Occupational Health and Safety Tribunal Canada

Date: 2015-08-27
Case No.: 2011-38 and 2012-22

Between:

Francisco Diaz Delgado, Meng Liang and Hadin Blaize, Appellants

and

Air Canada, Respondent

Indexed as: *Diaz Delgado et al.* v. *Air Canada*

Matter:	Appeals under subsection 129(7) of the *Canada Labour Code* of decisions rendered by a health and safety officer.
Decision:	The decisions that a danger does not exist is confirmed.
Decision rendered by:	Jean-Pierre Aubre, Appeals Officer
Language of decision:	English
For the appellants:	Mr. James Robbins, Cavalluzzo Shilton McIntyre & Cornish LLP
For the respondent:	Ms. Rhonda R. Shirreff, Heenan Blaikie LLP
Citation:	2015 OHSTC 15

REASONS

[1] These cases concern appeals brought under subsection 129(7) of the *Canada Labour Code* (the Code) by the appellant employees of Air Canada, of decisions that a danger does not exist rendered under subsection 129(4) of the Code by Health and Safety Officers (HSOs) Mary Pollock and Rochelle Blain on March 26, 2012, and July 18, 2011, following their investigations into work refusals by the appellant Air Canada employees Diaz Delgado, Liang and Blaize. Given the commonality of documentary evidence and testimony, these two appeals were heard together with two other appeals which were brought under subsection 146(1) of the Code by employer Air Canada concerning directions issued under subsection 145(1) of the Code on November 4 and December 23, 2011, by HSO Mary Pollock pursuant to her investigation into work refusals by Air Canada employees Claudia Martinez and Jerome LaPorte (Air Canada appeals). The circumstances of the latter appeals are very similar to the appeals dealt with in the present decision. A separate decision will deal with these Air Canada appeals.

Background

[2] The parties had initially indicated wanting to call a considerable number of witnesses in addition to three expert witnesses. However, at the outset of the hearing and following discussion with the undersigned, the parties opted instead to present statements of agreed facts in all cases, thus avoiding the necessity of calling those witnesses to testify. Those were filed as exhibits. The lengthy statements of agreed facts provide a detailed description of the circumstances of each case, refer abundantly to the HSOs' reports and thus are extensively cited below for that reason.

<u>Francisco Diaz Delgado and Meng Liang</u>

[3] At all material times Mr. Diaz Delgado, Yan-Yee Yip, Marie-Claude Lemieux, Nadia Cabrera-Griffin, Meng Liang, Jessica Bondy and Megumi Martin were flight attendants employed by Air Canada and members of the flight attendant (FA) bargaining unit represented by the Canadian Union of Public Employees (CUPE). On June 23, 2011, Mr. Diaz Delgado was the Service Director (SD) on flight AC239 from Edmonton to Vancouver using aircraft Fin 415, also operated by flight attendants Yip and Lemieux. SD Diaz Delgado noted in his report for that flight that during the first 15 minutes of the said flight and before landing, there was an odour in the cabin akin to "blue cheese", said odour being described in his Refusal to Work Registration as the smell of "dirty sock; smelly gym bag". The HSO report indicates that following the Edmonton/Vancouver leg, SD Diaz Delgado, as well as flight attendants Yip and Lemieux, was scheduled to operate the Vancouver to Toronto leg (AC 1162) on board the same aircraft (Fin 415). All three exercised their statutory refusal right to operate that flight on the said aircraft, citing their concern about the safety of the aircraft and to themselves due to the odour in the cabin on the previous flight leg from Edmonton to Vancouver.

[4] In his refusal to work registration form, Mr. Diaz Delgado also noted that the cabin logbook entries for Fin 415 indicated that an odour had been noticed in the cabin previously, including on June 18 and 19. Cabin Crew Manager Chelsea Bardock was advised of the refusal and spoke to Fin 415 Captain Henri Asselin and Line Maintenance about the crew members concerns. In a witness statement on July 5, 2011, Captain Asselin described the odour on the Edmonton/Vancouver leg as lasting for two minutes during engine start and for about eight minutes during approach and landing and, from the cockpit, as being faint, short-lived and unobtrusive.

[5] It would also appear from a joint Employer/Workplace Committee report (AC-WPC Report) as well as from the work refusal summary form (AC summary) that Captain Asselin further advised that the aircraft (Fin 415) was safe to fly from Vancouver to Toronto and that the same odour noted on the previous leg would also be noticeable during take-off and landing on the Vancouver/Toronto flight. A distinct witness statement by Captain Asselin, this one dated July 4, 2011, indicated that on the Vancouver/Toronto flight of Fin 415, faint and unobtrusive odours from the cockpit had been present for approximately two minutes during engine start and 10 minutes during the approach phase and that Air Canada Maintenance had deemed the aircraft serviceable, airworthy and safe to operate from Vancouver to Toronto.

[6] It would appear from the AC-WPC Report that Maintenance believed the odour in the cabin was caused by the presence of oil somewhere in the air system, although it did not know exactly where the oil would be. Although Crew Manager Bardock explained to the crew that operating Fin 415 from Vancouver to Toronto presented no danger, as so informed by Captain Asselin and Maintenance, they disagreed and continued their work refusals. Upon being informed of the continued work refusals, members of the workplace committee attended at the aircraft. The AC-WPC Report indicates that a number of other flight attendants who would have operated the Vancouver/Toronto leg of the flight chose to also refuse to work upon being briefed about the reasons for the crew members' refusal to work.

[7] Replacement crew members Service Director Meng Liang and flight attendants J. Bondy and M. Martin were eventually assigned to operate flight 1162 to Toronto and were present when Mr. Diaz Delgado explained to Crew Manager Bardock and members of the workplace committee the reason for the refusal and the history of the aircraft (Fin 415) documented in the cabin defect logbook. This resulted in the work refusal by SD Liang as well as that of the other replacement crew members. Mr. Liang's work refusal registration form indicates that he chose to refuse to work "after debriefing from previous crew, knowing the same aircraft had a funny, unknown strong odour during (the Edmonton/Vancouver leg); the mechanics wouldn't be able to locate or pinpoint the defect why/where the odour was from."

[8] The witness statement of Maintenance Team Leader R. McKellar is to the effect that:

- Maintenance suspected the smell on Fin 415 during the Edmonton/Vancouver flight to be caused by oil in the pneumatic system and had contacted Maintenance Operations Control (MOC) regarding any history of such smell;
- Maintenance was aware of the issue and fleet management had requested downtime in Toronto for further troubleshooting;
- There was no high oil consumption in Fin 415 engines or Auxiliary Power Unit (APU).
- Furthermore, as per the Workplace Committee report and the refusal form, Mr. McKellar informed that:
    - it could only take a few drop of oil to produce a smell;
    - the oil source "could be a smear, a stain, drops or bearing";
    - a maintenance check of Fin 415 in Vancouver showed that there was no excessive oil quantities or high oil consumption in the engines or the APU and oil consumption was normal;
    - there is no Minimum Equipment List (MEL) for air quality;
    - the aircraft was safe.

[9] According to these same two documents, Fin 415 Captain Asselin explained to those crew members who were maintaining their refusal to work that the odour would be present for approximately 10 to 15 minutes only on take-off and landing, with then some of the crew members (Lemieux, Bondy and Martin) opting to operate the flight while Mr. Diaz Delgado and Mr. Liang and others (Yip and Cabrera-Griffin) continued to refuse to operate flight AC1162 on Fin 415 although indicating that they were willing to perform work that would not require them to do so on Fin 415, with the result that HSO Blain was advised of the continuing refusals.

[10] The Air Canada Maintenance reports covering the period June 18/26, 2011, as well as the HSO report note the following "snags" and maintenance interventions for that period and Fin 415:

• June 18, 2011 - On descent at 10,000 feet, an odour in J class was reported as coming from the air conditioning system ("mouldy smell from galley"). Two forward filters were replaced in Toronto on June 19, 2011, and the aircraft was considered serviceable.

• June 19, 2011 - A bad odour reported on descent. Maintenance ran the airpacks for ½ hour and was unable to detect any obnoxious smell throughout the aircraft.

• June 19, 2011 - With reference to the two previous items, it is reported that a strong odour of "dirty socks/feet" and "smelly gym bag" was noticeable to passengers approximately ten minutes before landing and passengers in J/C class were gagging. Maintenance reported that it operated the APU with bleed on and airpacks on, but were "unable to detect".

• June 20, 2011 - Maintenance action was requested concerning the two above-noted incidents, said action being deferred in Toronto the same day. The Maintenance log refers to inspecting the APU and ducts with black light.

• June 22, 2011 - A "dirty sock smell" was reported as coming from the air conditioning system. Maintenance noted the event as well as an existing outstanding "snag". The HSO report noted a log entry for that date stating that Maintenance had found a hydraulic leak coming from the yellow hydraulic bay, had replaced the yellow manifold main check valve and carried out a leak check. Maintenance reported that a leak had likely trickled down from the wheel well keel beam onto the fuselage and into the APU inlet.

• June 23, 2011 - A "dirty sock smell" was reported as coming from the air conditioning system during the first and last 15 minutes flight, with the Maintenance log reporting the matter deferred on that date in Edmonton.

[11] The HSO report noted a log entry for June 24, 2011, stating that while troubleshooting a cabin air smell, Maintenance had found the wheel well keelbeam wet along the belly of the aircraft to the APU inlet, that it had washed down and dried the subject area and fittings in MLG wheel well area to carry out a leak check, with no leak being found.

[12] A June 26, 2011, Maintenance report for Fin 415 states, *inter alia*:

- APU found wet with oil, checked for oil leaks with black light and cleaned;
- APU run and leak checked again—no leaks found and unable to find oil leak on APU;
- APU air duct has no oil;
- Decontamination stage 1 completed;
- Both recirculation filters replaced;
- Duct between PRV and OPV checked with no evidence of oil;
- High power GRD run bleeds operated individually with no obvious smell observed.

[13] HSO Blain conducted an investigation into the work refusals in Vancouver and issued a decision of "no danger" in regards to operating flight AC1162 onboard Fin 415 from Vancouver to Toronto on June 23, 2011. The "Facts" section of said report notes:

• The hydraulic leak was most likely Skydrol LD4, the composition of this oil being listed on the MSDS and not meeting the classification of a Dangerous Goods. If heated, the temperature and vapours would need to be known and measured in order to determine the level of concentration. In vapour or mist form, it may cause eye, skin and respiratory tract irritation;

- The ceiling values for Skydrol LD4 on the MSDS are based on a time weighted average of 8 hours a day for 40 hours a week. No measurements were taken for the odour or concentrations on flight AC239 Fin 415 from Edmonton to Vancouver, nor was the exposure time determined;

- There is no way of determining if the Skydrol LD4 was the only product causing odour. While there may have been other products or bi-products as contributing factors to the odour, there is no way to determine this as no measurements were taken and exposure time was not determined;

- A representative from the manufacturer of Skydrol LD4 (Solutia) stated that the "base stock" (first three components listed on MSDS under "composition") would likely be very irritating when inhaled with no reported long-term health effects;

- Crew members only complained of an odour and reported no illness or symptoms from said odour, whether in person when refusing or in their written refusal statements.

Hadin Blaize

[14] At all material times, Ms. Hadin Blaize was an Air Canada flight attendant and member of the flight attendant bargaining unit represented by CUPE who, on January 4, 2012, operated flight AC 119 from Toronto to Calgary onboard an Airbus A320 identified as Fin 214, and who was subsequently scheduled to operate the following leg of the flight (AC 215) from Calgary to Vancouver. While operating AC 119 to Calgary, the HSO report notes that Ms. Blaize noticed an odour in the aft section of the aircraft which she described as "similar to vomit/strong smelly feet/shoes", said odour occurring during pushback and dissipating "a few minutes/a while" after takeoff. According to FA Blaize, during the flight, "the O2/air was dry" from the wing area to the aft section of the aircraft, making it "a bit harder to take deep breaths" and causing her "some possible side effects of nausea".

[15] According to HSO Pollock's report, once the aircraft doors were closed and the aircraft was on the active runway, Ms. Blaize had been informed by the Flight Director for AC 119 that there was a cabin defect log entry for Fin 214 on or about December 28 or 30, which she recalled as indicating that a "problem/concern" about an inoperative airpack or possible oil leakage had been deferred. When, upon arrival in Calgary, Ms. Blaize learned that the same aircraft, Fin 214, would be used for the next leg of the flight (AC 215) to Vancouver, she exercised her right to refuse to work as she was not comfortable and did not feel safe because of the odour on the flight to Calgary and the cabin defect log for Fin 214. Ms. Blaize was the only member of the cabin crew that had operated the inbound flight to Calgary who was scheduled to operate the next leg (AC215) to Vancouver.

