Chapter 1 – INTRODUCTION

1.1 THE ROTARY-WING BROWNOUT PROBLEM

Brownout is the condition where there is little or no out-the-cockpit window visibility caused by dirt and dust being stirred up by the rotor downwash and then re-circulated by the rotor blades of a helicopter during taking off or landing in an arid climate. Similar conditions can be created by landing or taking off in snow (whiteout) or over water. It should be noted that whiteout in snowy conditions is also commonly referred to as "snowball" by aircrew to distinguish this particular condition from atmospheric whiteout caused by omnidirectional cirrus cloud formation, fog, or overcast sky over continuous snow surface or intermittent cloud blend in with snow-covered terrain. In general, Degraded Visual Environments (DVE) cause pilots to rely on inadequate cockpit instrumentation, callouts by on-board aircrew, and innate piloting skill to successfully execute a brownout landing. Flying in DVE has always been a challenge for rotary-wing pilots. Since NATO has been operating in the arid climates (e.g., Africa and Afghanistan), Rotary-Wing Brownout (RWB) is responsible for approximately 75% of coalition helicopter mishaps.

The US Department of Defense (DoD) has an inventory of over 7000 Rotary-Wing (RW) aircraft since 1985. In the US Air Force, more than 30 Special Operations RW aircraft and 60 crew-members have lost their lives during landing in desert environments in DVE since 1990. The US Army reports 50 helicopter mishaps with damage from 2001 – 2007; 40 of these incidents occurred in brownout conditions. The US Navy reported 38 personnel have been injured in brownout/whiteout mishaps in their helicopter operations since 1985. However, they report no fatalities due to mishaps in whiteout/brownout. RWB is a $100M/yr for the US Services, alone. Few lives are lost due to RWB and few injuries occur compared to other causes in the nearly 1000 lost or damaged US DoD helicopters (1985 – 2005) even though RWB landings are the overall largest cause of RW airframe loss in the US Services.

Other NATO countries also reported RWB mishaps that impact operations. The United Kingdom (UK) experienced 24 brownout mishaps involving material damage in the 5 year period 2005 – 2009 of which, 70% were assessed as being due to Spatial Disorientation (SD) and/or mishandling and 30% were attributed to an unseen Landing Site (LS) hazard. France has experienced eight brownout mishaps over the past 15 years, most of them in Africa. Since 1973, Bundeswehr (German Defence Forces) has recorded a significant number of mishaps (>30) in association with dust or snow. Similarly, the Netherlands has lost aircraft due to RWB as well. Most recently, RWB contributed to a Canadian Forces (CF) Griffon (CH146) crash in Afghanistan on 6 July 2009, during take-off, which resulted in three fatalities and three injuries. Between 1986 and 2006, there were 2 whiteout related accidents and 54 incidents in the CF. In Sweden, whiteout was a contributing factor in one fatal and one minor mishap. Norway cites seven whiteout/brownout mishaps since 1982.

Although research and development in dust penetration, "see through", "see and remember" and obstacle warning technology has been on-going for some time, the technology development has not reached the Technology Readiness Level (TRL) that will allow aircrew to "see through" dust and dirt and be able to be implemented operationally. Obstacles on the ground including poles, trenches, walls, barricades, trees, and uneven terrain can be catastrophic to the aircraft and crew. Currently, no 'electronic bumper' exists on RW aircraft to detect, display, and provide warnings for such obstacles. In addition, especially in legacy helicopters, there is no single instrument display that can indicate lateral and longitudinal drifts. Moreover, current cockpit displays do not provide information about the terrain and the designated landing zone in DVE. However, there are recent developments in landing symbology system that will provide better altitude, velocity cues, and a critical sense of drift for the rotary-wing pilot during landings. The objectives of this Task Group can be summarised as follows:

1) Assess the seriousness of RWB problem in each participating NATO country and compile the mishap statistics.
2) Evaluate the technology in rotary-wing development with emphasis on new radars, LADARs, flight-control systems, advances for the pilot-vehicle interface, display symbology, mathematical modelling, dust abatement, crew coordination techniques, and brownout simulation training.
3) Solicit opinions from specialists in rotary-wing operations, especially pilots, who have experienced brownout conditions in theatre.
4) Document our findings in a technical report and provide the findings in a lecture series or presentation at an international conference at the end of the Task Group study period.

Our goal is to improve the ability of NATO and PFP (Partners for Peace) countries to operate effectively in DVE by providing latest information on effective take-off/landing procedures employed by the various services, emerging technologies, and recommendations for near-term, intermediate and long-term risk mitigating strategies.

Members of the HFM-162 Task Group discussed and contributed the following examples of mishaps due to whiteout or brownout from their respective services.

Case 1: France – Three Pumas helicopters on a patrol flight under NVG. First aircraft landed provoking whirling dust. The second aircraft hovered in about 15 ft height, waiting for dissipation of the dust. A lateral drift was not detected and the puma bumped vegetation. The pilot in command decided to go around. After flight inspection showed a structural damage of the stabilizer.

