SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZFJ	
No & Type of Engines:	2 CFM CFM56-5B5/3 turbofan engines	
Year of Manufacture:	2009 (Serial no: 4040)	
Date & Time (UTC):	14 April 2016 at 0847 hrs	
Location:	Malaga Airport, Spain	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 157
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	57 years	
Commander's Flying Experience:	21,000 hours (of which 4,000 were on type) Last 90 days - 200 hours Last 28 days - 78 hours	
Information Source:	AAIB Field Investigation	

Synopsis

While calculating takeoff performance data, the flight crew elected to use the Multiple Runway Computation (MRC) function on their Electronic Flight Bag (EFB). Due to a software anomaly in the EFB, runway information for Runway 31 was displayed alongside takeoff performance data for Runway 13. The flight crew did not notice this during cross-checking and subsequently took off from Runway 31 using takeoff performance figures for Runway 13.

The manufacturer (of both the aircraft and the EFB), operator and flight crew were unaware of this anomaly at the time of the serious incident. The operator has since disabled this function in the EFB and the manufacturer has communicated this anomaly to all affected operators of this version of the EFB.

History of the flight

The aircraft was on scheduled flight from Malaga Airport, Spain to Liverpool International Airport. The flight crew consisted of the commander who was a Line Training Captain and a co-pilot who was under training. At the time, Runway 31 was in use and the wind was from 300° varying between 270° and 340° at 5 kt. The commander was the Pilot Flying (PF) and the co-pilot the Pilot Monitoring (PM) for the sector.

While calculating the takeoff performance figures using the Electronic Flight Bag (EFB), the co-pilot asked the commander if he could use the Multiple Runway Computation

(MRC) function in case the departure runway changed to Runway 13. Although it is not part of the line training syllabus, and as it was a training flight, the commander felt it would be beneficial for the co-pilot to look at this function. The operator's SOPs allow either the single runway calculation or MRC to be used, with the choice given to the crew.

After the performance figures had been calculated by the co-pilot, the commander cross-checked the 'Critical Data Entry' as PF in accordance with the operator's SOPs. He checked the aircraft configuration and that Runway 31 was displayed in the drop-down box on the top right of the EFB page. He also checked that the runway length was correct[1]; the takeoff speeds displayed on the EFB were then entered in the Flight Management Guidance Computer (FMGC). While he recognised the speeds were lower than his previous experience and the thrust reduction altitude was lower, he accepted the figures. He did this as he assumed that the operator had changed some of the aircraft's performance algorithms, as part of a number of other recent operational changes, which may not have been publicised to flight crew at the time. The subsequent takeoff was normal.

In the cruise, as a result of the commander's pre-takeoff observation regarding the speeds, he decided to check the calculations. He checked the co-pilot's EFB and noticed that with MRC selected, although Runway 31 was displayed with correct runway length and the correct engine out procedure, the takeoff performance figures displayed on the same screen were for Runway 13. The Runway 13 selection was in a small drop-down menu on the screen in a different place to where the runway was normally verified. He believes this was not noticed due to the subtle icon selection, the small text size and because the runway selection was normally verified in a different location on the screen. To help him to explain this upon his return he took photographs of the EFB screen (Figure 3).

Commander's comments

The commander commented that at a previous airline, takeoff performance figures were calculated with reference to paper documents. During the pre-flight preparation the crew could choose either normal speeds or "improved climb" speeds. He recognised that the EFB calculated speeds for Runway 31 would normally generate "improved climb" speeds but on this occasion the speeds seemed to be standard, ie lower. He added that he did not normally use the MRC function on the EFB.

Footnote

[1] Runway 31 and 13 have identical lengths.

