Elimination of ILS Navigational HMI in the Operational Environment

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ABSTRACT

Instrument Landing System (ILS) Hazardously Misleading Information (HMI) occurrence during FAA field maintenance procedures has been addressed both in Order 6000.15E, General Maintenance Handbook for National Airspace System (NAS) Facilities, and Order 6750.49A, Maintenance of Instrument Landing System (ILS) Facilities via maintenance procedural changes and elimination of single-string faults.

This paper examines the possibility of ILS Navigational HMI in the Operational Environment. One such situation is discussed and the question that other possible HMI conditions exist in the NAS is raised. The author proposes that these conditions are the result of unanticipated ILS installation circumstances, which when utilized by a pilot can result in deadly consequences.

An attempt is made to analyze one such HMI condition observed near the approach to Flagstaff Pullman Airport, Arizona. Alternative solutions are discussed that may be implemented to eliminate this particular HMI condition. Also discussed is a recommendation that a team of ILS Subject Matter Experts (SME) and Flight Inspection personnel be assembled for the purpose of a national review of NAS ILS installations and flight procedures. This team would investigate the potential for ILS HMI in the NAS Operational Environment, and provide risk analysis for identified ILS HMI problem areas. Possible solutions may be proposed by the team, with the object of reducing or eliminating the probability of ILS HMI due to Operational Environment issues.

1. INTRODUCTION

The purpose of this paper is twofold; first, to convey to the flight inspection and engineering community that an ILS facility radiated signal-in-space (SIS) can result in HMI due to the operational environment in places not normally expected; and second, to recommend an engineering solution for the elimination of one such area of ILS Navigational HMI.

This paper examines an ILS Navigational HMI from a different perspective. This perspective is an ILS HMI condition that results from the operational environment and not maladjusted equipment, and may exist miles (kilometers) from the radiating ILS facility. A HMI condition which the pilot doesn't have the benefit of a Notice to Airmen (NOTAM), or has there been a decision analysis conducted of the benefit vs. risk to leave the ILS facility ON/OFF. *In fact, everything is considered normal, and would be if the situation didn't exist and mistakes didn't happen.*

Instrument Flight Rules (IFR) procedures are in place to protect the pilot flying in Instrument Metrological Conditions (IMC). Air Route Traffic Control Centers (ARTCC) and Air Traffic Control (ATC) provides guidance via radar and beacon equipment to observe and assist the pilot to remain clear of obstructions, hazards, and other aircraft, to reach his/her destination, and line up on the correct runway ILS approach.

An ILS facility may radiate a SIS that can be received by an aircraft and produce cockpit indications/guidance miles (kilometers) past their required usable distance. An unaware pilot may mistakenly use such a SIS, at the wrong time and place, which can lead to tragic results. The pilot's last bit of protection from mistaken use of an ILS navigational signal is his verification of the ILS IDENT.

2. BACKGROUND

While an engineer with the FAA NAVAIDS Modification and Documentation Team located in Oklahoma City, Oklahoma, one of my assigned engineering projects was the investigation of heavy snowfall on the End-Fire Glide Slope (EFGS) antenna system. Snow effects on both the EFGS antenna array SIS and equipment monitoring were to be examined. One candidate for the project engineering study was the EFGS facility located at the Flagstaff Pulliam Airport, Arizona, Runway 21 (I-FLG).

Flagstaff was experiencing heavy snowfalls in the winter of 1995-1996 and therefore, was a perfect time to begin the engineering study. I requested the assistance of the Oklahoma City Flight Inspection Field Office (OKC FIFO) to conduct a special engineering flight inspection of the FLG EFGS Runway 21 approach. The OKC FIFO agreed and worked the requested engineering flight runs into their schedule.

In late February 1996 we arrived at Flagstaff to perform the EFGS approach flight checks. Metrological conditions at Flagstaff were changing from day-to-day requiring operations under Visual Flight Rules (VFR) one day, and Instrument Flight Rules (IFR) the next.

During the flight inspection runs I learned that an aircraft accident had occurred approximately one month earlier. The accident took place while the aircraft was making an ILS approach to this same runway. The aircraft was a Beech E90 and had collided into Mount Humphreys, which is located to the right of the Runway 21 approach. The pilot and his two passengers were killed in the collision.

This paper doesn't discuss snow effects on the EFGS antenna SIS, or its monitoring system. Instead, it discusses another ILS SIS observation that I and the flight inspection crew observed while conducting the approaches into Flagstaff. This ILS SIS originates from a Localizer (LOC) facility utilized for the ILS approach into the Prescott Ernest A. Love Field Airport Runway 21L (I-PRC) located approximately 65 NM (120 km) distant. This LOC SIS was found to be directly in line with and over Mount Humphreys, the same mountain that the aircraft had crashed into while making their ILS approach into Flagstaff.

3. HMI AND RISK MITIGATION

3.1 Radiated HMI

Hazardously Misleading Information (HMI) is defined as: "Erroneous information that is sent by navigational aids to an aircraft instrument, and that is presented in a manner that could result in a significant reduction in terrain, obstacle, or object clearance."[1]

The term HMI is typically used in reference to specific conditions of an ILS radiated signal-in-space (SIS). These ILS HMI SIS conditions are indistinguishable by an aircraft from a normal ILS SIS, and do not provide a safe ILS course/path. ILS HMI generally occurs as a result of particular maintenance and test procedures performed at ILS facilities by maintenance personnel.

