Flight Safety on Flight Inspection Missions – Past Statistics and Future Strategies

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ABSTRACT

By their very nature – flying low, often in densely populated airspace - , flight inspection missions do implicitly incur a higher potential risk than regular airline operations in transporting passengers and freight.

This paper identifies the specific risks involved in performing various flight inspection missions. It continues to analyse the past safety record the flight inspection community has achieved so far, and compares this safety record with other types of operation in the aviation world.

Having identified the individual risks involved, the author continues to outline potential mitigation tools to deal with these safety challenges – aspects of operational setup, training and equipment will be covered.

In closing, the paper uses the mitigations tools identified to start a discussion towards a common standard in flight inspection operations, looking at standards and recommended practises other branches of the aviation community (airlines, business aviation, survey operators) have produced so far.

INTRODUCTION

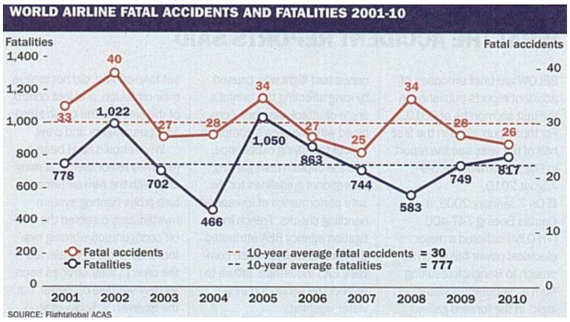
It is a well established fact that aviation is an extremely safe mode of transportation. Major progress in the fields of aircraft, engines and system design, infrastructure (like ATC, navigational systems etc.) and, almost as important, the way we operate aircraft today (introducing checklists, Standard Operating Procedures SOPs, focussing on Human factors, Crew Resource Management CRM etc), all lead to an imprecedended low level of accidents and incidents in civil aviation.

The look across the spectrum of aviation, though, reveals a wide variety in safety statistics among the various branches of the industry, with the public transport sector (airlines) featuring a very low accident rate, followed by other sectors like business aviation and general aviation.

In order to establish the current safety status of our flight inspection industry we have to look into the more general statistics mentioned above in more detail.

ACCIDENT AND INCIDENT STATISTICS

The metrics against which safety in aviation is measured are varied; a common unit is the number of hull losses per year, as indicated in Figure 1 below:



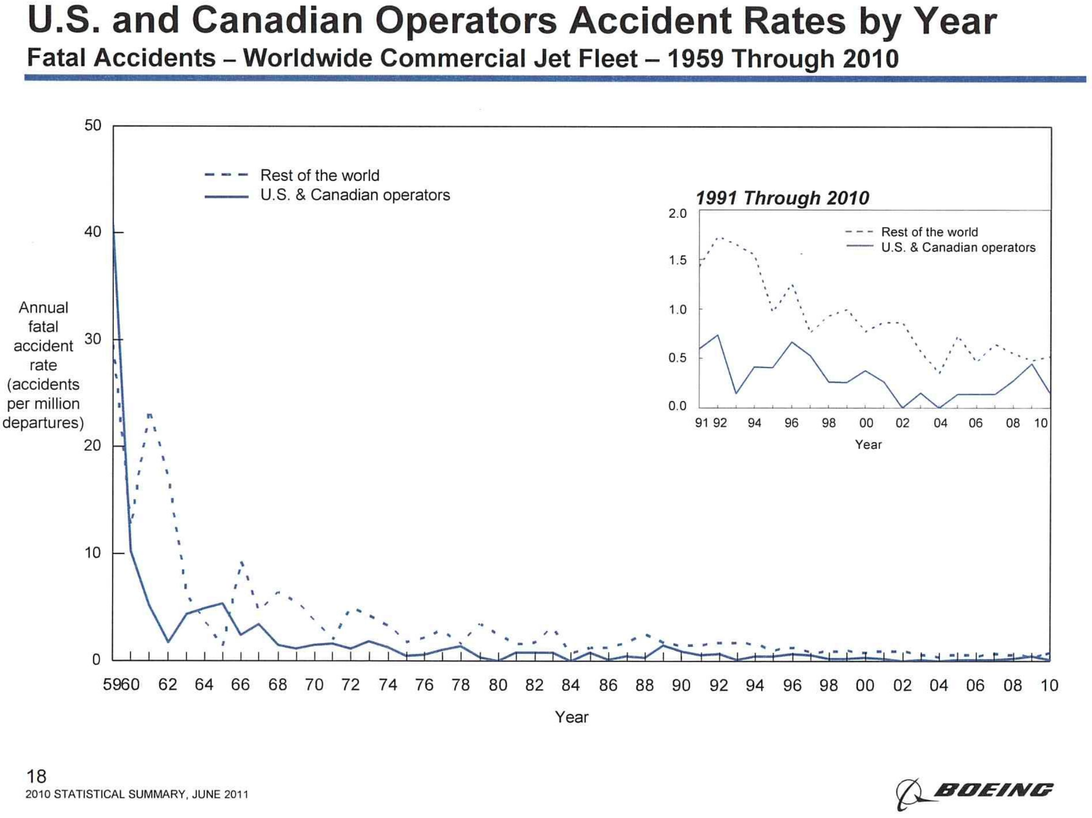
WORLD AIRLINE FATAL ACCIDENTS AND FATALITIES 2001-10

SOURCE: Flightglobal ACAS

Figure 1: Accidents and Fatalities by Hull Losses

According to this statistics of Flight International of 2011, the number of hull losses in the airline industry in 2010 has been 26, the number of fatalities 817.

