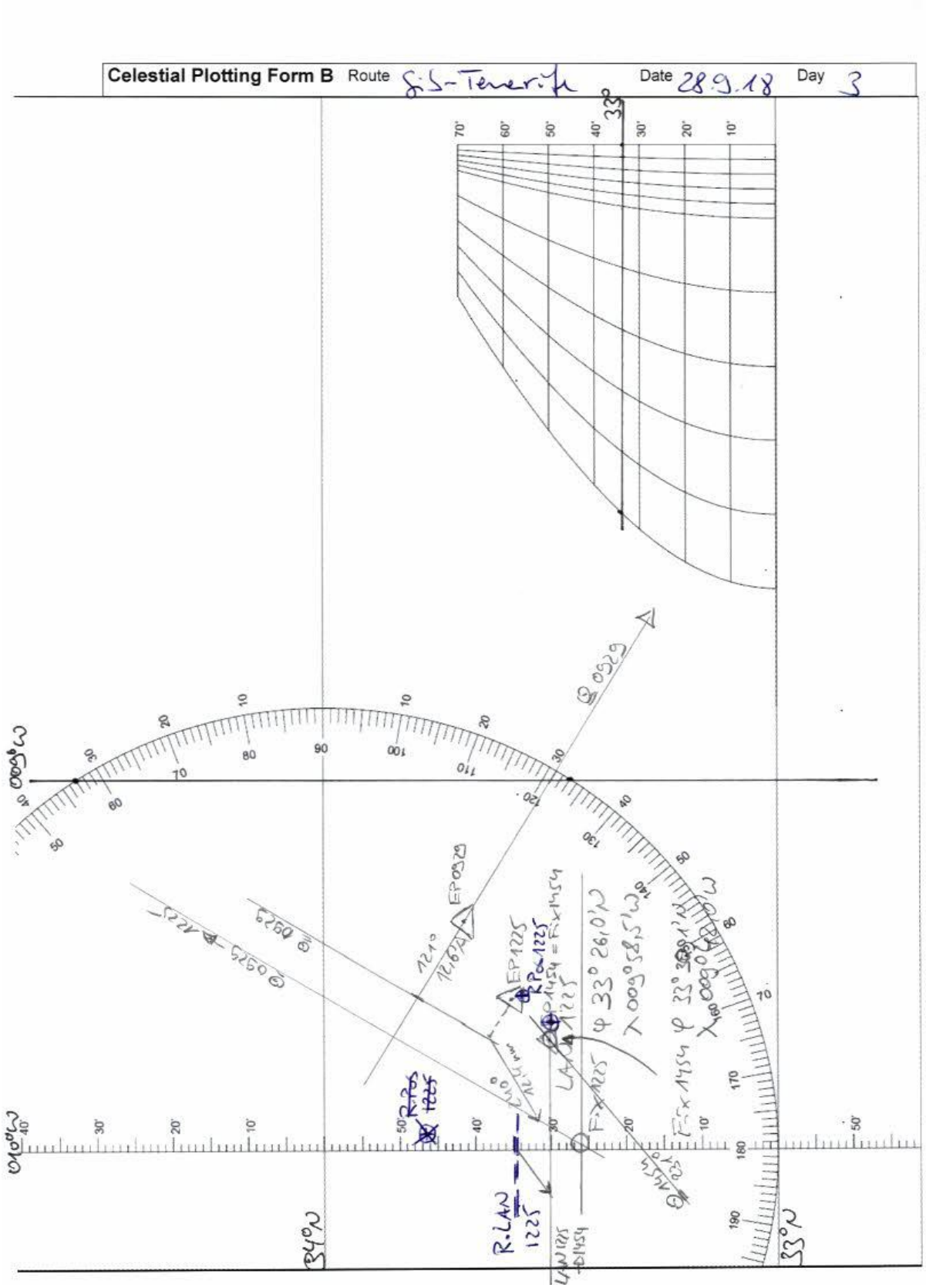
Position Error	**Course** °	**Distance** nm		
DR	φ =		λ =	
	Δφ =		Δλ =	
	DR φ =		**λ =**	

(*) ZD ist negative if GP is north of DR, positive else.

- All S-values get a – sign (are counted negative), alle N-values get a + sign, are treated positive.
- If the body is sigthed in the Northmeridian (observer (DR) is S of body (GP)), the ZD gets a – sign (is treated negative). If the body is sighted in the Southmeridian (observer (DR) is N of body (GP)), ZD gets a + sign (is treated positive).
- If calculated **φ = ZD + δ** is positive, it is a N-latitude, otherwise it is a S-latitude.

Celestial Sight Reduction – special running fixes – V 1.1 - © R. Zwönitzer – www.zwoenitzer.de

Table contains the LAN sight reduction needed today.



Plotting sheet for both fixes 1225 and 1454 of today. Real positions are marked blue.

Day 4 – 29.09.2018

Day 4 Log

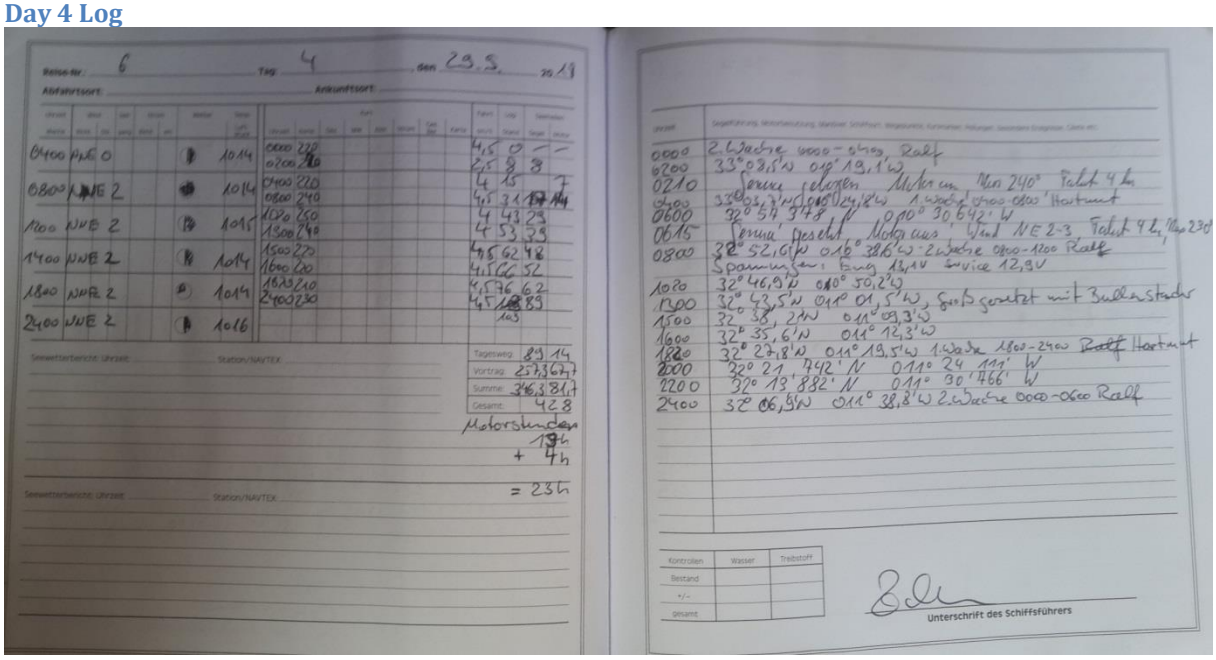


Image 41 Logbook pages 29. September 2018.

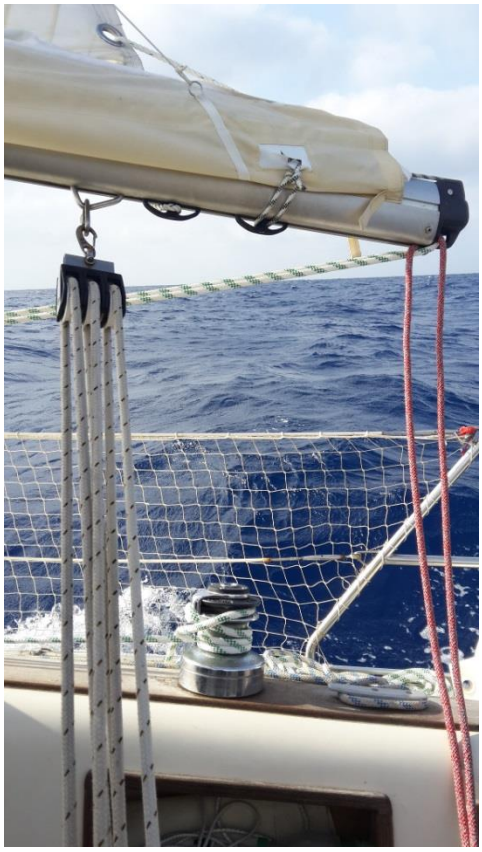


Image 42 Preventer rig of Nica.

Log day 4: *0210* headsail in, engine start 4kts, *0615* engine stop, head sail out, 4kts., *0800* voltages 13,1V/12,9V, *1300* main sail rigged with preventer, *1800* watch system changed to 6 hours with two 3 hour dog watches in the afternoon.

The preventer rig can be seen on the left. The white/green stb preventer returns from the bow block and is fixed on the head sheet winch. The red port preventer stays rigged but hangs loose until the next shift. She is already put in first reef for the night.

In the night at about 0140BT a very alarming incident occurred. A ship which just passed us on Stb disappeared at the horizon of a clear night with enough wind to sail all the time. Suddenly the AIS Alarm sounded and a motor vessel appeared 5nm exactly before us on the screen. It was their out of nowhere as if it had switched off its AIS before to not be seen or because any other reason.

The CPA was a dangerous couple of meters only with a passing time within 17 minutes. The ship could be seen with two masthead lights over each other and both side lights on collision course. It had a class A AIS without neither a ship's name nor a call sign configured. The only thing I saw was an MMSI beginning with an MID of 314 (Barbados) as well as course and speed - 17kt. I had seen the ship before, but because it came exactly out of the same direction the vessel that passed us before disappeared, I mistakenly thought that this would be the overtaker.

What so ever, now the time was getting short and things heated up. The vessel did not show any change in course or speed, so I started to contact them by VHF. Five tries I gave them: one

with MMSI, one with Position and one with “140miles southwest of Casablanca” as address. Two times an individual call to the MMSI, no answer at all.

At 0152BT 1,4nm before CPA I started to light the sails with my flashlight and head lamp. Both are very bright and could be switched to an alarming very quick mode. This helped; a searchlight was switched on in our direction, but what for please? We were illuminated with a tricolor and tried to raise attention for minutes before. They did not listen to the VHF nor did they keep proper lookout.

At 0204BT when they switched off their blinding spotlight, I suddenly saw their green side light and both whites besides each other. They really decided it would be a good idea to turn over port in this situation where everybody in the world would give way to stb!!! In addition they stopped their boat exactly in our way. I have never seen such a number of mistakes at once and I got a really bad feeling about their intentions.

Thus I decided to escape to stb with the maneuver of the right moment by luffing up about 90°. I ran away for about half a mile and then turned to old course again at 0212BT. In case of more trouble, I could have turned another 40° over stb or even head completely into the wind and stop. Because of the new angle to the waves, Hartmut woke up and asked what’s up. You will not believe…a totally boring night followed by 20 minutes of sheer terror. We were so close, we could even hear their engines!

Meanwhile they turned over stb back to their old course, showed red and disappeared with 17kt. After a couple of minutes I started to write things together in the logbook, when I saw their AIS switched off again and the vessel disappeared from the screen. So we do not have the MMSI, but is not very conspicuous to suspect that it was a faked one anyway. At 0210 we started the engine and tried to get away as quick as possible.

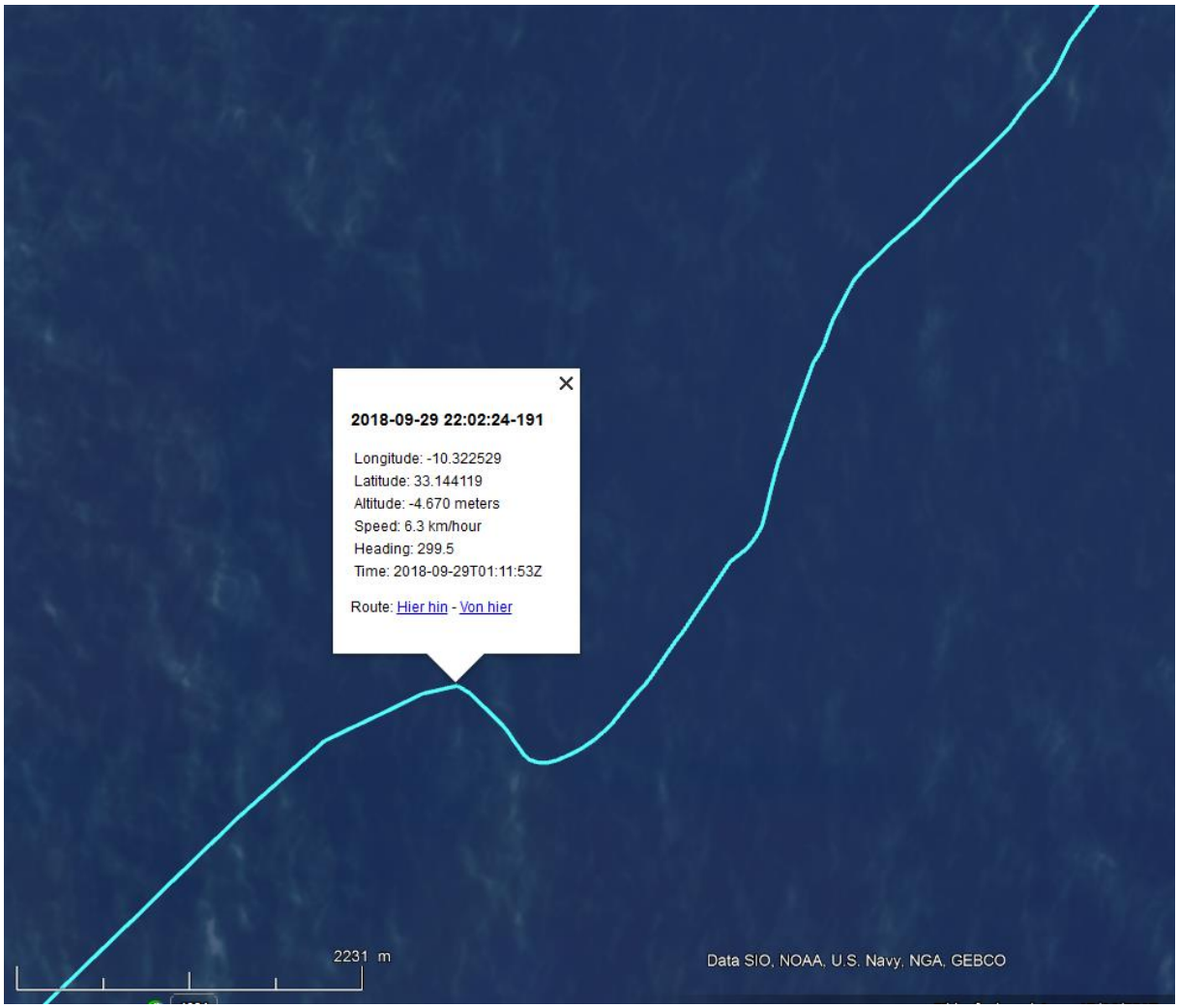


Image 43 This track shows the alarming event at night with the maneuver of the last moment to starboard at 0204 board time.

Day 4 Track

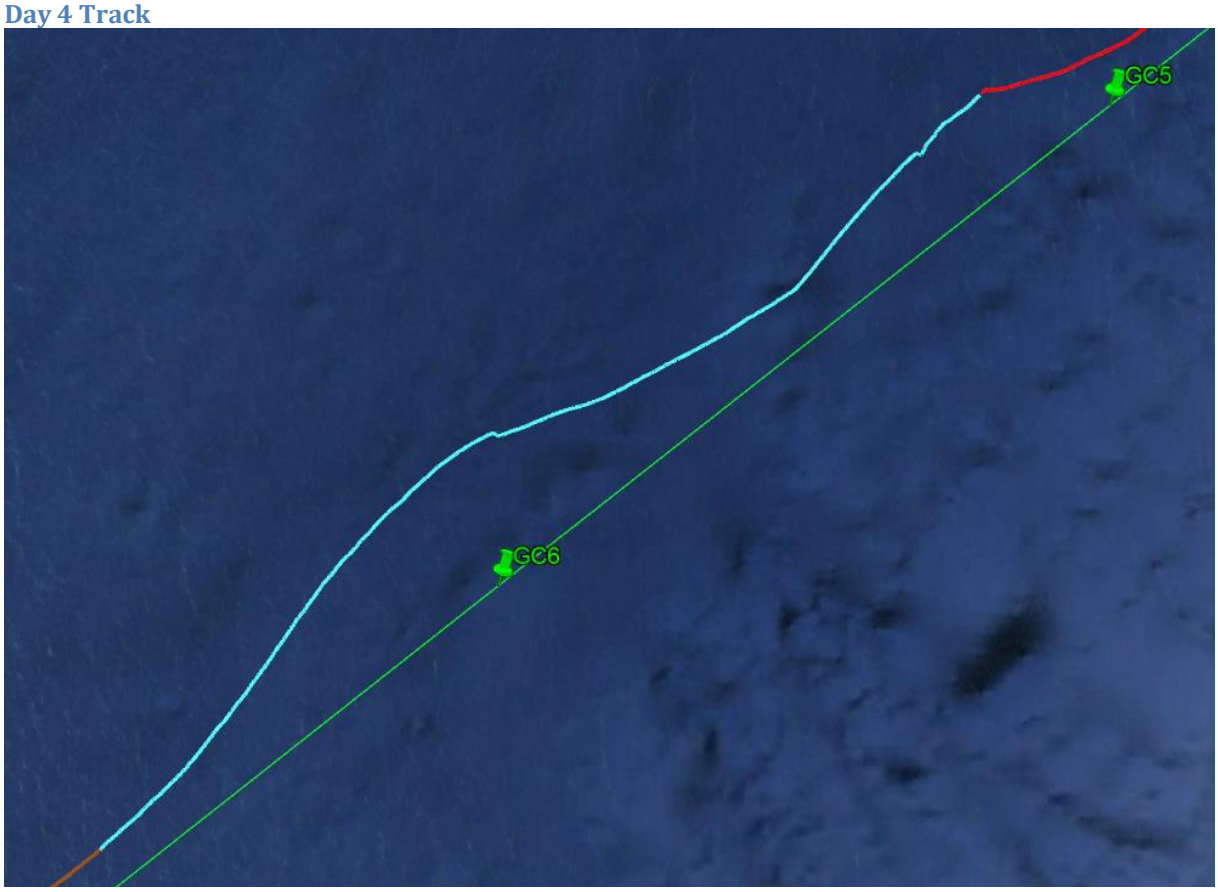


Image 44 Route planned (green) and real track (cyan) of day 4. Etmal was 103nm, distance between GC5 and GC6 is 66nm, max XTE 11,0nm.