Operator's manual

The operator's Operations Manual Part B (OMB) contains the following:

> *'**"CRITICAL DATA ENTRY"** **ANNOUNCE***
>
> *This announcement is made to ensure that both crew members understand that if they are distracted or disturbed when entering the take-off performance, then the whole process must be commenced from this point again.*
>
> ***TAKE-OFF DATA*** ***PREPARE AND CHECK/REVISE***
>
> *When the weight & balance data have been inserted, PM performs the Computation of the take-off data.'*

and:

> *'The PF checks and verbalises the following from the EFB in the **FRILS** format:*
>
> ***Flap*** *- Check the selected Flap setting.*
>
> ***Runway*** *- Check the selected runway.*
>
> ***Intersection*** *- State the selected intersection, if applicable.*
>
> ***Length*** *- State the displayed runway or intersection length.*
>
> ***Speeds*** *- State the V-Speeds, CONF* [configuration] *& Trim setting and Flex temperature, followed by the ENG OUT ACC ALT* [engine out acceleration altitude].
>
> *The PM inserts and verifies the data in the FMGS amending the THR RED* [thrust reduction] *altitude if necessary so that it is not less than the ENG OUT ACC altitude.*
>
> *The PM then calls out the green dot speed and the PF crosschecks this against the EFB as a gross error check.*
>
> ***WARNING: If any changes to the data in the EFB are made after the above process has been completed, the entire 'critical data entry' process shall be repeated.'***

The operator introduced EFBs and their associated SOPs to their specific operation requirements in 2003, which was accepted by the CAA. The SOP which referenced cross-checking involved the use of a single EFB but with cross-checking stages introduced throughout the data entry. Since then, the aircraft manufacturer introduced recommended SOPs, which involve each flight crew performing independent calculations of the takeoff performance data which are then cross-checked. These recommended SOPs were reviewed by the operator, but they did not incorporate them into their own SOPs as they felt their procedures were already more appropriate for their own operational requirements.

Airport information

Malaga Airport is located on the Costa del Sol on Spain's south-east coast. Takeoffs from Runway 13 track out to sea initially, whereas takeoffs from Runway 31 initially track inland towards rising terrain. To ensure appropriate terrain clearance, in the event of an engine failure after V_1, the operator's engine out procedure is to initially turn right at 3.3 nm from the Malaga VOR/DME[2] and to track 138°M, while flying less than 173 KIAS, and then to track out to sea. This information is displayed on the top half of the EFB between the runway information and the takeoff performance results (Figure 3).

Table 1 shows the declared lengths of Runway 13 and 31 at Malaga Airport.

Runway designator	Takeoff Run Available (TORA)	Takeoff Distance Available (TODA)	Accelerate-Stop Distance (ASDA)
13	3,200 m	3,450 m	3,200 m
31	3,200 m	3,419 m	3,030 m

Table 1

Declared Runway 13 and 31 lengths at Malaga Airport

Electronic Flight Bag (EFB)

The operator was using a ruggedised touchscreen PC with a Windows 7 operating system and Airbus FlySmart software as an EFB. The software version was L5.0.3 which was also assigned a version number by the operator of 1507. The operator used the EFBs for a number of functions including the calculation of takeoff and landing performance data and load sheet information.

To calculate takeoff performance data, the crew enter aircraft and environmental information into the 'CONDITIONS' area and then select the runway they wish to use at the chosen airport (Figure 1). There are two options for runway selection; single and multiple. The operator indicated that most takeoff performance calculations were performed using the single runway option. The multiple runway option calculates takeoff performance data for all the selected runways to allow comparison and also a ranking of the runways in order of the highest thrust derate.

Footnote

[2] The Malaga VOR/DME is located at the airport.