3.2 Operational Environment HMI

This paper takes a different point of view of ILS HMI. That is; from a perspective where a correctly adjusted and radiating ILS SIS may; "…result in a significant reduction in terrain, obstacle, or object clearance", due to the operational environment. In this case, the radiated ILS SIS itself is normal and is signaling to the aircraft *an assurance that everything is A-Okay*. If the operational environment is such that an obstacle is presented to the aircraft along the ILS path, the ILS signal itself is sending hazardously misleading information.

This paper contends that this type of ILS HMI can occur anywhere throughout the usable distance of the ILS radiated path (i.e. usable distance defined as anytime the aircraft can receive, process, and display the ILS information) if the risk posed by the obstacle is not properly mitigated.

From this viewpoint; ILS Operational Environment HMI could occur as a result of runway construction, where construction equipment is on a runway, or the runway is being resurfaced i.e. Abnormal Airport Environment[2] (AAE) and unsuitable for use while the ILS remains in operation. Or, this type of HMI might occur as a result of an obstruction in the local approach area, which hadn't previously been there, such as a construction crane. More distant obstructions such as Radio/TV antenna towers, hills, mountains that are in the direct path of an ILS SIS could also result in an ILS navigational HMI in the operation environment.

3.3 Risk Mitigation

There are many methods used for aircraft avoidance of obstructions and risk mitigation in the NAS ILS operational environment, especially during instrument meteorological conditions (IMC) requiring flight in accordance with IFR. Such as:

- Flight Inspection confirmation that ILS approaches are obstruction clear, both along the course/path and the horizontal or vertical azimuths, within certain requirement heights and areas.
- Critical ILS areas are established and posted.
- Radio Frequency (RF) clearance areas generated by the ILS itself help guide aircraft to the correct course/path position and away from obstructions.
- During AAE conditions maintenance and management personnel examine the benefit and risk associated with leaving an ILS in operation or removing it from service[3].
- NOTAMS are issued and procedures are in place to ensure that pilots are alerted to runway conditions and availability or the signal itself is removed.
- Approach plates and sectional aeronautical charts are sources of information to the pilot to alert them of any hazards in the area. As well as minimum en route, obstruction clearance, reception and crossing altitudes.
- Air Traffic Control provides Radar guidance to aircraft while operating under IMC and Instrument Flight Rules (IFR).
- Guidance by the ILS itself. The pilot has a high degree of assurance that when an ILS SIS is acquired, it will guide him to a safe landing and/or within visibility of the runway depending on category of operation.

3.4 Mistakes Happen

Even with all the afore mentioned Air Traffic and flight procedures, NOTAMS issued, cross checks, Radar guidance, and removal of IDENT, mistakes happen. We (FAA) will not be able to mistake proof the NAS. But in the case of ILS HMI, much attention and has been focused on minimizing the probability that an ILS HMI incident will occur.

Possible mistakes by FAA personnel have been addressed with cross checks of NOTAM issuance to eliminate single string faults, HMI warning statements in maintenance orders have been added, and NOTICES issued to alert the field to the danger. HMI maintenance procedures have been examined to reduce the radiating time and number of procedures, with alternate procedures developed where possible.

Possible mistakes by pilots are being addressed by the removal of associated ILS services during HMI generating procedures. That is; when performing HMI generating maintenance on a Glide Slope (GS), maintenance personnel must turn off the associated Localizer so that the aircraft cannot auto-couple. Note; the pilot could still manually fly the GS, but a flag would be present from the Localizer.

In spite of the issuance of a NOTAM and removal of IDENT it was discovered that some pilots may still mistakenly fly the ILS during performance of a Glide Slope HMI procedure. The only sure way to minimize the hazard was to turn off, or eliminate, the Localizer signal, whereby an aircraft cannot auto-couple.

4. FLAGSTAFF APPROACH

4.1 Aircraft Accident, 1996

National Transportation Safety Board (NTSB) ID: LAX96FA105; some excerpts[4]:

"On January 31, 1996, about 1305 hours mountain standard time, a Beech E-90, N300SP, was destroyed during an instrument approach to the Flagstaff Pullman Airport, Flagstaff, Arizona. The pilot and his two passengers received fatal injuries. Instrument meteorological conditions prevailed for the positioning flight and an IFR flight plan had been filed."

"At 1257:48, ZAB cleared him for the ILS runway 21 approach and advised that radar service was terminated and to contact Flagstaff ATCT." "The local controller asked '*you are on the ILS, verify*', and he responded, '*that's right I'm doing the ILS 21.*'".

NTSB determines the probable cause(s) of this accident as follows: "failure of the pilot to follow prescribed IFR procedures and his failure to maintain control of the aircraft. Factors relating to the accident were: the adverse weather conditions with icing and turbulence."

There seems to be some discrepancy in the various reports; perhaps due to the dates they were prepared. A brief of the accident says that the crashed occurred on the southeast side of Humphreys Peak. The more detailed Factual Report puts the location of the wreckage on the northeast side; at the 10,500 ft (3,200 m) level along the 354° radial, about 15 DME from the Flagstaff VOR and 10 miles (16 km) west of the final approach course (Ref. Figure 2).

