



WORKING PAPER

DANGEROUS GOODS PANEL (DGP)

TWENTY-SECOND MEETING

Montréal, 5 to 16 October 2009

Agenda Item 2: Development of recommendations for amendments to the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) for incorporation in the 2011-2012 Edition

REQUIREMENTS FOR MAGNETIZED MATERIALS

(Presented by Dangerous Goods Advisory Council (DGAC))

SUMMARY

This proposal would raise the strength of magnetic materials regulated by the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) to the level that causes a compass deflection of more than 2 degrees at 4.6 meters. Magnets of this strength or higher would require an approval by the appropriate national authority of the State of Origin.

Action by the DGP: The DGP is invited to review and adopt the changes proposed in Appendix C.

1. INTRODUCTION

1.1 Based on discussions at the DGP Working Group of the Whole Meeting in Auckland (DGP-WG09, 4 to 8 May 2009), it was generally agreed that there was a need to reconsider requirements for magnetized materials (see DGP/22-WP/3, paragraph 3.2.4). These requirements have been in place for many years and it was generally acknowledged that:

- a) the threshold level for regulated magnetized material is low and currently regulated levels were regarded as not posing a safety hazard for larger aircraft; however, effects on smaller aircraft and helicopters may need further consideration. On large aircraft the cargo area is, in general, approximately 4.6 m from the compass so that currently regulated magnetized materials would not cause a deflection of more than 2 degrees (a level regarded as safe);
- b) metallic objects not intentionally magnetized may have sufficient magnetic strength to be subject to the current magnetized material requirements (see Appendix A for

examples of information technology equipment meeting current magnetized material criteria);

- c) the requirements are difficult to apply in that to measure magnetic strength, the material must be located away from other metallic objects which may influence compass or gaussmeter readings;
- d) the requirements are confusing for both shippers and carriers so that often the requirements are not complied with;
- e) aircraft of all sizes (including small aircraft and helicopters) have operated safely, without incident, for 24 years in the US under domestic, air transport regulations where magnetized material covered by the Technical Instructions magnetized material requirements (i.e., materials causing a compass deflection of 2 degrees or less at 4.6 meters) are treated as non-dangerous;
- f) considering that other avionic equipment sensitive to magnetic effects must already be shielded from electromagnetic effects, magnetic compasses are the only aircraft devices that are of concern;
- g) two types of compasses are installed on transport aircraft — the compass typically installed above the windscreen in the cockpit (standby compass) and the gyro-stabilized compass that takes its readings from magnetic field sensing devices remote from the cockpit (usually out on the wing or in the tail). With the readings for the gyrocompass measured remotely, these compasses, even on small aircraft, are generally unaffected by magnetic strengths currently regulated under the Technical Instructions. For example, the remote compass sensing devices on small aircraft (maximum payload 900 kg, wingspan 15.8m) operated by a major US cargo aircraft operator is 6.1 m from the aircraft cabin so that a magnetic material causing a compass deflection of 2 degrees at 4.6 m would produce a maximum deflection of approximately 1 degree on the small aircraft gyrocompass when the cargo is oriented and stowed to produce the greatest deflection; and
- h) with airworthiness standards accepting both types of compasses, when installed, suitable for aircraft use if they are accurate to ± 10 degrees, it was acknowledged that aircraft compasses are not precision instruments but rather are intended to give general aircraft headings. They are not used for navigational purposes under normal conditions. Increasing the magnetic strength threshold would not render the compasses inoperable.

1.2 On the basis of the comments received, DGAC agreed to prepare a comprehensive draft proposal on magnetized material for consideration. DGAC has prepared the draft revised proposal in Appendix B on magnetized material. The proposal showing amendments to existing requirements is shown in Appendix C. The proposal includes substantive amendments as well as amendments intended to improve the understanding of the requirements.