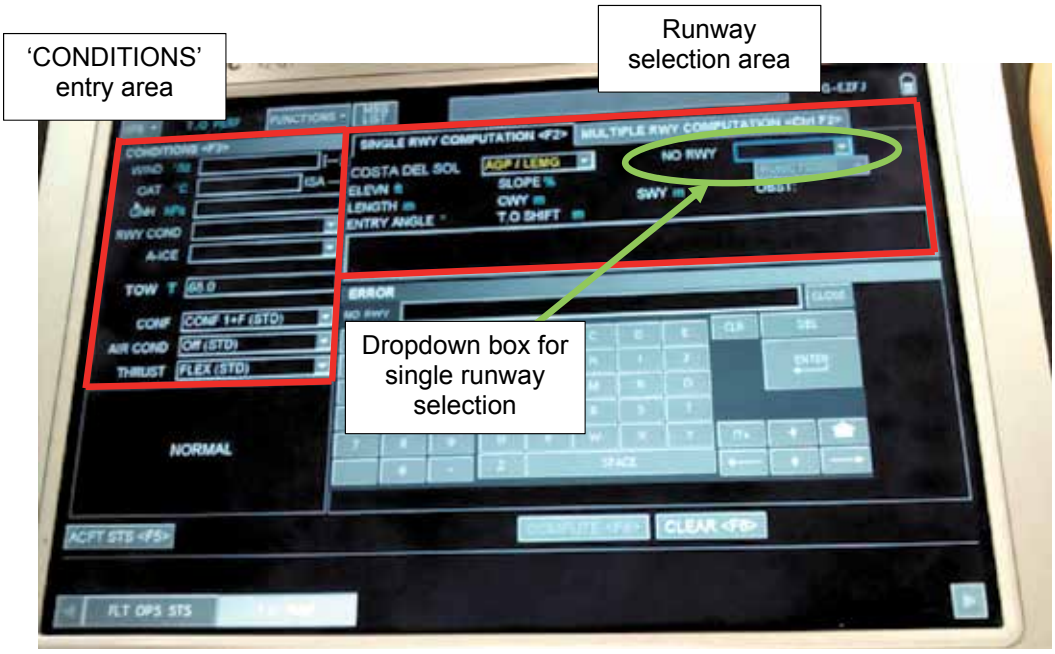

Figure 1

FlySmart takeoff performance screen

Multiple Runway Computations

For single runway computations, the runway number is selected using a single drop-down menu at the top right (Figure 1). For the Multiple Runways selection, the operator described a typical usage:

- Once the 'CONDITIONS' information has been entered, the 'MULTIPLE RWY COMPUTATION' tab is selected and a list of the available runways is presented in a table (Figure 2).

- Using a small checkbox located next to each runway, runways of interest can be selected, after which the user selects 'COMPUTE'.

Takeoff performance data is then displayed in the 'RESULTS' section. The selected runway in the 'RESULTS' section will be that with the highest FLEX temperature for the chosen runways (Figure 2). Other chosen runways can then be selected using this drop-down menu.

At this stage, specific runway information such as length, elevation and engine-out information is not displayed. To retrieve this information, the user has to select 'VIEW DETAILS'. The runway information will be selected but the 'RESULTS' screen will be obscured. The manufacturer commented that it should not be possible to display detailed runway information and the 'RESULTS' screen at the same time.

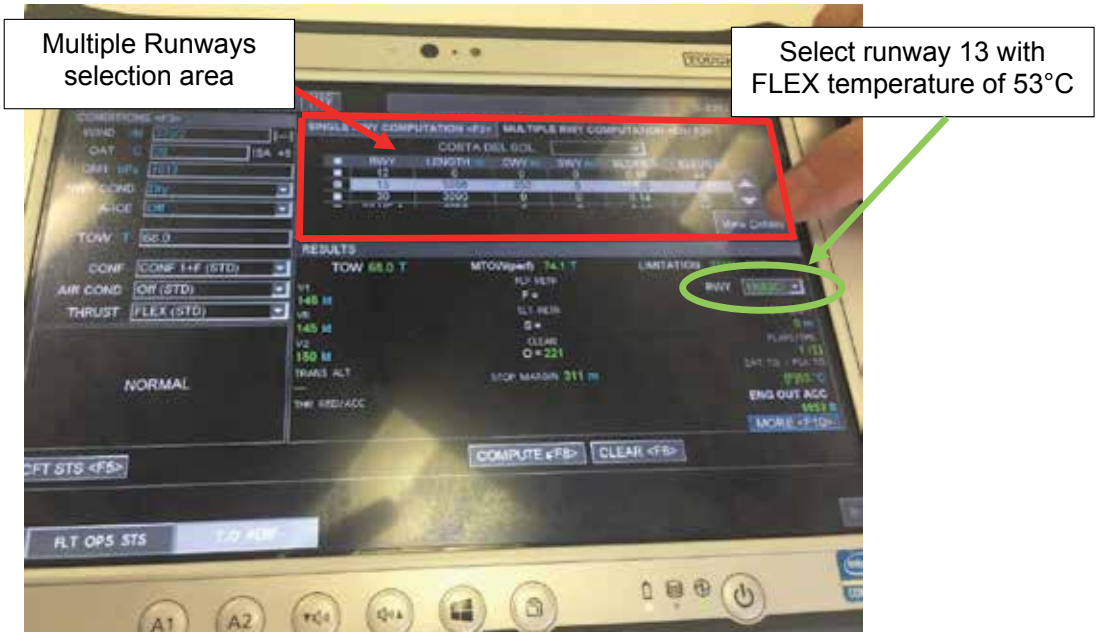

Figure 2

Results page for multiple runway computations

FlySmart anomaly during multiple runway computations

The sequence of events detailed by the flight crew suggested that the FlySmart software could display detailed information for one runway but with takeoff performance data for a different runway. Figure 3 shows a photo taken by the flight crew which confirmed this.