4.2 <u>Flight Inspection Observation, 1996</u>

While making approaches to Flagstaff in support of my engineering investigation of snow effects on the EFGS SIS, the OKC FIFO pilot stated that he is receiving another ILS signal. This signal is to the right of the Flagstaff Runway 21 approach, around and behind Mount Humphreys. The pilot states that one month earlier there had been an accident in this area. He states; if no one objects, he would like to fly this signal to see where it leads. We all agreed and he proceeded with the approach. I was located behind the panel operator and now observing the signal with a spectrum analyzer, an instrument that measures radio frequency and signal strength. The pilot indicated that this was the Prescott Ernest A. Love Field Airport Runway 21L (PRC) Localizer frequency.

The pilot flew the path until breaking off just before we would have hit Mount Humphreys. He stated that the aircraft accident had occurred right in front of us. I remember the spectrum analyzer indication of RF signal strength being greater than 50µv, more than enough for a modern receiver. No recordings were made and we continued with the engineering investigation of the EFGS.

I was left with several questions; probably the Beech aircraft had dual receivers, could the second receiver have been tuned for the Prescott PRC approach? I heard that the aircraft normally made runs between the two locations. Could the second receiver mistakenly have been selected? Was the IDENT verified? If not, and this signal was flown, the accident would be pilot error i.e. a mistake.

4.3 <u>Engineering Flight Inspection, 2008</u>

As mentioned, no flight data recordings of our 1996 observation of the PRC LOC SIS in the Flagstaff approach area were made. Therefore, to document and reconfirm our 1996 observations, I requested the help of Flight Check personnel for a special engineering investigation of the area. Especially, since it is somewhat counter intuitive that a LOC signal from 65 NM might be flyable around and behind a mountain. So, with help from the OKC and Sacramento FIFO personnel, a special engineering flight inspection was scheduled to be completed with their normal periodic checks of the Prescott Ernest A. Love Field Airport in March, 2008. A run sheet was developed and refined with help from the OKC and Sac FIFO flight crew, and flown on March 11, 2008 (Ref. Table 1). Following is a brief explanation of the runs:

- Run #1: The purpose of this run is to establish Flagstaff Runway 21 LOC approach path heading and signal strength (SS), on approach, at approximately 10 NM (18.5 km) out from FLG.
- Run #2: The purpose of this obit run is to check Flagstaff Runway 21 LOC Clearances, SS, for any false course(s) and/or RF null(s), at approximately 10 NM (18.5 km) out from FLG (i.e. a distance which puts us in the frontal area of Mount Humphreys).
- Run #3: Identical to Run #2, but 15 NM (27.8 km) out from FLG (i.e. behind Mount Humphreys).
- Run #4: The purpose of this run is to check for Prescott (PRC) Runway 21L LOC approach path at approximately 60 NM (111 km) point (i.e. behind Mount Humphreys).
- Run #5: Identical to Run #4, but 54 NM (100 km) out from PRC (i.e. in the frontal area of Mount Humphreys).
- Run #6: The purpose of this run is to check for PRC Runway 21L LOC SIS on approach and over FLG Runway 21.
- Run #7: The purpose of this run is to intercept PRC LOC course at approximately 65 NM (120 km) and 13,500 ft (4,115 m). If found, fly it to over Mount Humphreys to Prescott and record RF signal strength. PRC course was present and flyable (Ref. Figure 1).
- Run #8: The purpose of this run is to establish PRC Runway 21L LOC approach path heading and RF SS at approximately 10 NM (18.5 km) out from PRC. Note: This run was combined with Run #7.

Figure 1. PRC Localizer Course Over Mount Humphreys

Table 1. Flight Inspection Run Sheet
(11 March, 2008)