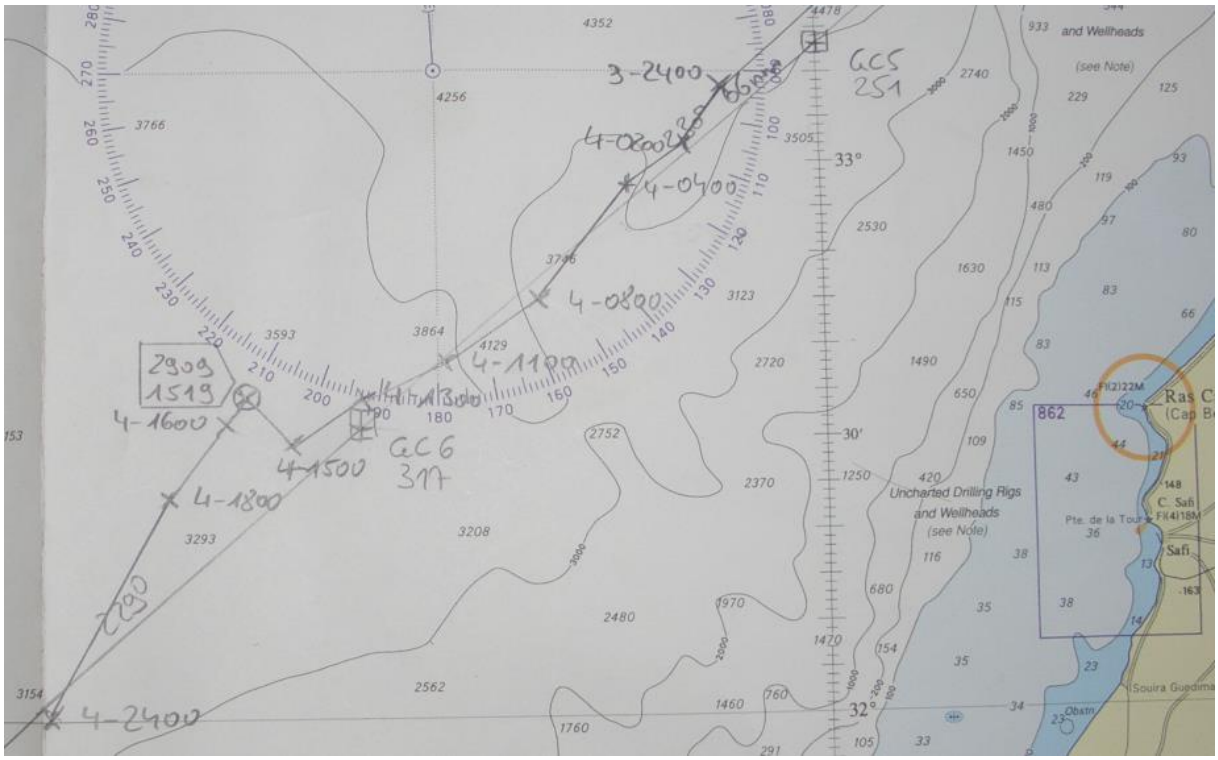


Image 45 Dead reckoning of day 4 started at DR 3-2400 with a fix at 1519BT (1419 UTC)

Day 4 Navigation

4.1) Meridian Passage LL

GMT 123348 (133348BT) DR-Pos: 32°44,6'N 010°57,2'W IE +2,0' Log 54,5 TC 220°

See "Celestial Day Form" today for all values: 123348 UTC Hs 54°34,8'

See "LAN (Sun)" in column 1 of form "Special Sight Reduction" today: φ_{1233} = 32°40,2'N
(This differed from real latitude 33°42,5'N by 2,3nm, better than he day before. RPos 32°42,5'N 011°03,3'W and the supervisors ok encouraged the afternoon sights.)

4.2) SunSight LL

141950UTC DR-Pos: 32°36,5'N 011°09,3'W IE +4,4' Log 62,3 TC 230° Hs 46°46,1''

See "Sun LL" in column 1 of form "General Sight Reduction" today: Az 220,3° 4,4' T

Fix_{1419} from LAN-Run-Sun plotted in form "Celestial Plotting Form B" today:

Fix_{1419}:	32°34,2'N 011°14,9'W
Pos_{1419}	32°37,7'N 011°09,9'W

This is a difference of 6nm / 054°. Not really good, but the time difference was small due to upcoming clouds resulting in a poor intersection angle. There were no observations possible later. However the fix was used for BT 1519 and the DR was continued from there.

Celestial Day Form Route Gib-Tenerife Date 29.9.2018 Day 4

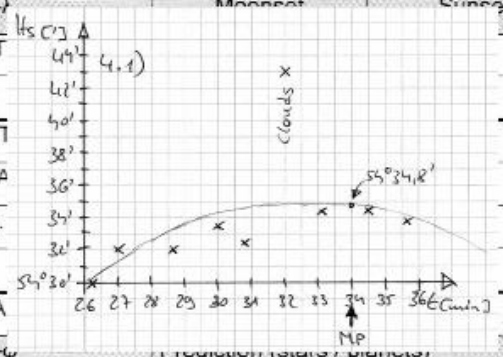
Time Sync | Error[sec] | ZD (+/- UTC)

	DR-λ	Nautical Dawn Twilight	Civil	Sunrise	Moonrise
Morning	LMT				
	λiT				
	GMT				
Aries	GHA				
	incr.				
	λ				
	LHA				

Morning Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#	WT	Hs	Log

LAN Results	DR-λ @10°57,2'W	Meridian Passage	#	WT	Hs	Log
	LMT	1150		122640	54°30,0'	
	λiT	0043'48		122700	54°32'	
	GMT	12 33'48		122840	54°31,9'	
	IE	+2,0'		123000	54°33,6'	54,5
	WT	12 33'48		123040	54°32,4'	
	Hs	54°34,8'		123205	54°43,0'	
	Log	54,5 (TC 220°)		123312	54°34,2'	

Evening Aries	DR-λ	~~Moonset~~	~~Sunset~~	~~Civil~~ Dusk Twilight	~~Nautical~~
	LMT			123730	54°34,5'
	λiT			123540	54°33,8'
	GMT				
	GHA				
	incr.				
	λ				
	LHA				



Evening Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	# IE	WT	Hs	Log
	SUN LL				44'	141950	46°46,1'	62,3 (220°)

Celestial Day Form – Whole Day Sights – V 1.0 - © R. Zwönitzer – www.zwoenitzer.de

Celestial Day Form containing all observations of the day. The LAN sun sight was interpolated by circular interpolation as shown in diagram in the middle.

	Special Sight Reduction Route Gz-Tenerife Day 4			
	Body	**LAN (Sun)** 4.1)	**Body**	**Polaris**
Run	Course °		Course °	
	SoG [kn]		SoG [kn]	
	Log / Dist [nm]		**Log / Dist** [nm]	
DR	Δφ = cos(C) * D		Δφ = cos(C) * D	
	Δλ = sin(C) * D / cos(φ)		Δλ = sin(C) * D * cos(φ)	
	Lat φ	32°44,6'N	**Lat φ**	
	Lon λ	010°57,2'W	**Lon λ**	
Date / Time	MerPass (T) LMT	1150	Watch	
	λiT	004348	Err / ZD	
	UTC	123348	UTC	
	Date	29.9.18	Date	
Lcl. Hr Angel			**GHA**$_{Aries}$	
			incr. (m.s.)	
			DR λ	
			LHA$_{Aries}$	
Declination	**Declination** δ (h)	02°29,9'S	a0 (from LHA)	
	incr. (d / quant)	+0,6' +1,0	a1 (from DR φ)	
	δ	02°30,5'S	a2 (from month)	
Sextant	**Sextant** Hs	54°34,8'	**Sextant** Hs	
	IE (+ off / - on)	+2,0'	IE (+ off / - on)	
	Dib (HE = ft / m)	-2,8'	Dib (HE = ft / m)	
	Ha	54°34,0'	Ha	
	Corr. all sights	+ 15,3'	Corr. all sights	
	Ho	54°49,3'	Ho	
	ZD = 90° - Ho (*)	35°10,7'		
	φ = ZD + δ	32°40,2'	**φ = Ho–1° + a0 + a1 + a2**	

Position Error	**Course** °	**Distance** nm		
DR φ =			λ =	
Δφ =			Δλ =	
DR φ =			**λ =**	

(*) ZD ist negative if GP is north of DR, positive else.

- All S-values get a – sign (are counted negative), alle N-values get a + sign, are treated positive.
- If the body is sigthed in the Northmeridian (observer (DR) is S of body (GP)), the ZD gets a – sign (is treated negative). If the body is sighted in the Southmeridian (observer (DR) is N of body (GP)), ZD gets a + sign (is treated positive).
- If calculated **φ = ZD + δ** is positive, it is a N-latitude, otherwise it is a S-latitude.

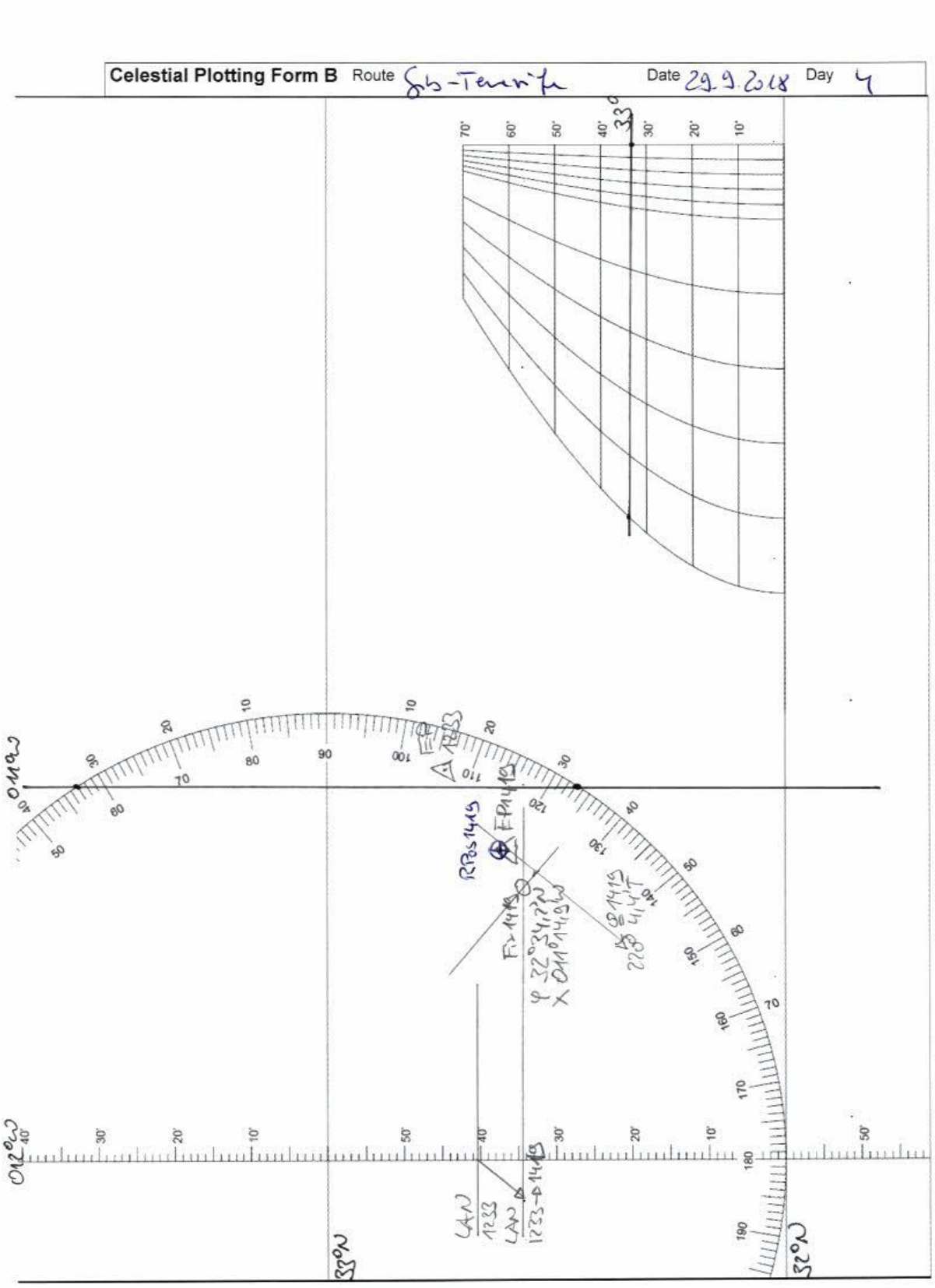
Celestial Sight Reduction – special running fixes – V 1.1 - © R. Zwönitzer – www.zwoenitzer.de

Table contains the LAN sight reduction needed today.

	General Sight Reduction	Route Sg - Tenerife	Day 4	
	Body	Sun LL 4.2		
Run	Course °	220°		
Run	SoG [kt]			
Run	**Log / Dist** [nm]	7,8		
DR	$\Delta\varphi$ = cos(C) * D	-6		
DR	$\Delta\lambda$ = sin(C) * D / cos(φ)	+6		
DR	**Lat φ**	32°36,5'N		
DR	**Lon λ**	011°09,3'W		
Date/Time	**Watch** Err ZD			
Date/Time	UTC	141950		
Date/Time	Date	29.9.2018		
Local Hour Angel	**GHA_{body} / Aries**	032°25,8'		
Local Hour Angel	incr. (m.s.)	4°57,5'		
Local Hour Angel	addtl. (v/quant) or SHA_{Star}	+		
Local Hour Angel	GHA	037°23,3'		
Local Hour Angel	DR λ / a-lon 229/249	-11°09,3'		
Local Hour Angel	**LHA_{body} / Aries**	026°14,0'		
Declination	**Declination** δ (h)	02°31,8'S		
Declination	incr. (d / quant)	+0,3 +1,0		
Declination	δ	02°32,1'S		
Sextant	**Sextant** Hs	46°46,1'		
Sextant	IE (+ off / - on)	+ 4,4'		
Sextant	Dib (HE = ft / m)	- 2,8'		
Sextant	Ha	46°47,7'		
Sextant	Corr. all sights	+ 15,1'		
Sextant	addtl.(UL moon -30') / HP			
T	Ho	47°02,8'		
	(Hc_{tab} / d / quant) 229/249			
A	Hc	46°58,4'		
	Δh (Ho-Hc) a =	4,4' (T) ~~A~~	T A	T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA		LHA < 180°	LHA >= 180°
	tan Az_r = sin LHA / (sin φ * cos LHA – tan δ * cos φ)		< 0 $Az=Az_r+360°$ else $Az=Az_r+180°$	< 0 $Az=Az_r+180°$ else $Az=Az_r$
	Azimut Az	220,3°		
	Position Error	**Course** °	**Distance** nm	
	DR φ =		λ =	
	$\Delta\varphi$ =		$\Delta\lambda$ =	
	DR φ =		**λ =**	

Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains the general sight reduction needed today.



Plotting sheet for the running fix of today. Real position is marked blue.

Day 5 – 30.09.2018

Day 5 Log

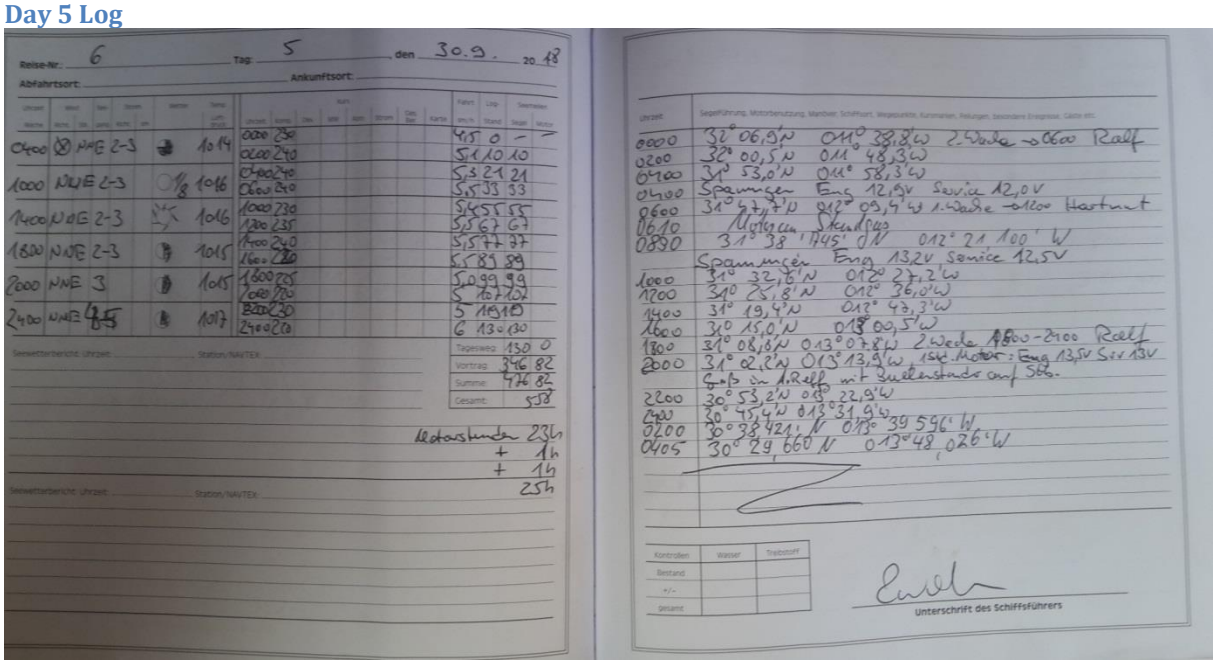


Image 46 Logbook pages 30. September 2018.

Image 47 Boomed out head sail on Nica.

Log day 5: *0400* voltages 12,9V/12.0V, *0610* engine start at neutral for charging batteries, *0830* engine stop 13,2V/12,5V, *2000* engine start again 13,5V/13V – wind generator does not deliver enough power to charge the batteries, main sail set to 1. reef and with preventer, head sail boomed out with a fore guy for security.

This was the fastest day ever for Nica to sail. 130 miles in 24 hours is very respectable for 35 year old 32 feet lady.

Day 5 Track

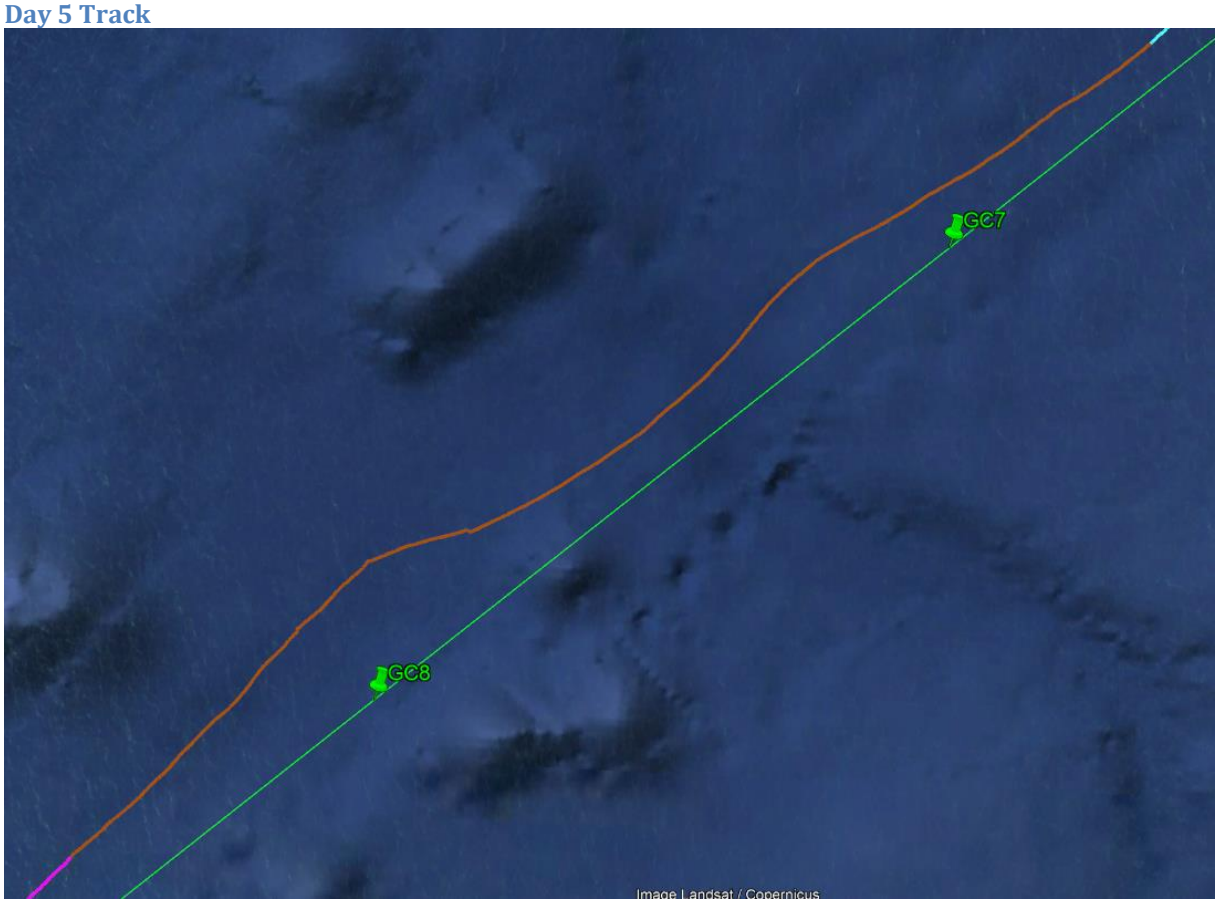


Image 48 Route planned (green) and real track (brown) of day 5. Etmal was 130nm, distance between GC7 and GC8 is 68nm, max XTE 10,2nm.