1.3 The primary substantive amendments revise the requirements so that:

- a) magnetized materials with a strength of 0.418 A/m or less at 4.6 m (0.00525 gauss or 2 degrees compass deflection) are no longer subject to the Technical Instructions;

- b) consistent with the existing notes in Part 2;9.2.1(d) and Part 7;2.10, greater emphasis is placed on the need to verify compass accuracy in the case of helicopters; and
- c) a provision for the transport of magnetized material with a strength in excess of 0.418 A/m under an approval by the Appropriate National Authority was added based on informal communications indicating a need to transport higher magnetic strength materials. [*Note.— DGAC has no direct experience in transporting such materials but has included them to make the proposal comprehensive. See discussion in paragraph 1.5. See also the pilot report in Appendix D for a case appearing to involve higher strength magnetized material.*]

1.4 The following revisions are introduced to improve understanding of the magnetized material requirements:

- a) gauss is proposed as the primary unit of measure for magnetized material. This unit is in more common usage than the A/m measure and is the unit normally read out by devices measuring magnetic strength;
- b) existing advice on how to measure magnetic strength as currently provided in the second half of PI 902 under “Determination of Shielding Requirements” has been simplified and moved to 2;2.9.2.1(d). This is an editorial change proposed because information on measurements relating to classification criteria (e.g., see 2;3.3, determination of flash point) are normally included in Part 2;
- c) with only magnetized material above 0.00525 gauss at 4.6 m proposed for regulation (i.e., forbidden to be transported by air except when authorized by an appropriate authority), the entry for UN 2807 is revised and a new Special Provision is proposed;
- d) the remainder of Packing Instruction 902 (the first part) was simplified and incorporated in the new Special Provision making Packing Instruction 902 unnecessary; and
- e) 7;2.10 is revised to take account of the change in regulated levels of magnetic strength.

1.5 Although not an area where DGAC has direct experience, it is noted that there are occasions when magnetized materials with a strength in excess of 0.418 A/m at 4.6 m are transported and such materials require transport by air. The present magnetized material requirements limit the permitted deflection on compasses to 2 degrees. Magnetic field decreases exponentially with an increase in distance as measured from the compass. On larger aircraft there are locations where higher strength magnetic materials may be stowed without adversely affecting compasses more than 2 degrees. For this reason, DGAC has proposed an approval provision for higher magnetic strength materials.

1.6 For aircraft such as helicopters where the cockpit compass and magnetic sensing units for the gyrostabilized compass may both be located closer to cargo compartments than is common on fixed wing aircraft, special procedures may be necessary. As acknowledged by the existing note under 2;2.9.1(d), even currently unregulated steel parts could affect compass readings. It is common practice for the pilot on any aircraft to check compass readings against other aircraft heading devices prior to operation independent of whether the pilot is notified of the presence of magnetized material. If unusual compass readings are noted, the accepted procedure is to carry out an aircraft swing to recalibrate the

compasses. Such an operation is not unreasonable for helicopters, especially considering the low frequency with which a helicopter operator might be confronted with an abnormal compass reading.

2. DISCUSSION OF COMMENTS RECEIVED AT DGP-WG09

2.1 Comments by one member appear to suggest that the amendments DGAC is proposing will affect the compass in a manner that will render it useless in an extreme air emergency such as a total power failure. This is clearly not the case. First, on larger aircraft, the distance separating the standby compass and the closest location in the cargo area is generally sufficient to ensure that the highest compass deviation will not exceed 2 degrees (the currently authorized deviation) even in the case of the strongest magnetic material proposed to be considered non-dangerous. Second, the effects on smaller aircraft will not render the compass ineffective in providing a general indication of the aircraft heading. The compass is not a precision navigational tool and even under proper working conditions some degree of inaccuracy is acceptable under avionics regulations (± 10 degrees). An electrical failure will itself cause changes in the compass readings as the compass will have been calibrated with cockpit equipment producing an electromagnetic field. When this equipment ceases to operate, the compass will likely go out of calibration, providing direction readings differing from the readings given in normal circumstances. However, it would continue to provide reliable information on the relative direction of the aircraft. The same would be true if magnetized materials were present. The compass would continue to give an indication of the relative direction of the aircraft. The presence of magnetic material on an aircraft in such an emergency while possibly causing some change in the compass reading would not override this functionality. In the case of both large and small aircraft, the gyro-stabilized compass is not significantly affected by the levels of magnetic material proposed to be treated as non-dangerous.