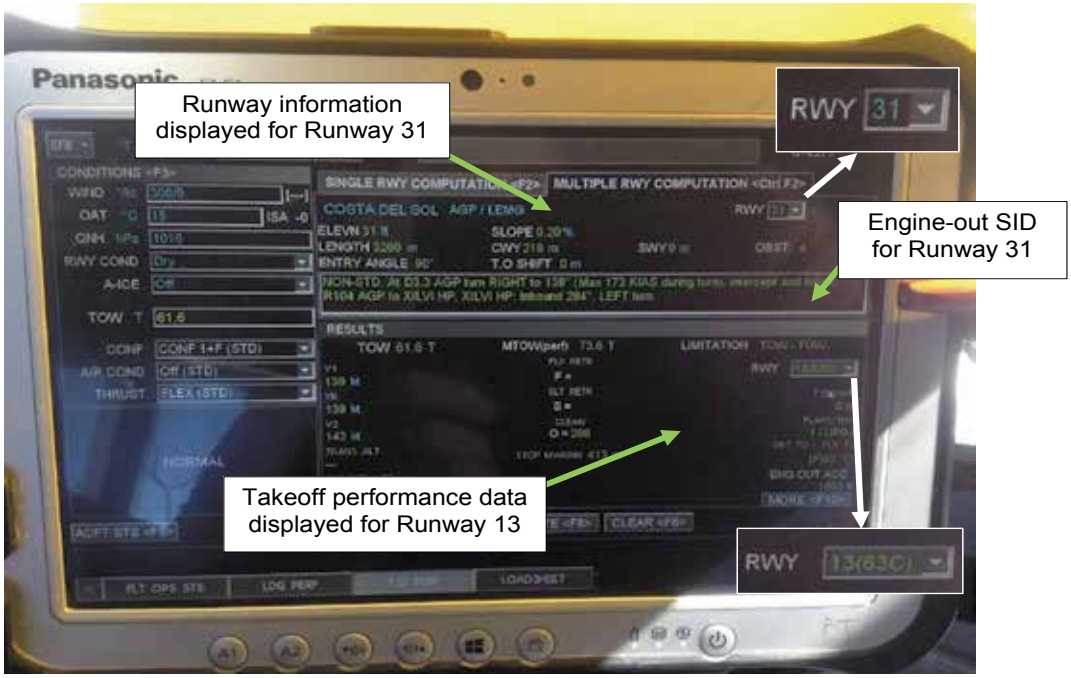

Figure 3

Photograph of EFB taken by G-EZFJ flight crew

A specific sequence of events discovered by the operator confirmed this was possible which was also reproduced by the AAIB and demonstrated to the manufacturer. This sequence of events differed from typical usage described by the operator in that, just prior to selecting 'COMPUTE', the crew switched to the load sheet screen to update it which ultimately updated the takeoff weight. Switching back to the takeoff performance screen and then selecting 'COMPUTE' allowed the display of detailed information for one runway but with takeoff performance data for a different runway to be reproduced.

EFB approval

The operator's EFB system[3] was granted approval by the CAA in 2003, based on the guidance material available at the time[4]. In 2014, the EASA published EASA AMC 20-25 *'Airworthiness and operational consideration for Electronic Flight Bags (EFBs)'* which is the most recent EU-specific guidance material. This AMC was issued to integrate TGL 36 into the structure of the Agency's rules and also to update the content. It is not currently linked to any Implementing Rule so the interpretation is open to the individual National Airworthiness Authorities (NAAs).

