Magnetic hazards at heliports

RISK MITIGATION STRATEGIES

So, North is which way? Rex J Alexander, board member and past president of the US National EMS Pilots Association, discusses the problems that can be caused by magnetic disturbances associated with rooftop and ground level helipads, and the simple steps that can be taken to alert pilots to the dangers

Navigation, as it pertains to aviation, is a critical skillset that every aviator endeavours to master and improve upon throughout their lives. So what happens when some of the most important tools used in navigation point the wrong direction and you don't catch it? Imagine merging an extremely high workload environment with a time sensitive operation at an unfamiliar location where your navigational instruments are susceptible to a complete reversal and you are not aware of it. Well you get the idea. Identifying and avoiding areas of magnetic interferences, as well as communicating its existence to pilots, are all important risk mitigation strategies for creating a safe aviation infrastructure at airports and heliports alike.

> "buried objects ... have the potential to distort the magnetic field"

Regulations

On 16 June 2010, the US Federal Aviation Administration (FAA) released Safety Alert for Operations (SAFO) 10010, entitled *Magnetic Heading Disturbances Emanating During Ground Operation*. While the focus of this SAFO was directed entirely towards planes operating at airports, it also contained essential information for helicopters operating at heliports, though it may not have said so in so many words. The following excerpt is one good example: "There is a likelihood that significant errors in magnetic directional heading can result from disturbances caused by trucks, tugs, power carts, buildings, and even buried objects, i.e. rebar in the ramp, taxiways, and runways which have the potential to distort the magnetic field." The following quote is of particular importance to all pilots: "... of the need to ensure proper directional heading alignment of slaved compass systems and

The hazard marking as it appears at the University of Kansas Hospital
Rex J. Alexander

indications prior to the airplane taking flight."
On 16 March 2012, the FAA's Terminal Operations Headquarters published a General Information Safety Notice through their Safety Team (FAASTeam), entitled *Your Aircraft May Be Vulnerable*. The primary caution associated with this notice reads as follows: "Magnetic disturbances or magnetic flux fields propagated by underground/buried or surface objects made of steel can cause significant directional heading errors in slaved compass system(s) indications ..."
FAA Advisory Circular (AC) 150/5390-2C, Heliport Design, does discuss 'electromagnetic effects' under 'site selection' in sections 205-d, 304-d and 404-d, but does not discourage utilising sites that exhibit excessive 'electromagnetic interference' (EMI). In previous versions of the heliport AC, only magnetic resonance imaging (MRI) equipment was brought into question to explain high levels of EMI. In the more recent 2012 version, additional items such as large ventilator motors, elevator motors and other large electrical consumers are now listed as being potential culprits of EMI. It is only in section 404-d that we find the mention of using a sign to alert pilots, but only in those cases where an MRI scanner is present. There is, however, no illustration or picture explaining what this sign should say or look like, or how and where it should be installed.

A caution sign near the heliport's entrance is an integral part of any good safety alert programme
Rex J. Alexander

Close encounters

My first encounter with excessive magnetic interference occurred over 16 years ago at a newly constructed nine-storey rooftop heliport. While many pointed to the hospital's MRI as the probable culprit, it was in fact the 15 elevator motors located adjacent to the heliport that were disrupting everyone's navigation instruments. On further investigation, it was discovered that when more than five elevators were activated simultaneously, the aircraft's radio magnetic indicator (RMI) would rapidly slew as much as 90° off course in less than 20 seconds.
A few years later, at a subsequent location exhibiting similar magnetic anomalies, it was discovered that the rooftop heliport had been built directly over several pre-existing building ventilation systems. When the ventilation motors were in operation, they created a significant amount of EMI that in turn played havoc with the instrumentation of any aircraft at or near the heliport. In both instances, the overabundance of magnetic interference had never been considered or investigated during the selection, design, construction, or completion phase of either of these two heliport sites.
This magnetic phenomenon is also not isolated to rooftop or elevated locations alone. Significant magnetic deviations can also occur at ground-based heliports. In many of these cases it is generally not because of an excessive amount of EMI from a large electrical consumer, but rather a high density of nearby ferrous metal. Excessive amounts of iron-core rebar used in a heliport's concrete construction, or large quantities of underground metal piping used in the surrounding drainage system, are generally some of the most common culprits.

> "magnetic disturbances ... can cause significant directional heading errors"

Over the years, several colleagues working in the helicopter and heliport industries have shared similar experiences of encountering large magnetic variations at both elevated and ground locations around the world. This would indicate that this issue has indeed existed for some time, but has only recently garnered any significant attention. Whether caused by excessive EMI or an overabundance of ferrous metal, magnetic interference can be a significant safety hazard.