2.2 One member identified several power failure emergency incidents where it was suggested use of the compass was important. DGAC has studied available information on incidents brought to DGAC's attention. The incidents along with DGAC observations include:

- a) American Airlines Flight AAL 268 was en route from Seattle-Tacoma to New York when an electrical problem developed. At the time of the diversion to O'Hare the aircraft had flown on batteries for 1 hour and forty minutes even though the instructions indicated the battery system was reliable for 30 minutes. At that time, the aircraft's Instrument Landing System (ILS) receivers were reportedly inoperative. The crew made a visual landing at Chicago O'Hare. *Observation:* There is nothing in the US NTSB report indicating the compass played a meaningful role in safe landing of the aircraft.
- b) A BA A319 suffered a 90 second power failure on a flight from London to Budapest. After power was regained the plane flew on to its destination. The UK investigating body noted in its report that "The flight crew had not received any formal training on how to operate A320-family aircraft by sole reference to the standby instruments [i.e., including the standby compass in the cockpit]." *Observation:* Apparently current training requirements do not require training to operate the aircraft solely using standby equipment. There was nothing in the available literature to suggest the compass played a role in correcting the situation.
- c) United Airlines Flight 731 (A320) was forced to return to Newark NJ the night of 25 January 2008 shortly after departure. The flight crew landed the jetliner without further incident, and there were no injuries. The captain's primary flight display

(PFD) and navigational display (ND), along with the upper electronic centralized aircraft monitoring (ECAM)2 display, went blank. The ND for the first officer remained functional. *Observation:* There is no indication the compass played a meaningful role in safely landing the aircraft.

- d) United Airlines 767 incident involving power failure and safe landing in Bogota, Columbia (no report available from IFAPA and none located in a search).

2.3 In conclusion, none of the available reported incidents identify the compass as a critical device during the severe emergencies reported. In any case, even with magnetized material present, the standby compass would have been operative should it have been needed.

APPENDIX B

PROPOSED AMENDMENTS TO THE MAGNETIZED MATERIAL REQUIREMENTS

Amend the Technical Instructions as follows:

1. Amend 2;9.2.1(d) to read as follows:

- d) Magnetized material: Any material which, when packed for air transport, has a magnetic field strength of more than 0.00525 gauss at a distance of 4.6 m from any point on the surface of the assembled package.

The magnetic field strength of magnetized materials must be measured using a gauss meter having a sensitivity sufficient to measure magnetic fields greater than 0.0005 gauss within a tolerance of plus or minus 5 per cent, or with a magnetic compass sensitive enough to read a 2 degree variation, preferably in 1 degree increments or finer. A gauss meter reading of 0.00525 gauss at a distance of 4.6 m is considered equivalent to a compass deflection of 2 degrees at 4.6m.

Measurements must be taken in an area free from magnetic interference other than the earth's magnetic field. The packaged material is rotated through 360 degrees in its horizontal plane while maintaining a distance of 4.6 meters between the measuring device and any point on the outside surface of the package. When using a compass, the material and the compass must be aligned in an East/ West direction. When the highest meter reading is 0.00525 gauss or less or the maximum compass deflection is 2 degrees or less, the packaged material is not subject to these Instructions.

When the measured maximum field strength of a package exceeds 0.00525 gauss:

- 1) shielding may be applied until a reading of 0.00525 gauss or less has been attained; or
- 2) the material may be repackaged with another material so that the overall magnetic strength of the new package is 0.00525 or less.

When the measured maximum magnetic strength of the package is reduced to 0.00525 gauss or less, the package is not subject to these Instructions.

Note.— Masses of ferro-magnetic metals such as automobiles, automobile parts, metal fencing, piping and metal construction material, even if not meeting the definition of magnetized material may affect aircraft compasses, as may packages or items of material which individually do not meet the definition of magnetized material but cumulatively may do so. Aircraft operators should check their compasses when transporting large amounts of metal assemblies and should consider alternative stowage if deemed necessary. If the aircraft being used does not have the master compass detector units in a remote location amply distant (i.e., more than 4.6 m) from cargo locations (e.g., helicopters) a special aircraft swing and compass calibration should be made after loading and prior to operation.