Another fairly common approach is to measure the annual fatal accident rate against millions of departures, see Figure 2 below:



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So according to this graph by Boeing, in 2010 there were 0,3 fatal accidents per 1 million departures in the U.S. & Canada within the commercial jet fleet. Note the difference against the rest of the world with 0,6 fatal accidents. It is important to note that this Boeing graph is based on an everage sector length of 1,5 hrs per departure, so as a proximation it is fair to say that the 0,3 fatal accidents per 1 million departures in the U.S. & Canada translates into 0,2 fatal accidents per 1 million flight hours, or 0,4 fatal accidents per 1 million flight hours for the rest of the world. This will later help us compare these numbers against other sectors of the industry.

There are other metrics available to document the accident rate of the commercial airliner industry, like hull losses and fatalities against hours flown, distances covered and seat capacitiy offered and used.

All these data indicate a very low accident rate, it further shows a steady decline in both accident rates as well as fatalities over the last 30 years, albeit with the number sort of plateauing around 0,5 fatal accidents per 1 million departures per year for roughly 12 years now.

These are all values for the airline industry – finding similar data for our industry proved to be much harder.

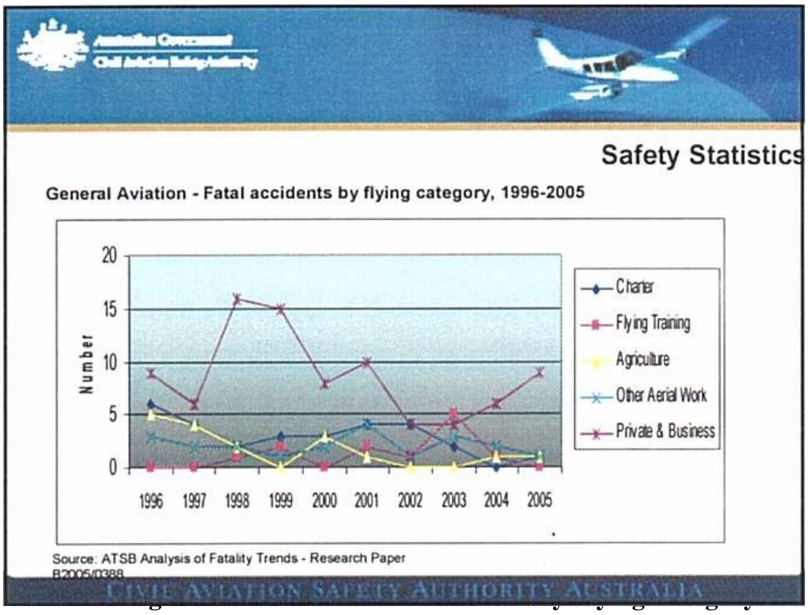
First, one had to differentiate all available accident data into the different aviation activities of Commercial (Airlines), Business, Corporate, State, Military and General Aviation. There are in some cases some major differences between countries in how certain aerial activities are summarised under which category: some countries, in their statistics, further differentiate Commercial activities in Airline, Commuter and Air Taxi, others put all activities below the commercial world under General Aviation, and others again differentiate the General aviation domain quite extensively into Training, Leisure flying, and Aerial Work.

In other words, a comprehensive, worldwide database with accident data splitted as per category of aerial activity does not exist.

To give us a first feeling as to where the aerial work community – of which flight inspection is a part of – stands, it helps to look at the statistics of two countries, which respective regulator took some effort to further differentiate accident data and break it down into the different categories of aerial activities.

The Civil Aviation safety Authority of Australia took some effort in differentiating Australian data: they splitted General Aviation into Charter, Flight Training, Agricultural Flying, Aerial Work and Private and Business Flying. For the purpose of accident analysis it appears to be fair to combine both Agricultural Flying and Aerial Work under one category of Aerial Work.

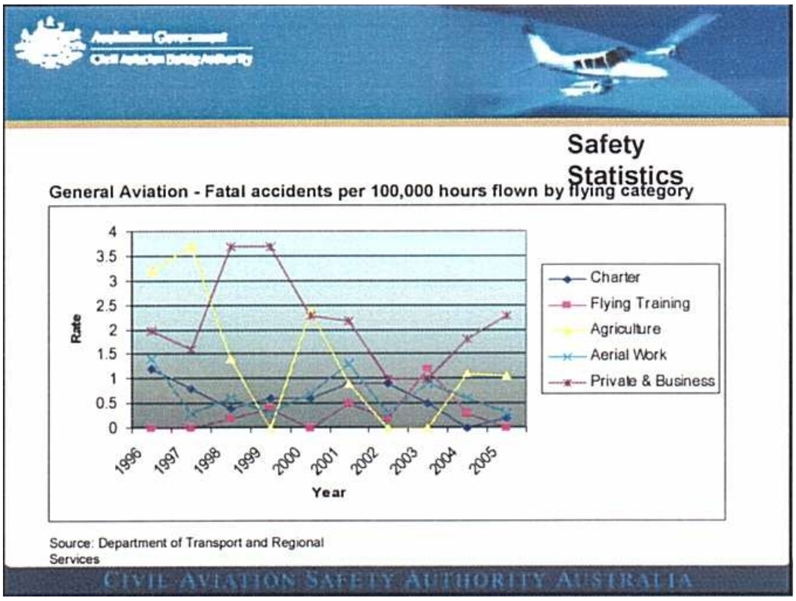
Figure 3 below gives us tha fatal accident rate by flying category in Australia from 1996 to 2005:



Safety Statistics

General Aviation - Fatal accidents by flying category, 1996-2005

Source: ATSB Analysis of Fatality Trends - Research Paper B2005/0388



Safety Statistics

General Aviation - Fatal accidents per 100,000 hours flown by flying category

Source: Department of Transport and Regional Services

According to Figure 3, Australia suffered 2 fatal accidents in 2005 in the aerial Work domain, for stance (1 in Agriculture, 1 in other aerial Work).