[16] Air Canada Cabin Crew Manager T. Ibbot was informed by Employee Co-Chair of the Workplace Committee K. Allbright that Ms. Blaize had declined seeking medical attention in Calgary because she was no longer symptomatic and, having been informed of Air Canada's preference that she be checked by a doctor as a precaution, she subsequently informed HSO Pollock having called to see her family doctor on or about January 5, 2012, with no further comment. Informed of the Blaize refusal, Cabin Crew Manager Ibbot met with Captain Brent Martel (Marterall), who was to pilot Fin 214 to Vancouver (AC 215), and who indicated that there were snags pertaining to the APU and advised that the APU was inoperable due to a possible [oil] leak into the air conditioning pack and that any smell associated with the burn off of the [oil] leak would dissipate after takeoff. Ms. Blaize was advised by Manager T. Ibbot that there was no fuel leak on Fin 214. The nature of the snags was also explained by Captain Martel (Marterall) to Ms. Blaize who recalled being told that the aircraft had an inoperative APU due to a bit of oil seepage, that the odour could be smelled on pushback and landing for two minutes or so, that Fin 214 was cleared to operate and that should suspicious smells be noticed on taxi, he would return immediately to the gate.

[17] While this information caused Cabin Crew Manager Ibbot to conclude that no danger existed, Ms. Blaize advised that she was continuing her work refusal. She was subsequently provided with the Material Safety Data Sheet (MSDS) for Mobil Jet Oil II as well as a copy of a "Globe" message regarding cabin odours. Furthermore, the following information from Maintenance was obtained:

- the APU and airpack #2 had been deactivated because of the smell;
- on January 3, 2012, both air filters and ozone filters had been changed, as well as the flow control valve on airpack #2;
- the aircraft was due for an APU change and decontamination in Toronto on the night of January 4.

[18] Maintenance Control subsequently informed that there had been no report of an odour by the pilots or crew on the Calgary/Vancouver (AC 215) leg of the flight who was met upon arrival in Vancouver. The Captain advised Cabin Crew Manager Colin Murphy that there was no issue that he was aware of that could be hazardous to the crew and added that the MEL concerning the APU should not present a problem. The flight attendants who operated AC 215 to Vancouver were also met. The two flight attendants who had been seated in the rear of the aircraft stated that they did not smell anything. The Service Director and the flight attendant seated at the front of the aircraft stated that they had detected a bit of an odour during climb and descent but added that they were fine. According to the flight attendant, the odour smelled a bit like "smelly socks" but may just have been a case of carpet cleaning. She did not have a headache or feel nauseous and added that the crew had a heightened sense of awareness because they had been aware of the issues with Fin 214.

[19] HRSDC (Now Employment and Social Development Canada (ESDC))/Transport Canada was informed of the continued work refusal on January

4, 2012, and HSO Wylie initiated an investigation on the same day. She later (February 16, 2012) informed Air Canada that the file had been reassigned to HSO Pollock, who completed the investigation on March 13, 2012.

[20] Fin 214 had been inspected by Air Canada Maintenance prior to flight AC 215. The inspection concerned snags related to reported cabin odours on previous flights and the following was reported for the dates ranging from December 28, 2011 to January 4, 2012:

- December 28, 2011 - two employees operating flight AC 190 reported an odour in the cabin. The first employee noted a strong odour smelling like "musty dirty socks". Maintenance followed up, confirmed that the APU and engine oils checked full, but did not note any smell or history. According to the Captain, the aircraft had been de-iced and Maintenance suspected the odour to be from de-icing fluid, found no fault with the aircraft and pronounced it serviceable. According to the second employee, a "dirty/wet/gym socks" smell was noticeable upon boarding and logged accordingly. On December 31, 2011, the recirculation filters were replaced with Maintenance attributing the fault to an apparent APU oil leak and, under the MEL, de-activating the APU bleed valve. On the same day, Maintenance stated the APU required "oil monitor" and noted that the aircraft remained under MEL.

- January 1, 2012 - on flight AC 418, a "dirty socks smell" in the cabin was reported on descent at about the same time anti-icing was engaged. Maintenance reported this fixed on January 2, 2012, stating that the APU bleed valve had been deactivated physically and advising the crew to "continue to monitor sock smell".

- January 3, 2012 - a bad smell was reported lasting until after takeoff. No smell was noted during cruise but it reappeared below 5000 feet with APU bleed off. According to Maintenance, the APU remained on MEL, the bleed valve was physically locked out, the ECS system decontaminated and the recirculation and ozone filters replaced. Noting that a GRD run had generated no odours, Maintenance indicated that the "APU bleed (was) not to be used until APU replacement".

- January 4, 2012 - an employee on flight AC 464 reported a haze in the back galley on takeoff until cruise, stating that it smelled "like something was overheating" and a "smell of dirty socks when pax 2 (airpack) is on". Due to the snags repetitiveness, Maintenance deferred the matter to Engineering for evaluation. On AC 119 on the same day, a "dirty sock smell" was reported in the cabin and flight deck after engine start. It dissipated during taxi and was not present after takeoff. Again on January 4, 2012, this time on flight AC 215, a flight attendant (R. Del Rosario) reported an odour of "dirty sock/dirty wet carpet" towards the front of the cabin during taxi and takeoff.

Maintenance noted that groomers were advised to clean thoroughly and deodorize the cabin.

- January 5, 2012 - Fin 214 was out of service all day for an APU change.

[21] According to Crew Manager Colin Murphy, the Service Director (Ms. Brigitte Forget) who, following the Blaize refusal, had operated AC 215 on January 4, 2012, reported that on the subsequent leg of the flight (AC 100), she and the crew had noticed an odour in the cabin described as "dampness/smelly feet". Ms. Forget had provided the following particulars:

- the First Officer had been in the washroom for a long time and when coming out, had indicated feeling very unwell and having vomited numerous times;
- Ms. Forget and all 3 flight attendants had noticed a strong unpleasant odour during the flight that she described as dampness/smelly feet and also a smell similar to "body odour" in the flight deck, although the pilots appeared to be very hygienic;
- Ms. Forget and the cabin crew had headaches, and she felt nauseated and light-headed, although she sometimes gets headaches on flights. However, by the end of the flight, she had a "metal" or "oil" taste in her mouth. She could not sleep when she got to her hotel. She was now feeling fine although tired from lack of sleep.

As stated above, HSO Pollock issued her decision of "no danger" on March 26, 2012. Her investigation report states, *inter alia*:

- Air Canada had developed processes and procedures to manage smell events since November 2011 and thus, with these processes and procedures, Air Canada was in a position to identify the product Ms. Blaize had been exposed to during flight AC 119;

- Air Canada had committed to strict maintenance and troubleshooting investigation procedures to address smell events;

- Air Canada's Industrial Hygienist had conducted and finalized the Hazardous Substance investigation directed by Transport Canada on November 4, 2011 and the information had been shared with the Inflight Group via GLOBE, an online method of communicating with cabin crew;

- Ms. Blaize had been provided with a copy of the MSDS for Mobil Jet Oil II. According to that MSDS, Mobil Jet Oil II is not expected to produce adverse health effects under normal conditions of use and with appropriate hygiene practices. The product may decompose at elevated temperatures or under fire conditions and give off irritating and/or harmful carbon monoxide gases/vapours/fumes. Symptoms from acute exposure to these

decomposition products may include headache, nausea, eye, nose and throat irritation;

- HRSDC Industrial Hygienist confirmed that Mobil Jet Oil is not a controlled product, nor a hazardous substance;

- It is not uncommon for individuals to react to said odour and some individuals may experience more severe reactions than others. The odour can be significant for short periods of time but disappears after several minutes. A low threshold does not mean that it is harmful, nor does the fact that something smells mean that it is hazardous to one's health;

- Regarding the situation resulting in Ms. Blaize refusal, Air Canada had locked the APU bleed valve on December 31, 2011, replaced the filters and did decontamination run on January 3, 2011. While decontamination run burns off residual oil in the air conditioning system, a bad smell can still be present due to the heat generated during that procedure. Although an air pack (#2) was inoperative, Air Canada Maintenance Technical Support Manager (E. Bérubé) and the Transport Canada Maintenance Inspector confirmed that having one inoperative air pack would not make a difference to air quality.

Issue

[22] The present appeals are challenging the conclusions arrived at by HSOs Pollock and Blain regarding the work refusals registered by the appellant employees of Air Canada. Those conclusions were that in the work circumstances surrounding these work refusals, there was no danger within the meaning of the Code to the appellant employees. While the circumstances of each refusal may vary slightly, central to all, and this includes the refusals by flight attendants LaPorte and Martinez that are dealt with in the parallel case and decision mentioned at the outset, is the fact that all those refusals originated by the presence of a smell described as "smelly wet gym back" or "dirty socks" that all the said employees perceived or were informed of.

[23] Consequently, stated as simply as possible, the issue raised by the present appeals is whether in those work circumstances described in the HSO reports as well as in the statements of agreed facts filed as exhibits, that smell represented or served to indicate a danger to those employees that justified their refusal to work action. All the evidence that has been presented in all of those appeal cases dealt singularly with this question.

Submissions of the parties

A) Appellants' submissions

[24] In the course of preparatory pre-hearing conferences, the parties to these cases had indicated intending to resort to considerable documentary evidence as well as calling a large number of witnesses in the presentation of their positions. While much documentary evidence was indeed filed at the outset and in the course of the hearing, the parties opted to call just four witnesses, three of whom were tendered as experts and recognized as such by the undersigned appeals officer in the following fields.

[25] The appellants tendered two experts, Dr. Robert Harrison and Dr. Clifford P. Weisel. Dr. Harrison, who is licensed to practice medicine in California, is a clinical professor of medicine at the University of California at San Francisco as well as visiting professor at the School of Public Health at the University of California at Berkeley and serves as chief of the Occupational Health, Surveillance and Evaluation Program of the California Department of Public Health. He is attending physician for the occupational health services and for the blood borne pathogen Program at the University of California at San Francisco and Director of the Occupational Health Internship Program of the Association of Occupation and Environmental Clinics. Dr. Harrison was recognized as expert in occupational and internal medicine as well as toxicology and epidemiology, albeit with objection from respondent Air Canada as regards the fields of toxicology and epidemiology on the basis of limited experience.

[26] The sole other witness who testified at the hearing was Mr. David Supplee, who presently is a Financial Officer for district 142 of the International Association of Machinists representing aircraft mechanics for numerous airlines, including US Airways, Hawaiian Airlines and Alaska Airlines, but not Air Canada mechanics who are instead represented or part of district 140 of the same union. Mr. Supplee was in the employ of U.S. Airways starting in 1980 and over the years worked for the said airline as an aircraft mechanic, lead mechanic, including certified and lead Airbus mechanic at U.S. Airways and as such was part of the airline's service entry team when it introduced Airbus aircraft to its fleet, and designated quality control inspector for U.S. Air fleet comprising Boeing 737 and 757 as well as Airbus A 319, 320 and 321.

[27] Mr. Supplee was called to testify in response to a request from the undersigned to provide insight into the workings of an Airbus A 319, 320 and 321 ventilation and air conditioning system, be it mostly from the perspective of the functioning of the main aircraft ventilation system and air packs or that of the Auxiliary Power Unit (APU), although his testimony did extend to other equipment of the aircraft that has a function in the ventilation system. While his testimony was initially sought to provide information as to the workings of those systems and equipment, it did also broach rather extensively on what would be the various

sources of air contamination on the Airbus A 319, 320 and 321 which are essentially the same narrow bodied aircraft.

[28] Mr. Supplee's testimony on air management and ventilation systems on the airbus aircrafts was essentially unchallenged and uncontested. He testified that there are primary and residual sources of air contamination on the Airbus. Specifically, cabin air on an Airbus is an amalgamation of outside air brought into the aircraft through the engines of the aircraft by way of a technique that calls for the outside air to be bled off the engines, and recirculated air, the last being essentially the same air as the first but recycled and recirculated after being sanitized by going through High Efficiency Particulate Air (HEPA) filters that collect particles of various origins that may have found themselves in, contaminated, the cabin air. It is important to note that contaminants from external sources may also be ingested from the front of engines, enter the engine air and thus subsequently the bleed air.

[29] There are two engines on an Airbus, it is through those engines that the outside air is normally bled off into the ventilation system to the cabin. Under certain circumstances, the outside air may also be bled off the APU, this being mostly when the aircraft is stationary on the tarmac and the main engines are not in operation. The engines and the APU, according to Mr. Supplee, represent the main sources of cabin air contamination via the bleed air system, as jet engine oil and outside contaminants can enter the bleed air system at these points.

[30] The outside air entering the engines (or the APU) is compressed by fans and thus reaches high temperatures and then is bled out of each engine through two bleed valves ("taps") and into ventilation ducts that lead the bleed air through a "pre-cooling" system into the two air packs of the aircraft that cool the hot bleed air. This air then goes into a mixing unit to be mixed with recirculated air and then released into the cabin. While the recirculated air may have gone through HEPA filters before being mixed with bleed air, the mixture is not filtered when being released into the cabin. The fans that compress the outside air as it goes through to the back of the engines are on a common shaft supported by bearings that need to be kept lubricated. Jet engine oil is the lubricant used and it is prevented from mixing with air by seals (carbon and labyrinth or air seals). Those seals are subject to wear and thus may leak, with the result that oil will mix with the extremely hot compressed air in the engines (210-225ºC), thereby vaporizing the oil. The bleed valves through which air is circulated are located behind or "downwind" of a number of the bearings and consequently, if a bearing "upwind" of a bleed valve leaks, vaporized oil will enter the ducting leading to the cabin and contaminate that air potentially with pyrolysis products.