2. Amend the table entry for Magnetized material to read as follows:

Name	UN No.	Class or division	Subsidiary risk	Labels	State variations	Special provisions	UN packing group	Excepted quantity	Passenger aircraft		Cargo aircraft	
									Packing instruction	Max. net quantity per package	Packing instruction	Max. net quantity per package
1	2	3	4	5	6	7	8	9	10	11	12	13
Magnetized material	2807	9		Magnetic		AXXX						

3. Add the following new special provision AXXX in Part 3;3 as follows:

<i>TIs</i>	<i>UN</i>
AXXX	<p>Magnetized material is forbidden from transport by air, except when approved by the appropriate authority of the State of Origin in accordance with written conditions established by the authority.</p> <p>When possible, magnets of any strength should be transported so that keeper bars are installed or so that the polarities of the individual units oppose one another.</p> <p>When the maximum field strength of a package exceeds 0.00525 gauss at a distance of 4.6 m, shielding or other alternative means may be applied until a reading of 0.00525 gauss or less has been attained, in which case the package is not subject to these Instructions.</p>

4. Delete Packing instruction 902.
5. Amend 7;2.10 as follows:

2.10 LOADING OF MAGNETIZED MATERIAL

Unless authorized by an approval by the appropriate authority of the State of Origin, magnetized material must not be loaded onboard an aircraft. Loading must be in accordance with conditions specified in the authorizing approval.

Note.— Masses of ferro-magnetic metals such as automobiles, automobile parts, metal fencing, piping and metal construction material, even if not meeting the definition of magnetized material may affect aircraft compasses, as may packages or items of material which individually do not meet the definition of magnetized material but cumulatively may do so. Aircraft operators should check their compasses when transporting large amounts of metal assemblies and should consider alternative stowage if deemed necessary. If the aircraft being used does not have the master compass detector units in a remote location amply distant (i.e. more than 4.6 m) from cargo locations (e.g. helicopters) a special aircraft swing and compass calibration should be made after loading and prior to operation.

APPENDIX C

PROPOSED AMENDMENTS TO THE MAGNETIZED MATERIAL REQUIREMENTS (REDLINE/STRIKEOUT VERSION)

Part 2

CLASSIFICATION OF DANGEROUS GOODS

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Chapter 9

CLASS 9 — MISCELLANEOUS DANGEROUS SUBSTANCES AND ARTICLES

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9.2 ASSIGNMENT TO CLASS 9

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- d) Magnetized material: Any material which, when packed for air transport, has a magnetic field strength of ~~0.150 A/m or more~~ more than 0.00525 gauss at a distance of ~~2.4~~ 4.6 m from any point on the surface of the assembled package (~~see also Packing Instruction 902~~).

The magnetic field strength of magnetized materials must be measured using a gauss meter having a sensitivity sufficient to measure magnetic fields greater than 0.0005 gauss within a tolerance of plus or minus 5 per cent, or with a magnetic compass sensitive enough to read a 2 degree variation, preferably in 1 degree increments or finer. A gauss meter reading of 0.00525 gauss at a distance of 4.6 m is considered equivalent to a compass deflection of 2 degrees at 4.6m.

Measurements must be taken in an area free from magnetic interference other than the earth's magnetic field. The packaged material is rotated through 360 degrees in its horizontal plane while maintaining a distance of 4.6 meters between the measuring device and any point on the outside surface of the package. When using a compass, the material and the compass must be aligned in an East/West direction. When the highest meter reading is 0.00525 gauss or less or the maximum compass deflection is 2 degrees or less, the packaged material is not subject to these Instructions.

When the measured maximum field strength of a package exceeds 0.00525 gauss:

- 1) shielding may be applied until a reading of 0.00525 gauss or less has been attained; or
- 2) the material may be repackaged with another material so that the overall magnetic strength of the new package is 0.00525 or less.

When the measured maximum magnetic strength of the package is reduced to 0.00525 gauss or less, the package is not subject to these Instructions.