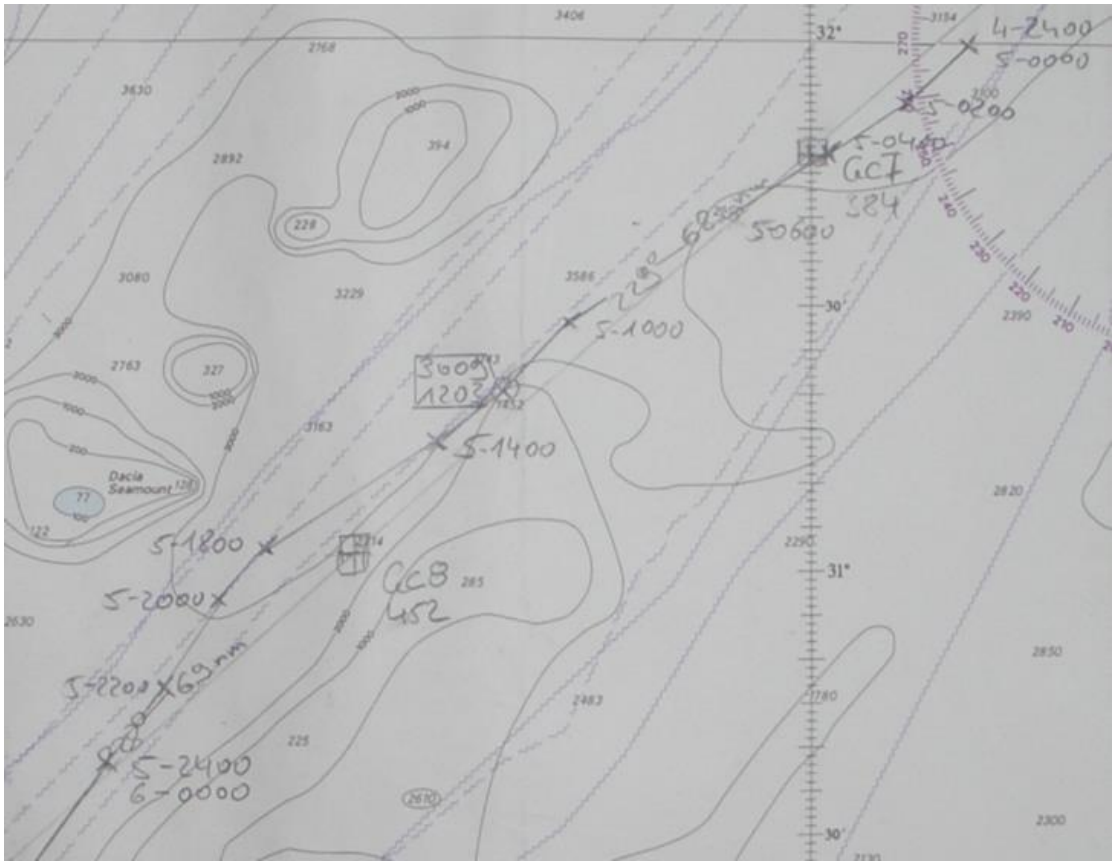


Image 49 Dead reckoning of day 5 started at DR 4-2400 with a small correction fix at 1203BT (1103 UTC)

Day 5 Navigation

5.1) Sun Sight LL

DR-Pos: 31°34,3'N 012°25,3'W IE +4,8' Log 51,9 TC 230°
Interpolated values: 083915UTC Hs 23°10,3'
See "Sun LL" in column 1 of form "General Sight Reduction" today: Az 109,3° 1,5' A

5.2) Moon UL Sight

DR-Pos: 31°31,3'N 012°29,6'W IE +4,9' Log 56,6 TC 235°

Moon UL	092316	28°00,1'
Sun LL	092450	32°04,2'

See "Moon UL" in column 2 of form "General Sight Reduction" today: Az 274,7° 1,4' T

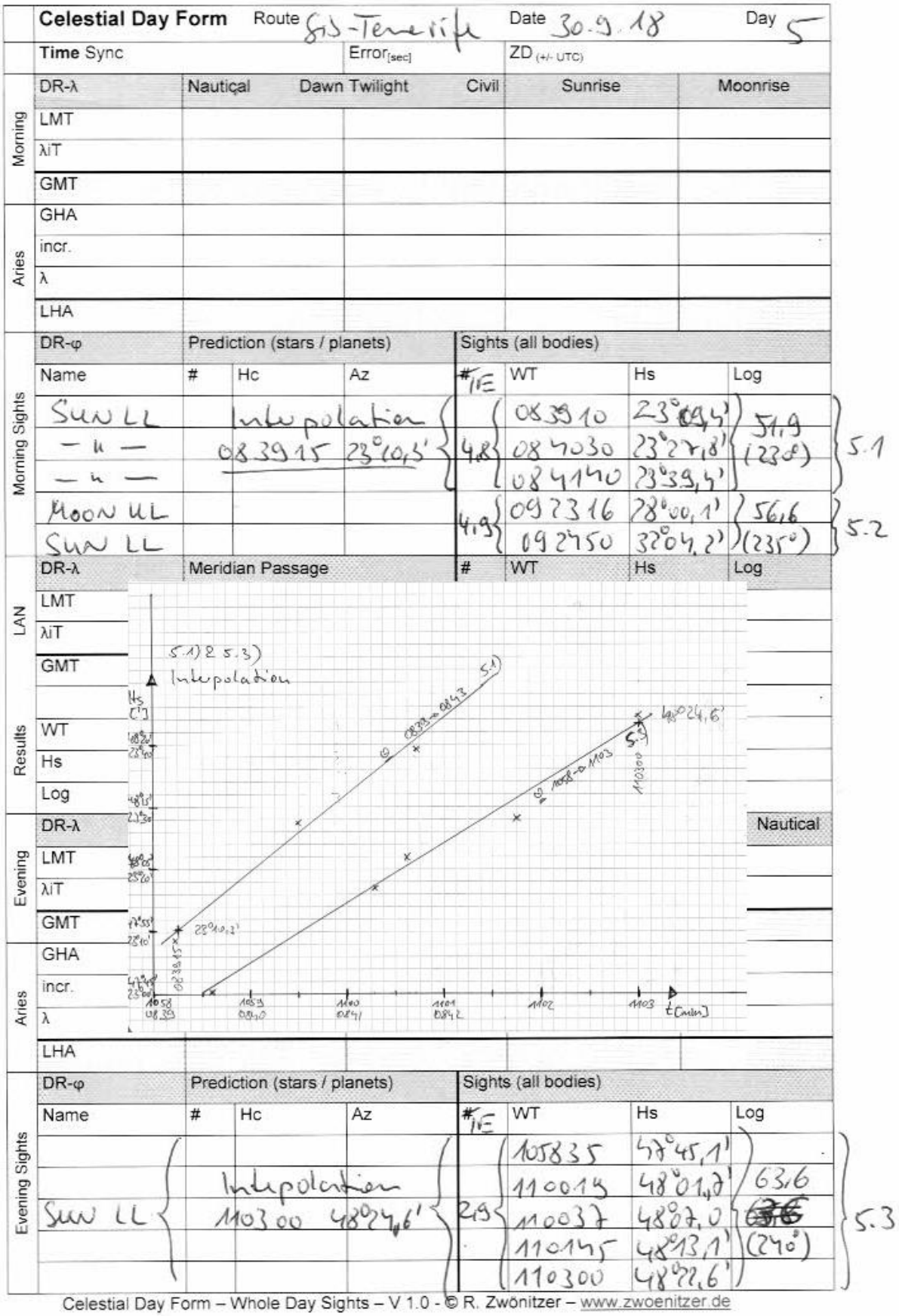
5.3) Sun Sight LL

DR-Pos: 31°27,3'N 012°36,4'W IE +2,9' Log 63,6
Interpolated values: 110300UTC Hs 48°24,6'
See "Sun LL" in column 3 of form "General Sight Reduction" today: Az 141,5° 4,2' T

Fix_{1103} from Sun-Run-Moon-Run-Sun plotted in form "Celestial Plotting Form B" today:

Fix_{1103}:	31°20,5'N 012°40,0'W
Pos_{1103}	31°25,3'N 012°36,8'W

This is a difference of 5,3nm / 029°. For a three sight run fix with interpolation of multiple sights, this is kind of frustrating, since there seems to be a limit of accuracy about 5nm? (RPos: 31°25,3'N 012°36,8'W Log 63,8) The fix is used for BT 1203 and the DR will be continued from there. It might be a good idea to concentrate more on non-runs. Maybe there will be favorable constellations tomorrow.



Celestial Day Form Route GS-Tenerife Date 30.9.18 Day 5

Time Sync | Error[sec] | ZD (+/- UTC)

	DR-λ	Nautical	Dawn Twilight	Civil	Sunrise	Moonrise
Morning	LMT					
	λiT					
	GMT					
Aries	GHA					
	incr.					
	λ					
	LHA					

Morning Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)				
	Name	#	Hc	Az	#/IE	WT	Hs	Log	
	SUN LL		Interpolation			083910	23°09,4'	51,9	
	— " —		083915	23°10,5'	4,8	084030	23°27,8'	(230°)	5.1
	— " —					084140	23°39,4'		
	MOON UL				4,9	092316	28°00,1'	56,6	
	SUN LL					092450	32°04,2'	(235°)	5.2

LAN / Results	DR-λ	Meridian Passage	#	WT	Hs	Log
	LMT					
	λiT					
	GMT					
	WT					
	Hs					
	Log					

Evening / Aries	DR-λ	Nautical
	LMT	
	λiT	
	GMT	
	GHA	
	incr.	
	λ	
	LHA	

Evening Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)				
	Name	#	Hc	Az	#/IE	WT	Hs	Log	
						105835	47°45,1'		
			Interpolation			110014	48°01,7'	63,6	
	SUN LL		110300	48°24,6'	2,9	110037	48°07,0	~~63,6~~	5.3
						110145	48°13,1'	(240°)	
						110300	48°22,6'		

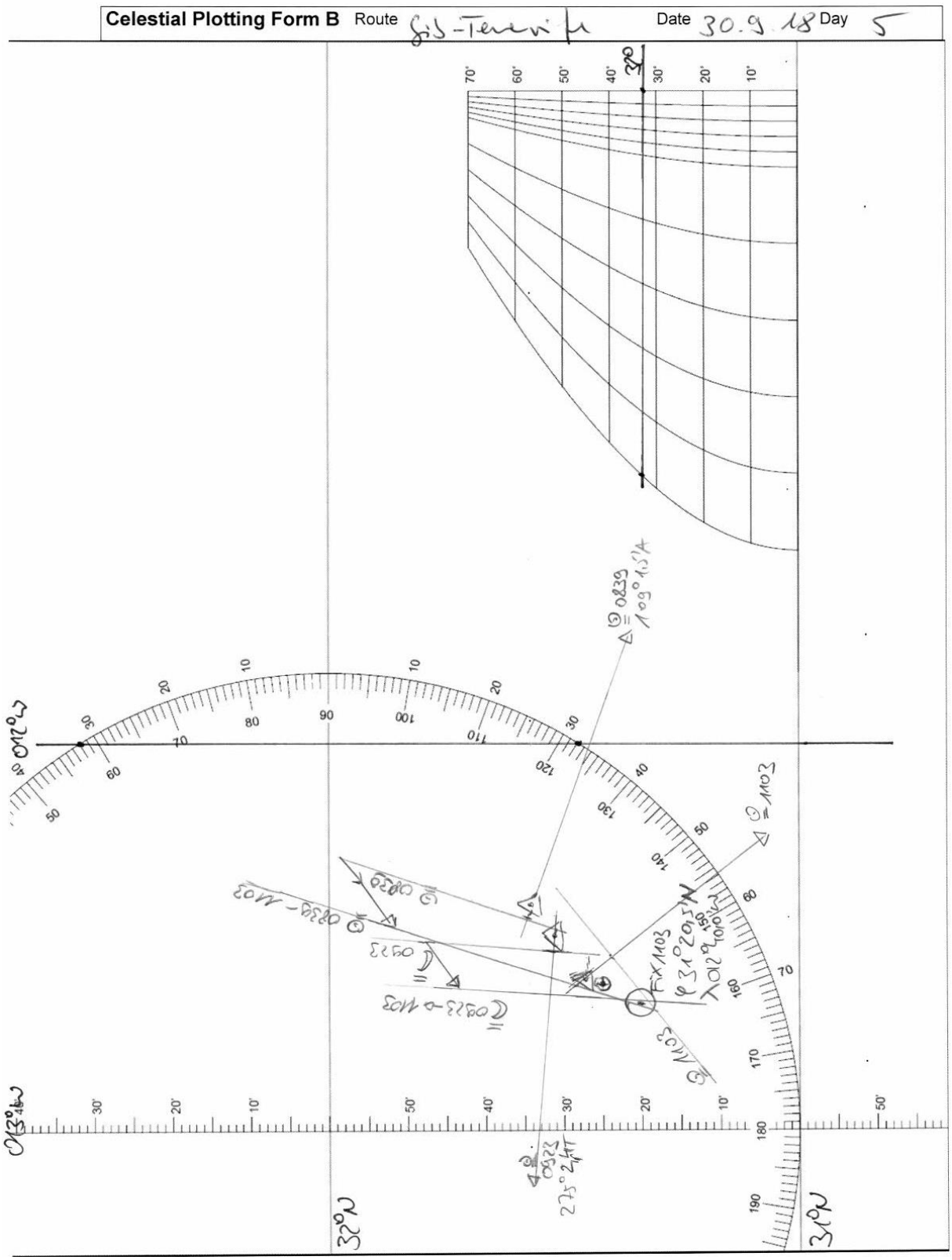
Celestial Day Form – Whole Day Sights – V 1.0 - © R. Zwönitzer – www.zwoenitzer.de

Celestial Day Form containing all observations of the day. The two sun sights 5.1 and 5.3 were corrected by linear interpolation as shown in diagram in the middle.

	General Sight Reduction	Route Gib-Tenerife		Day 5
	Body	SUN LL (5.1)	MOON UL (5.2)	SUN LL (5.3)
Run	Course °		230	235°
	SoG [kt]			
	Log / Dist [nm]		4,7	7
DR	Δφ = cos(C) * D		-3	-4
	Δλ = sin(C) * D / cos(φ)		+4,3	+6,8
	Lat φ	31°34,3'N	31°31,3'N	31°27,3'
	Lon λ	012°25,3'W	012°29,6'W	012°36,4'
Date/Time	**Watch** Err ZD			
	UTC	083915	092316	110300
	Date	30.9.2018	30.9.2018	30.9.2018
Local Hour Angel	**GHA$_{body}$ / $_{Aries}$**	302°29,6'	073°58,1'	347°30,2'
	incr. (m.s.)	9°48,8'	5°33,1'	0°45,0'
	addtl. (v/quant) or SHA$_{Star}$	—	+3,2' 8,2	—
	GHA	312°18,4'	079°34,4'	348°15,2'
	DR λ / a-lon $_{229/249}$	-12°25,3'	-12°29,6'	-12°36,4'
	LHA$_{body}$ / $_{Aries}$	299°53,1'	067°05,8'	335°38,8'
Declination	**Declination** δ (h)	02°49,3'S	18°06,2'N	02°52,2'S
	incr. (d / quant)	+0,7' +1,0	+2,5' +6,4	+0,1 +1,0
	δ	02°50,0'S	18°08,7'N	02°52,3'S
Sextant	**Sextant** Hs	23°10,3'	28°00,1'	48°24,6'
	IE (+ off / - on)	+4,8'	+4,9'	+3,9'
	Dib (HE = 2,5 ft / m)	-2,8'	-2,8'	-2,8
	Ha	23°12,3'	28°02,2'	48°24,7'
	Corr. all sights	+13,8'	59,7'	+15,1
	addtl.(UL moon -30') / HP	—	+3,9' -30' 58,1	—
T	Ho	23°26,1'	28°35,8'	48°39,8'
	(Hc$_{tab}$ / d / quant) $_{229/249}$			
A	Hc	23°27,6'	28°39,7'	48°35,6'
	Δh (Ho-Hc) a =	+1,5 T A	2,4 T A	4,2' T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA		LHA < 180°	LHA >= 180°
	tan Az$_r$ = sin LHA / (sin φ * cos LHA – tan δ * cos φ)		< 0 Az=Az$_r$+360° else Az=Az$_r$+180°	< 0 Az=Az$_r$+180° else Az=Az$_r$
	Azimut Az	109,3°	274,7°	141,5°
	Position Error	**Course** °	**Distance** nm	
	DR φ =		λ =	
	Δφ =		Δλ =	
	DR φ =		**λ =**	

Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains all three general sight reductions needed today.



Plotting sheet for the double run fix of today. Real position is marked blue.

Day 6 – 01.10.2018

Day 6 Log

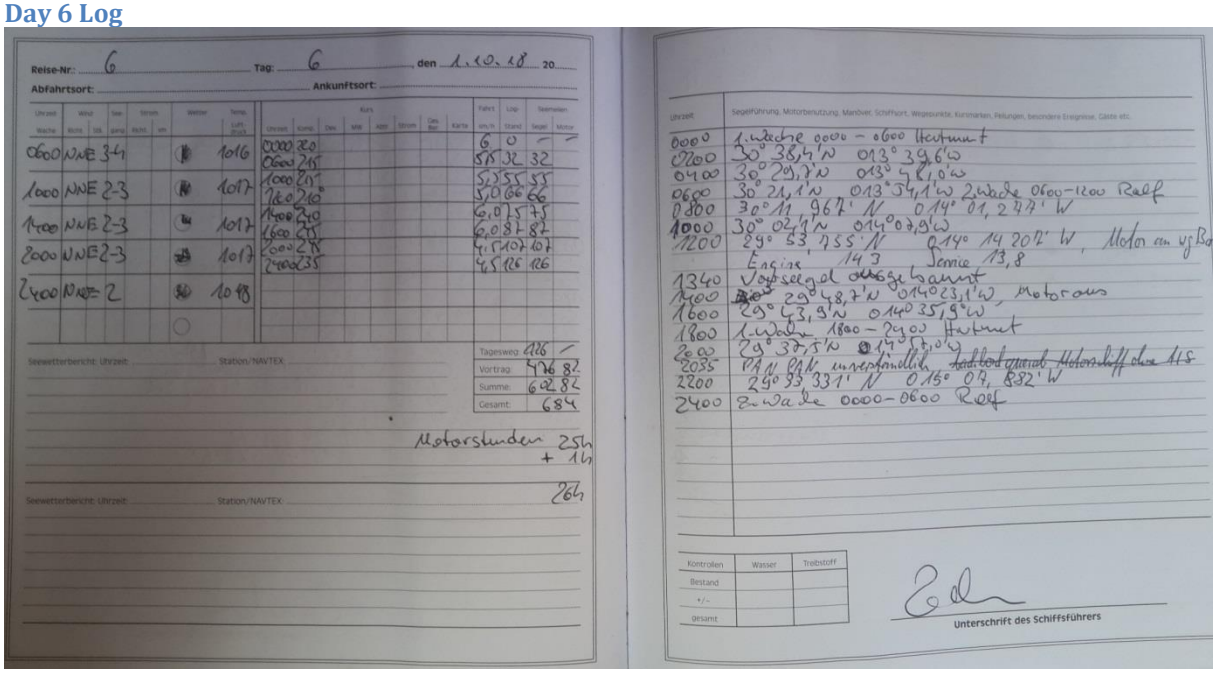


Image 50 Logbook pages 1. October 2018.