[31] The APU functions essentially as an aircraft engine. It has the same basic design as the main aircraft engines, albeit on a smaller scale, including a bleed air valve which feeds air into the same ducting system that serves to release air into the cabin. It is used to start aircraft engines by supplying them with compressed air and supplies air to the cabin as well as powers aircraft systems when the engines are not

running. While the APU compressed air may be slightly cooler than that of the main engines, it nonetheless operates at sufficient temperatures to vaporize oil.

[32] Like the main engines, the APU may be subject to oil leaking through worn bearing seals resulting in vaporized oil and pyrolysis material being carried by the compressed air being bled off into the air circulation system and entering the aircraft cabin. There are also other circumstances where the APU may serve as conduit for contamination. One such circumstance is when fluids on the outside of the aircraft, such as de-icing fluid, may run down the belly of the aircraft and be ingested through the intake of a running APU. Another would be when a cooled down APU is "over-serviced", i.e. where too much engine oil is added, with the excess oil leaking and being ingested into the hot running APU.

[33] In addition to the main engines and the APU, oil contamination in the cabin air may originate with the air cycle machine (ACM) or "turbine compressor" located in the air packs. The turbine is supported by bearings whose carbon seals are subject to wear and leak, although the temperatures in the ACM are much cooler than in the engines or APU. The same Mobil Jet engine oil II is used in the engines, the APU and the ACM.

[34] Mr. Supplee's testimony also dealt with residual sources of air contamination. Vaporized oil or other contaminants that find their way into the ventilation system ducting can also condense under certain conditions and thus leave residues in the system. Mr. Supplee noted that because of the design of the system (air flowing through 3" ducting to various valves then distributed in the cabin through flat ducting at top of fuselage), it is difficult to find and correct the source of contamination when it is caused by the presence of residues in the ventilation system. In normal operations, bleed air from engine 1 follows ducting to air pack 1, both on the left side of the aircraft, and similarly engine 2 and air pack 2 operate on the right side of the aircraft. Under normal circumstances, air pack 1 will feed the cockpit and air pack 2 will do the same for the cabin, although both are usable for both with the possibility of cross-bleed from the system feeding one air pack to the other using cross-bleed valves. Three inch round ducting leads from the engines on the forward edge of the wing to the air conditioning bay where the air packs are situated, just forward of the wheel well. From there, air is distributed in the aircraft through the distribution flat ducting.

[35] The APU generates bleed air that is ducted to the aircraft engines to start them. This bleed air uses ducting (65-75 feet in length) under the cargo floor to reach the starter valves on the engines, and then flows through the same ducting to air packs used by engine bleed air to provide ventilation when the aircraft is on the ground. As stated above, a cross-bleed valve allows air from engine 1 to supply air to air pack 2 and vice versa. The cross-bleed valve may be opened for two main reasons. First, if there is a problem with an engine, the other engine can be used to supply air to both air packs. Second, if the APU cannot be used, a ground source of air will be used to start engine 1 which will then provide hot compressed air to start engine 2. As a result of this design, oil leaks or external contamination from either

engine or the APU can result in residue being formed in any part of the ducting system, potentially resulting in contamination of cabin air when such residue is either disseminated or pyrolyzed. Where there are leaks or suspected leaks, or problems with the APU, opening of the cross-bleed valve will increase the chances of residual contamination throughout the ventilation system.

[36] The hot bleed air is cooled by means of heat exchangers in the air packs that are designed to maximize the surface outside of which "ram air" (cold air) flows and cools the hot air that is inside. Temperatures in the ventilation system vary, which causes vaporized oil to condense to form residue. This can happen on the heat exchangers as the ram air cools the hot ventilation air.

[37] When the aircraft stops operating, temperatures lower and vaporized oil condenses. Oil can condense on ducts, valves and heat exchangers after various degrees of transformation through heating and cooling. Mr. Supplee testified to seeing pack valves coated with oil and baked on carbonized oil and heat exchangers with a black tar-like substance up to oil sheen that could be smeared. Furthermore, if particulates enter the cabin, they will be deposited on the HEPA filters when the cabin air is recirculated. Since residues from any source can form on either air pack or ducting on either side of the aircraft, shutting down one air pack or bleed air valves from one engine or APU will not prevent contaminated air from entering the cabin. Once hot bleed air from the remaining engine comes into contact with the residue, it can vaporize and contaminate cabin air. Mr. Supplee agrees that very small quantities, a few drops, of oil can produce a fume event. A sign of an oil leak would be increased oil consumption by an engine. As such, under normal conditions of operation, an aircraft engine will use one to two quarts of oil per day. A leaking bearing will bring up oil consumption to three to four quarts per day.

Dr. Clifford P. Weisel

[38] Dr. Clifford P. Weisel, Ph.D., is a professor in the Department of Environmental and Occupational Medicine at the Robert Wood Johnson Medical School, University of New Jersey and Deputy Director of the Exposure Science Division of the Environmental and Occupational Health Sciences Institute. He has conducted research and taught in the field of exposure sciences for more than 20 years and also directs laboratory analysis of various compounds related to releases of jet fuel oil into aircraft bleed air. Dr. Weisel was recognized as expert in exposure science. He has written extensively and has been peer reviewed on subjects that relate to the matters at hand.

[39] In his report, he evaluates the likelihood that hazardous chemicals would have been released into the air of an aircraft cabin when several cabin crew members reported an air quality problem relative to an odour present in the cabin that was described as dirty socks or vomit. Dr. Weisel evaluated the initially encountered air quality problems, whether the same air quality problems would potentially be encountered in subsequent flight legs on the same aircraft and finally what is known about the air quality associated with the odours that were reported

by the refusing employees. Regarding the source of air in an aircraft, the witness noted that fresh air to the aircraft comes from the high temperature compressed air that is bled off the engines or the APU which, after being cooled, is mixed with re-circulated air to provide the necessary ventilation to the aircraft cabin. The APU is used when engine bleed air is needed for optimum aircraft performance or when the aircraft is on the ground and the engines are turned off. He noted that in the present cases, the odours in question were detected when the APU was in operation on each aircraft.

[40] According to Dr. Weisel, oil leakage into the bleed air which then finds its way into the aircraft cabin through the ventilation system is often associated with an odour that is characterized as a smelly sock or vomit odour. Oil can contaminate the aircraft bleed air if there is a mechanical failure with the oil seal that separates the section of the air compressor that is filled with oil from the section that supplies the ventilation air. Contamination can also occur if the oil reservoir is over serviced (overfilled), if oil is spilled during the filling process or if the oil seal has a failure while operating at transient high-temperature/power engine conditions. Where bleed air is contaminated by oil, the high air temperature may cause the oil to be pyrolyzed and the oil constituents as well as the pyrolysis products can mix into the air being circulated into the cabin, thereby exposing the crew and passengers to the hazardous chemicals that emanate from either the oil or its pyrolysis.

[41] Oil leaking into bleed air results in many potentially hazardous compounds being released into the aircraft cabin, including isomers of tricresyl phosphate (TCP), dibutyl phenyl phosphate (DPP), various hydrocarbons which are components of jet oil and/or hydraulic oil, and several pyrolysis products such as carbon monoxide, trimetholpropane, formaldehyde and octanoic and decanoic acids. These acids have a rancid odour and likely contribute to the dirty sock odour, although only some of the compounds in the hazardous mixture cause the smell. However, Dr. Weisel noted from consulted research publications that little data has been collected on the contaminants that might be present in engine bleed air under normal operating or upset conditions, such as when odour episodes occur due to engine oil entering the bleed air during commercial flights, given that such odour events occur at a relatively low frequency, a very large number of flights with incidents would have to be evaluated to collect sufficient air samples and health data from the crew and passengers to evaluate if health effects are related to such episodes.

[42] Research publications consulted by Dr. Weisel lead to the conclusion that there would need to be a certain concentration of pyrolyzed oil in the bleed air to present hazardous air conditions to crew members. Based on calculations and a set of assumptions used in the research publication[1] it was determined that pyrolysis of 1gram of oil would produce formaldehyde concentrations at the TLV-C level. Set

[1] Winder, C., Air monitoring studies for aircraft cabin contamination, Current Topics in Toxicology Vol 3, 33-48, 2006, National Research council *The Airliner Cabin Environmental and the Health of Passengers and Crew*, National Press, Washington, DC 2002.

against this, Dr. Weisel noted that while based on some of the assumptions in the said research, 1 gram of oil may be an underestimation of the amount required to reach a formaldehyde air concentration above the TLV, typical oil consumption rates of commercial aircraft are on the order of 0.5 quarts per hour, which would represent ±470 grams, and thus, he considered from these estimations that losses of oil to the bleed air during flight so as to produce a hazardous concentration are consistent with what might happen during an oil leak that would not be readily identified by routine maintenance.

[43] Comparatively, Dr. Weisel referred to studies that measure TCP concentration measurements in the cockpit of military aircrafts in flight and on the ground, prompting the opinion that higher concentrations would have been expected had the canopy been closed. He noted however that no similar concentration measurements have been reported in the open literature for commercial aircraft. Dr. Weisel also pointed to 94 air samples collected by Honeywell Corporation to establish a summary of concentrations of organic compounds in bleed air in a dissertation[2]. He noted however that the document presented no indication as to whether those samples had been collected during an oil leak or when an odour was present in the aircraft. Furthermore oil leak events/incidents occur at an average frequency rate of 1% of flight cycles.

[44] Dr. Weisel thus concluded that the mean concentrations provided for aldehydes, aromatic and aliphatic hydrocarbons, TCP, carbon monoxide (CO) and other compounds would reflect normal operating conditions of the aircraft rather than an upset condition. While, as previously stated, the frequency of such incidents (oil entering the bleed air) may vary from one type of aircraft to another, with BAe 146 being the most likely[3], Dr. Weisel pointed out that based on the Van Netter (2005) study, the Airbus A320 had the second highest air quality at 1.29 reported incidents per 1000 flight cycles. He also formulated the opinion that when an aircraft has an odour that is associated with oil leakage into the bleed air that is likely due to a degrading oil seal or other malfunction of the mechanism that separates the oil from the bleed air, it is likely that air quality problems will persist on that aircraft until the source of the oil leak is found and properly repaired.

[45] In his report, Dr. Weisel reviews the results of a test flight conducted on May 3, 2012, for Air Canada by an independent firm (Golder Associates) for the purpose of evaluating compounds present in the cabin of an aircraft when an APU with a known oil leakage was operated during said simulated flight. Provided by the said report are measurements of triorthocresyl phosphate (TOCP), total organic compound (screening) and carbon monoxide in three locations on the aircraft during the flight. The APU was turned on for various increments of time while the

[2] Richard B. Fox, Assessing Aircraft Supply Air to Recommend Compounds for Timely Warning of Contamination.

[3] Van Netten Aircraft "Air Quality Incidents, Symptoms, Exposures and Possible Solutions", in Air Quality in Airplane Cabins and Similar Enclosed Spaces Martin B. Hocking Ed. The Hanbook of Environmental chemistry Volume 4 Air Pollution Part H, Springer-Verlag Berlin 2005.

aircraft was on the ground, during the climb and during descent and return to the hangar.

[46] According to Dr. Weisel, there were problems with the procedures used for the said evaluation, particularly if the objective was to determine if hazardous chemicals were emitted from the leaking APU. First, the compound that was measured (TOCP) is not the only hazardous (namely TCP isomers) that could be present in engine oil. Second, the air samples that were collected exceeded the maximum volume allowed for such test by triple the amount. Third, during the majority of the time that air samples were collected, it was not expected that compounds from the APU would be generated because the samples were collected over the entire time of the flight instead of over the shorter periods when the APU was being operated and during which the actual emissions would be likely to occur. Consequently, according to Dr. Weisel, while the results reported to Air Canada by Golder Associates may in the end have found no evidence that either CO or TOCP were above regulatory standards through the flight, the measurement of carbon monoxide while the APU was being operated suggested that the said APU was emitting compounds that would cause cabin air quality to decline.

[47] The opinions arrived at by Dr. Weisel were to the effect that each of the aircrafts involved in the incidents central to the refusal action by the appellants have been documented to have had air quality problems that were associated with oil leakage into the bleed air of the aircraft, with such leakage resulting in a mixture of chemicals being released into the aircraft cabin that include a mixture of hazardous and toxic chemicals. Said mixture would have been composed of engine oil and unknown pyrolysis products of the oil. Dr. Weisel formulated the opinion that there was a reasonable expectation of the cabin crew that working a subsequent flight on the same aircraft in which they smelled the odour without that aircraft receiving proper maintenance to identify and repair the source of the oil leakage in the APU would result in them, other crew members and passengers being exposed to a mixture of hazardous chemicals associated with further oil leakage into the bleed air of the aircraft.