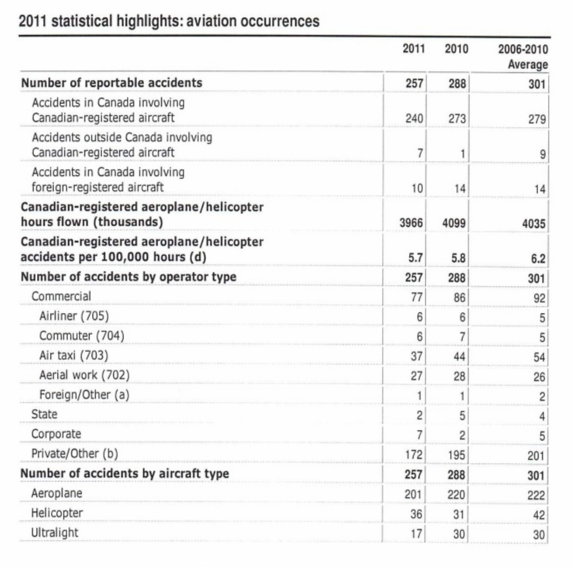
According to Figure 4, in 2005 there were 1,3 accidents per 100.000 flying hours in Australia in the Aerial Work domain.

This gives us a first, rough comparison to the data of the airline sector given above: 0,4 fatal accidents per 1 million flight hours stand against a statistical value of 13 accidents per 1 million hours flown in the Aerial Work sector in Australia – roughly 33 times the number of the airline sector.

Of course this number has to be treated with caution: Australia has a very active aerial work community (thus increasing the chances of a mishap statistically), on the other hand it has a well established infrastructure around this sector, with good training being available, and a comprehensive and competent oversight by the regulator being exercised. So in the absence of world wide statistics being available, it might be fair to take the Australian data as a first proximation and indication were the Aerial Work Community in general might stand in terms of safety.

The Transportation Safety Board of Canada's statistics below support this proximation in a way; unfortunately it does not differentiate the number of hours flown by the operator type. Canada suffered 257 accidents across the whole spectrum of the industry, of which Aerial Work contributed 27 (roughly 10%). As this can not be broken down to the number of hours being flown in the individual sector, direct comparisons are somewhat hampered, furthered by the fact that the Australian data refer to fatal accidents only, the Canadian data to reportable accidents.

Figure 5: Canadian Accidents Data 2011



2011 statistical highlights: aviation occurrences

	2011	2010	2006-2010 Average
Number of reportable accidents	257	288	301
Accidents in Canada involving Canadian-registered aircraft	240	273	279
Accidents outside Canada involving Canadian-registered aircraft	7	1	9
Accidents in Canada involving foreign-registered aircraft	10	14	14
Canadian-registered aeroplane/helicopter hours flown (thousands)	3966	4099	4035
Canadian-registered aeroplane/helicopter accidents per 100,000 hours (d)	5.7	5.8	6.2
Number of accidents by operator type	257	288	301
Commercial	77	86	92
Airliner (705)	6	6	5
Commuter (704)	6	7	5
Air taxi (703)	37	44	54
Aerial work (702)	27	28	26
Foreign/Other (a)	1	1	2
State	2	5	4
Corporate	7	2	5
Private/Other (b)	172	195	201
Number of accidents by aircraft type	257	288	301
Aeroplane	201	220	222
Helicopter	36	31	42
Ultralight	17	30	30

Flight Inspection specific Statistics

As indicated above, there is no country-specific, let alone world-wide statistic data available for accidents and incidents in the flight inspection community. It is even impossible to quantify the share of flight inspection activities within the Aerial Work sector.

All that notwithstanding, our industry did suffer some accidents and incidents in the past, which will be described in more detail below. The listing starts in 1993; there is anecdotal evidence that there were accidents and incidents before that date (there is anecdotal evidence that the German Airforce lost a Flight Inspection Douglas C-47 on take off in the sixties, for instance), but these data are hard to verify. As both the technical as well as the operational environment of our sector has changed considerably over the past 20 years, the question arises as to how relevant these pre-1993 incidents – as tragic as they might have been – are for conclusions to be drawn from them to today's flight inspection environment. It was therefor decided to concentrate on the last 20 years.

