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RISK SESSION

Doppler Weather Radars and Weather Decision Support for DP Vessels

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Return to Session Directory

Introduction

In the past two decades there have been many incidents with DP vessels that were caused by sudden wind shifts or other weather hazards. Most of these Emergency Disconnect Sequence (EDS) incidents could have been prevented or mitigated if the proper weather information was available to captains and/or DP operators of the vessels even just a few minutes before the event occurred. The stakes are very high, the loss of position of a DP Vessel can result in personal injury, environmental pollution, or catastrophic damage. One incident can cost tens of millions of dollars, plus lost productivity. And many can be avoided.

We propose that the industry as a whole jointly (or individually) invest in DP vessel or oil platform-borne Doppler weather radars along with software analytics tools that will automatically provide alerts of rapid wind shifts and strong wind speeds, at a minimum, providing 5-20 minutes lead-time to hazardous events. With today's Doppler weather radars and superior automated weather hazard detection and tracking capabilities, there is no reason that hazardous weather should hit a DP vessel without warning.

How Big is the Weather Problem for DP Vessels?

We have examined DP incident reports compiled by the International Marine Contractors Association (IMCA) from 1994 – 2010. From 1994-2003 they defined two types of incidents with respect to their severity:

- Loss of Position 1 (LOP1): Major Loss of Position
- Loss of Position 2 (LOP2): Minor Loss of Position

One of the categories they have identified as causing a trigger for these incidents is classified as the "Environment", which is defined as winds, waves and current. From our analysis of the data compiled by IMCA, it suggests that 8% of LOP1 incidents during this 10 year period were caused by the Environment and 10% of the LOP2 incidents were caused by the Environment (see Figure 1).

From 2004-2010, IMCA chose to analyze one class of incident and during that 7 year period, there were 370 incidents reported and analyzed and of those, 27 of them (7.3%), were attributed to the Environment.

During this 17 year period there was a total of 58 incidents attributed to the Environment out of the total of 741 (7.8%). An interesting point that IMCA makes in its report is that only a small percentage of DP vessels report incidents, with the average of 1 to 2 incidents/year per reporting vessel. Although estimates of the number of DP vessels in operation today vary significantly, most report more than 2,000. As a rough order of magnitude calculation, if 2,000 vessels average (conservatively) 1 loss of position event per year and 7.8% of those events are caused by the environment, then globally, there is roughly 150 weather triggered incidents each year.