Dr. Robert Harrison

[48] Dr. Harrison was tendered by the respondent as an expert in occupational medicine, and also qualified as an expert in toxicology. He has authored a guide entitled *Exposure to Aircraft Bleed Air Contaminants Among Airline Workers*, in which is discussed the potential for toxic chemical compounds such as pyrolyzed engine oils and hydraulic fluids that may leak into the aircraft cabin and flight deck air supply systems and may be associated with health effects. Dr. Harrison notes that in his work as physician and internal medicine specialist, he has consulted with over 50 aircraft cabin crew members who had experienced exposure to bleed air contamination as an occupational medicine physician and Qualified Medical Examiner for the State of California, he has evaluated the cause of patients' occupational diseases. In this respect, he has prepared reports concluding that patients with exposure to bleed air (presumably contaminated) suffered

neurological, respiratory and systemic health effects. In considering whether it is reasonable to expect that the exposure(s) aboard the aircrafts involved in the present cases would lead to injury or illness, he notes that there is considerable scientific and medical literature indicating that for many decades, both the airline industry and aircraft manufacturers have acknowledged the potential for toxic air contamination from multiple sources aboard aircraft.

[49] According to Dr. Harrison, when employees smell an odour (and here one would assume that Dr. Harrison means odours that would be out of the ordinary and different from usual odours in their work place), it is reasonable for them to suspect that a condition exists that constitutes a danger to their health. After exposure to bleed air and other contaminants aboard aircraft, cabin crew members may experience acute symptoms including cough, shortness of breath, nausea, chest pain, headache, dizziness and confusion. These symptoms indicate toxic effects to the respiratory and central nervous systems. Physical examination may show wheezing or crackles in the lungs, and neurological testing may show impairment in balance, gait and coordination. If symptoms persist, objective testing may show abnormal pulmonary function and impaired concentration, memory and other cognitive abnormalities. It is thus the conclusion of Dr. Harrison that the Air Canada flight attendants who refused to work had reasonable cause to expect that they may develop either acute and/or chronic health problems as a result of exposure to toxic air contaminants aboard the aircraft.

[50] Dr. Harrison makes particular reference to an Airbus service information letter dated May 13, 2004, part of the arguably relevant documents filed by Air Canada and titled "Cabin Air Quality Troubleshooting Advice". He notes in particular that the letter states that "there are many potential causes of cabin odour or smoke and it can sometimes prove difficult to isolate the cause of an odour quickly". He notes that the list includes engine or APU ingestion of de-icing fluid, exhaust fumes from other aircraft, pollution, hydraulic fluid leaks, birds and compressor wash procedure residues. Added to this, engine oil leaks can occur into the bleed air system.

[51] Though odours can be very useful in determining the presence of a particular gas or vapour in the environment, the variable relationship of odour threshold and the minimum concentration which would reduce toxic effects renders odour an unreliable indicator of toxicity". Mr. Koroneos, Manager, Industrial Hygiene, recommended medical evaluations only if experiencing significant health effects regarding an exposure to confirmed primary bleed air fume event. Referring to the same document, Dr. Harrison notes that Mr. Koroneos' document summarizes the potential biological effect and toxicity index for bleed air contaminants, including upper respiratory tract or central nervous system irritants of slight to moderate toxicity and concludes, in a revision dated January 9th, 2012, that "significant health effects would include symptoms such as chronic, severe headaches, disorientation and vomiting". He also notes that a study (Cranfield) cited by Mr. Koroneos shows that there are detectible levels of triorthocresyl phosphate (TOCP) in the flight deck of aircraft during routine flight operations.

[52] Dr. Harrison makes the suggestion that any flight attendant reading those documents from Air Canada would conclude that exposure to toxic air contaminants could reasonably be expected to cause injury or illness. He further points out that in each of the instances where employees refused to work, there was evidence of a mechanical problem aboard the aircraft and that since air measurements were not obtained during the incidents involved in these cases, something that in fact would have been impossible, and consequently opines that the mechanical investigations alone (presumably the results of such) were sufficient evidence to reasonably expect that toxic air contaminants were released into the cabin air and could result in health problems, as confirmed by the Material Safety Data Sheets for (Mobil) jet engine oil and Skydrol stating that these chemicals are toxic to the respiratory system.

[53] Regarding the one test flight conducted by Air Canada on May 3, 2012, mentioned above, Dr. Harrison formulates the opinion that the absence of TOCP detected aboard that flight does not provide any salient evidence regarding the potential for toxic air contaminants to cause illness to the employees who refused to work in the present cases. In jet engine oil, TCP are contained as multiple isomers, of which the TOCP isomer is present in a relatively small concentration. In that test flight, the testing was not adequate to assess the potential hazard to TCPs as only the TOCP isomer was measured.

[54] By way of conclusion, Dr. Harrison states that he followed the accepted methodology in the field of occupational medicine in finding that the employees in these cases had a reasonable expectation that they were exposed to toxic air contaminants that cause illness, both acute and potentially chronic. In each case, the perception of an odour by the flight attendants was a warning sign that a toxic air contaminant was present in the aircraft cabin. This toxic contaminant likely was the result of engine oil and/or other volatile hydrocarbons that entered the ventilation system of the aircraft. When these chemicals are breathed into the lungs, they are rapidly absorbed and can cause damage to the respiratory tract and nervous system. Flight attendants have been documented to suffer both acute and chronic health problems as a result of bleed air exposure and it is reasonable to conclude that the Air Canada flight attendants had reasonable expectation that the exposures would lead to illness.

[55] The appellants summarize the relevant facts and evidence of the present appeals into 4 categories (A) fume events that occurred (B) reported smells are associated with contaminants (C) the exposures are dangerous and (D) illness is to be expected from the exposures.

A) Fume Events

[56] Mr. Supplee presented uncontradicted evidence that jet oil and other contaminants can leak into the ventilation system on the aircraft where the work refusals took place. The appellants accept Mr. Supplee's explanations concerning

the primary and residual sources of contamination; particularly that jet oil can leak into the cabin air from the 2 engines on the airbuses, from the APU and the air cycle machine in the airpacks. Contamination can also occur from external sources and from secondary sources that leave residues in the ventilation system. The appellants also retain the explanation that cross-bleed valves can increase residual contamination throughout the ventilation system when opened. Once hot bleed air from the remaining engine comes into contact with the residue, it can vaporize and contaminate cabin air. Very small quantities of oil, even a few drops, can produce a fume event.

[57] Furthermore, the appellants submit that Airbus and Air Canada correlate fume events with oil leaks and residues. According to the Service Information Letter (SIL) provided by Airbus to its customers, the contamination known as dirty socks smell can be caused by the APU or engine oil leaks or a contaminated environmental control system (air conditioning). This is consistent with Mr. Supplee's evidence. The appellants submit that the maintenance protocol established by Air Canada, which includes inspecting ducts and cleaning affected areas after a leak is fixed, is consistent with Mr. Supplee's evidence regarding sources of contamination and the formation of residues in the ventilation system as the result of oil leaks.

[58] According to the appellants events were associated with mechanical failures and oil leaks on the aircraft in these refusals. As stated in the agreed statement of facts and documents, Air Canada's maintenance staff took the reports of fume events seriously as indicators of mechanicals problems on the aircrafts in question and that they attempted to fix the problems. Specifically, the details of the fume events relating to the work refusals of Delgado, Liang and Blaize and the steps taken are detailed in the agreed statement of facts of flights AC 1162 and AC 215.

B) Smells as Indicators of Contamination

[59] The appellants further submit that both Airbus and Air Canada recognize that smells are associated with contaminants and mechanical failures. In particular a "dirty sock" smell is associated with oil leaking into the bleed air system. This is consistent with the evidence of CUPE's witnesses. According to Mr. Supplee, smell is used to diagnose mechanical problems and "dirty socks" smells are related to oil. The Airbus SIL is consistent with this categorization of the smell. Dr. Weisel testified that smell tells you about the amount of compound that is the source of the odour. Dr. Weisel identified two aspects of smell in this regard: (i) the odour threshold which is the point at which a smell is perceived and (ii) intensity at which it is perceived. Both aspects give some indication about concentration. Smell is useful in determining exposures because chemical techniques are generally comparative but not absolute.

[60] Dr. Weisel testified in cross-examination that reliable information could be obtained on odour from untrained people and that people can describe a new odour that is not a normal one. Dr. Harrison testified that while smell alone should not be

relied on as an indicator of a hazard being present, if workers smell something reasonable likely to be caused by chemical exposure, it is an indicator of a hazard to an occupational medicine specialist. Smell is a warning sign, particularly when there is reason to believe a mechanical failure exists. According to Dr. Harrison, smell is associated with chemical exposure when other sources can be ruled out.

[61] The appellants do not agree with the testimony of Air Canada's witness, Dr. Pleus, that smell itself is neither an illness, nor is it indicative of toxicity. Rather, the flight attendants refused to work not because they did not want to smell an unpleasant smell but rather because that smell indicated a bleed air leak that could result in contaminants with potential health effects in the cabin air. The appellants agree with Dr. Harrison's comment that Dr. Pleus suggesting that odour is irritating but not a pathological effect assumes that odour is annoying but has no medical significance. However the appellants submit that this does not apply in these cases where the odours are associated with exposures to substances involving TCPs, pyrolysis products and VOCs with known toxic effects. Furthermore, although Dr. Pleus explained that some toxic substances are odourless and others can be detected as concentrations lower than levels associated with toxicity, he did not deny in his expert report or testimony that "dirty sock smells" were associated with jet oil or pyrolyzed jet oil compounds. In fact, Dr. Pleus testified that he had smelled the smell described by the flight attendants once and in that instance the flight was aborted. It is the appellants' submission that this occurrence bolsters the idea that the "dirty socks smell" is unusual and associated with mechanical failure.

C) Nature of the Exposures: Dangerous Chemicals

[62] The appellants submit that the exposures most likely consisted of jet oil and pyrolyzed jet oil products. These products contain compounds which are known to cause illness. In support of this position the appellants retain the expert evidence of Dr. Weisel and Dr. Harrison.

[63] First, the appellants support Dr. Weisel's expertise and submit that he is qualified to testify on the nature of the exposures as his expertise is in exposure science which is the science that describes and tries to understand the linkage between environmental science, toxicology and public health; or namely, how contaminants can contact people. He also has specific expertise in airline exposures and in bleed air contamination and has studied chemicals resulting from pyrolysis of jet oil. Dr. Weisel's evidence concerns the nature of the actual exposures and he noted that the compounds that may be produced by pyrolysis have a very characteristic odour. His explanation of the exposure was consistent with the maintenance histories on the aircraft in question and the Airbus and Air Canada maintenance literature associating the reported smells with oil contamination in bleed air.

[64] The appellant submits that Dr. Weisel presented un-contradicted evidence on the composition of jet oil, namely that it is composed of approximately 97% base and 3% additives. The research performed by Dr. Weisel examined HEPA

recirculation filters from aircrafts, where markers of oil were found on a number of filters. These markers included TCPs, which are additive components of jet oil and synthetic lubricant markers-pentaerythritol. When both TCP and base markers are present, there is a higher probability of oil contamination on the filter than under normal circumstances. Dr. Weisel testified in cross examination that the study lends credence to the fact that TCP and oil get into cabin air which results in air quality problems and where airlines feel they need to do something beyond routine maintenance.

[65] Concerning the presence of TCP isomers, Dr. Weisel explains that they are distinct compounds that are related by the same chemical formula but with differing structures. TCP isomers include TOCP which was the focus of Dr. Pleus's report, although there are three general types (para, meta and ortho). However Air Canada's report by Mr. Chris Koroneos notes that most TCP in engine oil contains less than 0.1% TOCP. An exclusive focus on TOCP ignores the vast majority of TCP compounds that flight attendants would be exposed to during fume events.

[66] The appellants further rely on Dr. Weisel's explanation that pyrolysis is the process of breaking chemical bonds in a substance and creating new compounds as the result of heat. Pyrolysis increases the number of compounds in a substance because the original mixture is not destroyed, while new compounds are added. Pyrolsis affects both additives and base. While the base of jet oil is mostly non-hazardous, pyrolyzation of the base will produce new compounds which are irritant and carcinogenic. Some pyrolysis products are listed in the Air Canada report prepared by Mr. Koroneos and many are noted as having irritant effects on the upper respiratory tract and the central nervous system. The appellants submit that it is necessary to consider additive, synergistic effects of different compounds on the body and not just consider them one by one. This is one of the difficulties of relying exclusively on a toxicological approach: toxicologists study individual compounds and there are very few toxicological studies dealing with mixtures of compounds.