Log day 6: *1200* engine start for batteries 14,3V/13,8V, *1340* head sail boomed out for butterfly, *1400* engine stop, *2035* Pan Pan unclear message, could not understand

Day 6 Track

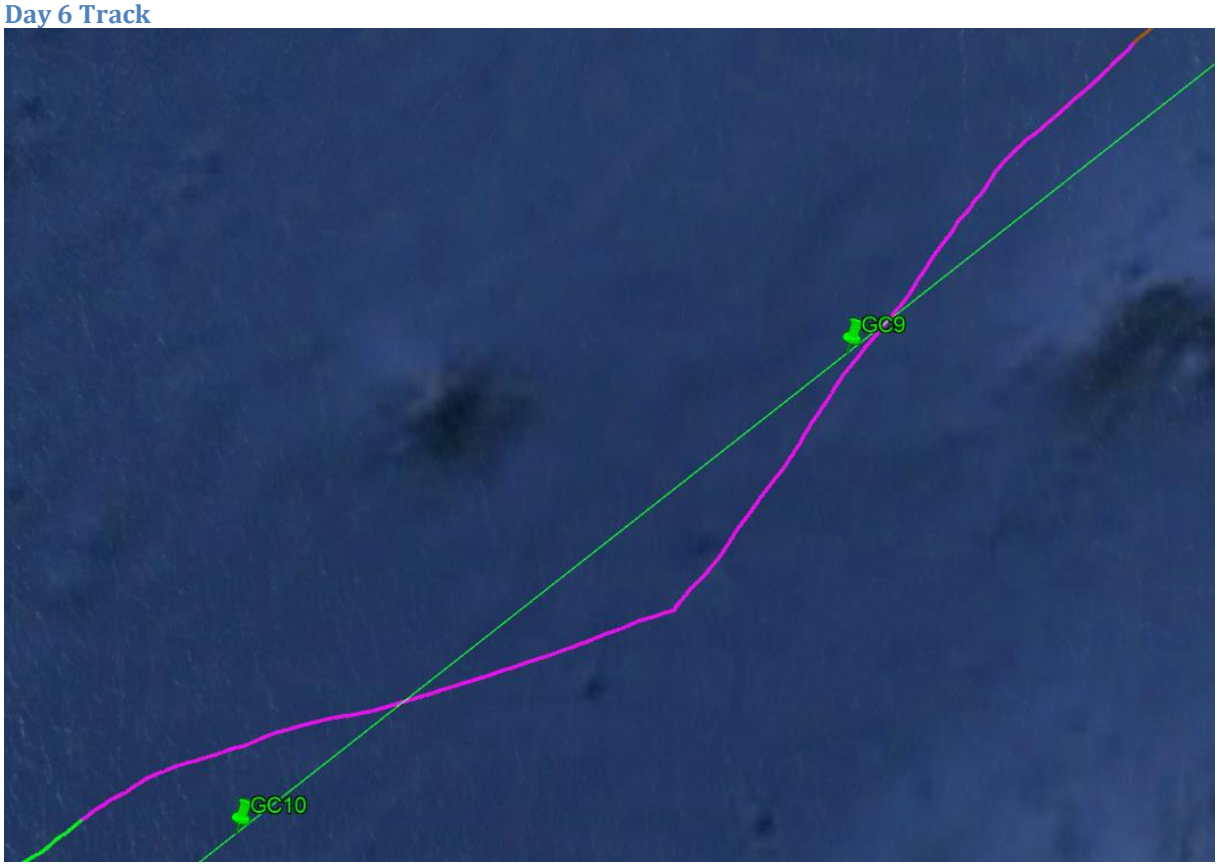


Image 51 Route planned (green) and real track (purple) of day 6. Etmal was 126nm, distance between GC9 and GC10 is 70nm, max XTE 9,5nm.

Image 52 Dead reckoning of day 6 started at DR 5-2400 with a small correction fix at 0722BT (0622 UTC)

Day 6 Navigation

6.1) Star & Moon Sight

At dawn twilight on DR-Pos: 30°14,7'N 013°59,4'W I saw a star with an azimuth of approx.. 170° and measured its height. Thereafter I took a Moon UL and found out with the starfinder the star must be Mirzam. IE +0' Log 39,8 TC 215°

Mirzam (Beta Canis Majoris)	061417UTC	Hs 41°29,6'
Moon UL	062240UTC	Hs 77°07,2'

See "Mirzam" in column 1 of form "General Sight Reduction" today: Az 171,9° 1,5' T
See "Moon UL" in column 2 of form "General Sight Reduction" today: Az 219,6° 1,8' A

This side reduction was done by calculating and by looking up from the Pub.249 Vol.2

See "Mirzam " in column 1 of form "General Sight Reduction V.249" today: Az 172° 15,6' A
See "Moon UL" in column 2 of form "General Sight Reduction V.249" today: Az 219° 3,6' A

Fix_{0622} from Star & Moon plotted in form "Celestial Plotting Form B" today for calculated fix and "Celestial Plotting Form B V.249" today for the Pub.249 fix:

Fix_{0622}: Calcul.	30°13,8'N	013°55,9'W
Fix_{0622}:Pub249	30°13,4'N	015°56,2'W
Pos_{0622}	30°14,9'N	013°59,2'W

This was a difference of 3,5nm / 283°. The Pub.249 and the calculated fixes show nearly the same position error.

6.2) Compass bearing at true sunset

DR-Position 29°37,6'N 014°56,5'W

Sunset 1744 UTC
λiT 0100
Local 1844 UTC

Sight taken at true sunset **1838UTC** MC = 250°
Classes compass, bearing measured MB = 270°

6.2.a) Simplified version of true sunrise/sunset only

See "True Sunset" in column 3 of form "General Sight Reduction" today: δ = 03°22,9'S

Az = arccos(sin(3°22,9') / cos(29°37,6')) = S86,1°W = 180° + 86,1° = 266,1°

AZ = 266° MB + Dev + Var = Az Dev = Az – Var – MB = 266 + 5 – 270 = +1° = 1°E

6.3) Evening stars

Evening star sights were prepared in "Celestial Day Form" but could not be measured due to clouds.

Image 53 Last sunset on the passage. Arrival was scheduled for the next day.

Celestial Day Form Route Gib-Tenerife Date 1.10.18 Day 6

Time Sync | Error[sec] | ZD (+/- UTC)

Morning

DR-λ 014°W	Nautical Dawn Twilight	Civil	Sunrise	Moonrise
LMT	0502	0530	0554	2239
λiT	0056	0056	0056	0056
GMT	0558	0626	0650	2335

Aries

GHA	
incr.	
λ	
LHA	

Morning Sights

DR-φ 30°N

Name	#	Hc	Az	# IE	WT	Hs	Log
Mirzam			~170°	0'	061417	41°29,6'	39,8(215)
Moon UL				0'	062240	77°07,2'	

LAN Results

DR-λ	Meridian Passage	#	WT	Hs	Log
LMT					
λiT					
GMT					
WT					
Hs					
Log					

Evening

DR-λ 015°W	Moonset	Sunset	Civil Dusk Twilight	Nautical
LMT	1253 (2.10.)	1744	1808	1836
λiT	0100	0100	0100	0100
GMT	1353	1844	1908	1936

Aries

GHA	295° 27,4'
incr.	2° 00,3'
λ	-15°
LHA	282° 27,7'

Evening Sights

DR-φ 29°N

Name	#	Hc	Az	#	WT	Hs	Log
Alphecca		23°51'	069°			clouds	
Antares		23°57'	217°				
Alkaid		29°06'	313°				
ALTAIR		66°33'	146°				
ARCTURUS		25°24'	279°				

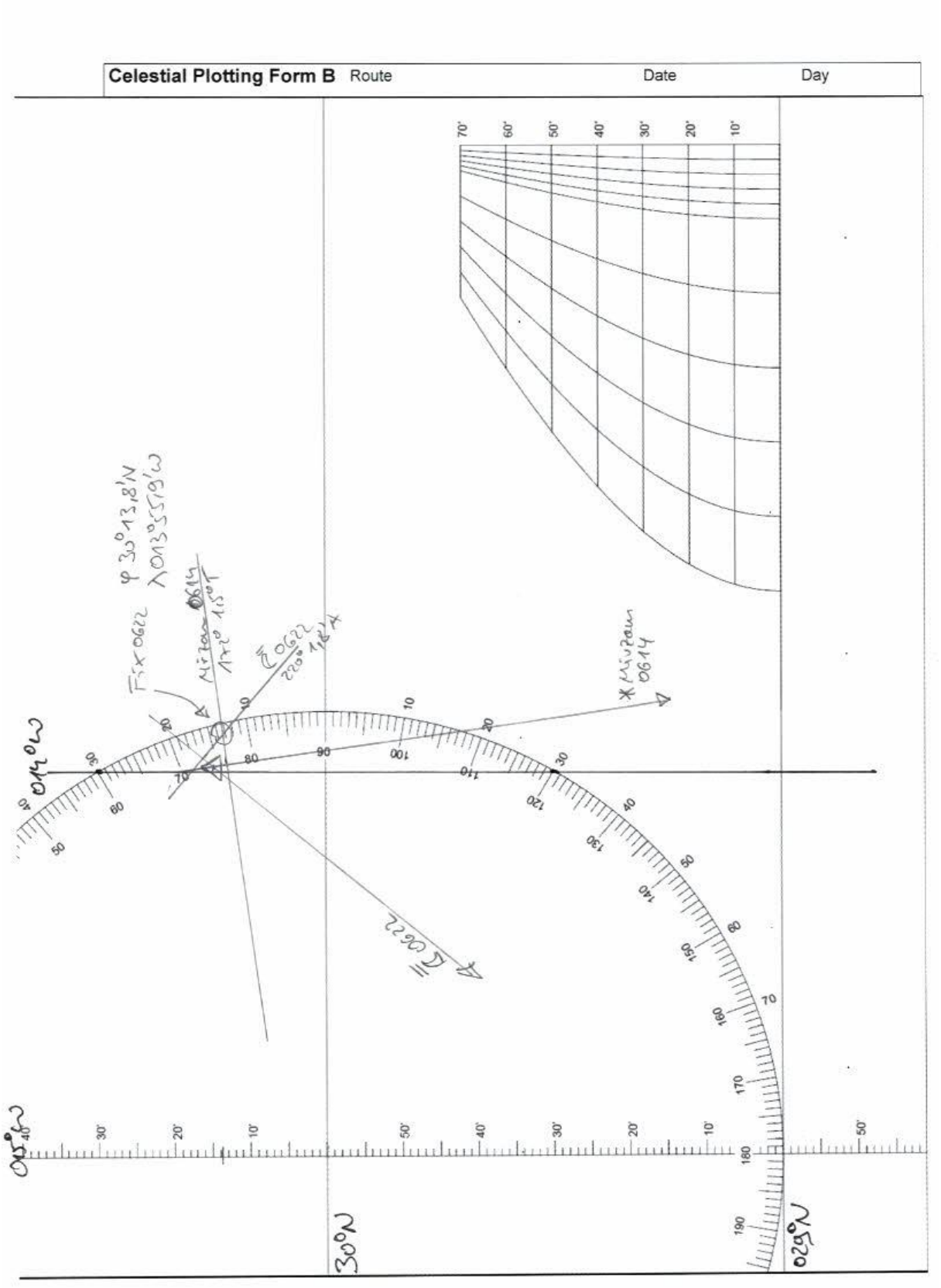
Celestial Day Form – Whole Day Sights – V 1.0 - © R. Zwönitzer – www.zwoenitzer.de

Celestial Day Form containing all observations of the day as well as star predictions for the evening twilight.

	General Sight Reduction	Route Gib-Tenerife		Day 6
	Body	Mirzam (6.1)	(Moon UL (6.1)	True Sunset
Run	Course °			
	SoG [kt]			
	Log / Dist [nm]			
DR	Δφ = cos(C) * D			
	Δλ = sin(C) * D / cos(φ)			
	Lat φ	30° 14,7' N	30° 14,7' N	29° 37,6'
	Lon λ	013° 59,4' W	013° 59,7' W	014° 56,5' W
Date/Time	**Watch** Err ZD			
	UTC	061417	062240	183828
	Date	1.10.18	1.10.18	1.10.18
Local Hour Angel	**GHA$_{body}$ / $_{Aries}$**	099° 55,4'	17° 16,8'	
	incr. (m.s.)	3° 34,8'	5° 24,5'	
	addtl. (v/quant) or SHA$_{Star}$	264° 2,1'	2,7' 7,0	
	GHA	007° 37,3'	22° 44,0'	
	DR λ / a-lon $_{229/249}$	-13° 59,4'	~~-13° 59,7'~~ 008° 44,3'	
	LHA$_{body}$ / $_{Aries}$	353° 37,9'	~~19° 57,4' N~~	
Declination	**Declination** δ (h)		19° 57,4' N	03° 22,3' S
	incr. (d / quant)		1,6' +4,0	+0,6' +1,0
	δ	17° 57,8' S	19° 59,0' N	03° 22,9' S
Sextant	**Sextant** Hs	41° 29,6'	77° 07,2'	
	IE (+ off / - on)	0	0	
	Dib (HE = ft / m)	-2,8'	-2,8'	
	Ha	41° 26,8'	77° 04,4'	
	Corr. all sights	-1,1'	23,4'	
	addtl.(UL moon -30') / HP		+3,6 -30' 58,5'	
T	Ho	41° 25,7'	77 01,4'	
	(Hc$_{tab}$ / d / quant) $_{229/249}$			
A	Hc	41° 24,2'	77° 03,2'	
	Δh (Ho-Hc) a =	1,5' T A	~~2 15,6'~~ 1,8' T A	T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA		LHA < 180°	LHA >= 180°
	tan Az$_r$ = sin LHA / (sin φ * cos LHA – tan δ * cos φ)		< 0 Az=Az$_r$+360° else Az=Az$_r$+180°	< 0 Az=Az$_r$+180° else Az=Az$_r$
	Azimut Az	171,9°	219,6°	
	Position Error	**Course** °	**Distance** nm	
	DR φ =		λ =	
	Δφ =		Δλ =	
	DR φ =		**λ =**	

Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains the two general sight reductions needed today as well as the declination of Sun at true sunset.

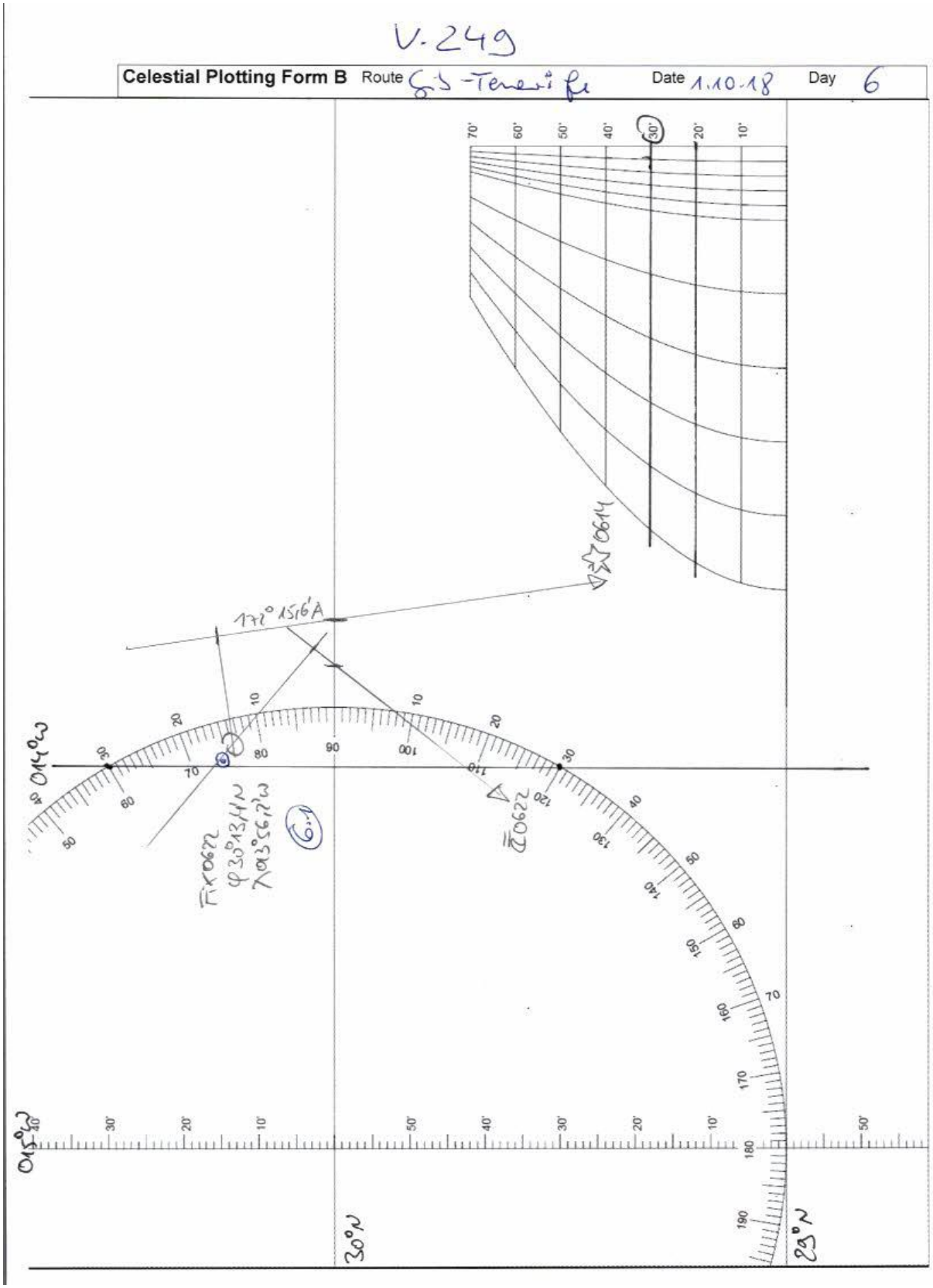


Plotting sheet for fix and its two sights reduced by calculation.