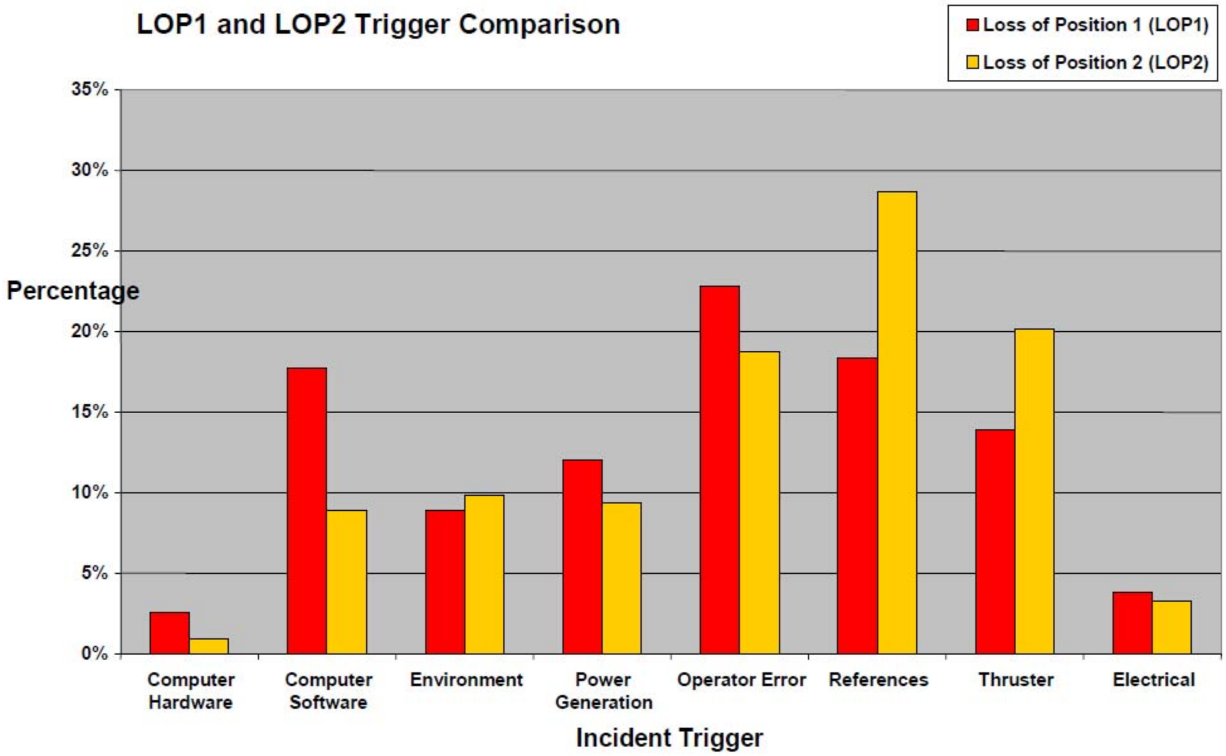


Figure 1: Loss of position incidents and the triggers that caused them (from IMCA, 2004).

Lessons Learned from other Industries

In the United States over the past 30 years, there have been large, but valuable investments in Doppler Weather Radars with automated weather detection software and tools that have created great value to our society. The first of these was the NEXRAD program led by the National Weather Service, FAA, and DOD, which has ultimately enhanced warnings of tornadoes and other severe weather such that the average lead time between the issuance of a tornado warning and the touchdown of a tornado has gone from zero minutes to 14 minutes.

Similarly, the FAA developed and deployed a Terminal Doppler Weather Radar system that ultimately has been responsible for ZERO aviation wind shear accidents since 1995 when it was deployed.

Federal Aviation Administration's Wind Shear Accident Mitigation Strategy

In the 1970s and 1980s, commercial aviation incidents and accidents caused by wind shear were becoming a big problem. During those two decades, 536 fatalities were caused by aircraft accidents due to aircraft attempting to land or take off and encountering strong wind shear on final descent or just after departure. The August 2, 1985 Delta 191 wind shear accident at Dallas Fort Worth Airport ended up being a catalyst to the FAA and the aviation industry as a whole to take action.

When aircraft accidents started to be attributed to encounters with wind shear, the response of the U.S. Federal Aviation Administration (FAA) was to initially fund research into the wind shear phenomena starting in the mid-1970s. This active research effort led by the National Center for Atmospheric Research, MIT/Lincoln Laboratories and NOAA Research Laboratories (notably the National Severe Storms Laboratory) found that strong downdrafts from thunderstorms or sometimes from light rain showers created wind shears for aircraft that could cause more than 100 knots of loss of airspeed to aircraft penetrating them. These strong and small scale downdrafts were called "microbursts", and research showed that pilots would experience certain precursors as they entered into these microbursts and if they immediately took action, they could mitigate the risk of an accident.