[67] Dr. Weisel also refers to a National Research Council publication which calculated that one gram of oil pyrolyzed over a fifteen minute period would be sufficient to produce formaldehyde that reached an occupational exposure threshold limit value (TLV) ceiling which is an exposure level that should not be exceeded to protect the health of an individual. The appellants reason that if only 1% of oil were pyrolyzed, 100 grams of oil would need to be leaked in order to produce a gram of pyrolyzed oil. Since typical oil consumption is in the range of 470 grams per hour (half a quart), a consumption of 100 grams of oil would not necessarily be noticed by maintenance. A gram of pyrolyzed oil could result in exposures of formaldehyde and other compounds with harmful effects.

[68] Studies of air quality on aircrafts analyze data that was obtained in normal operating conditions. In fact, mean concentration studies where concentrations of chemical compounds are averaged over the course of a flight do not provide information on peak exposures where the exposure is for a limited time. Peak exposures in this case are significant because there are numerous reports of the

smells occurring for only portions of the flight and then dissipating. The Golder Report involving a test flight commissioned by Air Canada that Dr. Weisel viewed as a step in the right direction since it took actual measurement on board an aircraft with a known history of fume events did not measure peak exposure levels or any compounds produced by pyrolysis other than carbon monoxide.

[69] The appellants summarize Dr. Weisel's conclusions by saying that there was a leakage of engine oil to bleed air so that crews were exposed to a mixture of hazardous and toxic chemicals from engine oil and pyrolysis products at concentrations that would cause adverse health effects. Dr. Weisel testified that he was able to ascertain that the levels of compounds that were released were hazardous based on the reports of persons exposed under these and similar circumstances, and based on anecdotal evidence and evidence presented by Dr. Harrison. Dr. Weisel testified that he assumed that the amounts of oil leaked and pyrolysis products were similar to those on flights where there were reports of illness, but testified that the assumption was justified, since according to the reports, none of the other flights had problems, such as emergency landing, suggesting larger quantities of oil leaked.

D) The Exposures Cause Illness

[70] Counsel for the appellants submits that the exposures that the flight attendants suffered cause illness and in support of that position relies on the evidence by Dr. Harrison, the only medical expert called in this case. He testified to having 15 years of clinical experience with flight attendants involved in bleed air exposures. Dr. Harrison testified that irritation is a health effect from the point of view of a medical expert. Employees in an occupational medical program would be encouraged to report symptoms such as scratchy throat, runny nose, and irritated eyes and Dr. Harrison would diagnose them as suffering from chemical exposure with respiratory irritation, a standard medical diagnosis as per the International Classification of Medical Diseases. Dr. Harrison further testified that illnesses are not necessarily chronic (i.e. they may be only temporary) nor do the symptoms have to be irreversible. This opinion is contrary to that of Air Canada's expert, Dr. Pleus, who focused only on irreversible health effects. He maintained that the medical issues at stake were not reactions to bad smells; rather they were respiratory tract and neurological symptoms. The appellants contrast this with Dr. Pleus's non-expert view of illness which maintained that fumes could be irritating but were not pathological.

Methodology

[71] The appellants submit that Dr. Harrison followed the standard occupational medicine methodology which he testified as being not limited to the methodology of toxicology. Namely, the appellants assert that he addressed the six components of the methodology below:

a) *What is the medical or case history?*

[72] In the present case, Dr. Harrison looked generally at the environment, job duties, unusual occurrences, ventilation, personal protective equipment, the length and time of exposures, and symptoms. He testified that reliance on symptoms is very important regarding the determination of hazard and causal connections. According to Dr. Harrison, symptoms are a reliable indicator of exposure. He also added that the temporal correlation of symptoms with exposure is important as acute symptoms appear minutes to hours from exposure, sub-acute symptoms are delayed and appear days to weeks after exposure. Chronic symptoms are delayed and appear months to years after exposure.

b) *Was there an exposure and if so what was the intensity?*

[73] Dr. Harrison considered the exposure route (inhalation, skin absorption, ingestion) and workplace processes that could lead to exposure. In considering chemical exposure, occupational medicine specialists get information on the amount of chemical in the air or on the surface, either by direct measurement from an industrial hygienist and lab analysis, thus the quantitative method, or qualitatively, by taking information from other studies where same or similar workplaces have been measured. Dr. Harrison highlights the many differences between an occupational medicine approach to exposure and that of a toxicologist: it is very difficult to recreate an exposure in a lab setting, it is risky to re-expose a person and animal studies are not necessarily helpful for respiratory issues because they breathe differently and do not report the same symptoms as humans do.

[74] Furthermore, it is common in occupational medicine not to have all the data due to no collection of the air when the exposure happened. A significant fact in these cases is that exposure to chemicals happened during abnormal flight conditions: mechanical failures. Therefore, the measurements in major studies of aircraft air quality which Dr. Pleus uses in his expertise are not helpful. Dr. Harrison notes also that a lack of exposure under normal conditions does not imply a lack of exposure in failure.

c) *Assuming there was an exposure, what is the intrinsic toxicology of the chemical?*

[75] The appellants submit that the ability of toxicology to predict what levels of chemical exposures will result in health effects is limited since it examines the mechanism of injury at the cell level. According to Dr. Harrison, while it is true in general that “dose makes the poison”, there are examples in toxicology and epidemiology where small exposures result in a health effect, for example with respect to carcinogens. Dose and response is usually considered on a dose/response curve. However there is variability within that curve and variability within an individual based on individual response. Dr. Harrison noted that variability of response is greater when doses are low. At higher doses, the entire population would suffer. With respect to threshold limit values (TLV), Dr. Harrison suggests that they may not be sufficiently protective because most TLVs are not set to

prevent all adverse health conditions. Many chemicals do not have TLVs and they do not take into account mixtures of chemicals and their additive and synergistic effect. Namely, mixtures have multiplied risk of exposure.

d) *Biological plausibility, i.e. is the link between exposure and outcome what we would expect to occur?*

[76] According to Dr. Harrison, where there is not a lot of data available, physicians reason by analogy to chemicals within the same class where data exists. Since chemicals with similar structures have similar properties, the intrinsic toxicology of one compound can provide some predictability regarding what would happen if similar chemicals get into the human body. It would also be useful to compare symptoms as they may vary between insects and humans. Organophosphates are used as pesticides because of their toxic effect on the nervous system of insects; so it was expected that humans exposed to them might have similar effects. In fact, studies of workers populations showed organophosphate insecticide had effects on long nerves. This sort of reasoning is fundamental to occupational medicine.

e) *Differential Diagnosis: can other factors be ruled out?*

[77] The appellants submit that differential diagnosis is an important tool in occupational medicine, since the methodology is designed to deal with incomplete data. It allows unlikely explanations to be ruled out. In looking at flight attendants exposed to bleed air events, Dr. Harrison considered those and other possibilities including jet exhaust, de-icing fluid, kitchen, food smells, malfunctioning galley equipment, bathroom sewage, inadequate ventilation, shift work issues, infectious sources and psychosomatic explanations.

f) *Professional and Medical Experience: evaluation of the case in the context of the physician's experience in diagnosing and treating patients, and collecting and analyzing data.*

[78] Dr. Harrison explained that in occupational medicine, there are many examples of sentinel cases where the first critical lead connecting toxic effects is made by a clinician. Surveillance and monitoring of common exposures is at the core of occupational medicine programs. This relies on employees making reports and physicians taking appropriate histories and making diagnoses. The appellants submit that it is evident from Dr. Harrison's testimony that occupational medicine requires the examination of a large number of factors which are not addressed by toxicology. Furthermore, Dr. Harrison, who is himself qualified as an expert in toxicology, was able to comment on the appropriate application of toxicology in the context of an occupational medicine approach to the present cases.

[79] The appellants submit that a significant component of the methodology in this case was Dr. Harrison's clinical experience with flight attendants who experienced fume events. Partly based on that experience, Dr. Harrison was aware

of the connection between the events and neurological symptoms. Of the patients that Dr. Harrison examined, all flight attendants had experienced a similar event where the APU or engine seals were leaking and there were flight attendant reports of odours. The patients had a range of symptoms, from mild to severe. The flight attendants were given objective testing. Based on the cluster, Dr. Harrison estimated the number of exposure events in a year. He estimated that based on fume events occurring on one in every 3,000 to 5,000 flights, fume events would affect several thousand flight attendants per year.

[80] Dr. Harrison addressed the possibility of bias on his part and that of the patients he had treated but determined that it was not significant. He strongly held the conclusion that, given the circumstances of these work refusals, he had a reasonable expectation that injury or illness would occur. He concluded that the odour was a warning sign that a toxic air contaminant was present in the aircraft cabin which was likely the result of engine oil and/or volatile hydrocarbons entering the ventilation system. In response to questions from the Tribunal, Dr. Harrison stated he believed that there was more than a 50% probability that there was a chemical contaminant in the present cases.

[81] The appellants point out that Air Canada has accepted that a danger is a reasonable conclusion in cases dealing with flight attendant exposure to fume events. Furthermore, Air Canada accepts most of the evidence on which the appellants rely. As for the expert evidence of Dr. Pleus, on which Air Canada relies, the appellants submit his evidence is largely irrelevant to the case since he looked at only one type of compound in oil, TCP and its isomer TOCP. He largely ignored pyrolysis products. In this respect, the appellants submit that there is no need to weigh expert opinion evidence as the only opinion evidence from the experts that is admissible is that within their expertise. The only common area of expertise in the present case is toxicology; however according to the appellants, there is no disagreement over toxicological principles, only over its relevance in the present appeals. The medical expert evidence of Dr. Harrison and the evidence on exposure science of Dr. Weisel is unchallenged by any person qualified to give an opinion.

[82] The appellants qualify Dr. Pleus's expertise as being a lay opinion since Dr. Pleus is a consultant as opposed to an academic and lacks the hands-on experience with airline fume events that Dr. Weisel and Dr. Harrison have. The appellants also submit that he showed a willingness to give opinions outside his field of expertise. These lay opinions provide good examples of why expert opinion has to be limited to the expert's field of expertise because Dr. Pleus's lay opinions were generally wrong. Specifically, Dr. Pleus testified that smells are a normal condition of employment, contrary to the jurisprudence on this subject, namely *Rehab Rivers* v. *Air Canada,* 2010 OHSTC 11. It is also contrary to the evidence in the agreed statements of fact and documents that the smells were unusual and are used for diagnosing mechanical failures. According to the appellants, he also interpreted illness as excluding medical conditions that were not permanent. The appellants believe it would be difficult to find a medical expert that would agree with Dr.

Pleus's assertion. Given that Air Canada did not lead any medical evidence, their medical theories are unsubstantiated. The appellants claim that the respondent apparently intends to rely on medical theories it is creating while avoiding any relevant medical commentary on them.

[83] Furthermore, the appellants point out that in cross examination, Dr. Pleus agreed to the limits of his expertise and the importance of other methodology. Dr. Harrison, who is a toxicologist as well as a medical expert, testified that Dr. Pleus's approach was limited because he claimed there is no scientific evidence to support a claim of damage to the respiratory tract and nervous system without specifying doses to specific chemicals. However the appellants submits that it is well known that chemicals cause problems and that flight attendants have the same problems as reported from physicians and this provides the basis for a conclusion of a causal relationship independent of dose. Dr. Pleus is biased by his field of expertise to see only the intrinsic toxicology of chemicals.

[84] Also, the appellants believe that animal studies such as the hen study relied upon by Pleus are irrelevant because the health effects of concern affect the central nervous system (not long nerves) and respiratory tract but cannot measure symptoms such as headache, dizziness, or inability to concentrate in subject animals. A risk assessment cannot be performed in isolation from its purpose. Furthermore, randomized control trials are done for the purpose of drug testing. They are never done in occupational medicine because they require exposing a group of employees to potentially harmful chemicals.

[85] The appellants submit that the main problem with Dr. Pleus's evidence is that it is irrelevant to these cases because he did not look at the actual exposures. In cross-examination Dr. Pleus testified that to his understanding none of the references he relied on were studies where people reported odours similar to the ones reported in the circumstances of these work refusals. As a result he did not have data on aircraft with conditions like the ones at issue in the present cases. He failed to consider pyrolysis products of jet oil (except carbon monoxide), although when cross-examined, he accepted that the base components that make up over 90% of jet oil are hydrocarbons which, when pyrolyzed, can produce harmful compounds apart from carbon monoxide. Dr. Pleus also looked at extreme health outcomes (LD50) which are not useful for studying the exposures at issue. The appellants retain Dr. Weisel statement that the death of half the population or instant death are not useful outcome measures. The appellants submit that Dr. Pleus limited his risk analysis to only certain compounds considered individually instead of considering the risk of a mixture of compounds, resulting in an inaccurate conclusion.

[86] Relying on *Verville* v. *Canada* (Service correctionnel), 2004 FC 767, the appellants assert that danger includes circumstances where illness or injury does not occur every time. The test has been repeatedly adopted and approved by appeals officers. Furthermore the appellants add that the Federal Court has reiterated that it is not necessary to establish the precise time when the hazard will occur or that it

occurs every time (*Canada Post Corporation* v. *Pollard*, 2008 FCA 305). The facts of the cases under appeal are consistent with the expert evidence of Dr. Harrison and Dr. Weisel regarding these types of exposures: they have resulted in illness before and they can reasonably be expected to result in illness again.