Accidents and incidents of the flight inpection community have been identified as follows:

1. On October 26, 1993, the FAA's flight Inspection Area Office of Atlantic City, NJ, lost a Beech B300 near Front Royal, Virginia, on a transit flight after a calibration mission
   The primary cause has been identified as being a controlled-flight-into-terrain (CFIT) accident; the flight was continued under VFR in IMC, the aircraft subsequently hit terrain. 3 fatalities

2. On October 24, 2000, the German Flight Inspection International FII GmbH lost a Beech B300 near Donaueschingen, southern Germany, after the aircraft completed a commisioning flight check for a new NDB and tried to land back at the airfield. Again, primary factor was a CFIT accident (here as well the flight was continued under VFR in IMC). 4 fatalities

3. On June 23, 2004, an Indian Airports Authority Dornier Do228 landed gear up inadvertently at Pune Airport, India. No fatalities, no injuries

4. On November 26, 2006, a Pakistan CAA Beech B200 skidded of the runway at Sharjah, United Arab Emirates, after a main gear tyre burst on landing. No fatalities, no injuries
   There are news reports that report the same aircraft to belly land again at Sharjah on July 26, 2007; however, these reports could not be verified, it rather appears the aircraft had an "Gear Unsafe" indication and made a precautionary diversion, and subsequent safe landing, at Minhad Airbase, UAE.

5. On August 17, 2008, a Cessna 402C of Reconnaissance Ventures, had a mid-air collision with a Rand KR-2 single engine aircraft at Coventry airport, UK. The Cessna was on a flight calibration training flight, flying an ILS approach to runway 23. ATC error as well as ambigeous procedures for mixing IFR and VFR traffic in Class G uncontrolled airspace played a part in this accident. 4 fatalities in the Cessna, 1 fatality in the KR-2.

All causes and explanations were derived by the author from the relevant accident investigation reports.

Table 1. Accidents and Incidents Flight Inspection Aircraft 1993 - 2011

Date	Aircraft	Operator	Accident, Location	Primary Cause	Fatalities
26 Oct,	Beech	FAA; USA	CFIT, Fort Royal,	Continued VFR flight in IMC	3

Date	Aircraft	Operator	Accident, Location	Primary Cause	Fatalities
1993	B300		Virginia, USA		
24 Oct, 2000	Beech B300	FII GmbH, Germany	CFIT, Donaueschingen, Germany	Continued VFR flight in IMC	4
23 Jun, 2003	Dornier Do228	Indian Airport Authority	Gear-up landing	Cause not known	nil
27 Nov, 2006	Beech B200	CAA Pakistan	Gear failure on landing	Cause not known	nil
17 Aug, 2008	Cessna 402C	Reconnaissance Ventures, UK	Mid-air collision, Coventry, UK	ATC error / airspace and ATC-set-up ambigiuities	5

The primary cause for the belly landing of the Do228 is not known; inadvertent gear-up landings, by experience, though, do indicate an unresolved Crew Resource Management (CRM) issue within the crew and / or its organisation at that time.

Neither is the cause of the gear failure on landing of the Beech B200 known. This might be indicative of a maintenance issue, however, this would be purely speculative.

It should be noted though, that from a more generic view, and expressively irrespective of that specific incident, maintenance issue very often do have broader implications towards the organisational set-up of a flight organisation, were insufficient oversight is given to issues like maintenance intervals and quality, obsolescense issues with aircraft, systems and equipment, training, etc.

The term of organisational environment or set-up or processes has been named several times in this paper so far. By that it is meant that over the last odd 25 years the focus of any accident analysis has shifted from purely concentrating on the crew actions and failings (which still form a vital part of any accident investigation) to looking into the broader concept in which the ill-fated flight took place. How was the flight organisation set up at the time of accident? Did the crew receive the amount of support required for that specific mission to be flown? Was a coherent strategy in place in that particular organisation, starting from top manangement down, to ensure a safe flight operation?

That approach was a simple necessity to further bring down accident statistics; up to that point, in the vast majority of cases, an accident investigation closed with the verdict: crew error. And in the broader sense of that term, 70% of all aviation accidents still fall under that category. However, in order to faster safety that verdict left stand alone proved to be useless and had to be scrutinized much further: why did the crew react the way it did? What was the organisational environment it was operating in? Was a coherent strategy in place how to operate the aircraft, including SOPs, checklists, CRM and CRM training? What was the safety culture of that flight organisation at the time of accident?

It is interesting to note that most Accident Investigation Reports, like those of the US NTSB, now start by looking into these organisational issues first prior turning to the individual crew action in question.

In the light of these organisational environment issues the two CFIT accidents warrant a closer look.

Although both accidents were, at first glance, a straightforward CFIT, and thus a classic pilot or crew error, accident investigation unearthed a number of deficiencies in both organisation that were at least contributing factors.

In both cases it was fairly quickly established that a number of organisational prerequisites were overlooked: CRM and SOPs were either non-existent or not enforced by the respective organisation; in both cases a very steep hierarchy gradient between the cockpit crew existed, with an overbearing commander not seeking feedback and advise from his fellow crew member – a known fact within the respective flight departments for quite a while without being addressed. Further training issues, like training on the job / supervision time, or the lack of, were discovered.

It is comforting to know that both organisations involved successfully took all steps necessary to tackle the deficiencies identified by the respective accident investigation reports. To that end both cases could be viewed as text book examples of challenges our industry does face, and that it is possible to address them.

The Coventry mid-air collision does feature several contributing factors; some are related to the specific UK airspace and ATC structure (the ILS training approach was flown in class G uncontrolled airspace, were responsibilty for separation between traffic lies with the respective pilots, yet both aircraft were in contact with ATC, maybe erroneously believing to be under “positive” control by ATC); other contributing factors were the late handover of the Cessna from the approach controller to the local tower controller. The geometry of both targets approaching each other in the traffic pattern, according to the accident investiigation report, positively prevented both crews from seeing each other.