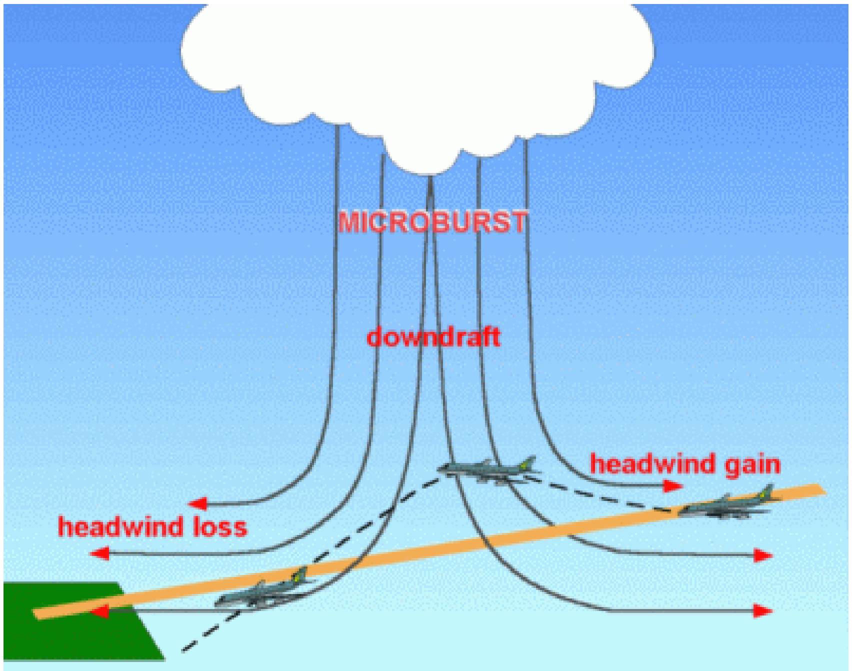


Figure 2: Diagram of microburst and its effects on aircraft

Based upon those findings, the FAA embarked on a robust training program to teach pilots how to respond if they started experiencing these precursors as they were landing.

The August 2, 1985 Delta 191 wind shear accident at Dallas Fort Worth Airport that claimed 137 lives, ended up being a catalyst to the FAA and the aviation industry as a whole to take a much more proactive approach to mitigating future wind shear accidents. The FAA and NASA accelerated funding of R&D into developing automated Doppler weather radar solutions to detect and predict microbursts and gust fronts. By the early 1990s small Doppler weather radars were implemented on many commercial aircraft that included automated wind shear detection software that provided pilots with alerts if wind shear was detected a few miles in front of the aircraft along the flight path. Additionally, a large R&D program that ended with the development and operational testing of a custom "Terminal Doppler Weather Radar" solution was procured by the FAA and deployed at 47 of the largest and most vulnerable airports in the United States. This Terminal Doppler Weather Radar system is a combination of a high quality radar that was tuned to work in an airport environment along with automated algorithms that detect wind shear, microbursts and gust fronts and relay that information to air traffic controllers in real-time.

Since the TDWR was deployed at 47 airports in the mid-1990s there have been ZERO commercial aircraft accidents in the United States due to wind shear. This is considered one of the largest successes in the weather industry.