[87] The appellants rely on *Rivers* which stated that illness or injury includes constellations of symptoms and medical conditions which are not chronic or severe. Furthermore, the appellants note that in *Tracey Rathwell* v. *Air Canada*, 2011 OHSTC 15, the appeals officer held that "the Code does not require that the possible injury be severe in order for it to be considered a danger […] there are no requirements of severity enacted in the definition of danger.". Given its preventative purpose, the Code simply requires that the "injuries… were not inconsequential, have already occurred and there is a reasonable possibility that it will happen again".

[88] The appellants submit that in this case, the potential illness or injury resulting from the exposures, according to the expert medical evidence, ranged from relatively mild neurological and respiratory tract symptoms that could result in little or no lost time to extremely severe chronic conditions preventing flight attendants from returning to work at all. The appellants further submit that it is not necessary that the exact nature of a hazardous substance be completely known. In support of this assertion the appellants rely on *Boone* v. *Air Canada*, 2010 OHSTC 005 and *Rivers*. The appellants posit therefore that the un-contradicted expert evidence is that flight attendants exposed to bleed air contamination will probably be exposed to classes of chemicals from jet oil and pyrolyzed jet oil that are known to produce adverse health effects. This is more than sufficient to find that bleed air contamination of cabin air is a hazard for the purpose of the definition of "danger" in the Code.

[89] The appellants also raise an evidentiary issue, namely that opinion evidence is of no weight unless it is within a qualified expert's field of expertise. In support of this, the appellants cite *R.* v. *Marquard* [1993] *4 SCR 223*. The appellants submit that it is an error in law to permit an expert qualified in non-medical subjects to give opinion evidence on medical issues. Furthermore, if no foundation has been laid for expertise in a particular area, it is an error of law to have regard to an expert's opinion in that area. In support of these assertions the appellant relied on *Vigoren* v. *Nystuen*, 2006 SKCA 47 and *R.* v. *Selles*, 34 OR (3d) 332.

[90] The appellants therefore ask that the recommendations of Dr. Harrison and Dr. Weisel be adopted and reiterate their remedial requests to wit, that the no danger decisions be rescinded, that findings of danger be made and that directions be issued pursuant to subsections 145(2) and (2.1) of the Code directing Air Canada to:

a) Discontinue the use of the specific aircraft at issue until the source of cabin air contamination has been determined and corrected;

b) Cease and desist from dispatching aircraft where there are known or suspected oil and or hydraulic fluid leaks into cabin air supply;
c) With respect to OHSTC No. 2012-22 (Blaize), cease and desist from dispatching aircraft where there are air packs that are not functioning; and
d) Such further relief and remedies that the Appeals Officer deems appropriate.

B) Respondent's submissions

[91] Respondent Air Canada tendered Dr. Richard Carl Pleus, Ph.D. as its expert. The latter is a toxicologist and pharmacologist who has project experience with air and exposure to chemicals by humans as well as health risks to workers resulting from acute exposures. He holds a Ph.D. in environmental toxicology from the University of Minnesota, Department of Public Health, has conducted toxicological assessments for human exposure to chemicals in the workplace and other environments. He has written and co-authored numerous peer-reviewed articles on toxicology issues and contributed chapters to books on the subject. Dr. Pleus is founder and managing director of Intertox Inc., a Seattle-based company that provides toxicology research and consulting services to a plethora of clients, including U.S., state and government agencies, foreign governments, non-profit organizations and private companies. Dr. Pleus was tendered and recognized as expert in toxicology.

[92] In a Summary introduction to his report, Dr. Pleus states that he has been asked to determine whether there is (was) an unacceptable level of health risk to the employees who exercised their right to refuse to work on the Air Canada flights involved in the present cases as well as in the cases concerned by the parallel decision previously mentioned, due to possible exposures to jet engine oil (Mobil Jet Oil II), hydraulic fluid (Skydrol LD4), or the components of these. He formulates at the outset the conclusion that there is (was) no unacceptable level of health risk to these employees. He describes toxicology as the scientific study of the adverse effects that human made, natural and endogenous compounds have on living organisms. As part of the toxicological assessment, he reviewed technical reports, medical records, sampling results and other documents describing the nature and timing of the so-called fume event(s) involved in these cases and he has formed the opinion that the objective information relative to the said cases does not support a conclusion of danger due to acute exposures to the chemicals in engine oil (Mobil Jet Oil II) or hydraulic fluid (Skydrol 4).

[93] Based on fundamental toxicological principle, an exposure threshold for toxicological effects exists for most chemical agents. Before harm can result from an exposure to an agent, exposure must be of sufficient concentration and duration to produce the necessary internal dose that exceeds that threshold. Furthermore, the potential for adverse health effects is highly dependent on the exposure scenario, what happens to the chemical in the body and whether the individual is more sensitive than average. Dr. Pleus asserts that in order to fully characterize the potential hazard of an agent, one must not only know what type of effect it

produces and the dose required to produce that effect but also be informed about the agent, the exposure and the disposition by the subjects. The major factors that influence toxicity as it relates to the exposure situation for a specific chemical are the route of administration and the duration or frequency of exposure.

[94] The mere presence of a chemical in the environment or an exposure medium does not mean that adverse toxicological effects will occur. According to Dr. Pleus, it is scientifically invalid to classify chemical agents as either toxic or non-toxic. Whether a toxic effect occurs is dependent on the chemical and physical properties of the agent, the exposure situation, how the agent is metabolized by the system, and the overall susceptibility of the biological system or subject. Stated differently, in order for harm to result from an exposure, that exposure must be of sufficient concentration and duration to exceed the chemical's dose-response threshold for some adverse effect, and this is true for the chemicals assessed in Dr. Pleus' report. Thus, even for chemicals labelled as toxic, exposures must be above this threshold level for the possibility of any adverse effect to exist, and for exposure(s) to a chemical agent to occur, there must be a pathway of exposure from the source of the chemical to the exposed individual.

[95] As concerns the aircraft concerned in these cases, several independent hydraulic systems are located throughout the aircraft. For exposure to hydraulic fluid to occur, there must be a leak or spill from one of these systems at or near locations where the fluid could reach the cabin. Some examples include leaks that occur near air conditioning units or near APU intakes. If hydraulic fluid is drawn into the air conditioning units or APUs, then the eventual concentration is dependent upon many parameters that include temperature changes, the design of the ventilation systems and filter efficiency.

[96] The aircraft ventilation system operates throughout the flight to control cabin temperature and pressure and air is distributed through the cabin. Thus, if chemicals enter the ventilation system of the aircraft, they will as a result distribute throughout the passenger cabin, and all cabin attendants, pilots and passengers would be exposed. High efficiency particulate air filters (HEPA) are used in Airbus A319s or A320s (the aircraft involved in these cases) to remove concentrations of chemicals. The filtration process is done by interception, impaction and diffusion and can remove particles, bacteria, viruses, mist, dust and aerosols. Cabin air is also vented constantly from the cabin back into the environment and replaced by incoming air. According to the literature, the most common exposure pathway to engine oil in cabin air occurs when air from the engine compressor is diverted or bled (bleed air) to the cabin through a closed system. Bleed air is used to pressurize and ventilate the cabin air. Once in the cabin, air consists of approximately 28-57% filtered bleed air with the remainder consisting of outdoor air.

[97] Skydrol LD4 and Mobil Jet Oil II were used by Air Canada on the planes in the present cases. Both the hydraulic fluid and the jet engine oil are chemical mixtures. In short, hydraulic fluid is used to lubricate and conduct power in the hydraulic system, which is used to drive essential components of the aircraft and jet

engine oil is used to lubricate, protect and cool engine use. Of all the chemical constituents in these products, the chemicals often alleged to be the cause of adverse health effects are members of a class of chemicals called organophosphates and representing a large class of chemical compounds with great diversity in their toxicological potency due, in part, to different mechanisms of action. Some organophosphates inhibit acetylcholinesterase (AChE) and others do not. Of these, the most frequently recorded organophosphate is an additive to jet engine oil called tricresyl phosphate (TCP), including an isomer of TCP called tri-ortho-cresyl phosphate (TOCP). TCP is listed as a component of Mobil Jet Oil II but not of Skydrol LD4 as per its MSDS.

[98] The primary toxicological (neurotoxic) effect of exposure to TCP is known as organophosphate-induced delayed neuropathy (OPIDN). According to the literature, it is a rare neurodegenerative disorder in humans that is characterized by loss of function and ataxia of distal parts (in the far end) of sensory and motor axons in peripheral nerves and ascending and descending tracts of the spinal cord. The early neurological symptoms are usually sharp, cramp-like pains in the calves, tingling in the feet followed by distal numbness and paresthesia. Pain and weakness in muscles becomes progressive and spreads to flaccid paralysis, motor signs such as weakness and muscular atrophy, ataxia (lack of muscle coordination) and gait abnormalities and sensory deficits.

[99] According to Dr. Pleus, it has been reported that in some cases, ingestion of preparations contaminated by TOCP may be followed by gastro-intestinal symptoms (nausea, vomiting and diarrhea). In contrast to those organophosphates that cause OPIDN, organophosphates that affect AChE can cause other syndromes like acute cholinergic syndrome, intermediate syndrome and chronic organophosphate induced neuropsychiatric disorder (COPIND). Plasma and red blood cell AChE activity is used to monitor exposure to these organophosphates. COPIND is reported in some farm workers with chronic low-level exposure to organophosphate pesticides, not TCP. Common symptoms are impairment in memory, concentration and learning, anxiety, depression, psychotic symptoms, chronic fatigue, peripheral neuropathy, autonomic dysfunction and others.

[100] On the toxicity of Skydrol LD4 and its components, Dr. Pleus notes that its main constituents are TBP (Tributyl Phosphate), DBPP (Dibutyl Phenyl Phosphate). He reports that toxicity data from Skydrol suggests low acute toxicity via the oral, dermal and inhalation routes. The lethal concentration or dose (lethality) on test animals (LD50) was used as end point to compare the relative potency of chemical agents following acute exposure and the data has shown that the acute toxicity of Skydrol LD4 on humans would be classified as “slightly toxic” for acute exposure via ingestion and “practically non-toxic” for acute exposure via the dermal route.

[101] Dr. Pleus relied on testing on rabbits that resulted in rabbit eyes being slightly irritated by Skydrol LD4 and skin moderately irritated following direct application to tissue for a 24hour exposure. Where human volunteers were involved

in testing via patch application, no dermal sensitization was reported. Similar testing conducted in rats over a period of 28 days caused respiratory irritation as well as reduced body weight and increased organ weights were also observed at higher doses exposure. Of the constituents of Skydrol LD4, TBP is a non-flammable, non-explosive, colorless and odourless liquid used as a solvent, a primary plasticizer, metal extractant and as an antifoaming agent. In animals, it is irritating to both skin and eyes with no dermal sensitization, and on humans, it has an irritant effect on the skin and mucous membranes as well as on the human eye and respiratory tract.

[102] According to Dr. Pleus, based on data obtained through research on rats, TBP would be classified as moderately to lightly toxic for acute exposure via ingestion, moderately toxic for acute exposure via inhalation and practically non-toxic for acute exposure via the dermal route. He notes that no case of OPIDN caused by TBP has been reported in humans, and studies conducted on hens has shown that TBP does not cause OPIDN at less than lethal doses. Similar studies of TBP conducted on rats have also revealed that the potential for any type of neurological effects is very low, even when very high levels of the chemical are administered daily for prolonged periods. Very large doses are required to produce cholinergic symptoms and when the dosages applied to rats are proportionately calculated for humans, they would need to ingest 1/10 of a liter. Workers exposed to 15mg/m3 in air have complained of nausea and headaches.

[103] A comprehensive study of the toxicity of TPP, which is another chemical found in some hydraulic fluids, including Skydrol LD4, has shown that workers regularly exposed to airborne TPP vapour, mist or dust for an average of 7.4 years suffered no increase in any type of symptoms including neurological, neuropsychiatric, dermatitis and respiratory irritation, even though they were under particularly close medical observation. It is noted that the TPP TLV was set at 0.2 ppm, with the same being assigned to TBP, representing concentrations "considerably less than the concentrations reportedly associated with worker complaints of nausea and headache.

[104] According to the American Conference of Governmental Industrial Hygienists (ACGIH), "this value is intended to minimize the potential for headache, nausea and irritation of the eyes, skin, mucous membranes and upper respiratory tract. It should also provide a wide margin of protection from narcosis and cholinergic effects". Another component of Skydrol LD4, DBPP (Dibutyl Phenyl Phosphate) is a clear, slightly yellow liquid with an odour similar to butanol. Based on the data obtained from research on rats and rabbits, DBPP would be classified as "slightly toxic" for acute exposure via ingestion, and "practically non-toxic" for acute exposure via the dermal route.