V. 249

	General Sight Reduction	Route GS-Tenerife	Day 6	
	Body	Mirzam (6.1)	Moon UL (6.2)	
Run	Course °			
	SoG [kt]			
	Log / Dist [nm]			
DR	$\Delta\varphi$ = cos(C) * D			
	$\Delta\lambda$ = sin(C) * D / cos(φ)			
	Lat φ	30°14,7'N → 30°N	30°14,7'N → 30°N	
	Lon λ	013°59,7'W	013°59,7'W	
Date/Time	**Watch** Err ZD			
	UTC	06:14:17	06:22:40	
	Date	1.10.18	1.10.18	
Local Hour Angel	**GHA** body / Aries	~~099~~ 099°55,4'	17°16,8'	
	incr. (m.s.)	3°34,8'	5°24,5'	
	addtl. (v/quant) or SHA_{Star}	264°7,1'	+2,7' 7,0	
	GHA	~~007~~ 007°37,3'	22°44,0'	
	DR λ / a-lon 229/249	−13°37,3'	−13°44,0'	
	LHA body / ~~Aries~~	354°	009°	
Declination	**Declination** δ (h)		19°57,4'N	
	incr. (d / quant)		1,6' +4,0	
	δ	17°52,8'S	19°59,0'N	
Sextant	**Sextant** Hs	41°29,6'	~~77~~ 77°07,2'	
	IE (+ off / - on)	0'	0	
	Dib (HE = 45 ~~ft~~ m)	−2,8'	−2,8'	
	Ha	41°26,8'	77°04,4'	
	Corr. all sights	−1,1'	23,4'	
	addtl.(UL moon -30') / HP	/	+3,6 −30 58,5'	
T	Ho	41°25,7'	77°01,4'	
	(Hc_{tab} / d / quant) 229/249	42°39' −60 −58'	76°13' +48 +47	
A	Hc	41°41'	77°05'	
	Δh (Ho-Hc) a =	15,6' ~~T~~ A	3,6' T A	T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA		LHA < 180°	LHA >= 180°
	$\tan Az_r$ = sin LHA / (sin φ * cos LHA – tan δ * cos φ)		< 0 Az=Az_r+360° else Az=Az_r+180°	< 0 Az=Az_r+180° else Az=Az_r
	Azimut Az	172°	219°	

Table contains both general sight reductions needed today for the fix reduced by Pub.249 table lookup.



Plotting sheet for fix and its two sights reduced by Pub.249 table lookup.

Day 7 – 02.10.2018

Day 7 Log

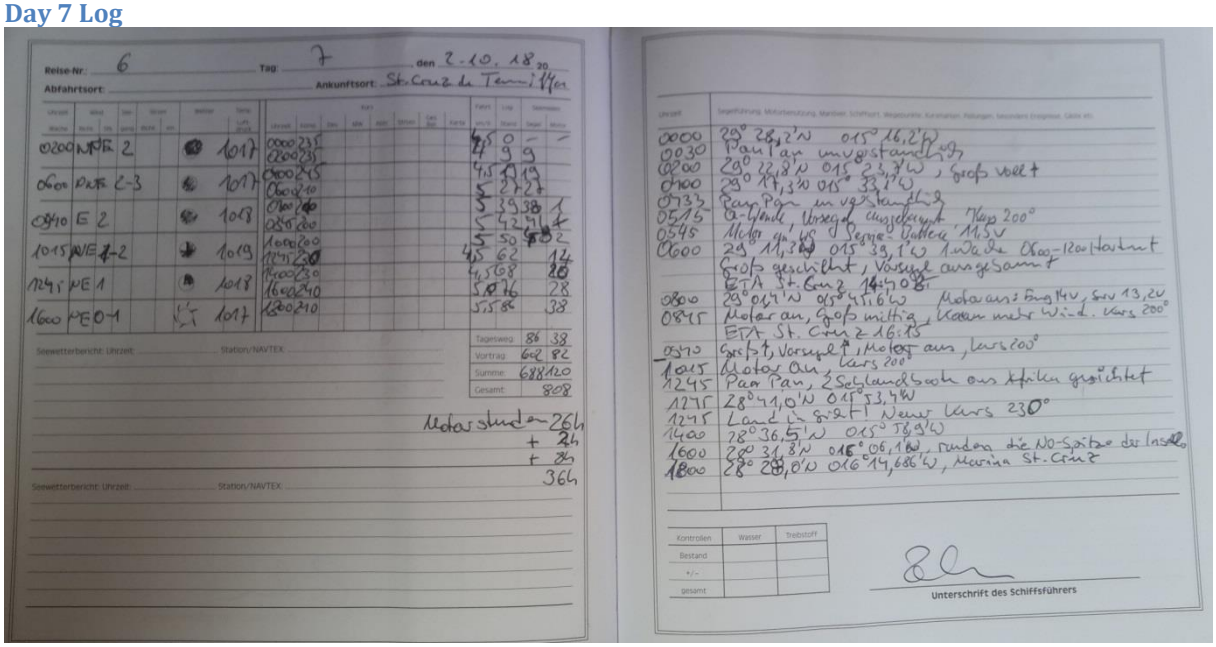


Image 54 Logbook pages 2. October 2018.

Log day 7: *0030* Pan Pan unclear message, could not understand, *0200* main up full, *0433* Pan Pan unclear message, *0515* prevented main and boomed out head sail shifted to 200°T, *0545* engine run because 11,5V, *0600* shifted back, ETA St. Cruz 14:40BT today!, *0800* engine stop 14V/13,2V, *0845* less wind, engine start, head sail in, main sail to center, *0940* engine stop, head and main set again for 200°T, *1015* engine start, maintain 200°T, *1245* Pan Pan, two rubber boats sighted before the African coast, *1245* **LAND!**!! Course set to 230°T, *1600* NE hug of Tenerife rounded, *1800* arrival in Marina St. Cruz de Tenerife.

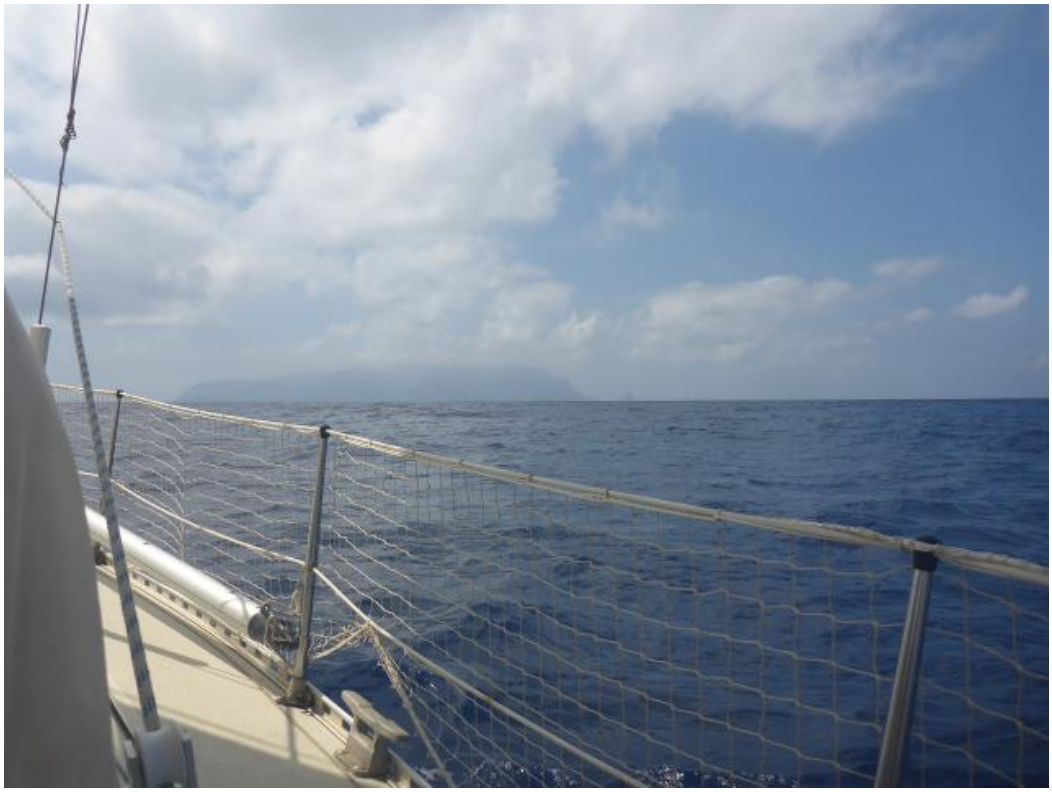


Image 55 NE hug of Tenerife in Passat clouds.

Day 7 Track

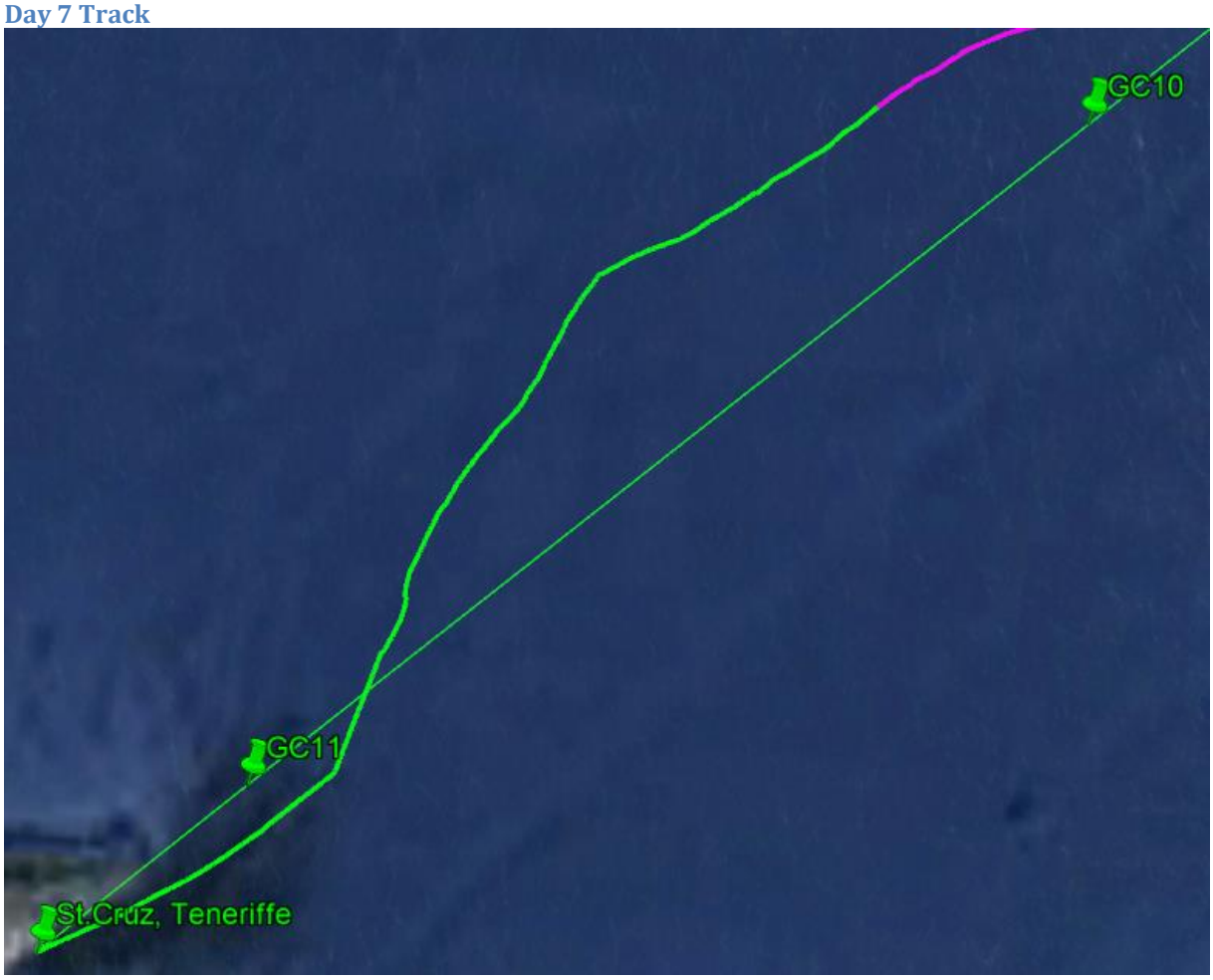


Image 56 Route planned (green thin) and real track (green thick) of day 7. Etmal was 86nm, distance between GC10 and GC11 is 72nm, max XTE 12,4nm.

Image 57 Route planned (green thin) and real track (green thick) of final approach to St. Cruz de Tenerife. Arrival was at day light, so no confusing lights could occur.

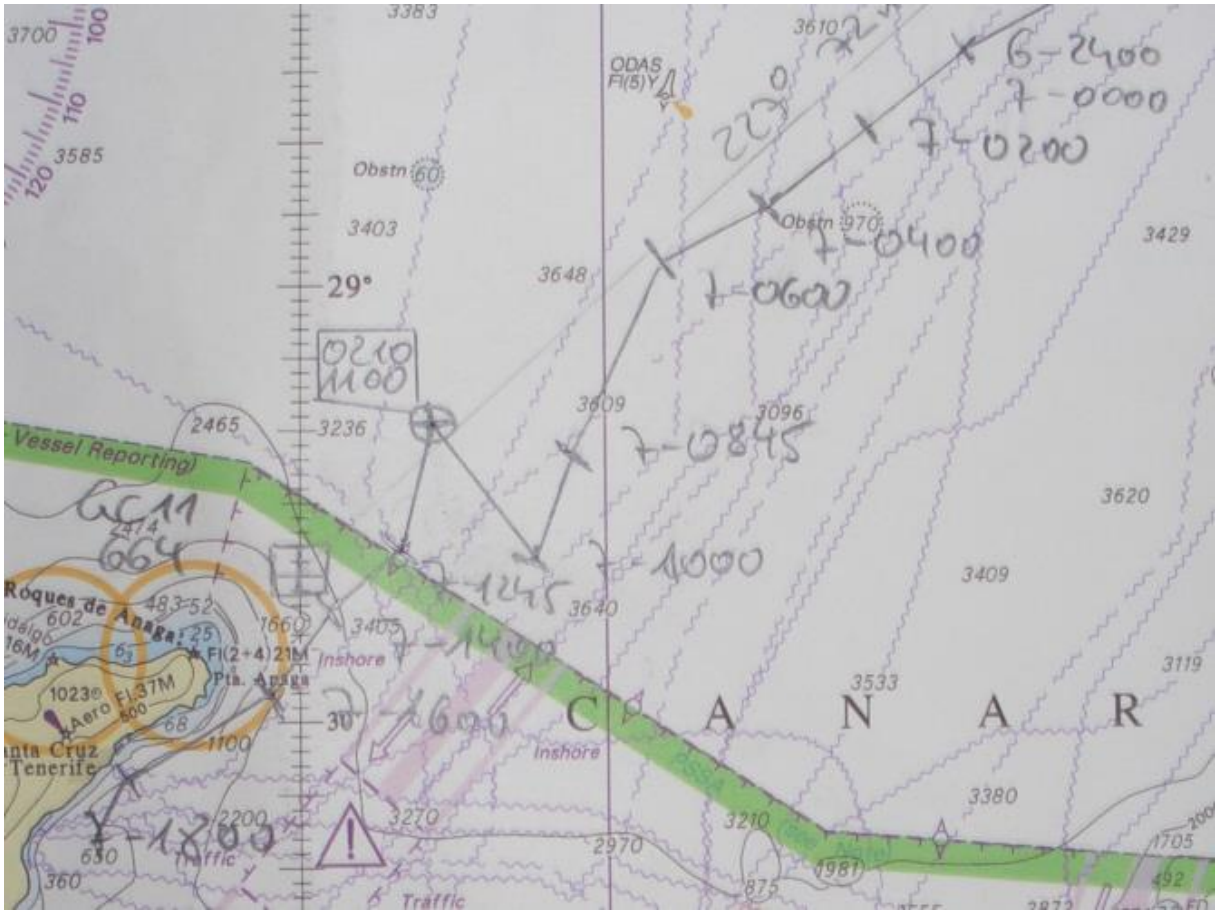


Image 58 Dead reckoning of day 7 started at DR 6-2400. After the major correction fix at 1100BT (1000 UTC) land was sighted at 1245BT and navigation was continued terrestrial.

Day 7 Navigation

7.0) Morning stars

Morning star sights were prepared in “Celestial Day Form B” but could not be measured due to clouds.

Celestial Day Form B Route Gib-Tenerife Date 2.10.18 Day 7.

Time Sync | Error[sec] | ZD (+/- UTC)

	DR-λ 015°50'W	Nautical	Dawn Twilight	Civil	Sunrise	Moonrise
Morning	LMT	0502	0530		0554	
	λiT	010320	010320		010320	
	GMT	060520	063320		065820	
Aries	GHA		100° 54,5'			
	incr.		+8° 21,4'			
	λ		−15° 50,0'			
	LHA		093° 25,9'			

Morning Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#	WT	Hs	Log
	Dubhe	1	33°10'	033°				
	Regulus		32°29'	094°				
	Procyon	2	58°21'	135°				
	Sirius		43°32'	169°				
	Aldebaran		54°50'	246°				

Results	DR-λ	Meridian Passage	#	WT	Hs	Log
	LMT					
	λiT					
	GMT					
	WT					
	Hs					
	Log					

Evening	DR-λ	Moonset	Sunset	Civil	Dusk Twilight	Nautical
	LMT					
	λiT					
	GMT					
Aries	GHA					
	incr.					
	λ					
	LHA					

Evening Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#	WT	Hs	Log
	Rigel	3	50°23'	202°				
	Mirfak	4	52°21'	316°				

Celestial Day Form – Whole Day Sights – V 1.0 - © R. Zwönitzer – www.zwoenitzer.de

Celestial Day Form containing star predictions for the morning twilight.

7.1) Sun & Moon Sight

DR-Pos: 28°50'N 015°50'W IE +0' Log 52,8 TC 195°
Sun LL 095835 Hs 36°53,1' IE +0'
Moon UL 100058 Hs 47°45,4' IE +9,1'

See "Sun LL" in column 1 of form "General Sight Reduction A" today: Az 120,5° 1,0' A
See "Moon UL" in column 2 of form "General Sight Reduction A" today: Az 269,9° 0,1' A

This side reduction was done by calculating and by looking up from the Pub.249 Vol.2

See "Sun LL" in column 1 of form "General Sight Reduction A V.249" today: Az 120° 25,7 T
See "Moon UL" in column 2 of form "General Sight Reduction A V.249" today: Az 270° 25,4' T

Fix1000 from Sun & Moon plotted in form "Celestial Plotting Form B" today for calculated fix and "Celestial Plotting Form B V.249" today for the Pub.249 fix:

Fix_{1000}: Calcul.	28°51,9'N 015°48,7'W
Fix_{1000}:Pub249	28°50,3'N 015°50,1'W
Pos_{1000}	28°48,9'N 015°50,8'W

This was a difference of 3,6nm / 216°. The same difference as the day before and abetter result for the Pub.249 fix. The fix will be used for BT 1100 and the DR will be continued from there, hopefully for the last time.

7.2) Sun & Moon Sight

DR-Pos: 28°40'N 015°55'W Log 60,3 TC 195°
Sun LL 113647 Hs 52°27,2' IE +9,0'
Moon UL 113905 Hs 27°02,2' IE +13,4'

See "Sun LL" in column 1 of form "General Sight Reduction B" today: Az 147,3° 2,2' A
See "Moon UL" in column 2 of form "General Sight Reduction B" today: Az 280,0° 2,6' T

This side reduction was also done by calculating and by looking up from the Pub.249 Vol.2

See "Sun LL" in column 1 of form "General Sight Reduction B V.249" today: Az 147° 12,9 T
See "Moon UL" in column 2 of form "General Sight Reduction B V.249" today: Az 280° 1,7' A

Fix1139 from Sun & Moon plotted in form "Celestial Plotting Form B" today for calculated fix and "Celestial Plotting Form B V.249" today for the Pub.249 fix:

Fix_{1139}: Calcul.	28°40,2'N 015°58,0'W
Fix_{1139}: Pub249	28°41,5'N 015°56,5'W
$Pos_{1139:}$	28°41,4'N 015°53,3'W

This was again a difference below 5nm and therefore inside the supervisors tolerance: 4,6nm / 259° and another win for the Pub 249 Fix.