So, although a single, primary cause may not be derived from that accident, it serves as a grim reminder that most of our work is done in rather densely populated airspace, and that a properly arranged and trained ATC environment, clear communications between all parties involved and a constant, vigilant look out is absolutely paramaount for the safety of our mission. In this particular case, although purely speculative, appropriate technical equipment (in this case TCAS) might have helped to mitigate the situation. More to that in the latter chapter of this paper.

SPECIFIC RISKS OF FLIGHT INSPECTION MISSIONS

We now have looked at some safety statistics of aviation in general and aerial work / flight inspection statistics in particular. What are the specific risks now involved in doing flight inspection?

Before we address that question, we quickly look at risk definition in aviation in general.

Aviation Risk Models in General

Numerous risk models do exist in the aviation industry and research community, like Fault Tree Analysis (FTA), Probabilistic Risk Analysis (PRA) or Aviation System Risk Model (ASRM).

They all share the approach to modell as closely as possible the rather complex factors influencing flight operations and their respective inter-dependencies.

It is worth to note that according to the standards of risk research, all aviation accidents fall under the category of the so-called low probability / high consequence events (lp/hc), were
“The lp/hc problem domains are inherently ill-structured, multi-layered, and characterized by consequences with low likelihoods, high severities and numerous, pervasive uncertainties. Decision making is typically complex, multitiered and non-transparent with conflicting objectives and multiple perspectives” (Clement 1996)

Translated into a much more simplified formular, it might be fair to say that risk is the product of probability times severity

$$\mathbf{R_{isk} = P_{robability} * S_{everity}}$$

One has to note though that this approach contains a fairly subjective element, in how to judge severity: if we categorize the consequences or severity of an event as being absolutely unbearable, severity in our formular will be indefinite. Even with our probability being very small, the product of anything times indefinite will be indefinite as well – in this case, our risk would be indefinite as well. In other words, first, a general consensus within the industry and / or society has to be reached as to what severity is still acceptable.

If we label a single aircraft loss as being totally unbearable, in the light of our formular above flying has to stop, as the risk would be indefinite. Obviously, society informally agreed on the current level of safety in aviation (at least within a certain margin) of being acceptable.

As the risk cannot be brought down to zero, the challenge is to minimise probability as much as possible.

To further refine our formular above we might break down probability into number of (flight) events times interfering factors – and these are all things that might go wrong, like weather, ATC, crew performance, technical issues with airframe and systems, operational environment and circumstences, etc.

$$\mathbf{R_{isk} = P_{robability} * S_{everity}}$$

With $\mathbf{P = (E_{vents} * I_{nterfering}\, F_{actors}),}$

= $\mathbf{R = (E * IF) * S}$

According to that approach, the airline industry has been very successful in bringing down the interfering factors, as the number of events (= flight) per day is very high, yet the risk(= number of accidents) is exceptionally low.

On the other, although the aerial work community has worked hard to bring down the interfering factors over the last years, our operational environment still remains challenging; the fact that accident numbers did not roared sky-high is probably due to the fact the number of events is just a fraction of those of the airline industry.

So the sheer quantity of our activity plays in our favour, statistically, it also indicates that the aerial work industry might be able to take on more challenging environments (= accepting specific interfering factors) without our accident rate (= risk) reaching unacceptable levels.

In order to substantiate the claim of being able to accept more specific interfering factors, we might have to brake down these interfering factors into mission-specific factors that can not be changed (we have to fly low, in densely populated airspace; a rescue helicopter has to land in tight spots, maybe in marginal weather, etc.), and operational factors, which encompass all aspects like aircraft, equipment, weather, ATC, operational environment, etc.

$$\mathbf{R_{isk} = P_{robability} * S_{everity}}$$

With $\mathbf{P = (E_{vents} * I_{nterfering}\, F_{actors}),}$

= $\mathbf{R = (E * IF) * S}$

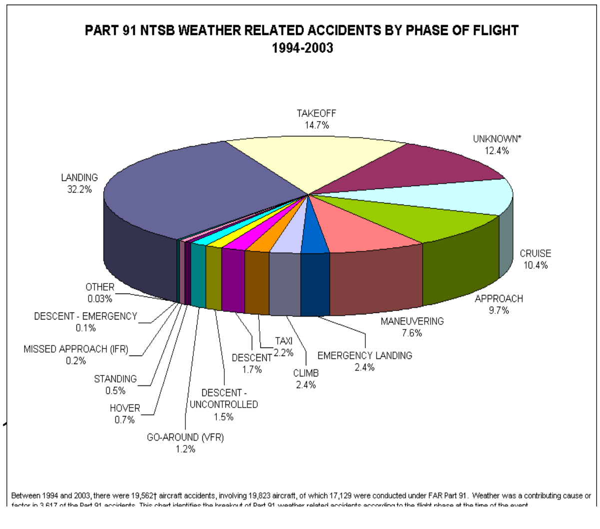
With $\mathbf{IF = (M_{ission}\, S_{pecific} * O_{perational})}$

= $\mathbf{R = (E * (MS * O)) * S}$

With all this said, it is quite obvious that the flight inspection has to focus on the operational aspects (O) of our working environement, as we cannot bring lower some mission-inherent factors, to keep the current level of safety, or better, to improve that level. More to that in the following chapter.