Run No:	Equip. Config.	AFIS	Positioning	Measurement	Remarks
1	Normal	I-3; Tuned to I-FLG	Flagstaff ILS RWY 21 as Procedurally drawn from overhead FLG VDME 11,000	Lat/Long where 0μA at 10 NM or 0μA when established after PT. Align, structure, SS of Loc (minimum). *(GPS: N035°15.97'; W111°31.31')*	Use DME fix page to print LAT./LON & A/C heading if possible to the AUX printer
2	Normal	I-1; Tuned to I-FLG	Fly I-1 - **10** NM / 10,000 MSL Orbit approx ± 90°on FLG, Sector 1, 2, & 3 both sides of front course I-FLG (KFLG RWY 21). *Note: 10 NM from FLG LOC in front of Mount. Humphreys; -60° to 60°.*	Clearance, SS	Note False course and or RF Nulls
3	Normal	I-1; Tuned to I-FLG	Fly I-1 - **15** NM / 10,000 MSL Orbit approx ± 90°on FLG, Sector 1, 2, & 3 both sides of front course I-FLG (KFLG RWY 21). *Note: 15 NM from FLG LOC behind Mount Humphreys; -60° to 60°.*	Clearance, SS	Note False course and or RF Nulls
4	Normal	I-1 tuned to I-PRC	Fly **60** NM / 10,000 MSL I-1 on FLG recording I-PRC. Orbit approx ± 90°, Sector 1, 2, & 3 both sides of front course I-FLG (KFLG RWY 21). *Note: 60 NM from PRC LOC.*	If I-PRC rcvd - Lat/Long of 0μA cross over point. SS of Loc (minimum). *Pilot Notes: CL I-PRC @ 10,000'; noted at: N 35° 23.47'; W 111° 37.16'. Also noted: 150 Hz side at: N 35° 25.41'; W 111° 39.95'; good signal; 60 NM @10,000'.*	**Caution 12,000+ Mountain RT of Course.** Fly on East side to avoid if necessary. Use DME fix page to print Lat/Long & A/C heading. If possible to AUX printer. Expect to receive I-PRC approximately 40°/ 150 Hz referenced to I-FLG.
5	Normal	I-1 tuned to I-PRC	Fly I-1 - **54** NM / 10,000 MSL Orbit approx ± 90°on FLG, Sector 1, 2, & 3 both sides of front course I-FLG (KFLG RWY 21). *Note: 54 NM; -20° to 20°; just clears front of Mount Humphreys.*	If I-PRC rcvd - Lat/Long of 0μA cross over point. SS of Loc (minimum). *Pilot Note: CL I-PRC @ 10,000'; noted at: N 35° 19.37'; W 111° 42.52'.*	**Caution 12,000+ Mountain RT of Course.** Fly on West side if necessary to avoid. Use DME fix page to print Lat/Long & A/C heading. If possible to AUX printer. Expect to receive I-PRC approximately 40°/ 150 Hz referenced to I-FLG.
6	Normal	I-3; Tuned to I-PRC	Flagstaff ILS RWY 21 as Procedurally drawn from overhead FLG VDME 11,000.	Micro Amp value of **I-PRC** when established after PT. SS of Loc (minimum). *Note: Event 9.7 DME from FLG; No PRC Signal.*	Print DME fix page when established after PT for Lat/Long A/C Heading. If possible to AUX printer.
7	Normal	I-3 tuned to I-PRC, Tune FLG VDME to Sys C Auto AZ	Intercept I-PRC (**65** NM) and fly to facility, minimum Intercept alt 13,500. Maintain minimum 1,000 ROC until GS Intercept. Intercept course Approximately FLG VDME R000/ 17 MN. *Note: Over Mount Humphreys then 10,000'; continue course to GS intercept and 10 NM point; mark Lat/Long; break off.*	Lat/Long of I-PRC intercept 0μA cross over point. Align, structure, SS of Loc (minimum). *Note: Lat/Long: N34° 47.086'; W112° 16.873'.*	Annotate start AZ and reference there after for FLG VDME, Sys C.
8	Normal	I-3 tuned to I-PRC	Prescott ILS RWY 21L as Procedurally drawn for an inbound arrival from Northeast.	Lat/Long where 0μA at 10 NM or 0μa when established whichever occurs first. Align, structure, SS of Loc (minimum).	If procedural acceptable may be combined with run 7. (*Combined with Run 7.)*