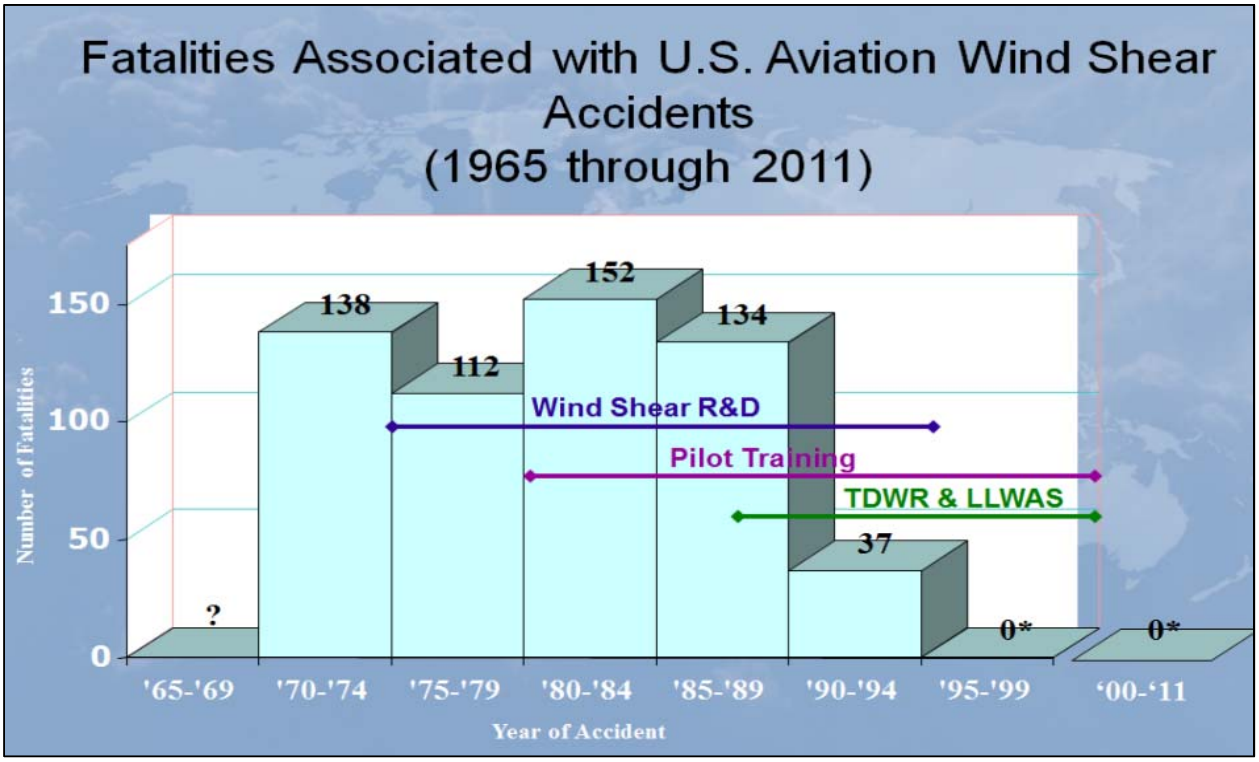


Figure 3: Timeline of successful FAA program that eliminated aviation wind shear accidents in the US.

National Weather Service Tornado Warning Enhancement

The U.S. National Weather Service funded (along with the FAA and DOD) the development and deployment of the WSR-88D (NEXRAD) program in the 1980s and early 1990s. Since that network of 144 radars was deployed across the United States and a suite of automated algorithms were developed to help meteorologists automatically predict and detect tornadoes, the average lead time for tornado warnings has increased from zero minutes to 14 minutes. Ultimately this has saved many lives over the past 20 years (see Figure 4).