[105] The MSDS for Skydrol LD4 indicates that DBPP is practically non-irritating to the eyes and skin of rabbits but ACGIH states that it can injure the eyes and is irritating to the skin and upper respiratory tract in humans and contact with the eyes has caused marked pain. Repeated dermal contact has caused drying and

cracking of exposed skin and exposure to aerosolized or vaporized DBPP has caused nose and throat irritation accompanied by coughing and wheezing. However, based on the results of patch tests on human volunteers, it is not considered a primary irritant or a sensitizing agent in humans. Dr. Pleus reports also concerning BDPP (Butyl Diphenyl Phosphate) that the MSDS for Skydrol LD4 lists no toxicity information and that he has found no toxicological data in separate literature review.

[106] On the toxicity of Mobil Jet Oil II, Dr. Pleus notes that it contains between 1-3% TCP. Other component chemicals listed on the MSDS are alkylated diphenyl amines at <2% and n-phenyl-l-naphthylamine (PAN) at 1%. PAN is a potential skin sensitizer in its undiluted form. However, human testing of 1% PAN resulted in no reactions or sensitization. Research on hens at a repeated dose exposure of 1000mg/kg for five days per week for 13 weeks has shown no alterations indicative of OPIDN. Such a dose in hens would be equivalent to a 70 kg adult ingesting a dose of 70,000mg of jet engine oil per day for 13 weeks.

[107] The MSDS for Mobil Jet Oil II does report however that decomposition products can be harmful. Those are listed as carbon monoxide, phosphorous oxides, aldehydes, smoke, fume and incomplete combustion products. At elevated temperature and under fire conditions, the oil may decompose and give off irritating and/or harmful gases, vapours or fumes. The possible symptoms from acute exposure to these decomposition products in a confined space may include headache, nausea, eye, nose and throat irritation. TCP, or Tricresyl Phosphate, is a synthetic heterogeneous oily mixture historically added to some jet engine oils and hydraulic fluids to provide high temperature, anti-wear properties. Since the anti-wear properties of TCP are unique to this class of compounds, complete replacement in jet engine oils by other additives is not presently possible for many applications.

[108] The term “TCP” refers to a complex mixture of aryl phosphate congeners comprised of ortho-, meta-, and para-isomers. In production, the isometric composition of the final “TCP” product depends on the composition of the original reactant mixture and processing conditions. The isometric composition is important, since the neurotoxicity potential of a particular brand of TCP depends largely on the concentration of ortho-configured components in the mixture. A molecule of TCP may thus be ortho-configured on one (mono), two (di) or three (tri) cresyl groups. TCP is found in many products that people have used and been exposed to for over 50 years. It is used as a plasticizer, flame retardant, waterproofer, lead scavenger in leaded gasoline, and solvent. Given its common uses, it is reasonable to assume that a large population has been exposed to TCP at one time or another, albeit at very low levels.

[109] Dr. Pleus notes that toxicity data for TCP suggests low acute toxicity (lethality) via the oral and dermal routes. It would be classified as “slightly toxic” for acute exposure via ingestion and practically “non-toxic” for acute exposure via the dermal route. The report indicates that no published data on skin or eye

irritation were found. In the absence of human data, data from research using mature hens and cats are considered the most useful in determining the OPIDN-producing potential of organophosphates. Both types of research express OPIDN by signs very similar to those of humans. By way of example, in the hen, OPIDN is characterized by leg weakness, then severe paralysis and degeneration in the spinal cord and peripheral nerves. Studies of TCP and TCP isomers in the hen demonstrate that exposure thresholds exist below which development of OPIDN does not occur. In general, the dose required to cause OPIDN is lower for ortho-containing isomers of TCP than other isomers. Various studies of ingestion of jet engine oil by hens with varying concentrations of TCP and TOCP have shown that the minimum dose of jet engine oil that caused OPIDN in hens was 2,000 mg oil/kg-d for repeated oral dosing five days per week for 10 weeks, this being the equivalent to a 70kg human ingesting a dose of 140,000mg (1/2 cup) of oil per day, 5 days per week for 10 weeks. At 1% TCP concentration with a dose of 1000mg/kg over 13 weeks at 5 days per week, which would transpose into human ingestion of 70,000mg (1/4 cup) over the same period, hens showed no sign of neurotoxicity. Other repeated dose exposures done with hens equating to human ingestion ranging from 1/4 to 11/2 cup of oil did not result in OPIDN, causing Dr. Pleus to conclude that it is clear that substantial doses of oil containing TCP are required to cause OPIDN.

[110] Dr. Pleus however notes that a number of incidents have historically (mostly in the 1930s through the 1950s) occurred in which exposure of humans to TCP through accidental or intentional ingestion has caused OPIDN. These incidents were associated with high doses of TCP mixtures showing a high concentration of ortho-configured components. Today, the toxicity of TCP mixtures is much lower because manufacturers have made an effort to reduce the concentrations of ortho-cresyl phosphate constituents in TCP, which are considered to be primarily responsible for the ability of TCP to induce OPIDN. Potencies of TCP formulations in terms of ability of the product to induce OPIDN are up to 100 times lower than earlier formulations. Furthermore, of the possible ortho-isomers, the report by Dr. Pleus notes that it has been reported that unsymmetrical mono-ortho (MOCP) and di-ortho (DOCP) isomers are more toxic than the symmetrical tri-ortho (TOCP) isomer, although some research findings suggest that MOCP may be the least toxic of the three isomers.

[111] On the regulatory aspects of occupational exposures, Dr. Pleus notes that governmental agencies or non –government entities develop occupational exposure levels (OEL) to protect workers. Such exposure limits are recommended by bodies such as the American Conference of Governmental Hygienists (ACGIH) and the National Institute for Occupational Safety and Health (NIOSH) or legislated by federal, provincial and territorial agencies responsible for occupational safety and health. He points out that in Canada, OELs are regulated on a provincial level whilst airlines are not subject to provincial health regulations. While the exact definition of an OEL may vary depending on the developing agency, Dr. Pleus notes that an OEL is typically based on repeated exposures to a particular chemical for 8 hours a day, 5 days per week for many years of employment, and that OELs

applied in Canada include ACGIH TLVs. In the case of a single exposure, other OELs have been developed, such as NIOSH's Immediately Dangerous to Life or Health (IDLH) values. Such single episode values reflect exposure levels that can cause significant adverse effects after a short duration exposure, such as 15 or 20 minutes. Given the shorter duration of exposure, reaching a short term exposure limit or IDLH would require exposure to a much higher concentration of the chemical.

[112] From the standpoint of chemical exposure assessment, the Pleus report states that exposure evaluation consists of assessing the pathways and the possible magnitudes of exposure to a chemical agent. In the case of the present appeals as well as in that of the parallel appeals by Air Canada relative to the directions issued to it, the reports from the employees as well as from Air Canada are said by Dr. Pleus to provide information that was used to characterize the possible exposures to Skydrol LD4 or Mobil Jet oil II, including information on the source, magnitude and duration of possible exposure. For the purpose of his assessment, Dr. Pleus makes the assumption that the employees could be exposed to the chemical constituent in hydraulic fluid and jet engine oil for eight hours. It must then be determined if the chemical exposure is sufficient such that it will meet or exceed the threshold for adverse effect. From a toxicological perspective, for a chemical agent to cause long-term (chronic) adverse health effects following an exposure of short duration, the agent will generally need to be highly potent and found at sufficient concentrations for sufficient time, i.e. at concentrations much higher than the TLV.

[113] A further component to be considered in such assessment is the aircraft cabin air ventilation system. More on point, in the Airbus A319 and A320, air is brought into the air conditioning unit which is located underneath the passenger cabin near the wings, as per a schematic of the ventilation system of the Airbus A319/320 obtained from a training manual on the A319 air conditioning system. Because the ventilation system runs the length of the passenger cabin, the assumption is that if one person were to be exposed to sufficient quantities of a chemical to cause adverse effects, others would be expected to have been as well. Further, there are great quantities of air that are circulated in the cabin of the aircraft. In the Airbus A319, approximately 28% to 49% of the air is recirculated depending on how many air conditioning packs are used and the conditions of their use. In the case of the Airbus A320, approximately 37% to 57% of the air is recirculated, again depending on the number and conditions of use of the air packs. Dr. Pleus quotes from the Airbus A319/320 Technical Training Manual as follows:

> Bleed air coming from the pneumatic system is controlled in flow before reaching two air conditioning packs which ensure basic temperature regulation. Air delivered by the packs is mixed with recirculated air from the cabin zones. Fine temperature adjustment of air distributed in the pressurized zones is obtained by controlling the amount of hot air added to the air coming from the mixer unit. Correct pressurization is obtained by controlling the

> conditioned air discharge through one outflow valve. (…). As the cabin air gets recirculated, it passes through HEPA cabin recirculation filters.

[114] Using diagrams of the Airbus A319/320 bleed air and air conditioning systems, of the APU and of the fuselage showing the position of the distribution air ducts and recirculation filters, Dr. Pleus states that once a chemical has entered the cabin air, it is further diluted compared to its concentration in bleed air, something akin to adding a drop of food colouring into a pool of water. Thus, anytime dilution occurs, this decreases the concentration of any particular chemical in the air to which a passenger or flight crew could be exposed.

[115] In the assessment of exposure and duration, the report states that from a scientific approach, for there to be a reasonable expectation of injury or illness due to a chemical exposure, there must be exposure to a sufficient dose of that chemical. Since no air concentrations were measured during any of the reported odour events, detection of odour or a visible smoke/mist can be used to estimate what doses might have occurred. Noting that a visible mist of jet engine oil or hydraulic fluid would signify a higher concentration of dispersed aerosol compared to an odour, the report indicates that the documents reviewed concerning the involved flights do not confirm that any vapours or mists actually entered the cabin air during any of the flights involved in the present or the parallel cases. Dr. Pleus' calculations indicate that exposure levels of oil in air sufficient to bring about OPIDN, which constitutes the endpoint of TCP, would produce a visible haze that would have been noticeable by passengers and cabin crew. Referring to the HSO reports in all these cases, he notes that they provide no evidence that any of the employees were exposed or would have been exposed to hazardous substances in amounts that would be likely to result in a chronic illness or disease.

[116] Dr. Pleus further notes that reports of air concentrations of TCP measured in commercial aircraft are very low and that TCP is found in many consumer products in low concentrations, thus making determination of the source potentially challenging. The expected concentrations of TCP and its isomers, based on concentrations measured at different times of aircraft operations, are expected to be exceedingly small. Several studies have measured contaminant levels of hydraulic fluid and its associated constituents in commercial aircraft, TBP and engine oil and TCP in cabin air. In one study (Muir)[4], concentrations of airborne contaminants were measured in a medium-sized aircraft manufactured in the UK (BAe 146). Four different scenarios were used: hangar background, aircraft background, APU on and one scenario with a chemical release. In all scenarios, levels of hydraulic fluid and TBP were consistent within the aircraft at 0.002 to 0.003 mg/m3 and 0.023 to 0.042 mg/m3. TBP is also found in plastics and the components of hydraulic fluid have different volatilities, which may explain the higher concentration of TBP compared to hydraulic fluid.

[4] Muir, H., C. Walton, et al., 2008 *Cabin Air Sampling Study Functionality Test*.

[117] Regarding TCP and engine oil, the same study (Muir) reports that when the APU was running, engine oil was found at consistent concentrations of 0.011 to 0.014 mg/m3 and TCP concentrations were 0.0006 to 0.0013 mg/m3. In a different aircraft (Boeing 757), an unplanned bleed air contamination event during ascent when testing to measure cabin air contaminants showed the highest levels of TCP contamination at concentrations of 0.005 to 0.00004mg/m3. The instantaneous values might have been ten-fold higher as the sampling was taken over a short period of time. In another report (Waters), trace levels of TBP were found in cabin air, but no quantitative levels were given and the number of flights and the type of aircraft were not reported. Some studies where analysis for TCP in cabin air and bleed air involving different types of commercial aircraft was conducted yielded no detections. Another study (Crump) where cabin air was measured on 100 flights involving 5 different makes of aircraft yielded maximum measured levels of TOCP at 0.0228mg/m3, TCP at 0.0377 mg/m3 and TBP at 0.0218mg/m3 with arithmetic means levels being considerably lower.

[118] Dr. Pleus thus notes that from a toxicological perspective, the lowest OELs for TCP and TBP being 0.1 mg/m3 and 2.2 mg/m3, these represent permissible work place exposure levels that would be unlikely to cause harm if a worker were exposed for an 8 hour day, 5 days per week for many years of employment. In addition, the exposure to chemical agents that enter the cabin will be diluted, distributed throughout and of short durations. A considerable amount of air is introduced into the cabin compartment during flight and thus, there will be constant dilution and short duration of any chemical agent exposure. Dr. Pleus adds that air enters the cabin environment along the length of the aircraft which not only causes dilution but also no particular area where increased concentrations are expected. He finally points out that even if the HSO has determined that a danger existed in two other cases, a finding he opines unlikely based on the definition of "danger" in the Code and his own assessment; odours are not uncommon in the aviation industry and could be classified as normal conditions of employment.