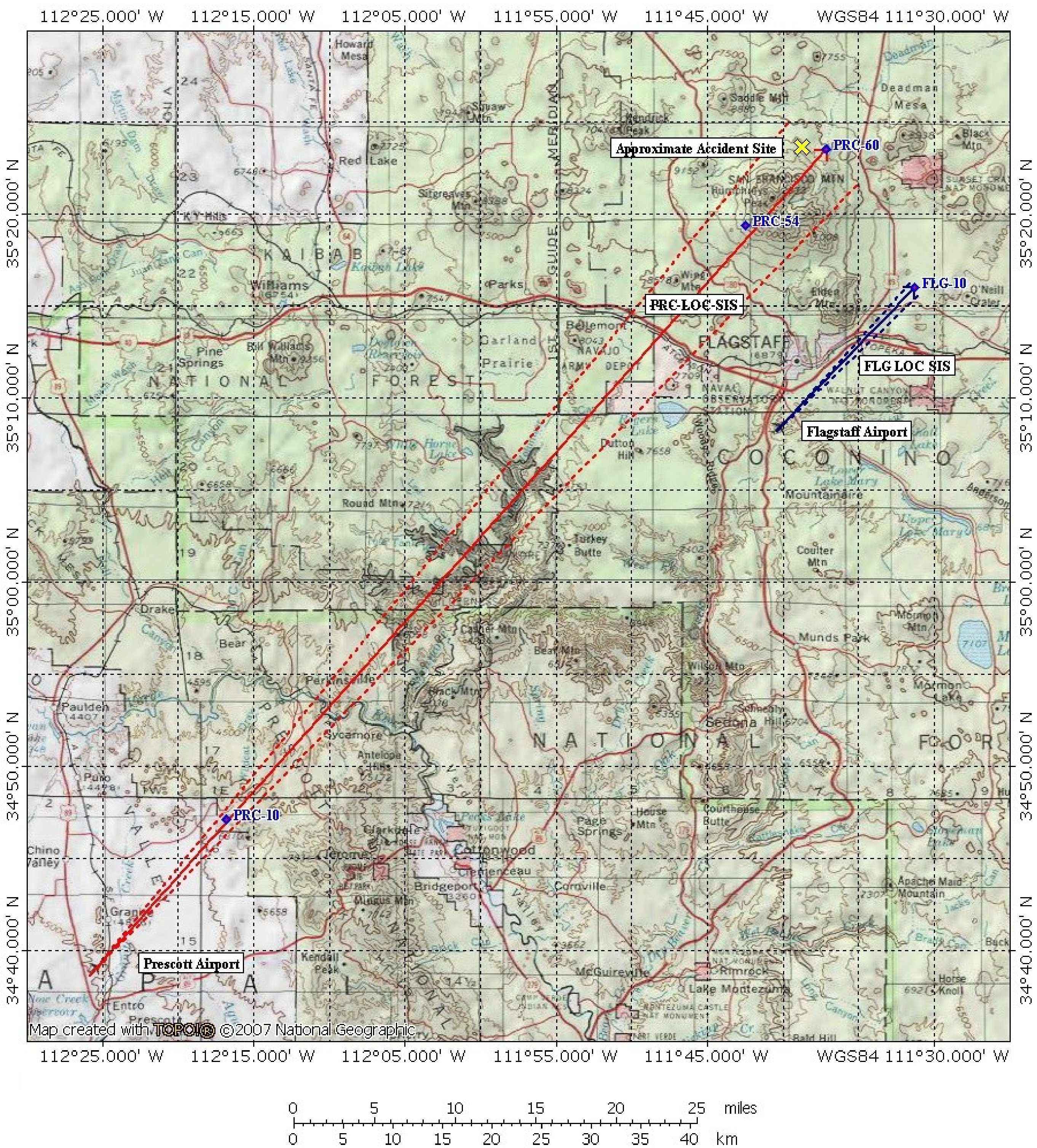

Figure 2. PRC and FLG Localizer Signals and Approximate Accident Location

4.4 Flight Inspection Results, 2008

Some of the flight inspection results are noted in Table 1: Flight Inspection Run Sheet (March 11, 2008), in blue italic font. Also, a map of the area is shown in Figure 2: PRC and FLG Localizer Signals, with some of the as-found Lat/Long coordinates plotted. Course widths of the Localizers are shown drawn in (i.e. dashed lines); Red lines indicate the PRC LOC, with blue the FLG LOC. PRC 10, 54, 60 points represent the PRC as found centerline at the various nautical miles; FLG-10 is FLG centerline at 10 NM (18.5 km). Following is a brief summary of the flight inspection findings;

- The flight Inspection data recorded during this trip verified and established locations of the previously observed PRC LOC Runway 21L SIS in the FLG Runway 21 approach area (i.e. around the Mount Humphreys area).

- At the 10,000 ft (3,048 m) level behind Mount Humphreys, the PRC LOC "Centerline" dropped off the Automatic Flight Inspection System (AFIS) recording, apparently blocked by Mount Humphreys. However, the pilot was still able to note the Lat/Long coordinates of the centerline using his front instrument indications. There is some question as to whether this was due to a difference in receiver's, or the added capability of the aircraft Flight Management System (FMS) to indicate the centerline location.

- RF signal strength (SS) was low but receivable by the AFIS and recorded the locations of the "fly right" and "fly left" signals present within 1° to 1.5° of the centerline. Note that these signals are within the LOC course width.

- At 13,500 ft (4,115 m) and 65 NM out, again behind Mount Humphreys, the PRC LOC centerline was present and flyable (20 & 26 µV two receivers). This indicates that the PRC centerline signal is of sufficient strength to fly, behind the mountain, somewhere between 10,000 ft (3048 m) and 13,500 ft (4,115 m).

- The PRC Runway 21L LOC SIS was found flyable at 10,000 ft (3,048 m) and 54 NM (100 km) distant (i.e. if front of Mount Humphreys), which was flown to within 10 NM (18.5 km) of Prescott.

- The PRC LOC signal was found to be non-existent (non-flyable) on the approach and over the FLG Runway 21.

- The Flagstaff LOC signal wasn't found to be present behind Mount Humphreys.

5. CONCLUSION

The March 2008 flight inspection data recordings support our initial observation made during the EFGS snow-effect engineering study in 1996. That is; the PRC Runway 21L LOC SIS exists in the FLG Runway 21 approach area, around and in a direct path with Mount Humphreys in particular.

We'll never know if the pilot of the aircraft discussed in this paper made a mistake and tried to fly the PRC LOC SIS. But this accident leads one to consider that here is a location that an ILS Navigational HMI due to the operational environment exists, and if used in error can lead to tragic results.

This paper contends that the situation discussed herein constitutes ILS Navigational HMI in the Operational Environment; from the perspective that a pilot who mistakenly uses the PRC ILS SIS is being assured that the path is safe by the ILS signal itself. This paper also contends that this particular ILS Navigational HMI condition is the result of an unforeseen installation circumstance.

This paper also contends that the risk (i.e. probability) of a pilot mistakenly using the PRC ILS SIS while making an approach to Flagstaff is low; however, it is not zero. It is possible that we have seen evidence of this; hence the discussion of the 1996 aircraft accident.

This paper recommends the elimination of any such risk, if possible by an engineered solution. Following is a discussion of how this might be accomplished at Flagstaff.

6. RECOMMENDATIONS

6.1 Elimination of ILS HMI at Flagstaff

For the short term recommend that ATC at Flagstaff make sure that during IFR approaches into FLG Runway 21, that the pilot be alerted to verify the FLG LOC IDENT.

For a permanent fix I'd recommend that an engineered solution be developed and implemented to eliminate the condition. The following are several I considered, with the one I consider the best to be discussed in more detail.

6.1.1 Possible Solutions

- Change course direction of PRC Localizer to avoid Mount Humphreys. Not recommended since this would involve a change of several degrees, the rework of PRC LOC antenna array, and non-alignment to PRC runway 21L.