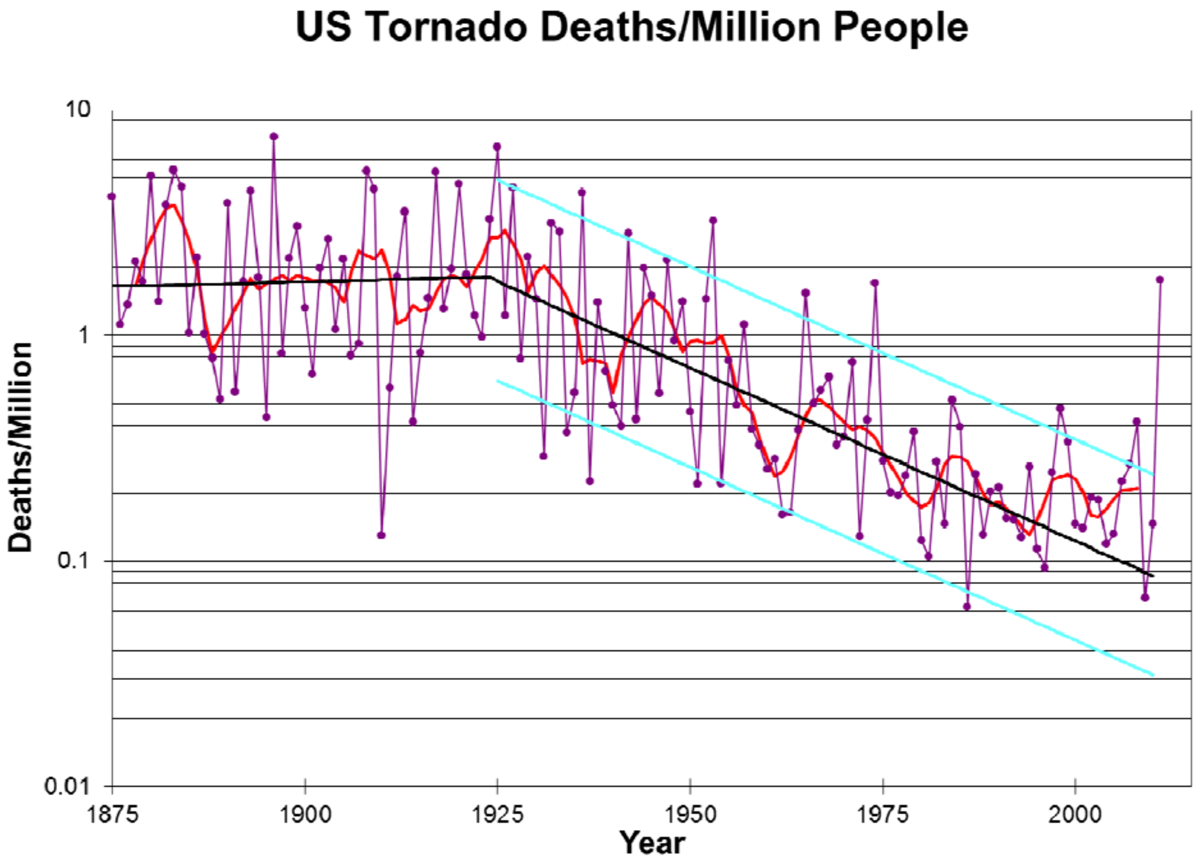


Figure 4: Deaths from tornadoes from 1875-2012 from Dr. Harold Brooks, personal communication.

Weather Safety and Information for DP Vessels

As we have shown, the FAA made a long-term investment in mitigating wind shear related accidents and their investment has had a great payoff, resulting in no commercial wind shear accidents since 1995. Similarly, the National Weather Service invested in a network of Doppler Weather Radars and automated software that detects and predicts tornado locations and likelihood, that along with training for their meteorologists, has resulted in lead-times of tornado warnings going from 0 minutes to 14 minutes resulting in many lives saved.

In the off-shore energy market, DP vessels continue to operate with very little weather information, yet technology from the TDWR and NEXRAD programs are available for use and Doppler weather radars are available to be installed on DP vessels. The stakes are very high, the loss of position of a DP Vessel can result in personal injury, environmental pollution, or catastrophic damage. One incident can cost tens of millions of dollars, plus lost productivity. And many can be avoided.

We believe that the manner in which the FAA approached the wind shear problem is a good corollary for how we can greatly mitigate the environmental hazards that cause loss of position incidents with DP vessels. We envision a 4-pronged approach to mitigating these environmental incidents:

1. Understanding the weather phenomena that are causing the incidents through examination of previous incidents,
2. A broad-based training program for DP Operators on how to mitigate loss of position when faced with large wind shifts or waves,
3. Development and deployment of individual Doppler weather radars with automated software on DP vessels to provide short-term (5-10 min) detection and warnings of rapid wind shifts and expected strong wind speeds,
4. Networking of these radars, along with deployment of larger Doppler Weather Radars on stationary platforms to provide broader coverage and to utilize other automated algorithms and expert meteorologist's input to provide longer-term 30-60 minute predictions of hazardous weather events.

Some DP vessels already have Doppler Weather Radars, but most do not, and the radars deployed do not have sophisticated detection and tracking software deployed as part of the solution. Another optional solution is for joint investment of larger more powerful Doppler Weather radars that could be located on fixed platforms which could provide value to a larger number of vessels and operations in say a 50 nautical mile radius of the radar.