Flight Inspection specific Risks

Flight inspection mission do pose certain challenges. To illustrate one of them, a quick step back to a more



Between 1994 and 2003, there were 19,562† aircraft accidents, involving 19,823 aircraft, of which 17,129 were conducted under FAR Part 91. Weather was a contributing cause or factor in 3,617 of the Part 91 accidents. This chart identifies the breakout of Part 91 weather related accidents according to the flight phase at the time of the event.

fundamental aviation accident statistics:

Figure 6: US Accidents per Flight Phase

Figure 6 depicts the relative percentage of accidents per phase of flight. These are US data, they are consistent with data from other coutries as well, though. They show that a combined 56,6% of all accidents happen either on take off, approach or landing - in this segment of the we spent between 70 to 80% of all our flight time, this being the first challenge.

We fly low, sometimes very low.

We fly in densely populated airspace, seeing and avoiding other traffic is absolutely paramount.

We fly demanding mssions with at times high crew workload, neccessitating to liase with ATC, ground engineers and the NavAid Inspector on board simultaneously..

We might find ourselves in operatinally harsh environments, both with regard to climate / weather, as well as infrastructure, ATC, etc.

Even if we are not working for a private service provider, we face a certain commercial pressure most of the times, as flight inspection does tend to interrupt the usual routine at any airport, which might cause delays to (and in turn: generates pressure from) the airlines.

On commissioning flight checks, unknown terrain and obstacle data might pose a challenge.

Working internationally, language barriers might hamper communications, both on the ground as in the air.

Flying demanding missions, maybe on deployment for several days or even weeks in a row, ever poses the danger of crew fatigue.

To keep the aircraft being used for flight inspection and their respective systems technically up to date with current requirements at times poses a challenge, again in the light of ever present commercial pressure.

Finding the right staff with the right skill set and the right attitude commensurate with the flight inspection mission is a challenge, retaining them through the cyclic ups and downs of the industry even more so!

How to address these challenges will be covered in the following chapter.

MITIGATING TOOLS AND STRATEGIES

To start with, as indicated in the statistics part of this paper, there are some mission specific external factors we simply cannot avoid, like the neccessity to fly low.

This requirements (i.e. on coverage / clearance flights for both localizer and glideslope) do not only stem from the appropriate ICAO Doc8071, they are a bare neccessity in order to ensure proper signal coverage for those, who on a dark, stormy night, tired after a long flight, stray off course and find themselves off centerline and glideslope – in other words, increasing our safety margins in terms of terrain clearance considerably would definitely help us, but not the others, who we vowed to serve.

For this dilemma, we may draw comfort from the statistics discussed above: let us assume we look at an airport with 10.000 landings per year, and maybe a challenging terrain in the approach sector. Chances are that of these 10.000 arrivals 10 (= 0,1%) over the year get it wrong and end up off localizer, below glideslope, yet still in ICAO-defined coverage limits of 1.500ft above station level,.and not 1.000 ft above highest obstacle in the arc area.

No problem in this case, as the flight inspection organisation tasked with checking this approach selected to fly the coverage at the basic ICAO requirements, making sure that signal coverage is given even at that lower altitude. The arriving traffic, even off-course, does have signal reception, and is thus able to recover and land safely.

To achieve this signal reception guaranty, a well trained, well equipped flight inspection crew has to fly the coverage twice a year at that level – compairing the numbers (2 flights of a well prepared crew vs. 10 flights of crews that for a moment lost situational awareness), it is fairly obvious what statistically is overall the more safe solution.

A similar thought process applies to the densely populated airspace dilemma: although some mitigation strategies might apply, like looking for low times in traffic flow, this might collide with other requirements and will not solve the problem 100%.

It remains a fact that in our walk of life certain challenges cannot be avoided, they have to be tackled. How this might be achieved will be broken down in 4 areas:

1. Equipment
2. Operational Environmen, internally
3. Operational Enviroenment, externally
4. Training

Equipment:

In an ideal world, our flight inspection aircraft is 3 years old, has the transit speed of a fast business jet, the slow flying qualities of a Piper Cub, a visibility from the cockpit like a F-16, a stand-up cabin with separate toilet and suffcient baggage space, an effective air conditioning system even in hot climates, and all that of course for the operating economics of a light piston twin – obviously, such an aircraft does not exist.

What is achievable and desirable, though, is to fly, maintain and upgrade the flight inspection aircraft in use as best as possible to the current, mission-specific requirements.

Proper maintenance by qualified staff, at the right intervals, should go without saying.

Providing a cockpit environment that offers a good support to achieve situational awareness is highly desirable. Today, this almost automatically translates into a glass cockpit with a suitable Flight Management System FMS, and moving map displays that goes with it.

Being able to depict the calibration mission (desired tracks, tracks to starting point of a run) as well in one way or the other to the cockpit crew is highly recommended as well , either by interfacing the Flight Inspection System FIS with the existing avionics (preferred option), or by providing an additional display.

It cannot be stressed enough that keeping situational awareness is absolutely paramount on flight inspection missions, any piece of equipment supporting that goal, therefor, is highly desirable.

When flying Procedure Validation missions, a FMS commensurate with the task is a must – the FMS must be capable of processing the ARINC424 formats used by the procdedure designer / coder, for instance, and depicting them properly.