Note.— Masses of ferro-magnetic metals such as automobiles, automobile parts, metal fencing, piping and metal construction material, even if not meeting the definition of magnetized material may be subject to the operator's special stowage requirements since they may affect aircraft instruments, particularly the compasses. Additionally, *as may* packages or items of material which individually do not meet the definition of magnetized material but cumulatively may do so, may also be subject to the operator's special stowage requirements. *Aircraft operators should check their compasses when transporting large amounts of metal assemblies and should consider alternative stowage if deemed necessary. If the aircraft being used does not have the master compass detector units in a remote location amply distant (i.e. more than 4.6 m) from cargo locations (e.g. helicopters) a special aircraft swing and compass calibration should be made after loading and prior to operation.*

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Part 3

**DANGEROUS GOODS LIST,
SPECIAL PROVISIONS AND
LIMITED AND EXCEPTED QUANTITIES**

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Name	UN No.	Class or division	Subsidiary risk	Labels	State variations	Special provisions	UN packing group	Excepted quantity	Passenger aircraft		Cargo aircraft	
									Packing instruction	Max. net quantity per package	Packing instruction	Max. net quantity per package
1	2	3	4	5	6	7	8	9	10	11	12	13
Magnetized material	2807	9		Magnetic		<u>AXXX</u>		E0	902	No limit	902	No limit

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Chapter 3

SPECIAL PROVISIONS

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Table 3-2. Special provisions

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TIs UN

<u>AXXX</u>	<p><u>Magnetized material is forbidden from transport by air, except when approved by the appropriate authority of the State of Origin in accordance with written conditions established by the authority.</u></p> <p><u>When possible, magnets of any strength should be transported so that keeper bars are installed or so that the polarities of the individual units oppose one another.</u></p> <p><u>When the maximum field strength of a package exceeds 0.00525 gauss at a distance of 4.6 m, shielding or other alternative means may be applied until a reading of 0.00525 gauss or less has been attained, in which case the package is not subject to these Instructions.</u></p>
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Part 4

PACKING INSTRUCTIONS

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Chapter 9

CLASS 7 — RADIOACTIVE MATERIAL

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902	PACKING INSTRUCTION 902	902
Magnetized material will be accepted only when:		
— a) devices such as magnetrons and light meters have been packed so that the polarities of the individual units oppose one another;		
<u>Note.— It is doubtful that magnetrons and light meters with high strength magnets are still in use.</u>		
— b) permanent magnets, where possible, have keeper bars installed;		
<u>Retained in proposed Special Provision AXXX.</u>		
— c) the magnetic field strength at a distance of 4.6 m from any point on the surface of the assembled consignment:		
— 1) does not exceed 0.418 A/m; or		
— 2) produces a magnetic compass deflection of 2 degrees or less.		
Magnetized material may be shipped in a unit load device or other type of pallet prepared by a single shipper provided that the shipper has made prior arrangements with the operator. The shipper must provide the operator with written documentation stating the number of packages of magnetized material contained in each unit load device or other type of pallet.		
<u>Considered unnecessary considering that an approval to transport regulated magnetized material would be required.</u>		
— Note.— For loading instructions, see 7;2.10.		
<i>Determination of shielding requirements</i>		
The magnetic field strength of magnetized materials must be measured using measuring devices having a sensitivity sufficient to measure magnetic fields greater than 0.0398 A/m within a tolerance of plus or minus 5 per cent, or with a magnetic compass sensitive enough to read a 2 degree variation, preferably in 1 degree increments or finer. If the maximum field strength observed at a distance of 2.1 m is less than 0.159 A/m or there is no significant compass deflection (less than 0.5 degree), the article is not restricted as a magnetized material. Methods of determining if a magnetized article meets the definition of a magnetized material include:		
— a) When an oersted meter is used, it is placed on one of two points positioned 4.6 m apart and located in an area that is free from magnetic interference other than the earth's magnetic field. The oersted meter is then aligned with the second point and "balanced" to a zero reading. The magnetic article is then placed on the other point and the magnetic field strength is measured by reading the meter while rotating the package 360 degrees in its horizontal plane. If the maximum field strength observed is 0.418 A/m or less, the article is acceptable for air transport. When the maximum field strength exceeds 0.418 A/m, shielding should be applied until a reading of 0.418 A/m or less has been attained.		
— b) When a magnetic compass is used as a sensing device, it should be placed on one of two points positioned 4.6 m apart which are aligned in an East/West direction and in an area that is free from any magnetic interference other than the earth's magnetic field. The packaged item to be tested is placed on the other point and rotated 360 degrees in its horizontal plane for indication of compass deflection. When the maximum compass deflection observed is 2 degrees or less, the article is acceptable for air transport. When the maximum compass deflection of an item exceeds 2 degrees, shielding must be applied until the maximum deflection is not more than 2 degrees.		
<u>"Determination of shielding requirements" in its entirety was simplified and moved to 2;2.9.2.1(d).</u>		