- Reduce RF output power of PRC LOC. Not recommended, since the power reduction required would be significant and do not recommend reduction of power in the normal LOC usable distance area.

- Add voice warning to PRC LOC signal. Might help alert the pilot but currently not allowed, and does not eliminate the risk.

- Install "clearance" transmitter. Recommended and explained in further detail below.

6.1.2 Recommended Solution

A recommended solution would be the installation of an RF "clearance" transmitter for the Flagstaff approach area. This transmitter would be set to transmit an un-modulated RF frequency approximately eight (8) KHz below the PRC LOC frequency of 108.50 MHz. The aircraft receiver would then receive the stronger un-modulated signal and block the PRC LOC SIS. In addition this clearance signal would present a flag to the pilot indicating that this signal is unusable.

For location; the best location for the transmitter would be on top of Mount Humphreys, perhaps located with other radio type installations. In this case an Omni antenna would be used to radiate the RF signal (Ref. Figure 3).

Another possible location for the installation would be at the FLG EFGS facility located on the Flagstaff airport property. In this case a YAGI antenna would be used installed at the EFGS and directed towards Mount Humphreys (Ref. Figure 4).

The transmitter RF output power would be determined so that the PRC signal would be overridden by at least 10 dB, and would not interfere with the usable distance requirement (i.e. 18 NM) for the PRC approach.

A through-the-air receiver could be installed at the FLG ATCT for monitoring capability. Actual signal levels and performance would be verified by Flight Inspection.

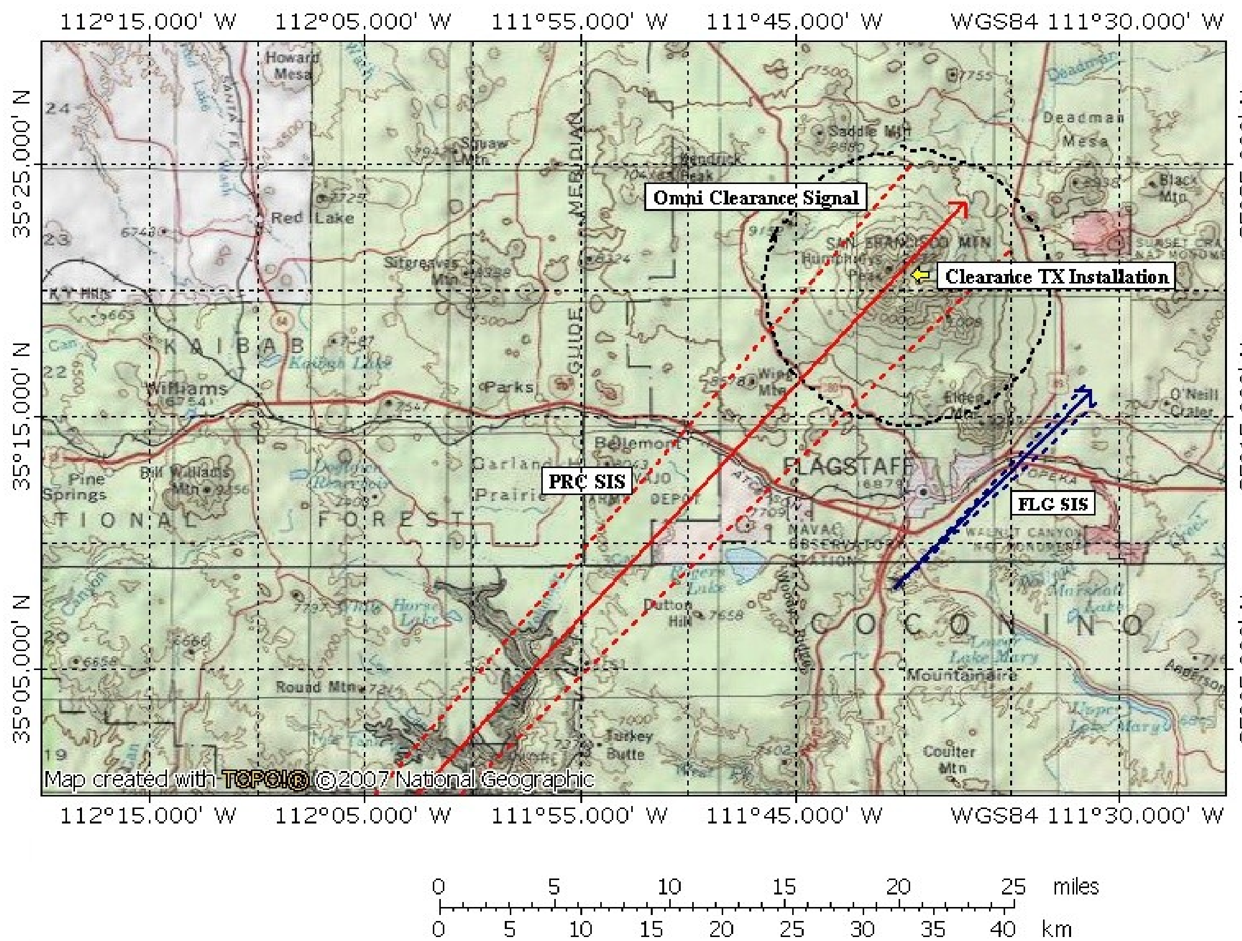

Figure 3. Installation of Clearance TX on Mount Humphreys (OMNI Antenna)