A Traffic Collision Avoiding System TCAS is a highly desirable piece of equipment to have on board, especially when flying in densely populated airspace. As TCAS is not really cheap (USD 250.00 – 500.000,- per aircraft), this might easily collide with the commercial pressures mentioned above. Nevertheless, as this is a very effective tool to enhance safety, it should be installed whenever possible. To benefit from it, proper training should be supplied; part of that taining should be to raise awareness that TCAS might not be able to "see" all traffic, as some other targets might have switched off their transponders or do not have on to start with – like gliders, a major challenge in Germany at times, for instance. So the requirement for constant airspace surveillance remains.

There are other, low-cost TCAS-Look-alike solutions out there on the market. When installed, great care must be taken that the installation was done properly, otherwise false / nuisance indications might result, which effectively do more harm then good, as they distract the crew and undermine the confidence in the system.

Enhanced Ground Proximity Warning Systems EGPWS are another valuable safety feature. It might have saved both the US as well as the German B300.
On flight inspection missions it does have its limitations, though, as it will cause false alarms when flying low approaches with gear / flaps up. As repetitive false alarms must be avoided, when EGPWS is installed on flight inspection aircraft, having a switch available to turn the system off and back on, when required, is paramount. For turning the EGPWS off and later back on after mission, an appriate SOP has to be devised by the respective flight operation, and that SOP has to be reflected by the Normal Checklist in use.

In order to reduce stress for the crew as much as possible, all systems that provide cabin comfort should be operational and effective (heating in cold climate, air conditioning in hot climate). Notably an effective air conditioning is paramount in hot climates, as heat tends to foster the onset of fatigue considerably.

In the near future, Enhanced Vision Systems EVS might bring great benefits to safety, as these system swill dramatically enhance situational awareness in marginal weather and /or at night. Up to this point, these systems habve been fairly expensive, as some high tech is involved to cool the required infrared sensors down. At present, there are a number of low cost systems at the doorstep of being introduced into the aviation world; it remains to be seen how good and thus, how cost effective the systems are. First results by the manufacturers look promising.

At last, the type of aircraft picked to fly the mission is a very important issue. In general, the aircraft type should be able to fly the mission required without too many restrictions (i.e. fuel load, payload), in order not to pressure crews too much into accepting risks, just to get the mission done.

Under normal circumstances, the size of the equipment required to fulfill the role more or less dictates the size of the aircraft in use. With the advent of very small, low cost Flight Inspection Systems, using fairy small twin engined piston aircraft became a viable option in the flight inspection world. A prominent example of this new breed is the Diamond DA42 Twinstar. Under defined circumstances (limited amount of flying required per year, moderate climate, no high top speed required at busy airports) it is already clear that the combination of low cost FIS and low cost aircraft do work; it remains to be seen over the next years though, how well this combination fares when pushed harder, both in terms of flying hours required and harsher external environments encountered.

Operational Environment, internally

Here the internal organisation of the flight operation is addressed. It starts with the safety culture of that organisation, and it is absolutely paramount that this safety culture is a top priority from top management down – beyond pure lip service. Safety often does has cost implications (i.e. if equipment has to be replaced, systems to be upgraded or training to be initiated), always a tough proposition in times of commercial pressure, as mentioned before. The right balance has to be struck regardless, taking the requirements of both positions into account.

At the core of any safe and successful flight operation is a set of operating rules, workable SOPs Crew Coordination Concept and CRM and checklists that do reflect all this, with everything combined preferably in one comprehensive Operations Manual OM.

When setting up an OM and designing SOPs and Checklists that go with them, great care should be taken not to overload the sytem with complexity. It is with a certain degree of scepticism that this author watches the advent of ever new safety systems being introduced into the aviation industry: Flight Safety Systems, Risk Management Systems, Fatigue Risk Management Systems, not to mention an exhaustive Quality Assurance System that today is part of the legal requirements as per EU OPS, for instance, they all add to complexity, creating different reporting paths within an organisation, resulting in ambiguity or even friction. One has to bear in mind that most flight inspection organisation, compared to airlines, are fairly small. One should further bear in mind that flight inspection is a fairly demanding mission, requiring a considerable amount of mental capacity of the crews that fly it – one should avoid to overload them.

KISS – keep it simple and stupid, should be the way forward. This is not to say that issues like risk, fatigue, etc, should not be taken into account, far from it. The ensuing procedures dealing with these issues should be set up in way though, that is manageable and workable in an every day environment, especially in the field when away from homebase.

Normal checklists for operating the aircraft are another good example for the KISS approach: it is a well known fact that the manufacturer's checklists, especially when the aircraft in question is certified for single pilot operations, are often useless in a normal aviation environment for reasons of overcomplexiity and length. These checklists reflect legal and liability issues, which might be well required to keep the manufacturer from harm in legal terms, however, focussing on these legal aspects unfortunately renders these checklists almost useless.

So every operator is called upon to design checklists that do reflect its individual needs. Depending on the regulatory environment it might be necessary to get the altered checklist approved by the respective regulator.

In the arena of internal operational environment falls the issue of flight time limitations. What are the regulatory guidelines, and what does the flight inspection organisation expect from its crews to achieve? An internal survey of ICASC members brought to light a wide variety of operational flight and rest time regimes; it was impossible to draw a common line.
What all flight and rest time regimes should have in common is to combat fatigue, or even the onset of it.