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Part 7

OPERATOR'S RESPONSIBILITIES

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Chapter 2

STORAGE AND LOADING

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2.10 LOADING OF MAGNETIZED MATERIAL

Magnetized material must not be loaded in such a position that it will have a significant effect on the direct-reading magnetic compasses or on the master compass detector units. The significant effect will be produced if the magnetic field strength of the magnetized materials reaches 0.418 A/m at the location of aircraft compasses or compass detector units. The minimum stowage distance of the magnetized material to the aircraft compasses or compass detector units will depend on the intensity of the magnetized material's field strength and varies from 1.5 m for material which just meets the threshold level of the magnetized material definition in 2;9, to 4.6 m for materials which possesses the maximum field strength permitted by Packing Instruction 902 in 4;11. If the minimum stowage distance of a specific item, in its packed form, from the compass or detector units is not known and cannot be estimated, or if material which is to be transported affects the aircraft's compasses, a special minimum stowage distance check must be made on the freight to be transported. Multiple packages may produce a cumulative effect. See Packing Instruction 902 for determination of shielding requirements. Unless approved by the appropriate authority of the State of Origin, magnetized material must not be loaded onboard an aircraft. Loading must be in accordance with conditions specified in the authorizing approval.

Note.— Masses of ferro-magnetic metals such as automobiles, automobile parts, metal fencing, piping and metal construction material, even if not meeting the definition of magnetized materials may be subject to the operator's special stowage requirements since they material may affect aircraft instruments, particularly the compasses. Additionally, as may packages or items of material which individually do not meet the definition of magnetized materials material but cumulatively may do so, may also be subject to the operator's special stowage requirements. Aircraft operators should check their compasses when transporting large amounts of metal assemblies and should consider alternative stowage if deemed necessary. If the aircraft being used does not have the master compass detector units in a remote location amply distant (i.e. more than 4.6 m) from cargo locations (e.g. helicopters), a special aircraft swing and compass calibration should be made after loading and prior to operation.

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APPENDIX D

MAGNETIZED MATERIAL REPORT

The following was reported by a pilot on a 747-400 passenger aircraft on an international flight. For this aircraft design a significant distance (i.e. more than 4.6 meters) between the cargo and the cockpit is expected.

The pilot provided the following narrative:

“shortly before departure I was presented with 3 hazmat manifests for magnetized materials totalling almost 6000 pounds.

I checked the compass against the fmc and found that they differed by 7 degrees. I considered this excessive and called SAMC through dispatch to report the discrepancy and wrote it up. SAMC’s solution was to defer the standby compass.

The magnetic deviation reduced to 0-4 degrees once away from the gate.”

Comments/observations:

1. Considering that the cargo compartment would have been more than 4.6 meters from the standby compass, a maximum measured deflection of 7 degrees suggests at least one and possibly all three shipments of magnetized material exceeded the limits of what is permitted to be transported under the ICAO TI and exceeds the limiting level being proposed by DGAC. This suggests a need to transport higher strength magnetic material than is currently authorized by the ICAO TI.
2. In spite of the compass deviation, the aircraft continued its operation, which is believed to have involved a trans oceanic flight.
3. The “fmc” (flight management computer) was considered reliable even though magnetized materials of a strength prohibited for air transport were present on the aircraft.
4. The reduced deviation to 0 – 4 degrees was probably due to alignment of the earth’s magnetic field and that of the magnetic material.

— END —