To enable NAAs to assess the detail of a new EFB software standard, the EASA can form an Operational Evaluation Board (OEB) to provide a consistent methodology for assessing a new EFB software standard. This is not a requirement and was not performed for this version of FlySmart. The CAA indicated that they do not have in-house experts for analysing EFB performance software but rely on operators to demonstrate the software suitability and accuracy. Part of this is the Human-Machine Interface (HMI) assessment which is addressed in AMC 20-25. The appropriate CAA Flight Operations Inspector then assesses the individual applications to the CAA by operators to use an EFB.

When referring to the HMI assessment guidance in AMC 20-25, the CAA indicated that:

> *'clear guidance on what analysis is required is a bit of a weak point in 20-25…'*

They also indicated that they have:

> *'…asked EASA to consider expanding its guidance when the EFB rules[5] are published at the end of this year'*

The FAA and Transport Canada provide an Advisory Circular for EFBs[6] and both provide checklists for the operational approval of a new EFB. In addition to the Advisory Circular, the FAA provides the '*Electronic Flight Bag Authorization for Use*'[7] document which contains detailed criteria for assessing an operator's request to use an EFB. However, the FAA differs from the EASA in that the FAA are also responsible for operational approvals.

Footnote

[3] The term 'EFB system' refers to all parts of the EFB operation which includes risk assessments, human-machine interface, flight crew operating procedures and training, EFB administration and quality assurance.
[4] JAA Temporary Guidance Leaflet (TGL) No 36 *'Approval of Electronic Flight Bags (EFBs)*, 2004.
[5] The reference to 'EFB rules' related to a current EASA Rulemaking Task which is discussed in the 'EASA activity' section below.
[6] FAA Advisory Circular No AC 120-76C, Transport Canada Advisory Circular AC 700-020.
[7] FAA Flight Standards Information Management System (FSIMS) 8900.1 Volume 4, Chapter 15.

Previous events

In the past 12 months, the AAIB has investigated four other takeoff performance events with the operator of G-EZFJ[8], only one of which involved a software issue with FlySmart. The FlySmart software version used was the same as that in the G-EZFJ incident. That issue involved use of a 'single runway computation' where the runway number, selectable in a drop-down menu, could be inadvertently modified. In that case, the flight crew did not notice the inadvertent change during cross-checking. Following this event, the operator highlighted this issue in their operations manual and the aircraft manufacturer issued a communication to operators.

Following the above four events, the operator introduced new cross-checking SOPs using the acronym FRILS (see the '*Operator's manual*' section).

Recorded information

The operator provided data from their Quick Access Recorder (QAR) which is part of their Flight Data Monitoring (FDM) programme. This recorded a similar set of parameters to the FDR. In addition, input and calculated data from the EFBs was recorded which was downloaded by the operator and provided to the AAIB.

The downloaded EFB data revealed that prior to takeoff, performance data had been computed for both Runway 13 and 31 which is shown in Table 2. The EFB did not record which of the multiple Runways was selected in the drop-down menu.

Runway	FLEX temperature (°C)	V_1 (kt)	V_R (kt)	V_2 (kt)	Engine out Acceleration Altitude (ft)
13	63	139	139	143	1,052
31	58	156	156	160	1,666

Table 2

G-EZFJ EFB data download

Just prior to takeoff, the QAR recorded a FLEX temperature of 63°C, V_1 of 139 and V_2 of 143. After FLEX/MCT takeoff power was set, the aircraft accelerated and the sidestick was pulled back as the Computed Airspeed (CAS) increased through 146 kt. The aircraft took off and appeared to climb away normally.

Footnote

[8] G-EZAA AAIB Bulletin 5/2016, G-EZUH AAIB Bulletin 1/2016, G-EZIV AAIB Bulletin 5/2016, G-EZFP – published in this Bulletin (AAIB Bulletin 1/2017).

EASA activity

In recent years NAAs have seen an increasing demand for EFB approvals and hence an increased demand in the required approval expertise. Recognising this, the EASA initiated a research program in August 2013 entitled *'Electronic Flight Bag (EFB) - Aircraft performance calculations and mass & balance - Best practices for evaluation and use of EFB'*. Specifically, it was highlighted that *'a requirement to establish standardised evaluation processes for flight data calculation software applications has been recognised'.* The project attempted to review NAA approval procedures with a view to select the best available evaluation practices. The final report was issued in October 2015[9] which stated that this was not feasible but, using the information gathered, guidance for EFB operational approval was provided. There were also a number of recommendations directed at NAAs and the EASA.