Case 2: France – A Puma helicopter under NVG on a night training flight for dust landings. On short final the pilot flying lost outside references. Not being alerted by the pilot flying the pilot in command lost SA, the aircraft bumped into the ground.

Case 3: Netherlands – A CH-47 Chinook D did not notice left drift during an approach in Afghanistan. The aircraft was operating 80 NM south of Kandahar under marginal night-time conditions. Poor visibility conditions due to brownout obscured all necessary visual outside references in the final phase of the approach. The drift was detected too late to take corrective action and the aircraft rolled over on touchdown, coming to rest lying on its left side. A fire started in the rearward part of the helicopter and destroyed it.

Case 4: UK – A Lynx helicopter took off to a night/day sortie under white light configuration when origin of a warning light was diagnosed. The crew paused the take-off not recognizing the forward move of the post lift-off dust. The moving dust caused a vection illusion (a visually induced sensation of self-motion) of rearward drift. To counter this perceived drift attitude additional forward adjustment was made with insufficient power setting. The aircraft struck the ground 50 m in front of the departure point.

Case 5: US – A UH-l was operating in an area that had been heavily used by tanks. The aircraft landed about 35 meters from the tank trail to pick up a soldier. The PC, who was flying the aircraft from the left seat, took off. But before the aircraft reached transitional lift, it was engulfed by powdery dust blown up from the tank trail by rotor wash. The aircraft drifted to the right. The PC knew there were trees in front of the aircraft, and he pulled in torque and turned to the right to avoid a tree that was 55 feet high. The aircraft had flown about 380 feet when the blades hit four trees in quick succession, then hit the ground nose-low, rotated on its nose, and rolled onto its left side.

Case 6: Germany – A serious category B incident occurred during an intended landing in Rustaq, Afghanistan involving a CH-53GS. Recognizing a drift, the pilot decided for a go around. During the take-off, the rotor hit a wall followed by the fuselage front and side sections striking a tree. Though heavily damaged, the aircraft was able to return to its base. In his final report, the Director of Bundeswehr Flight Safety stated that the "technical tools to support the crews during dust landings (e.g., sensor-based or automatic landing technology) must be developed".

Case 7: US – A CH-47D Chinook was lost due to brownout. The helicopter crashed near the city of Ghazni in Afghanistan, killing 18 people on-board, having encountered spatial disorientation during a severe dust storm.

Case 8: US – A HH-60 approached into a survivor's location. As the Aircraft descended below 200 feet AGL and began to establish a hover, it encountered severe brownout conditions that obscured all outside references from the cockpit. Brownout at such high altitude is extremely rare and was completely unanticipated. At this point, the pilot determined the need for a go-around, called "on the go", and initiated a go around. Approximately one to two seconds after leaving the dust cloud, the aircraft impacted rising and rolling terrain. The helicopter skipped up the side of the hill on its belly for several feet until the momentum dissipated. The helicopter then rolled 5 – 7 times down the hill coming to rest on its right side approximately 180 feet below the point of impact.

Case 9: Sweden – During a flight in an Augusta Bell 412HP in northern Sweden the weather got bad with heavy snow and since it was early evening the light conditions were poor. The pilot decided to continue with reduced height and speed. When the weather situation got worse the pilot decided to land, but the situation was problematic with an ice-covered river and a large road in the surrounding. At a height of five meters the helicopter had a tail wind and shortly after they completely lost the ground references. The helicopter crashed in the ice with major damages of the helicopter but with no serious personnel injuries.

Case 10: Norway – The Lynx was flying westward following the northern shoreline of a snow covered lake in slight snow showers. The forward visibility was 2 – 4 km, but left hand visibility was very poor with no defined horizon due to dense snow showers. Slightly up-sloping terrain with small trees sticking out of the snow were visible on the right-hand side. As the shoreline turned southwest, a slight left turn was started at about 15 degrees bank. Shortly after the helicopter hit the snow-covered lake, it slid about 140 m before coming to a standstill. All three crew-members were convinced they had good clearance to the lake at the time of impact.

Case 11: Norway – After a difficult NVG snow landing to pick up an injured soldier, the Bell 412 crew had to shovel away a snow pile on the left of the aircraft for better rotor clearance. The pile had been invisible on NVGs during high and low recce. During take-off in white out, the helicopter drifted forward and hit the top of a tree with the nose and belly. The only damage was a broken left pitot tube.

Case 12: Norway – It was a very dark night, with the crew on NVGs, during a Bell 412 medevac pick-up exercise near Meymaneh, Afghanistan. The LZ seemed normal on high and low recce. They entered brownout three seconds before landing. Then the tail stinger unexpectedly touched the ground one sec before landing, hitting a 50 – 80 cm terrain elevation, not visible on NVGs. The only damage was the anti-collision lights falling off.