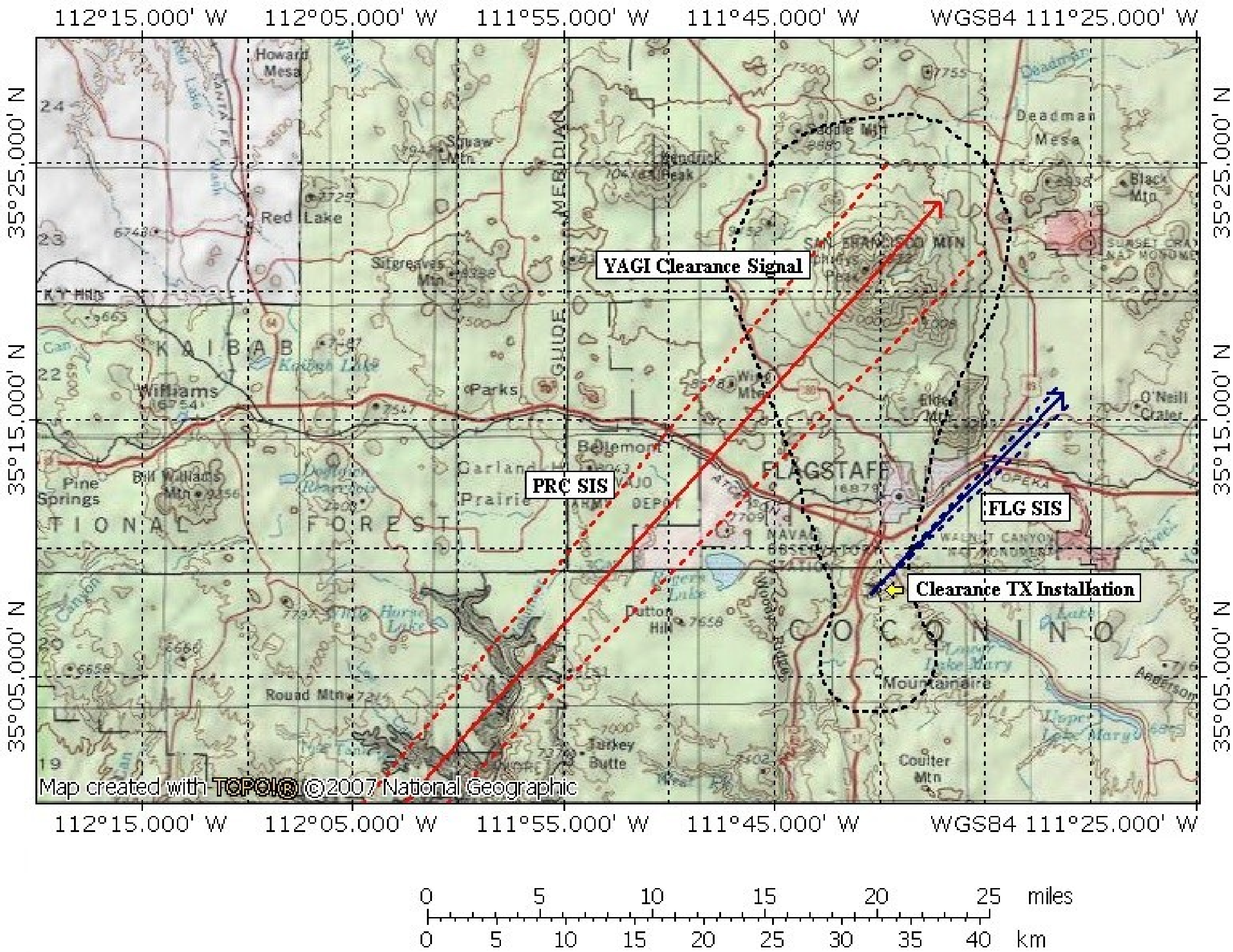

Figure 4. Installation of Clearance TX at Flagstaff (YAGI Antenna)

6.2 Recognizing Possible ILS HMI

6.2.1 Flight Inspection

For the benefit of Flight Inspection personnel I would recommend that they be briefed on the possible problems of ILS Navigational HMI due to the operational environment and the situations where it might pose a risk. Being on the "front-line" in the course of their normal flight inspection duties, they can stay alert for any similar type location and/or conditions.

If any similar locations are found or may present a possible problem area, further analysis by a team made up of flight inspection, safety, and engineering personnel for instance, may be conducted. A risk assessment could be performed and forwarded for further action if required.

I would think that the type of HMI instance discussed in this paper would be rare. As can be seen there are several circumstances all coming together, at just the right location that produce this situation. But, where there's one – there could be more. Also, other items to consider are;

- How tightly controlled is the approach?
- Do aircraft have to be lined up to land for miles out, with ATC radar coverage all the way to landing?
- Is it a small airport where radar service may be terminated in the last few minutes?

6.2.2 Engineering

For the benefit of ILS engineering personnel I would also recommend that they be briefed on the possible problems of ILS Navigational HMI due to the operational environment and the situations that it might pose a risk.