EASA currently have a Rulemaking Task (RMT)[10] which is studying the latest ICAO Standards and Recommended Practices (SARPS) and also possible updates to AMC 20-25. Part of this RMT will be transposing the operational provisions in AMC 20-25 into new Air OPS EFB implementing rules.

Analysis

Flight crew actions

The crew appeared to have conducted the initial flight preparation, with the relevant cross-checking of the performance figures on the EFB, in accordance with the operator's SOPs. While the MRC function is not in the line training syllabus, it was not unreasonable for the co-pilot to request to use it.

When it came to the checking of the Critical Data Entry, while RWY 31 was checked in the drop-down box in the top right of the EFB, along with the runway length and aircraft configuration, it was not noticed that RWY 13 was present in the drop-down box in the 'RESULTS' section further down the page.

As most of the takeoff performance calculations were usually performed using the single runway option, the crew were familiar with verifying the selected runway only in one place; at the top right of the screen. Therefore, with a particular runway selected at this upper position on the screen, it is possible to make the assumption that the corresponding takeoff performance figures on the 'RESULTS' page are related to that runway. However, in MRC the takeoff performance figures can in fact relate to another runway selected in the lower section of the display. In this case, owing to this configuration on the screen, the flight crew cross-checking, using a single computation on one EFB in accordance with the operator's SOPs, did not identify that incorrect performance data was being used prior to takeoff.

Footnote

[9] *Best Practices for approval of Performance and MB applications on EFBs, EASA_REP_RESEA_2014_1, October 2015.*

[10] EASA RMT.0601 and RMT.0602.

Operator's procedures

The aircraft manufacturer has reiterated their recommendation for both flight crew to perform duplicate takeoff performance calculations, and then cross-check the results of the independent calculations. The operator has reviewed their SOPs on several occasions and are in the process of an additional review given this event.

EFB display of conflicting takeoff information

The software manufacturer indicated that, for Multiple Runway Computations, it should not have been possible to display detailed runway information and the takeoff performance data at the same time.

EFB approval

This investigation has highlighted a second FlySmart software anomaly to feature as part of an AAIB investigation within a year. Flight crew cross-checking has always been important for the purposes of checking for erroneous inputs and reasonability of the output. Software anomalies are not always detected during testing and this investigation highlights the value of cross-checking to also identify anomalies in the software which may not have been previously detected.

The CAA expects the operator to demonstrate software suitability and accuracy according to the guidance in AMC 20-25. However, the guidance in AMC 20-25 for HMI testing is generic and there is currently no other means to capture best practices in EFB approvals, such as testing for anomalies discovered during investigations. The FAA provide the '*Electronic Flight Bag Authorization for Use*' document which contains detailed criteria for assessing an operator's request to use an EFB. The CAA have requested that EASA update the HMI guidance in AMC 20-25 as part of RMT.0601 and RMT.0602.

Safety action taken

- The operator sent an email to all pilots on 22 April 2016 highlighting this specific anomaly.
- The MRC function was disabled across the operator's fleet in May 2016.
- The operator has reviewed and proposed further modification to their SOPs.
- In the L6.x versions of FlySmart, it has been verified by the manufacturer that the MRC function is not affected by this anomaly.
- The manufacturer has sent Flysmart Communication reference X46D16018565 to operators highlighting the anomaly discovered during this investigation and recommending that the affected operators disable the MRC option.
- The manufacturer sent Flight Operations Transmission (FOT) 999.0095/16 to all operators reminding them of the manufacturer's recommended procedures for EFB use. This involves each crew member performing their own independent calculations, the results of which are then cross-checked.

Conclusion

The flight crew took off from Runway 31 using the takeoff performance data for Runway 13 at Malaga Airport. This incorrect data was provided by the EFB which contained an anomaly that allowed detailed runway information for one runway to be displayed alongside takeoff performance data for another runway. The flight crew, operator and manufacturer were unaware of the anomaly at the time of the event.

The operator has disabled the MRC function and other affected operators have since been informed of this anomaly with a recommendation to disable the MRC function. The L6.x versions of the software do not exhibit this MRC function anomaly.