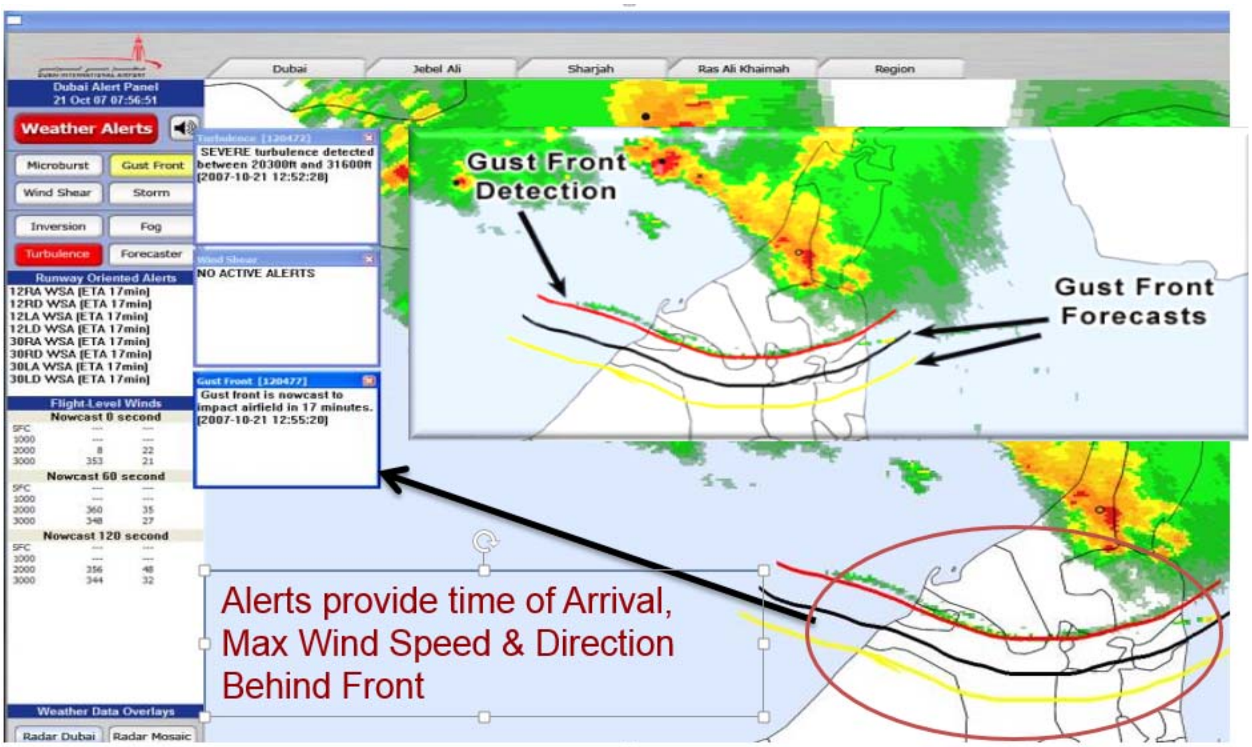
Figure 5 below shows an example of what a display could look like for DP Operators. This display is presently used by Dubai Airport Air Traffic Controllers to manage and keep aircraft safe as they land and take off at one of the busiest airports in the world. One of the key planning tools they have is the Machine Intelligent Gust Front Algorithm, developed by MIT/Lincoln Laboratory and the National Severe Storms Laboratory. This algorithm automatically detects wind shift lines and provides estimated time of arrival of those wind shifts, along with estimated wind speed and direction behind the front.

The use case for DP Vessels is that a ruggedized Doppler Weather Radar installed on the vessel itself could sweep at low altitude less than every minute. Automated software that was developed for the FAA TDWR system, would analyze the radar data in real-time and automatically detect wind shift lines, gust fronts and microbursts and if one of those phenomena is detected and is predicted to impact the location of the vessel, an alert will be sounded and information will be providing to a display located in the bridge. That message or information would be structured something like this:

> ***Red Alert: Wind shift line will impact DP vessel location in 17 minutes and winds will shift to the Northwest and strengthen to 75 knots.***

A second use case is to have the data from multiple smaller radars housed on DP vessels to be brought back to a data center, where similar automated algorithms can be run along with other "nowcasting" algorithms to provide a broader perspective and potentially longer lead time to very strong events. An expert meteorologist could also utilize these networked radars to provide information into their decision making process. In that way, the expertise of the meteorologist can be utilized to provide a few hour prediction of hazardous weather, to provide consultation to DP Operators and to warn for other weather phenomena that may not be as hazardous to the vessels themselves, but could still impact operations (e.g., lightning, heavy rain)

Finally, another solution is for a consortium of companies operating in close proximity to each other in the GOM or other areas around the world to fund the deployment of one or more larger, more sophisticated Doppler weather radars that could be mounted on fixed platforms, providing coverage over a larger area. The data could be sent to a central data center and then automated algorithms would produce alerts to vessel operators, along with expert meteorologists for further value-add, and finally the data could be put into a web portal and apps so that land-based management could receive the same information as DP Operators.



Conclusion

In the past two decades there has been many incidents with DP vessels that were caused by sudden wind shifts with strong winds behind the wind shift line and other hazardous weather phenomena. Most of these incidents could have been prevented or mitigated if the proper weather information was available to DP operators/captains of the vessels even just a few minutes before the event occurred. We propose that the industry as a whole jointly (or individually) invest in DP vessel or oil platform-borne Doppler weather radars along with software analytics tools that will automatically provide alerts of rapid wind shifts and strong wind speeds at a minimum providing 5-20 minutes lead-time to hazardous events. With today's Doppler weather radars and superior automated weather hazard detection and tracking capabilities, there is no reason that hazardous weather should hit a DP vessel without warning.