While I prepared this reduction we sighted land and changed course. So this one is for the audience and not involved in dead reckoning any more.

Celestial Day Form A Route G.C.-Tenerife Date 2.10.18 Day 7

Time Sync | Error[sec] | ZD (+/- UTC)

	DR-λ 015°50'W	Nautical	Dawn Twilight	Civil	Sunrise	Moonrise
Morning	LMT	0502	0530		0554	2337
	λiT	010320	010320		010320	010320
	GMT	060520	063320		065720	004020
Aries	GHA		100°54,5'			
	incr.		+8°21,4'			
	λ		-15°50,0'			
	LHA		093°25,9'			

Morning Sights	DR-φ 28°50'N	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	# IE	WT	Hs	Log
	SUN LL				0	095835	36°53,1'	528 (19,9°)
	MOON UL				9,1'	100058	47°51,4'	
	SUN LL				9,0'	113647	52°27,2'	60,3 (19,5°)
	MOON UL				13,4'	113905	27°02,2'	

LAN / Results	DR-λ	Meridian Passage	#	WT	Hs	Log
	LMT					
	λiT					
	GMT					
	WT					
	Hs					
	Log					

	DR-λ	Moonset	Sunset	Civil	Dusk Twilight	Nautical
Evening	LMT					
	λiT					
	GMT					
Aries	GHA					
	incr.					
	λ					
	LHA					

Evening Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#	WT	Hs	Log

Celestial Day Form – Whole Day Sights – V 1.0 - © R. Zwönitzer – www.zwoenitzer.de

Celestial Day Form containing all observations of the day.

	General Sight Reduction A	Route Gib-Tenerife	Day 7	
	Body			
Run	Course °	SW LL (7.1)	MOON UL (7.1)	
Run	SoG [kt]			
Run	**Log / Dist** [nm]			
DR	Δφ = cos(C) * D			
DR	Δλ = sin(C) * D / cos(φ)			
DR	**Lat φ**	28°50'N	28°50'N	
DR	**Lon λ**	015°50'W	015°50'W	
Date/Time	**Watch** Err ZD			
Date/Time	UTC	095835	100058	
Date/Time	Date	2.10.18	2.10.18	
Local Hour Angel	**GHA$_{body}$ / $_{Aries}$**	317°39,5'	061°07,3'	
Local Hour Angel	incr. (m.s.)	14°38,8'	0°13,8'	
Local Hour Angel	addtl. (v/quant) or SHA$_{Star}$	~~+1,0~~	0' +5,8	
Local Hour Angel	GHA	332°18,3'	061°21,1'	
Local Hour Angel	DR λ / a-lon $_{229/249}$	−15°50'	−15°50'	
Local Hour Angel	**LHA$_{body}$ / $_{Aries}$**	316°28,3'	045°31,1'	
Declination	**Declination** δ (h)	03°36,8'S	21°01,4'N	
Declination	incr. (d / quant)	+1,0' +1,0	0' +0,4	
Declination	δ	03°37,8'S	21°01,4'N	
Sextant	**Sextant** Hs	36°55,1'	47°45,7'	
Sextant	IE (+ off / - on)	0'	+9,1'	
Sextant	Dib (HE = 2,5 ft / m)	−2,8'	−2,8'	
Sextant	Ha	36°50,3'	47°51,7'	
Sextant	Corr. all sights	+15,0	+48,5'	
Sextant	addtl.(UL moon -30') / HP		+4,2-30' 59,0	
T	Ho	37°05,3'	48°14,4'	
	(Hc$_{tab}$ / d / quant) $_{229/249}$			
A	Hc	37°06,8'	48°14,5'	
	Δh (Ho-Hc) a =	1,5' T ~~A~~	0,1' T ~~A~~	T A

	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA	LHA < 180°	LHA >= 180°
	tan Az$_r$ = sin LHA / (sin φ * cos LHA – tan δ * cos φ)	< 0 Az=Az$_r$+360° else Az=Az$_r$+180°	< 0 Az=Az$_r$+180° else Az=Az$_r$
	Azimut Az	170,5°	269,9°

	Position Error	**Course** °	**Distance** nm	
	DR φ =		λ =	
	Δφ =		Δλ =	
	DR φ =		**λ =**	

Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains both general calculated sight reductions needed today for the first fix.

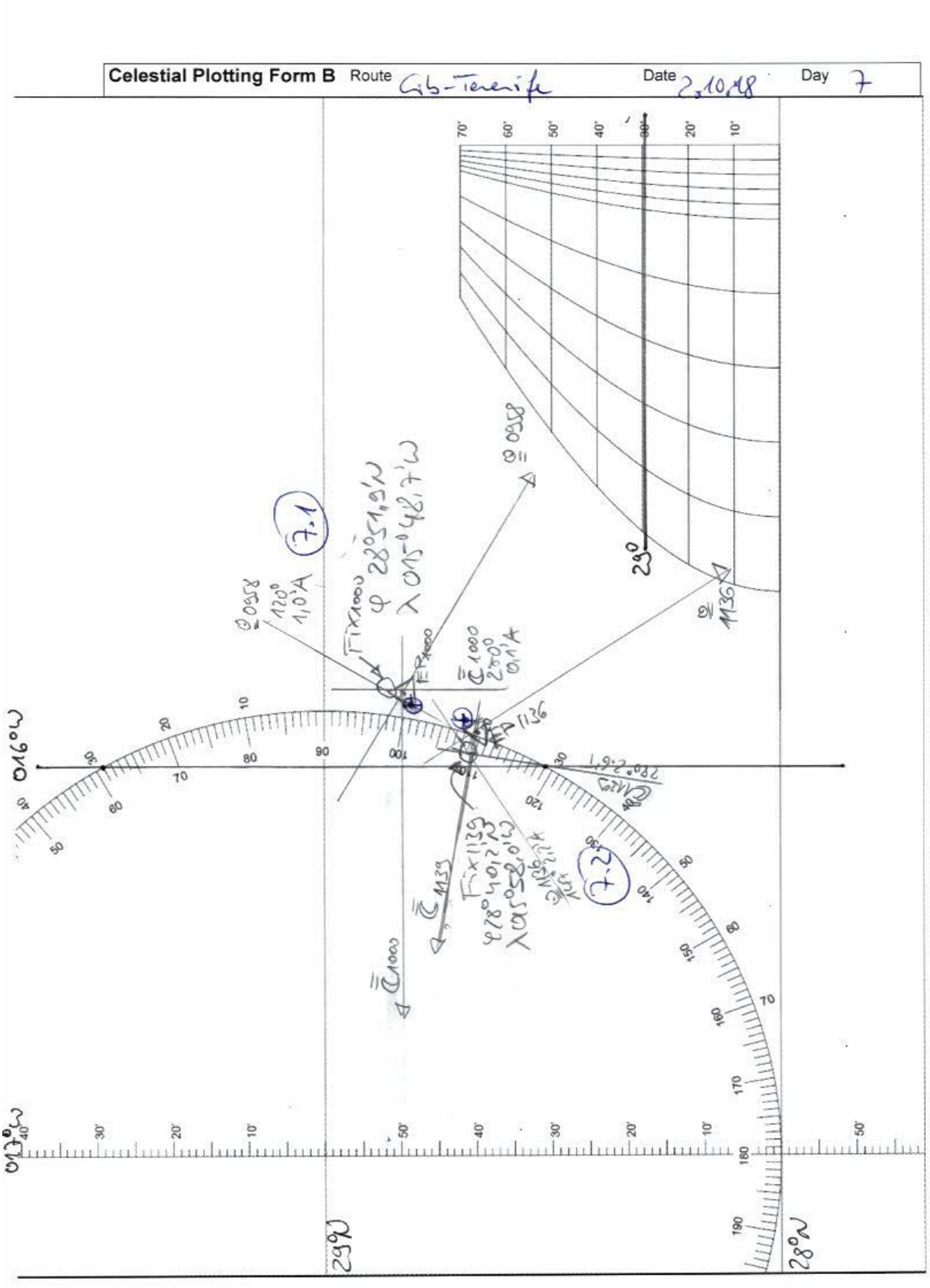
General Sight Reduction 3 Route GC-Tenerife Day 7

	Body	SUN LL(7.2)		MOON UL(7.2)	
Run	Course °				
	SoG [kt]				
	Log / Dist [nm]				
DR	$\Delta\varphi = \cos(C) * D$				
	$\Delta\lambda = \sin(C) * D / \cos(\varphi)$				
	Lat φ	28°40'N		28°40'N	
	Lon λ	015°55'W		015°55'W	
Date/Time	**Watch** Err ZD				
	UTC	113647		113905	
	Date	2.10.18		2.10.18	
Local Hour Angel	$\mathbf{GHA_{body}}$ / $_{\text{Aries}}$	347°39,9'		075°32,1'	
	incr. (m.s.)	+9°11,8'		9°19,5'	
	addtl. (v/quant) or SHA_{Star}	—		+3,9' 5,9	
	GHA	356°51,7'		084°55,5'	
	DR λ / a-lon $_{229/249}$	−15°55'		−15°55'	
	$\mathbf{LHA_{body}}$ / $_{\text{Aries}}$	340°56,7'		069°00,5'	
Declination	**Declination** δ (h)	03°38,7'S		21°01,8'N	
	incr. (d / quant)	+0,6' 1,0		+0,1' +0,2	
	δ	03°39,3'S		21°01,9'N	
Sextant	**Sextant** Hs	52°27,2'		27°02,2'	
	IE (+ off / - on)	+9,0'		+13,4'	
	Dib (HE = 2,5 ft / m)	−2,8		−2,8	
	Ha	52°33,4'		27°12,8'	
	Corr. all sights	+15,5'		+60,1'	
	addtl.(UL moon -30') / HP	—		+44'−30' 59,0	
T	Ho	52°48,9'		27°47,3'	
	(Hc_{tab} / d / quant) $_{229/249}$				
A	Hc	52°51,1'		27°44,7'	
	Δh (Ho-Hc) a =	2,2' T A		2,6' T A	T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA			LHA < 180°	LHA >= 180°
	$\tan Az_r = \sin LHA / (\sin\varphi * \cos LHA - \tan\delta * \cos\varphi)$			< 0 $Az=Az_r+360°$ else $Az=Az_r+180°$	< 0 $Az=Az_r+180°$ else $Az=Az_r$
	Azimut Az	147,3°		280°	

Position Error	**Course** °	**Distance** nm		
DR	φ =		λ =	
	Δφ =		Δλ =	
	DR φ =		**λ =**	

Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains both general calculated sight reductions needed today for the second fix.



Plotting sheet for both fixes and four sights reduced by calculation.

VII. Forms V. 249

	General Sight Reduction	A	Route SJ-Tenerife		Day 7
	Body		SUN (7.1)	MOON (7.2)	
Run	Course °				
Run	SoG [kt]				
Run	**Log / Dist** [nm]				
DR	Δφ = cos(C) * D				
DR	Δλ = sin(C) * D / cos(φ)				
DR	**Lat φ**		28°50'N → 29°N	28°50'N → 29°N	
DR	**Lon λ**		015°50'W	015°50'W	
Date/Time	**Watch** Err ZD				
Date/Time	UTC		09 58 35	10 00 58	
Date/Time	Date		2.10.18	2.10.18	
Local Hour Angel	**GHA$_{body}$ / $_{Aries}$**		317°39,5'	061°07,3'	
Local Hour Angel	incr. (m.s.)		14°38,8'	0°13,8'	
Local Hour Angel	addtl. (v/quant) or SHA$_{Star}$			0' +5,8	
Local Hour Angel	GHA		332°18,3'	061°21,1'	
Local Hour Angel	DR λ / a-lon $_{229/249}$		−16°18,3'	−15°21,1'	
Local Hour Angel	**LHA$_{body}$ / $_{Aries}$**		316°	046°	
Declination	**Declination** δ (h)		03°36,8' S	21°01,4' N	
Declination	incr. (d / quant)		+1,0' +1,0	0' +0,4	
Declination	δ		03°37,8' S	21°01,4' N	
Sextant	**Sextant** Hs		36°53,1'	47°45,4'	
Sextant	IE (+ off / - on)		0'	+9,1'	
Sextant	Dib (HE = ft / m)		−2,8'	−2,8'	
Sextant	Ha		36°50,3'	47°51,7'	
Sextant	Corr. all sights		+15,0'	+48,5'	
Sextant	addtl.(UL moon -30') / HP		/	+4,2 -30' 59,0	
T	Ho		37°05,3'	48°14,4'	
T	(Hc$_{tab}$ / d / quant) $_{229/249}$		37°05' −39 −35	47°49' +20 0	
A	Hc		36°40'	47°49'	
	Δh (Ho-Hc) a =		120° 25,7' T A	25,4' T A	T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA			LHA < 180°	LHA >= 180°
	tan Az$_r$ = sin LHA / (sin φ * cos LHA – tan δ * cos φ)			< 0 Az=Az$_r$+360° else Az=Az$_r$+180°	< 0 Az=Az$_r$+180° else Az=Az$_r$
	Azimut Az		120°	270°	
	Position Error	**Course** °	**Distance** nm		
	DR φ =			λ =	
	Δφ =			Δλ =	
	DR φ =			**λ =**	

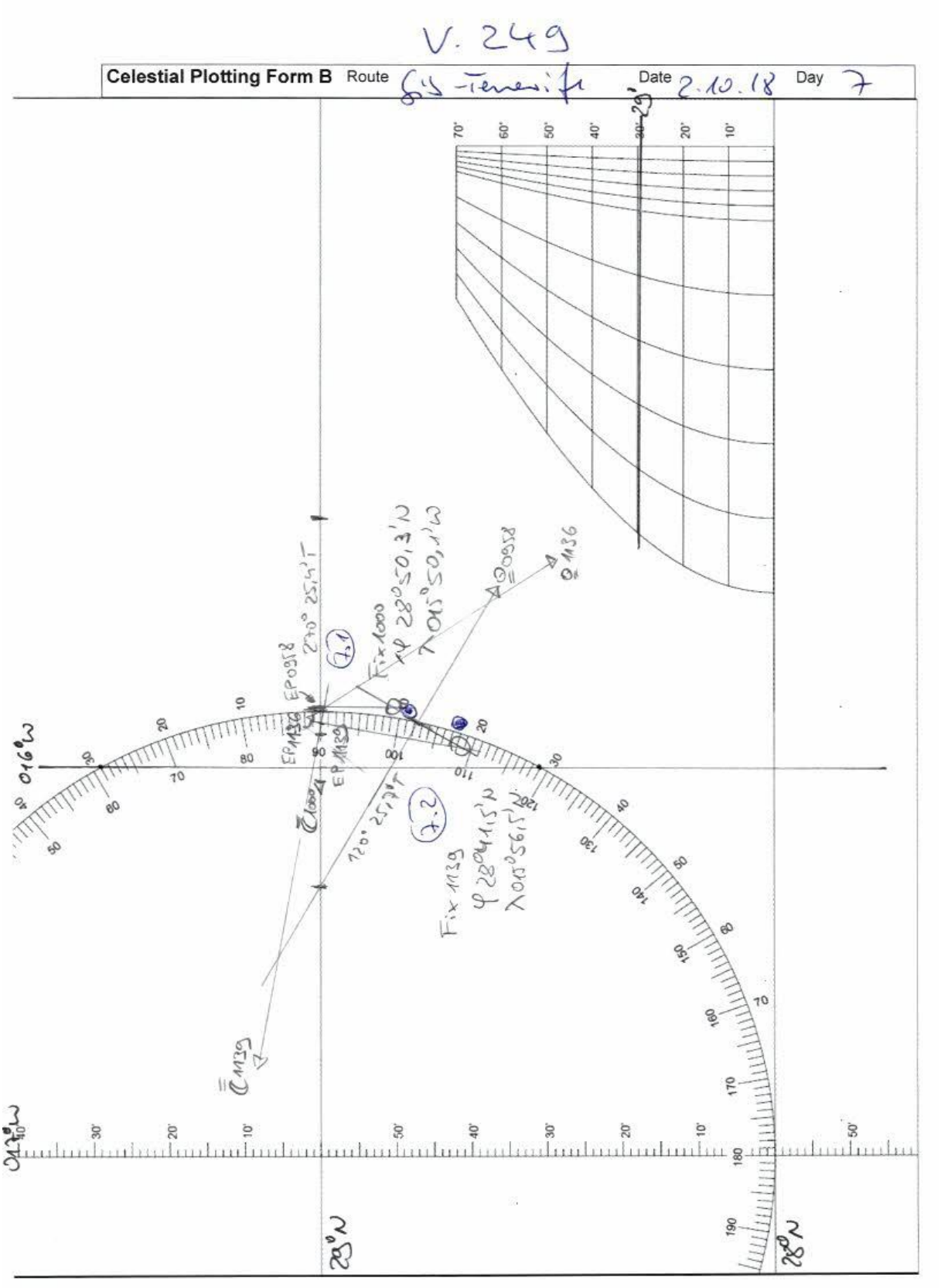
Celestial Sight Reduction – 3 running fix – V 1.3 - © R. Zwönitzer – www.zwoenitzer.de

Table contains both general sight reductions needed today for the first fix and reduced by Pub.249 table lookup.

V. 249

	General Sight Reduction	B Route Gib - Tenerife		Day 7
	Body	Sun LL (7.2)	Moon UL (2.2)	
Run	Course °			
	SoG [kt]			
	Log / Dist [nm]			
DR	$\Delta\varphi$ = cos(C) * D			
	$\Delta\lambda$ = sin(C) * D / cos(φ)			
	Lat φ	38°40'N → 29'N	38°40'N → 29'N	
	Lon λ	015°55'W	015°55'W	
Date/Time	**Watch** Err ZD			
	UTC	113647	113905	
	Date	2.10.18	2.10.18	
Local Hour Angel	**GHA$_{body}$ / $_{Aries}$**	337° 39,9'	085° 32,1'	
	incr. (m.s.)	9° 11,8'	9° 19,5'	
	addtl. (v/quant) or SHA$_{Star}$	/	+3,9' 5,9	
	GHA	356° 51,7'	084° 55,5'	
	DR λ / a-lon $_{229/249}$	-15° 51,7'	-15° 55,5'	
	LHA$_{body}$ / $_{Aries}$	341°	069°	
Declination	**Declination** δ (h)	03° 38,7'	21° 01,8'N	
	incr. (d / quant)	0,6' 1,0	+0,1' 0,2	
	δ	03° 39,3'	21° 01,9'N	
Sextant	**Sextant** Hs	52° 27,2'	27° 02,2'	
	IE (+ off / - on)	+9'	+13,4'	
	Dib (HE = 2,5 ~~ft~~/ m)	-2,8'	-2,8'	
	Ha	52° 33,4'	27° 12,8'	
	Corr. all sights	+15,5'	+60,1'	
	addtl.(UL moon -30') / HP	/	+4,4 -30' 59,0	
T	Ho	52° 48,9'	27° 47,3'	
	(Hc$_{tab}$ / d / quant) $_{229/249}$	53° 10' -52 -34'	27° 48' +23 1'	
A	Hc	52° 36,0'	27° 49,0'	
	Δh (Ho-Hc) a =	12,9' T A	1,7' T A	T A
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA		LHA < 180°	LHA >= 180°
	tan Az$_r$ = sin LHA / (sin φ * cos LHA – tan δ * cos φ)		< 0 Az=Az$_r$+360° else Az=Az$_r$+180°	< 0 Az=Az$_r$+180° else Az=Az$_r$
	Azimut Az	~~213°~~ 147°	280°	

Table contains both general sight reductions needed today for the second fix and reduced by Pub.249 table lookup.



Plotting sheet for both fixes and four sights reduced by Pub.249 tables.