At what point fatigue hits will very much depend on the type of mission flown (ILS low level work, in general, being more stressful then airway work high up), the aircraft being used (Cockpit equipment being available, space available on board, susceptibilty to turbulence, temperature control) and the environment operated in (poor ATC? Poor infrastructure,i.e. refueling a major undertaking? Night flying involved?). A very important consideration also is accomodation and transportation for crews, notably when away from base. It must be established that a good rest and a good night sleep can be accomplished at the accomodation picked.

So, in essence, again each operator will have to come up with its individual flight and rest time regulations, of course always in line with the respective regulatory environment of the country of registration, that take into account the individual environmental circumstances.

Operational Environment, externally

Here the external circumstances of the operation are addressed: were do we operate, doing what with whom? How is the terrain, how is the infrastructure (fuel / de-icing / hangar available)? How well is ATC organised, is radar coverage given? Who on a specific mission will be point of contact for the company? Who for the crew?

Giving all this a thorough consideration is even more important when doing commissioning flight checks at new airports.

Dealing with these questions effectively constitutes some sort of risk assessment prior embarking on the mission, something that is highly desirable. Whenever possible, these data should be collated prior bidding for a tender; marketing or management should try to find out as much information as possible prior committing to a task, in order to reduce pressure and stress to the crew on site later.

Training:

The training aspect of flight inspection flying cannot be overestimated.

It starts with the challenge to pick the right crews for the job. Every operator will have his individual selection and hiring process. Great care should be spent on finding pilots that have an professional attitude towards special mission flying – not too many as per class that annually leave flight school, as per own experience, as the vast majority a striving for a job with the big airlines.

Once the right set of people has been found, training them initially poses its next challenge. The initial training on the type of aircraft to be flown should be a chalennge that is fairly easily to be accomplished; in an ideal world the initial training on type already reflects the special requirements of the mission, the company's own SOPs, checklists, etc. Emphasis should be put on adjusting the candidates focus on the aircraft being merely a tool for a bigger purpose; when in commercial flying the task is to fly safely from A to B, in our world the real job only starts at B.

Whenever possible, and a suitable simulator does exist for the type of aircraft flown, a simulator should be used for initial and recurrent training, again according to a syllabus that already reflects the individuals company SOPs, checklists and tasks (" train as you fly, fly as you train").

Training a new entry on the mission specifics is much harder to achieve, as it inevitably involves a lot of in-house training (normally no commercial, off-the-shelf training solutions available for the flight inspection world). ICAO recently published a new document, Doc 9906 Volume 6 " Flight Validation Pilot Training and Evaluation", that provides valuable input to flight inspection pilot training in general and procedure validation training in particular.

It cannot be overstressed that a well trained crew is the most potent mitigation strategy to deal with the specific risks attached to flight inspection flying, as identified in the former chapters. Investment in training is also always a good indicator as to how seriously the whole company, from top management down, stands to its safety commitment, as described above.

THE LOOK BEYOND ONE'S OWN NOSE – HOW THE OTHERS FARE

Inevitably, other sectors of the aviation industry have tackled the issue of safety as well, coming up with tools and strategies to mitigate risks and dangers.

A good example for this is the International Standard for Business Aircraft Operations IS-BAO, published by theInternational Business Aviation Council IBAC.

IS-BAO is an industry standard, written by the industry for the industry. It gives guidelines how to organise a business aviation flight department and provides structures and recommendations, which closely resemble regulatory docuemnts like EU-OPS and others.

The interesting point of IS-BAO is that any flight department inplementing IS-BAO can register with IBAC to monitor, and later on audit the implementation, with the goal of receiving a seal of approval as being a IS-BAO registered and conformal organisation, a fact that then might be brought to the market as a quality attribute, to differentiate one self from the rest of the competition.

That might be an interesting approach for our industry as well, more to that further below.

Similar guidelines for the aerial work community have been issued by the International Airborne Geophysics Safety Association IAGSA.

IAGSA's Safety Policy Manual describes a set of issues and factors that have to be observed and addressed on survey flights, like Job Safety Analysis (basically a risk assessment of the impending survey to be flown), survey heights and procedures, speeds, flight following and survival provisions, flight and duty times, night flying, and many more.

This manual is already fairly close to our kind of operations in flight inspection and thus warrants further consideration for our line of work.

A very smart approach IAGSA brought to the fore was to condense the essence of its Safety Policy Manual into an Annex that should then be attached to potential survey contracts (Recommendation to Include Specific Safety Requirements in Geophysical Survey Contracts). This Annex has been distributed to all potential parties contracting airborne geophysical surveys, thus raising awareness within the industry, and providing a level playing field for all in the process. A very promising approach that warrants further discussions within our industry.

CONCLUSIONS

Although hard statistical data is hard to come by, some exemplary evidence provided by selected authorities indicate that safety in the aerial work domain, of which the flight inspection community is part of, remains at an acceptable level, given the challenges this demanding role poses.

As shown, not all factors contributing to the risks of our industry can or should be avoided, however, there are tools and strategies at hand to reduce or even mitigate the specific risks associated with our line of work.

FUTURE WORK

One of the purposes this paper should serve was to open the discussion within our industry on the topic of introducing similar standards and best practises, as other sectors of the aviation industry have done, to foster safety. To that end, in the view of the author, the work of both IBAC as well as IAGSA show great potential, and their adaption to our specific needs should warrant further discussions.

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