Installation engineers are mostly concerned with the local approach area, terrain, prevalent wind direction, facility location, power and monitoring cabling. Consideration at far distance is usually only given to the possibility of frequency interference with another installation. This concern is investigated by Frequency Management when the engineer orders the Frequency Transmitting Authorization (FTA) for each facility, where transmitter RF power and frequency is of consideration. They could also consider questions such as;

- Where are the new ILS installations signals headed?
- Are the signals intersecting another ILS in its approach area? With obstructions in the area?
- Do the new ILS facilities possibly present an ILS navigational HMI due to the operational environment – one mistake away?

For the benefit of field engineering personnel I would suggest that they be briefed on this type of ILS HMI so that they might be aware of such situations. Field engineers are mostly concerned with equipment operation issues such as equipment outages, reliability and availability, and not as much flight procedures or obstructions in the far field. But it wouldn't hurt to be aware of the possibility, where it might be recognized before a possible accident might occur by mistake.

6.2.3 <u>Initial ILS NAS Review</u>

For the benefit of the United States NAS (and those of the International Civil Aviation organizations) I recommend that a team be formed of flight inspection, safety, and engineering personnel to review existing NAS ILS installations for this type of ILS HMI.

The task shouldn't be as bad as it first sounds. It can be seen from this paper's example of Flagstaff, Arizona; that several conditions have to fall in place before there is a condition, or risk, of ILS HMI due to the operational environment.

If other locations where an operational environment obstruction and/or hazard is found in the path of an ILS; at a point where it might be used and not covered by other risk mitigations and secondary systems such as radar guidance, those locations should be forwarded for further risk analysis.

And, being an engineer, I recommend the complete *Elimination of ILS Navigational HMI in the Operational Environment* by engineered solutions where possible; whether than changes in warnings and procedures.

7. <u>ACKNOWLEDGMENTS:</u>

I would like to thank AJW-43, Monty Maughan for his assistance; those of the AFS-400/410 organizations for allowing me to present my planned paper during one of the monthly telecoms and request flight inspection assistance. I would like to thank the Oklahoma City FIFO and Sacramento FIFO for their support in performing the engineering flight inspections. The first brought my attention to the Prescott ILS SIS in the Flagstaff and Mount Humphreys area, and the second to obtain flight recordings and to document the signals.

In particular I would like to thank Michael Fleming of the OKC FIFO for coordination efforts for the Flagstaff engineering inspection, and the Sacramento FIFO flight inspection crew; Pilots Scott Thompson and Thomas Gano, and Engineering Technician, Doug Koehn, for their support. They were very helpful in refining the run sheet, providing explanations of their equipment measurements and flight inspection procedures, and their willingness to provide the runs needed to collect the data.

I would like to also thank James Pritchard, AJW-14, for his support and approval of time and travel funds for the engineering flight inspection data gathering effort.

8. <u>REFERENCES</u>

[1] FAA, 28 September 2007, <u>General Maintenance Handbook for National Airspace System (NAS) Facilities</u>, Order 6000.15E

[2] [3] L. Nelson Spohnheimer, Trip Report – <u>NAVAIDS and Abnormal Airport Environments (AAE's)</u>, Southwest Regional Office, ASW-470

[4] NTSB, Accident Report Identification Number: LAX96FA105, Occurrence Date: 1/31/1996, http://www.ntsb.gov

9. <u>DISCLAMER</u>

This paper is presented as a different viewpoint of ILS HMI, brought about by a field experience by the author. Speculation on possible reasons for the 1996 aircraft accident discussed in this paper is only that; speculation by the author for the purpose of furthering technical interchange on the subject. This paper does not represent the views of the Federal Aviation Administration or the United States.

BIO – Mickey Lindecker

After completing four years with the USAF in the communications electronics area in 1973, I continued my studies in electrical engineering at the University of Texas at Arlington, Arlington, Texas. I graduated with a BSEE from UT of Arlington in 1975, and started work with the Federal Aviation Administration (FAA) as a field installation engineer for Instrument Landing Systems (ILS) for the Southwest Region. My first full ILS system installation including a Capture Effect Glide Slope (CEGS) was at Addison, Texas, just north of Dallas.

I later transferred into the Southwest Regional engineering office where I was in charge of writing and coordinating ILS installations, and later transferred into communications engineering doing the same type work for communication installations. To obtain field work I transferred to the DFW System Management Office (SMO) and worked with the NAVAIDS and Communications Technician-in-Depth (TID) and obtained several equipment/facility certification credentials. Also obtained training in the performance of technical inspections and started doing inspections at ILS and communication equipment/facilities. Also began giving equipment performance exams technician certifications.

Late 1980 transferred to the Austin SMO Technical Support Office (TSO) in the ILS area and continued work supporting the field, performing technical inspections and giving performance exams to the field technicians for the Austin SMO area of responsibility. In 1984 transferred to National Airspace System (NAS) 2nd level engineering support office to work in the communications area. In this office I assisted the field engineers with equipment/facility problems and if national in scope, worked on engineering projects for the development of field modifications to correct the problem(s). I later transferred into the ILS area performing the same type work.

Through the years I've progressed through job duties as project and senior engineer, team lead(s), for both the communication and ILS areas. I continued my studies with numerous FAA and manufacturer training and equipment schools, and began work on an Applied Mathematics masters at the University of Central Oklahoma (UCO). Currently, I'm working for the Navigation/Landing Field Support Team in the ILS area of field support in the Navigation and Landing Systems office, AJW-143.