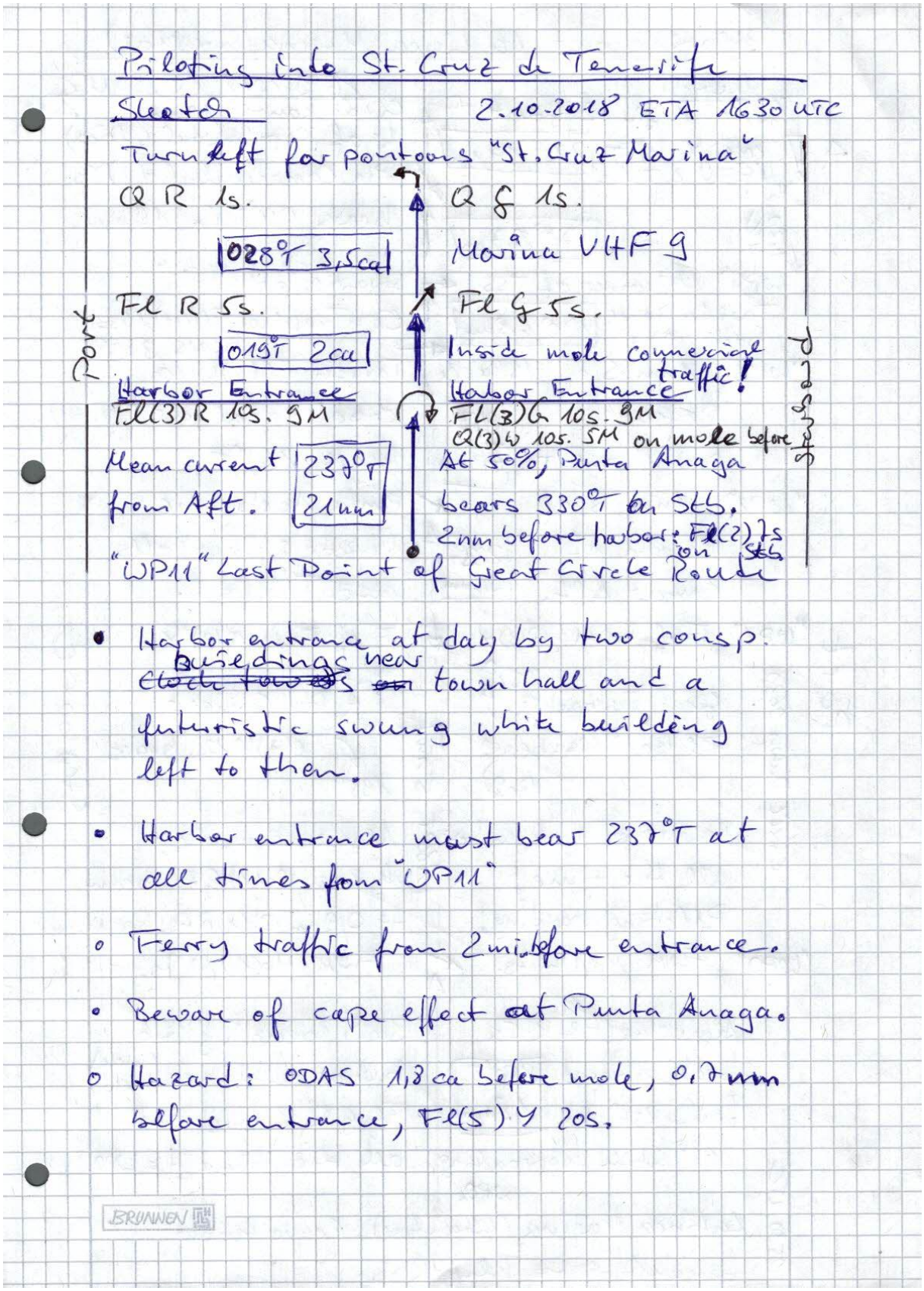


Image 59 Piloting sketch used into St. Cruz.

Discussion

It was a pleasant trip, with nearly no rain and good winds but for two days, when the engine must be started a couple of times. Wind and waves came from astern the complete time, we ran over the total distance shifting along the route. We could follow the passage plan in detail and every pre calculation proofed as correct. Especially the leg out if Gibraltar was exactly as planned but because of the strong wind we saved nearly four hours. We arrived one day earlier at Tenerife than scheduled without any problems on the way.

Sailing on the run needed to rig a butterfly. Two blocks were mounted at the bow at either side and two long ropes with more than double the boats length (25m.) were permanently in use on both sides, each going through its block. They were used as preventer for the main sail on one side and as foreguy for the boomed out head sail on the other side. This setup has the advantage, that one can swap sails for a shift with one walk around the deck. First luff up to a beam reach and sheet in the head sail. Release foreguy and preventer and make your way to the bow with the loose end of the preventer. At the bow, swap them both, the old foreguy is the new preventer now. Bring over the head sail and boom to the other side and come back into the cockpit with the loose end of the new preventer on the new lee side. Attach it to the main boom and complete the tack to the other beam reach. Lash preventer and foreguy before bearing away on the new run.

The 4 hour watch system was to exhausting, since one has to do the night with only four hours of sleep in between, while the other one has to get up for only 4 hours. We switched to a 6 hour alternating watch system, where everyone has half of a night to be awake. This was much better.

The water was more than enough and the other victualing proofed also as sufficient. The preparation was good, nothing was left before, overseen the giant mess the shipyard produced prior to departure. Any ideas and improvements worked well, most of all the Wind vane. When adjusted correctly it is the best invention since sliced bread.

A little disappointing was the performance of the silent wind generator. When rotating in a normal 3-4, it does not produce enough energy to recharge the batteries. It needs at least a 5-6 to generate a significant electrical output and its 300W might be produced from 35kt and up. When running, relative wind is less than on a reach, what might have enforced the problem additionally. We had to switch of the fridge and let the engine run for at least 1-2 hours a day. But that was also as planned in the electrical calculation above.

We must mention the physical strain when running flat before the wind for days on such a small boat. When reaching, one side is down, the other up and the waves coming from the side might turn the hull some degrees but the main side to lean on or to put things away stays the same. Not on the run. The waves passing from astern were long and only two or three found their way into the cockpit. The problem was the permanent rolling from one side to the other, which intensifies with a shorter length and a smaller displacement. A bigger boat will not be pushed from one side to the other like that. But on the other hand, that was what we wanted to discover: how an Atlantic journey felt in the last decades, when the first blue water passages where sailed. These unpredictable movements for 20 or more days and you will either love your boat or sink it. Fascinating!

Image 60 Skip and owner at the final destination Las Galetas.

Two attempts were made to perform star sights and reduce them by Pub.229 tables but could not be completed due to a cloudy sky. The tables were used at least to precalculate the estimated values for the twilight. The only star sight performed was Mirzam whose values were looked up in a star finder so he is not listed with the popular stars section.

The miles run for the running fixes were taken from the plotter, not from the log-device, since this one does what every log does, it was wrong. Moreover the log on Nica showed 0kts most of the time, although (or because) they were new and installed right before departure, maybe another problem left over from the shipyard? It does not matter how often we cleaned it, it was unreliable. So I decided to “cheat”, what is also the reason that no current was used for running fixes but only the sailed distances. Those were values over ground and needed not be corrected with an estimated current. However the dead reckoning was done in the chart as if they would be water values.

The scheme to be a skipper uninformed about the real position succeeded but it was very frustrating at the beginning. The position errors between the celestial fixes and the real positions were too big. Until the reason for the mistakes had been found, it would have been too dangerous using them for navigation alone. The last three days, the negotiated scheme worked fine, since the sights then were below the alarm threshold of 5 nm.

However the dead reckoning could be continued without falling back to an electronic fix but for the second day. After passing the strait of Gibraltar, a GPS fix was used at midnight to start day 2. Thereafter each new day began with the final DR of the day before. Celestial fixes where used to get the DR track back on the right way. Even if this was not the real position, at the end it shows that it was a good decision to use the fixes at all the time. Obviously celestial positions need to be regarded with patience and should never been thrown away. Errors that might be big from near, may be far less worse when looked on from far away. The over all result was completely satisfying: we found Tenerife after four days of celestial navigation.

When trying to do the two-body fixes without a run, Sun and Moon raised in a difficult constellation during the four days possible. When both had a reasonable height above the horizon to make good measurement, they both stood nearly opposite to each other, with an azimuthal difference of approx. 180°, resulting in nearly parallel position lines that intersected on the oven but on the plotting form. So I had the choice between pest or cholera, either a bad intersection angle or a low and inaccurate height. I decided the moon to be low, since it does not produce reflections like the sun does.

The sextant Mark 15 by Davis has to be handled with special attitude. First of all, adjust it daily. All three errors change rapidly. The index error changes over the day by some ten minutes. Even directly before and after a sight 5 to 10 minutes difference is not rare. The reason might be an inaccurate manufacturing of the bearing of the index arm or maybe it is worn. (The sextant was used when it was purchased. A calibration table is also missing.) The clamp sometimes does not snap in between the teeth and shall be moved slightly to do so every time it is released. The telescope has such a small field of view, that a measurement on a rolling boat needs very much experience and practice. The body is hardly to hold visible during the sight. It has also a semi-mirror not a translucent one. All of those are no big problems, but they add up to a significant error and if only one topic is not ideal, the error raises and beams you into another country. On the other hand, it is a robust device for a remarkably low price, used below 200,-€. The next time I would decide for a Mark 25, which has a translucent horizon mirror. Putting all together, the measurements were in the ranges expected and good enough to find the next island where one could buy a new GPS.

Forms

This section contains the pro forms used for planning and navigating. They are self-made to reflect the special needs of this journey and as well as the author's needs.

1. Celestial Day Form

   This form collects all celestial observations during each day. It is appended by one or more of the following forms.

2. General Sight Reduction (all bodies)

   A form for sight reductions of three bodies along with a running fix.

3. Special Sight Reduction (LAN and Polaris)

   A form for sight reductions of two bodies, one at LAN and one the Polaris along with a running fix.

4. Celestial Plotting Form B (derived from Starpath)

   Plotting form with greater detail.

	Celestial Day Form Route				Date			Day
	Time Sync			Error[sec]	ZD (+/- UTC)			
Morning	DR-λ	Nautical	Dawn Twilight	Civil	Sunrise		Moonrise	
	LMT							
	λiT							
	GMT							
Aries	GHA							
	incr.							
	λ							
	LHA							
Morning Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#	WT	Hs	Log
LAN	DR-λ	Meridian Passage			#	WT	Hs	Log
	LMT							
	λiT							
	GMT							
Results								
	WT							
	Hs							
	Log							
Evening	DR-λ	Moonset		Sunset	Civil	Dusk Twilight	Nautical	
	LMT							
	λiT							
	GMT							
Aries	GHA							
	incr.							
	λ							
	LHA							
Evening Sights	DR-φ	Prediction (stars / planets)			Sights (all bodies)			
	Name	#	Hc	Az	#	WT	Hs	Log

	General Sight Reduction Route			Day
	Body			
Run	Course °			
Run	SoG [kt]			
Run	**Log / Dist** [nm]			
DR	Δφ = cos(C) * D			
DR	Δλ = sin(C) * D / cos(φ)			
DR	**Lat φ**			
DR	**Lon λ**			
Date/Time	**Watch** Err ZD			
Date/Time	UTC			
Date/Time	Date			
Local Hour Angel	**GHA_{body} / $_{Aries}$**			
Local Hour Angel	incr. (m.s.)			
Local Hour Angel	addtl. (v/quant) or SHA_{Star}			
Local Hour Angel	GHA			
Local Hour Angel	DR λ / a-lon $_{229/249}$			
Local Hour Angel	**LHA_{body} / $_{Aries}$**			
Declination	**Declination** δ (h)			
Declination	incr. (d / quant)			
Declination	δ			
Sextant	**Sextant** Hs / SA			
Sextant	IE (+ off / - on)			
Sextant	Dib (HE = ft / m)			
Sextant	App alt			
Sextant	Corr. all sights			
Sextant	addtl.(UL moon -30') / HP			
T	Ho			
	(Hc_{tab} / d / quant) $_{229/249}$			
A	Hc			
	Δh (Ho-Hc) a =	**T A**	**T A**	**T A**
	sin Hc = sin φ * sin δ + cos φ * cos δ * cos LHA		LHA < 180°	LHA >= 180°
	tan Az_r = sin LHA / (sin φ * cos LHA – tan δ * cos φ)		< 0 $Az=Az_r+360°$ else $Az=Az_r+180°$	< 0 $Az=Az_r+180°$ else $Az=Az_r$
	Azimut Az			
	Position Error	**Course °**	**Distance nm**	
	DR φ =		λ =	
	Δφ =		Δλ =	
	DR φ =		**λ =**	

	Special Sight Reduction Route			Day
	Body	**LAN (Sun)**	**Body**	**Polaris**
Run	Course °		Course °	
	SoG [kn]		SoG [kn]	
	Log / Dist [nm]		**Log / Dist** [nm]	
DR	Δφ = cos(C) * D		Δφ = cos(C) * D	
	Δλ = sin(C) * D / cos(φ)		Δλ = sin(C) * D * cos(φ)	
	Lat φ		**Lat φ**	
	Lon λ		**Lon λ**	
Date / Time	MerPass (T) LMT		Watch	
	λiT		Err / ZD	
	UTC		UTC	
	Date		Date	
Lcl. Hr Angel			**GHA$_{Aries}$**	
			incr. (m.s.)	
			DR λ	
			LHA$_{Aries}$	
Declination	**Declination** δ (h)		a0 (from LHA)	
	incr. (d / quant)		a1 (from DR φ)	
	δ		a2 (from month)	
Sextant	**Sextant** Hs /SA		**Sextant** Hs /SA	
	IE (+ off / - on)		IE (+ off / - on)	
	Dib (HE = ft / m)		Dib (HE = ft / m)	
	App alt		App alt	
	Corr. all sights		Corr. all sights	
	Ho		Ho	
	ZD = 90° - Ho (*)			
	φ = ZD + δ		**φ = Ho–1° + a0 + a1 + a2**	

	Position Error	**Course °**	**Distance nm**		
	DR φ =			λ =	
	Δφ =			Δλ =	
	DR φ =			**λ =**	

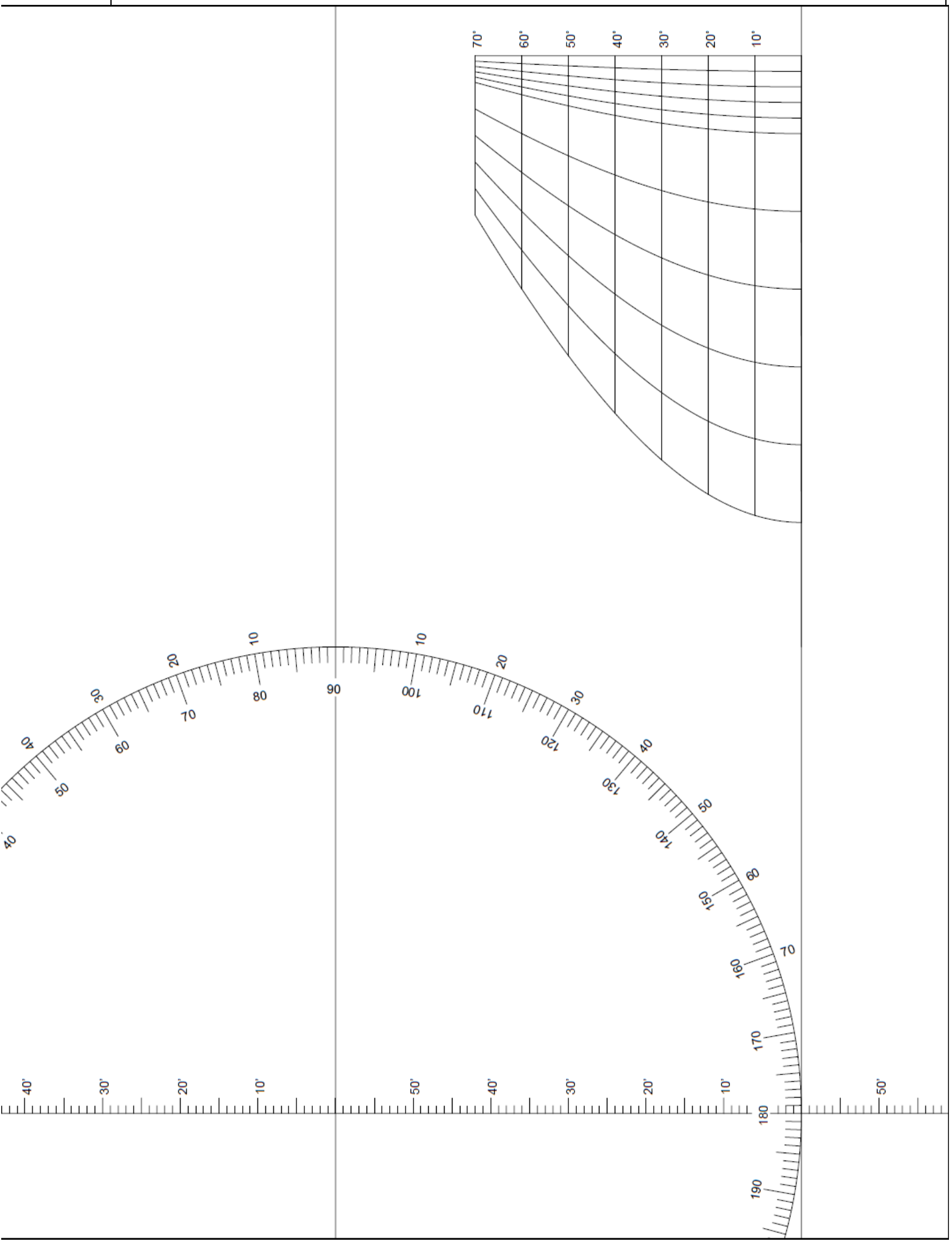
(*) ZD ist negative if GP is north of DR, positive else.

- All S-values get a – sign (are counted negative), all N-values get a + sign, are treated positive.
- If the body is sighted in the Northmeridian (observer (DR) is S of body (GP)), the ZD gets a – sign (is treated negative). If the body is sighted in the Southmeridian (observer (DR) is N of body (GP)), ZD gets a + sign (is treated positive).
- If calculated **φ = ZD + δ** is positive, it is a N-latitude, otherwise it is a S-latitude.