Significant hazard

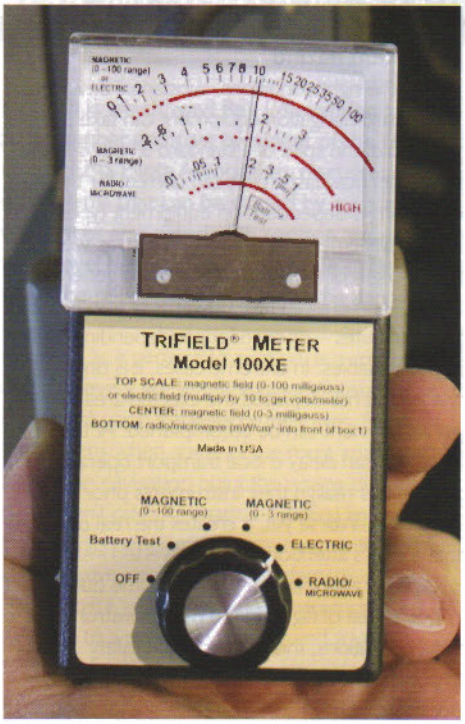
Under the right conditions, substantial deviations in onboard navigation equipment can take place very rapidly. In spite of a standard 3°-per-second slew rate, how fast a pilot can correct for these deviations is dependent on equipment type, sensor placement, sensitivity and age, as well as the strength of the interference being generated. Full realignment can take upwards of two to three minutes – or even longer depending on the above variables. In extreme cases, it is only after the aircraft has departed the affected area that full realignment can be accomplished. At the very least, this can delay critical transport operations while pilots realign their instruments prior to departure. Worse yet, it creates the real potential that a pilot's attention may be diverted inside the cockpit for an extended period of time during a critical phase of flight. In the case of instrument flight operations, this has significant safety implications if a pilot does not recognise the error prior to entering an instrument flight profile.

magnetic interference can be a significant safety hazard

Identification

The first line of defence should always be prevention through proper site selection during the design phase. This can be accomplished through a thorough investigative process, identifying locations containing large and abundant electrical consumers or high levels of ferrous metal. A very useful tool for checking areas for excessive magnetic variation is a standard magnetic compass; for more advanced investigative work, especially where disproportionate EMI is suspected, a hand-held electronic meter that measures different types of magnetic energy can be very effective.

In those cases where a location has been identified as having excessive EMI or magnetic flux, every effort should be made to identify the source(s) and, when possible, correct for it. If the problem cannot be corrected or the site cannot be relocated, every effort must then be made to properly alert pilots to its existence.



Top left: An intuitive hazard marking created by combining a modified compass rose design with the standard hazardous material labelling symbol used to identify magnetic hazards for shipping
Left: Where disproportionate EMI is suspected, a hand held electronic meter that measures different types of magnetic energy can be very effective
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Warning signs

While neither of the aforementioned safety notices nor the FAA advisory circular give much in the way of guidance as to how this should be accomplished, the following guidelines have been proven to be very effective at University of Kansas Hospital, Kansas City, Missouri.

The ultimate goal in creating any good hazard or warning marking is to create one that is intuitive to understand and is visible from a distance at every possible angle. Today's heliport markings also need to be apparent and clearly discernible during day, night and NVG operations as well. This particular hazard marking needs to be located on or very near the heliport landing area itself, while at the same time not introducing a vertical hazard into the operational environment.

An intuitive hazard marking to alert pilots to excessive amounts of magnetic interference was ultimately created by combining two symbols most pilots are already familiar with, these being a modified compass rose design, similar to the ones found at many airports, along with the standard hazardous material labelling symbol used to identify magnetic hazards for shipping. In using the blue and white colour schemes indicative of both of these symbols, not only was the original familiarity maintained, but an NVG-friendly marking was also achieved due to the 'albedo' (reflective coefficient) differential between these

two particular colours. By painting the symbol directly onto a heliport's TLOF (Touchdown and Lift-off area) or FATO (Final Approach and Take-off area), identification from altitude from every angle is ensured and does not introduce a vertical hazard to the flight enviroment.

To enhance ease of identification from altitude, a six-foot (1.8-m) diameter white circle with a 12-inch (0.3-m) blue border was chosen. Cardinal headings are depicted in blue like the points on a compass rose along the outside of the circle. The points corresponding to North, South, East, and West are twice as large as those for NE, NW, SE, & SW. Cardinal headings are labelled with white capital letters on the 12-inch blue outline. A blue magnetic horseshoe symbol is located against the white background in the centre of the circle. North is of course aligned with magnetic north as it relates to the heliport site itself. Incorporated wording states 'Magnetic Field Present' at the top and 'Check Compass' at the bottom.

In conjunction with a heliport hazard marking, a caution sign near the heliport's entrance is an integral part of any good safety alert programme. Again, we never want to introduce a vertical hazard into the helicopter operational environment, so any sign must be kept well outside of the heliport's safety area. The caution sign illustrated is in keeping with signage standards as outlined by the Occupational Safety and Health Administration (OSHA) and the American National Standards Institute (ANSI).

While prevention is the ultimate goal, there is always the potential for EMI and magnetic variation to exist in spite of our best efforts. When and where this does occur, the incorporation of the above hazard identification tactics can be a very effective risk mitigation strategy. △

> when more than five elevators were activated, the aircraft's RMI would rapidly slew as much as 90°

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