Celestial Sight Reduction – special running fixes – V 1.1 - © R. Zwönitzer – www.zwoenitzer.de

Forms -

Celestial Plotting Form B Route Date Day



Images

Image 1 Preventer for both sides, a rock solid wind vane and long waves from astern on the run– Atlantic. 1
Image 2 Bilge with oily water - nobody wants to see this. 4
Image 3 shows the complete passage round the Atlantic Ocean. 6
Image 4 Pilot chart of for the area of passage. Two wind roses marked for the Spanish coast and the NE Passat region off the African coast. For details see Passage Planning below. 8
Image 5 The distances of the passage: 720nm complete distance (purple), 274nm more than 50nm off the African cost and any island (green). 50nm distances in red. 10
Image 6 Comfortina 32 “Nica” in Spain, January 2018, still with lots of room for improvements. 11
Image 7 Nicas lateral plan, a fin keel with sail drive and a spade rudder protected by a small skeg. .. 12
Image 8 Risk severity matrix used. 12
Image 9 Navigation table of Nica after improvements. 15
Image 10 Water for the Atlantic. 16
Image 11 Provisioning for two and 14 days. 17
Image 12 Route out of Gibraltar, length 47nm to WP6, which will be the start of the passage to Tenerife. 22
Image 13 Great circle route (green) compared to Rhumb Line route, no significant difference. 24
Image 14 Passage Plan Page 1 26
Image 15 Passage Plan Page 2 27
Image 16 Passage Plan Page 3 28
Image 17 Passage Plan Page 4 29
Image 18 Rhumb Line passage through the Atlantic from Gibraltar to Tenerife. Harbors of refuge are shown orange. 30
Image 19 List of lights in the Atlantic for the first part from Gibraltar to Safi. 31
Image 20 List of lights in the Atlantic for the second half from Safi to Tenerife. 32
Image 21 Map view shows the NW corner of the TSS (WP Tenerife TSS), marked yellow, from where a course of 256° leads after 28nm to the entrance of St. Cruz. Do always maintain a course greater than 225° from Tenerife TSS to not enter the TSS accidently. 33
Image 22 Image shows the main approach to St. Cruz beginning at Tenerife TSS with the light of Punta de Anaga Fl(2+4) bearing 260° in 20nm and at day Punta de Antequera in 070° also within 20nm. It shall be at beam stb after 20,5nm on the way to St. Cruz. 34
Image 23 Image shows the entrance to St. Cruz Marina at the upper right end of the main harbor (marked yellow). 34
Image 24 shows the complete harbor of St. Cruz de Tenerife. 35
Image 25 shows all local lights for the approach to the marina. 36
Image 26 Local lights inside the big northern basin (for orientation only), no arrival planned here. 37
Image 27 showing the complete track from day 2 to day 7 with celestial fixes (yellow) and the according real positions (red). 39
Image 28 Logbook pages 26. September 2018. 40
Image 29 Leaving Gibraltar shows clearly, why the clouds are moving over the top of the hill. 40
Image 30 Route planned (yellow) and real track (green) out of Gibraltar. WP6 is identical with the first waypoint GC1 on the passage route. 41
Image 31 Route planned (green thin) and real track (green thick) of day 1. Etmal was 103nm (in 17,5 hours!), distance between GC1 and GC2 is 55nm, max XTE 2,4nm. 41
Image 32 Piloting sketch used out of Gibraltar. 42
Image 33 Dead reckoning of day 1 starting at 1500BT after passing the strait of Gibraltar. 43
Image 34 Logbook pages 27. September 2018. 43
Image 35 Route planned (green) and real track (yellow) of day 2. Etmal was 120nm, distance between GC2 and GC3 is 63nm, max XTE 7,8nm. 44
Image 36 Dead reckoning of day 2 started at fix 2-0000 with a fix at 1704BT (1604 UTC) 44
Image 37 Celestial navigation at Nica is sophisticated even with “no waves”. 45
Image 38 Logbook pages 28. September 2018. 52
Image 39 Route planned (green) and real track (red) of day 3. Etmal was 102nm, distance between GC4 and GC5 is 65nm, max XTE 7,4nm. 52
Image 40 Dead reckoning of day 3 started at DR 2-2500 with a fix at 1554BT (1454 UTC) 53
Image 41 Logbook pages 29. September 2018. 58
Image 42 Preventer rig of Nica. 58
Image 43 This track shows the alarming event at night with the maneuver of the last moment to starboard at 0204 board time. 59
Image 44 Route planned (green) and real track (cyan) of day 4. Etmal was 103nm, distance between GC5 and GC6 is 66nm, max XTE 11,0nm. 60

Images -

Image 45 Dead reckoning of day 4 started at DR 3-2400 with a fix at 1519BT (1419 UTC) 60
Image 46 Logbook pages 30. September 2018. 66
Image 47 Boomed out head sail on Nica. 66
Image 48 Route planned (green) and real track (brown) of day 5. Etmal was 130nm, distance between GC7 and GC8 is 68nm, max XTE 10,2nm. 67
Image 49 Dead reckoning of day 5 started at DR 4-2400 with a small correction fix at 1203BT (1103 UTC) 67
Image 50 Logbook pages 1. October 2018. 72
Image 51 Route planned (green) and real track (purple) of day 6. Etmal was 126nm, distance between GC9 and GC10 is 70nm, max XTE 9,5nm. 72
Image 52 Dead reckoning of day 6 started at DR 5-2400 with a small correction fix at 0722BT (0622 UTC) 73
Image 53 Last sunset on the passage. Arrival was scheduled for the next day. 74
Image 54 Logbook pages 2. October 2018. 80
Image 55 NE hug of Tenerife in Passat clouds. 80
Image 56 Route planned (green thin) and real track (green thick) of day 7. Etmal was 86nm, distance between GC10 and GC11 is 72nm, max XTE 12,4nm. 81
Image 57 Route planned (green thin) and real track (green thick) of final approach to St. Cruz de Tenerife. Arrival was at day light, so no confusing lights could occur. 81
Image 58 Dead reckoning of day 7 started at DR 6-2400. After the major correction fix at 1100BT (1000 UTC) land was sighted at 1245BT and navigation was continued terrestrial. 82
Image 59 Piloting sketch used into St. Cruz. 92
Image 60 Skip and owner at the final destination Las Galetas. 93

Tables

Table 1 Versioning of document. 2
Table 2 shows all hazards identified with its severity resulting from combined likelihood and consequence. Result shows the new assessment after actions taken or changes applied. . 14
Table 3 shows the approx. power consumption of Nica. (** for Mer see energy strategies below) 17
Table 4 shows a generalized way out of Gibraltar to a point south of the TSSs and W of the African coast. 21
Table 5 Twilights in Gibraltar. 22
Table 6 Possible departures from Gibraltar. * Favorable departures are with dawn around departure. Times are not local time, add 1h for DST. 23
Table 7 Great circle route 23
Table 8 shows the linear interpolated times for rise, set and twilights of sun on the proposed route. .. 24
Table 9 4 hour watch system for two. 25
Table 10 8 hour watch system for two. 25
Table 11 shows harbors of refuge in the Atlantic part of the passage. 30
Table 12 shows the list of lights in the Atlantic for the first half from Gibraltar to Safi. 31
Table 13 shows the list of lights in the Atlantic for the second half from Safi to Tenerife. 32
Table 14 shows the list of lights in the Canary Islands. 32
Table 15 Twilights in St. Cruz de Tenerife. 37
Table 16 shows the hours and distances run each day. 38
Table 17 shows an overview of all celestial sights taken during the passage. 39

Literature

WEB Links

1. Comfortina : https://www.comfortina.de/comfortina-32.html , last viewed 20.5.2018
2. Currents in the Strait of Gibraltar: http://www.windtarifa.com/eng/anavegar/corrientes/currents.htm , last viewed 23.5.2018
3. GPS Babel, translating geo data between different devices : https://www.gpsbabel.org/ last viewed 1.7.2018
4. Nautic Tools http://www.nautictools.de , last viewed 1.7.2018
5. GPX Manager 1.3 – Tool for managing GPX files like tracks or routes …ToDo WEB link.
6. Time and Date for sun and moon : https://www.timeanddate.com , last viewed 21.8.2018
7. Forecasts for tides : http://marine.meteoconsult.co.uk/marine-weather-forecast , last viewed 21.8.2018

Books and Articles

1. David Burch
   Celestial Navigation
   Starpath, Seattle, 2017
2. Jimmy Cornell
   Segelrouten der Welt (World Cruising Routes)
   Delius Clasing, Bielefeld, 2014
3. Jimmy Cornell
   Segeln über Ozeane (Sailing Oceans)
   Delius Clasing, Bielefeld, 2003
4. Tom Cunliffe
   The Complete Ocean Skipper
   Adlard Coles Nautical, London / New York, 2016
5. Anne Hammick
   Atlantic Islands
   Imray Laurie Norie & Wilson Ltd, Cambridgeshire, 1994
6. Pat Langley-Price, Philip Ouvry
   Ocean Yachtmaster
   Adlard Coles Nautical, London / New York, 3rd Edition 2013
7. Pat Langley-Price, Philip Ouvry
   Ocean Yachtmaster Exercises
   Adlard Coles Nautical, London / New York, 2006
8. National Geospatial-Intelligence Agency
   Sight Reduction Tables for Air Navigation
   Pub. No. 249, Vol. 1, Epoch 2015-2020
9. Chris Tibbs
   Weather Handbook. Northern Hemisphere Edition
   RYA, Southampton, 2005
10. Towler, Fishwick (Edts)
    Reeds Nautical Almanac
    Bloomsbury, New York, 2017
11. United Kingdom Hydrographic Office
    Nautical Almanach
    Snowball Publishing, 2017

Appendices

Appendix A - Out Take - Piloting into Gibraltar

This chapter is left in the document for clarification only. After engine repair, the owner had to do this piloting into Gibraltar on his own. However the information prepared was useful for him either.

- Time zone in Gibraltar UT-01 (CET), subtract 1h from local Standard Time for UTC
- Zonetime is UTC+1, add 1h to UTC for local Standard Time as in Spain.
- Up to end of October DST is effective with UTC+2 (CEST).

All tables are given in ZT (UTC+1), so add 1h for local DST.

Communication

Tarifa VTS (Tarifa Trafico) is on duty for the complete strait of Gibraltar. They give assistance if needed but are not mandatory for yachts.

- VTS Tarifa on VHF **10 (**16/67)
- MSI broadcasts at VHF 67 and on request.
- HM (Spanish) on VHF 06
- QHM (British) is on VHF 08
- Gibraltar Control especially for air traffic clearance on VHF 12 (20) (? 71 ?)
- Gibraltar arrival request a ?written permission? by customs. Call VHF 14 prior to arrival.
- No VHF for marinas in the reeds. Check other sources.

Time of arrival

The W-going 1-2kt current is setting from HW+3 Gibraltar to HW-3. So it is favorable to arrive within these 6 hours.

This table was changed from 18.8. to 20.9. with V2.0 for the new plan. Source was http://marine.meteoconsult.co.uk/marine-weather-forecast/tide-times-gibraltar-9-1.php.

UTC+1	HW	Time of arrival	Local time CEST	Civil Twlght CEST	Nautical CEST
20.9.2018 HW1	2342	0245-0915	0345-1015		
20.9.2018 HW2	1221	1515-2130	**1615**-2230	2047	2117
21.9.2018 HW1	0038	0330-1000	0430-1100		
21.9.2018 HW2	1306	1600-2215	**1700-**2315	2045	2115
22.9.2018 HW1	0119	0415-1045	0515-1145		
22.9.2018 HW2	1341	1645-2300	**1745-**2400	2044	2140
23.9.2018 HW1	0154	0500-1115	0600-1215		
23.9.2018 HW2	1413	1715-2330	**1815-**0030	2042	2112
24.9.2018 HW1	0227	0530-1145	0630-1245		
24.9.2018 HW2	1443	1745-0000	**1845-**0100	2041	2110
25.9.2018 HW1	0259	0600-1215	0700-1315		
25.9.2018 HW2	1514	1815-0030	**1915-**0130	2039	2109
26.9.2018 HW1	0331	0630-1245	0730-1345		

Table shows the possible times of arrival in Gibraltar (rounded to the quarter hour) regarding the W-going current: either in the first half of night (beware of sea breeze in the afternoon, see below) or between morning and forenoon / noon. Best slots are set to bold. There is enough time for the piloting, because civil twilight dusk is at quarter to nine.

Local winds

- Leventars – E-ly with high in the N and low in the S (rough seas in the strait, F8), squalls, eddies, …
- Poniente – W-ly, rare in summer

- Vendaval – strong SW-ly, with lows and rain
- Seabreeze at Pt. Europe – SSW in fair summer weather.

Way in

Start piloting into Gibraltar at WP0, which is 5ca. S of Pt. Europe (S tip of Gibraltar). Stay that close to the tip because of the increasing current to the center of the strait.

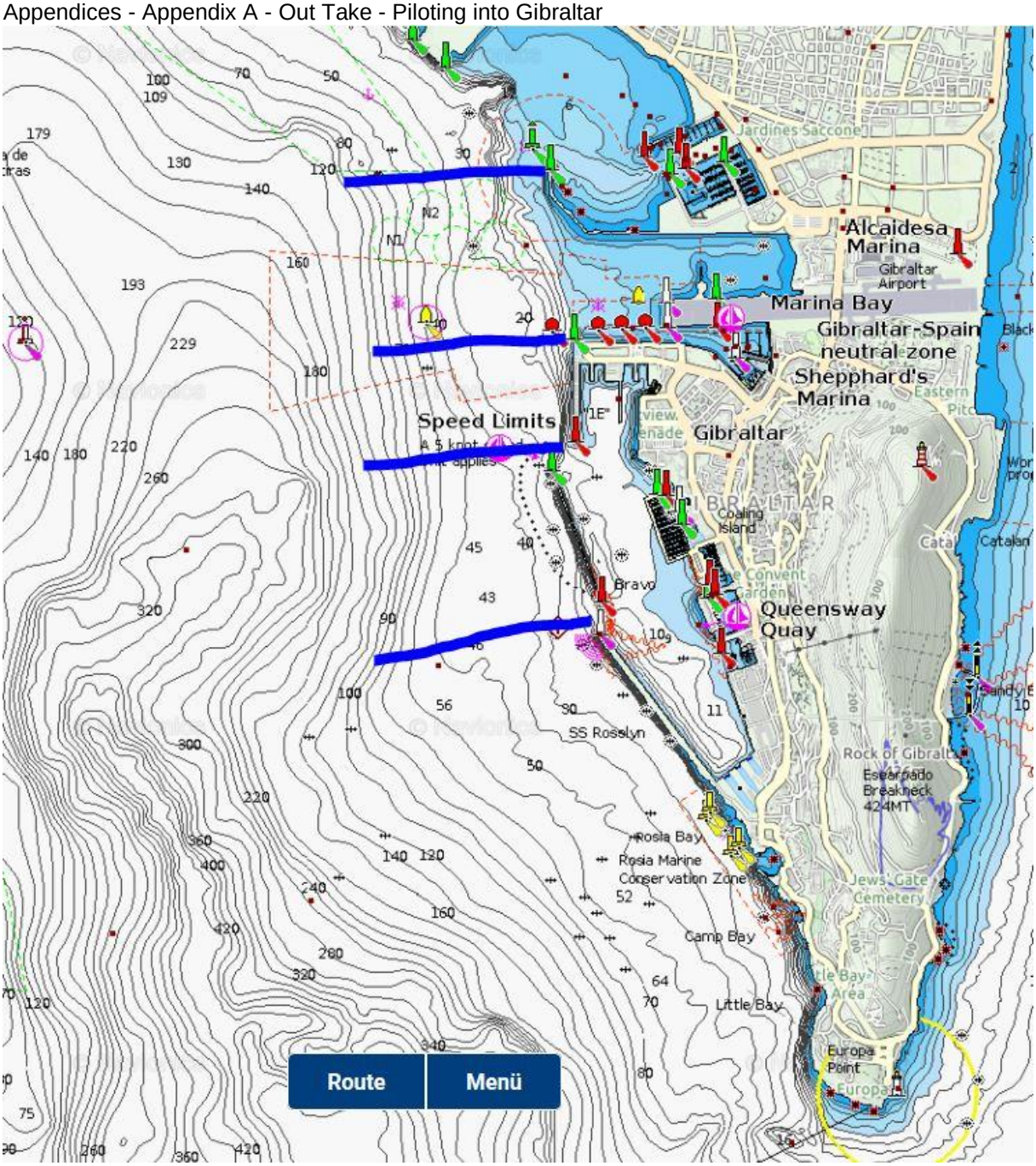
Proceed 1,7nm at 280°to WP1 (Pt. Europe will bear due E) to avoid merchant vessels at anchor on stb side. There is much traffic and many vessels at anchor inside the bay.

Head up into the Gibraltar Bay on course 355T for 3nm. On stb the following three British marinas and one Spanish marina will show up and might be accessible by turning to 080° for 0,8nm each.

Marina	Dist. from WP1	Lights		
Queensway Quay Marina	1,6 nm	S end of breakwater is marked Q.R. and FlW2s. Marina with 2F.R and F.G.		Close to "city" but no fuel
Mid harbor Marina	2,2 nm	N end of breakwater is marked Q.R. and Q.G Marina with F.R and F.G.		ONLY EMERGENCY – Locals only.
Marina Bay Marina FWM RW Mo(A) W 7s. is 7M at port	2,6 nm	10 PHM Fl.R. when aircraft activity restricts entry and Q.G. on the E head of N mole. VQ W strobe lights and loudspeaker announces are warning signals. **Do not proceed with mast > 10m.** You might catch a plane.		Call VHF 12 (20) for clearance
La Linea (Spain)	3 nm	Fl.G.2s. is N end of mole. Marina entrance Fl(2) R and G each 2s.		No clearing needed, it's Europe

Table shows the four marinas at the peninsula of Gibraltar (stb side) There is a 5kt. speed limit inside the breakwaters.

Piloting into Gibraltar, between WP1 and WP2 turn stb on 080° to reach any of the four different destinations (see table above).



Map view into Gibraltar with entrance to four marinas marked. At the left edge the FWM in the middle of the Bay of Gibraltar is visible (RW Mo(A) W 7s.7M).

Appendix B – News of the world

While the British decided to rebuild Hadrian's Wall, Nica made her way via the Capverdes Islands to Barbados into the Caribbean. By the end of January 2019 she and her owner arrived well in Grenada. Some results of the journey are of interest to this document.

Butterflies and Preventers

During the passage it turned out that rigging a butterfly was difficult, due to slow reaction of the wind vane. The wind found one edge to blow into on either side, while the wind vane shifted in wide arcs. On the other hand, rigging poles and preventers were impeded by the increasing waves and frequent squalls while reaching more westerly longitudes. Both were scenarios we could not practise during preparation period. The part in the Mediterranean was clearly missing for obtaining these skills. It shows mainly the difference to people sailing their boats for years before starting an Atlantic crossing.

Alternator and Wind generator

The alternator started making troubles on the 8 days journey to Mindelo. No charging after every third engine start followed by no charging until acceleration, all well-known signs for problems coming from poor brushes – no complaining after 30 years of brave operation.

Sad only, we had forgotten it during our risk analysis. Batteries, starter, wiring, everything was checked but the source of power. The alternator should have been maintained or replaced during the weeks of engine maintenance in Spain. A pair of brushes is absolutely affordable compared to the expensive maintenance that was necessary in Mindelo.

Water and Diesel

Water was more than enough. Although the trip Mindelo to Barbados took 20 days, not even one spare canister had to be refilled. It was a very good idea to reactivate the sea water pump at the sink. About 30% of drinking water could be saved.

Diesel was also enough. The reserves were only needed on the way to Grenada, since there was no refuelling possible in Barbados.

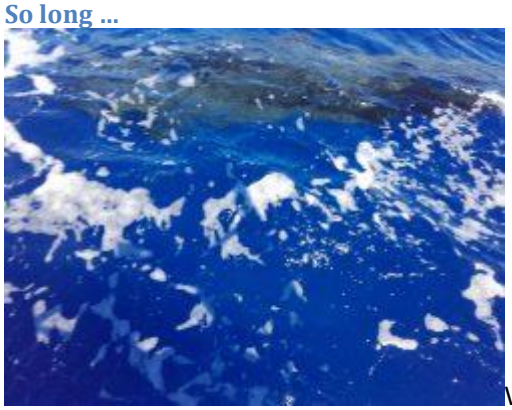
Electric energy and Provisioning

The estimated usage of electric power fitted perfectly the estimation made from page 17. Each day 1,5 hours of engine run were needed. Nica was operated in a mix of minimum power mode and fridge for half the trip. When everything fresh was consumed, the content was reduced to some cans of beer.

Communication

The Iridium go satellite phone was ok for emotionless phone calls and short e-mails. Fetching weather information needed minutes but it was reliable. The position telegrams it sends even when switched to standby stopped shortly after the Canary Islands. It seems to be a software issue that would have needed a huge download to be fixed. Since it was not clear if the phone would continue to work at all after that, this update was postponed for security reason.

So long …



Whale near Nica.

… and thanks for all the fish.