[119] This being said, regarding the potential for chronic health effects from chemicals in jet engine oil and hydraulic fluid, Dr. Pleus bases his evaluation on a number of assumptions to wit, that an odour was present in these instances, that some fumes that may be detected on an aircraft can contain, for example, chemicals such as aldehydes or carboxylic acids that are capable of causing short-term and temporary effects, including irritation of the throat, nose and eyes, changes in breathing rate and pattern, as well as nausea to the point of vomiting, for some. He further assumes that if an exposure occurred, each employee's potential exposure was short-term (acute) in duration and, given the lack of reported vapour or mist, that any exposures, if they occurred, were of low concentration, with the triggering events, for nearly all employees being foul odours.

[120] Given this, Dr. Pleus further notes that the employees who have reported an odour have not reported any health effect that would be consistent with the known mechanism of action of the chemicals assessed, and also that exposures would not be of sufficient air concentrations and durations to cause adverse effects due to the

said chemicals. According to the report, none of the employees involved in these refusals appear to be a member of a "sensitive population", such as pregnant women, children, sufferers from a chronic illness or the elderly, and thus more sensitive to chemical exposure than the average person. Given the possible duration of exposure, which he assumes at eight hours although actual exposures would have likely been much shorter, Dr. Pleus expresses the opinion that the potential dose would be insufficient to be considered, using the words of the Code, "exposure to a hazardous substance that is likely to result in chronic illness, in disease or in damage to the reproductive system".

[121] Regarding the foul odours per se, two alternative explanations for the employee reactions to the incidents are formulated. The first is physiological response to foul odours. According to Dr. Pleus, odours are sensations that occur when a chemical interacts with receptors in the nasal cavity, the mouth, the pharynx and other locations. The degree of negative perception of foul odours is characterized individually by the perceived intensity and acceptability of the odour. In addition, foul odours can directly stimulate sensory neurons, producing an irritation, but not a pathological effect. Further, detection of odour is not necessarily a reliable indicator of toxicity potential. For a number of chemicals, odours can be detected at concentrations that are lower than levels associated with toxicity. There can be an array of symptoms in response to the detection of foul odours. However, these responses are not adverse effects per se. The more unpleasant an odour, the stronger the negative reaction and the greater the likely perception of adverse health effects associated with the odour.

[122] The second explanation is the phenomenon of psychogenic illness which affects people with real symptoms that are often triggered by misunderstood or false information. These responses are not the result of toxicological effect, but rather a result of anxiety provoked by a triggering event, such as noxious odour. The predominant symptoms of mass psychogenic illness include headache, dizziness, nausea, cough, fatigue, drowsiness or weakness, watery or irritated eyes, inability to concentrate/trouble thinking, vomiting, tingling, numbness and others. In incidences where mass psychogenic illness has been reported, a plausible pathogenic agent or source is not identified.

[123] Given all of the above, Dr. Pleus concludes that there was no unacceptable level of health risk to the Air Canada employees due to exposures to jet engine oil (Mobil Jet Oil II) or hydraulic fluid (Skydrol LD4). Foul odours are not good indicators of health risk as odours do not correlate with toxicity. Thus odours are not reliable indicators of danger in many cases of chemical exposures. While it is possible that some symptoms occur with short term exposure, as indicated by the MSDS of these products, the doses and exposure duration that produced these symptoms in the animal studies that are the basis for these assertions are much greater than the employees would have received. Further, available evidence provides no indication that exposures would be sufficient to cause long term adverse effects. Dr. Pleus' conclusions are based on a reasonable degree of scientific certainty.

[124] Respondent Air Canada submits that the question to be determined in these appeals is whether there is a reasonable expectation that the flight attendants would have been exposed to a danger from the cabin air on the flights they refused to operate. The respondent asserts that the only objective way to answer this question is to follow the science. Following the accepted toxicological principle that the dose makes the poison, the respondent submits that it is the dose to which a person is exposed that determines whether a chemical agent can reasonably be expected to present a health risk. The mere presence of a foul odour is not a good indicator of health risk and odour does not correlate with toxicity.

[125] The respondent reviews the toxicological risk assessment methodology which involves 4 steps: (i) hazard assessment (ii) exposure assessment, (iii) dose-response assessment; and (iv) risk characterization. The respondent submits that Dr. Pleus rigorously followed this methodology and prepared an unbiased and independent report in which he concludes that the dose and exposure duration that the flight attendants in these appeals could reasonably have experienced were insufficient to endanger their health or safety. He holds that opinion with a reasonable degree of scientific certainty.

[126] Contrary to the appellants' submission, the respondent submits that Dr. Pleus's expertise is not irrelevant. In fact, the respondent opines that it is the expert opinions of Dr. Harrison and Dr. Weisel, their evidence and conclusions that present significant problems, as neither has sufficient expertise in toxicology, both base their opinions on limited evidence that is scientifically flawed and largely anecdotal, disregard relevant scientific authorities inconsistent with their views and deviate from the methodology they both claim to normally follow. At best, their evidence may arguably support the possibility of a risk from exposure to the type of transient cabin odours reported by the flight attendants, but it does not establish that the mere presence of the reported odours constituted a "danger" as defined by the Code.

[127] Based on his testimony, Dr. Harrison's toxicology experience appears to be limited to understanding how chemicals circulate, interpreting toxicological studies and teaching a course on liver toxicology as part of the certification process for a specialization in occupational medicine, and thus this should not be considered as sufficient to consider the latter as expert in toxicology, even where the respondent's objection to Dr. Harrison being accepted as such an expert was dismissed by the appeals officer. The respondent submits that contrary to the appellants' assertion, toxicologists endorse and follow a standard toxicological risk assessment which Dr. Pleus did.

[128] By contrast, Dr. Harrison demonstrated that he was unaware of the standard toxicological risk assessment. Furthermore, the respondent believes that Dr. Harrison misapprehended the well-established toxicological principle regarding the exposure threshold for toxicological effects. In essence, the respondent posits that before harm can result from an exposure to a chemical agent, the exposure must be

of sufficient concentration and duration to produce the necessary internal dose that exceeds the exposure threshold. Even for chemicals labeled as toxic, exposures must be above the exposure threshold level for the possibility of any adverse health effects to exist. In response to Dr. Harrison's example of carcinogens causing serious health effects even in small doses, the respondent submits that this does not mean that the exposure threshold principle is only generally true, but rather that it reinforces the very principle that the dose makes the poison (i.e. a small does can make the poison).

[129] The respondent also submits that Dr. Harrison also conflated the concepts of individual sensitivity or subjective response with the presence of toxicological hazard. The respondent submits that the fact that some individuals may have sensitivity or report subjective responses to odours at different levels does not equate to the conclusion that they were exposed to a toxic substance, nor that there was a reasonable expectation of harm. Air Canada submits that in the field of toxicology, the Tribunal should prefer the evidence of Dr. Pleus and give Dr. Harrison's evidence little or no weight. Dr. Harrison's testimony and expert report is based primarily on his experience in evaluating and treating over fifteen years about 50 flight attendants and pilots who had health effects resulting from contaminated bleed air exposure.

[130] During cross-examination, Dr. Harrison conceded that many of the symptoms reported by the individuals in the case series were subjective and, even if they were considered objectively, it would still be insufficient to establish a cause-and-effect relationship between exposure to contaminated bleed air and an outcome, without obtaining and considering, among other things, an individual's complete history, evidence of exposure, and toxicological information about the substance to which the individual was exposed. Dr. Harrison admitted that he did not ask for or review such information in the present cases. Furthermore Dr. Harrison confirmed that the "aertoxic syndrome" is not a recognized illness. Nor do the group of reported symptoms in the case series (headache, dizziness, nausea and memory and concentration problems) form a recognized medical illness and when coupled with precedents, at best the only conclusion is that the medical community is divided on this issue. Furthermore, Dr. Harrison explained that presentation of signs and symptoms is not itself sufficient to determine a cause and effect relationship.

[131] The respondent also submits that while Dr. Harrison developed and endorsed a Guide which sets out the methodology for health care providers when evaluating the potential or actual health effects after exposure to contaminated bleed air, he admitted failing to follow it himself when he evaluated the risk of adverse health effects to the flight attendants in the present appeals, or in preparing his medical opinion. Dr. Harrison conceded that, in reaching his expert medical opinion, he did not obtain or consider occupational history, nor did he obtain past medical history, consider non-occupational factors or conduct a physical examination of the flight attendants. He solely relied on the information provided to him by CUPE to form said medical opinion. Regarding the steps of differential

diagnosis, which entails ruling out other possibilities, the respondent points out that Dr. Harrison did not perform a differential diagnosis or consider the possible relevance of psychogenic illness in forming his opinion.

[132] On psychogenic illness, the respondent explains that it is a constellation of symptoms suggesting organic illness but with no identifiable cause and little or no clinical evidence of disease, which can manifest individually or occur among persons who share beliefs regarding symptoms. These symptoms or responses are not the result of toxicological effects, but rather a result of anxiety provoked by a triggering event, such as a foul odour. The respondent notes that the flight attendants in these appeals reported symptoms that are similar to those reported after outbreaks of psychogenic illness, such as headache, dizziness, nausea, cough, fatigue, drowsiness or weakness, watery or irritated eyes, inability to concentrate/trouble thinking, vomiting, tingling and numbness. Similar symptoms were also reported in the case series described in Dr. Harrison's Guide.

[133] Furthermore the respondent points out that Dr. Weisel confirmed in testimony that he did not consult with a behavioural scientist about possible psychogenic issues arising from exposure to foul odours although stating in cross-examination that "people can perceive themselves as sick and display symptoms for psychological reasons". It is the respondent's opinion that Dr. Harrison's failure to consider the psychogenic effect of foul odours and Dr. Weisel's failure to consult a behavioural scientist about this issue is particularly troubling since in the present cases, there is no objective evidence of exposure or dose.

[134] As for Dr. Weisel, the respondent believes that although he consults with toxicologists on his team, he is not a trained toxicologist and was not qualified or tendered as an expert in toxicology. Therefore, to the extent that he offered an opinion on toxicological concepts or their application to the present appeals, his evidence must be accorded no weight whatsoever. The respondent also identifies other problems with the methodology Dr. Weisel employed in coming to his expert opinion. For example, in his report he concludes that there was a reasonable expectation that the flight attendants would have been dangerously exposed to oil or pyrolysis products on the flights they refused, without preparing any quantitative evaluation of the oil or pyrolysis products that could reasonably be expected to get into the cabin air. Moreover, in cross-examination he admitted that he assumed that an oil leak had occurred in each case, but he made no attempt to measure or calculate the possible exposure, or the dose to which the flight attendants could reasonably have been expected to be exposed. The respondent points out that according to Dr. Pleus, Dr. Weisel's calculations are misleading because it assumes that all pyrolyzed oil reached cabin air, which cannot be ascertained.

[135] In response to Dr. Weisel relying on the study analysing the contaminants on standard and non-standard HEPA filters removed from aircrafts, which he stated showed that 90% of standard and non-standard filters tested in the study had some detectable level of TCP contamination, the respondent notes apparent flaws in the design and methodology of the study to wit, there appears to have been inadequate

designs and controls in place to ensure that the filters were selected, removed, handled, shipped, and stored in a manner that prevented contamination from other sources. The respondent submits that there is not sufficient information to determine whether manufacturing or design flaws and contamination from extraneous sources may have skewed the results of the study.

[136] The respondent also submits that the HEPA study may not have been entirely blind and thus if that is the case, Dr. Weisel could not rule out the possibility that bias by testers or maintenance workers may have affected the studies. It is the respondent's position that although conducting a quantitative evaluation and exposure to contaminants is within Dr. Weisel's expertise as an exposure scientist, Dr. Weisel made no attempt to estimate the dose of TCP that would have been required to result in the amount of TCP measured on the filters. The respondent posits that there is no way of knowing whether the TCP deposit on any of the filters could have accumulated after many low-level releases. The respondent therefore believes that it provides no insight into the exposure to or dosage of TCP that may have occurred during any single flight and that very little weight should be given to that study.

[137] In response to Dr. Weisel's conclusion that the odours in the aircraft were toxic based on the Harrison's Guide case series and a study from Australia, the respondent submits that this conclusion is speculative or at best a mere possibility. The respondent submits that odour is not a reliable indicator of a toxicity and also that a number of chemicals produce odours at concentrations lower than levels associated with toxicity or harm. The respondent believed that Dr. Harrison's case series cannot be treated as controlled peer-reviewed scientific study. Air Canada submits that the absence of a traditional peer review to ensure the quality and credibility of information should be weighed against the health care provider guide and the information it contains.

[138] The respondent submits that the CUPE experts unreasonably disregard numerous relevant scientific authorities that are inconsistent with their personal views. For example, Dr. Harrison disregarded the TLV of chemicals set by the American Conference of governmental Industrial Hygenists (ACGIH) because many chemicals do not have TLVs and they are not set to prevent adverse health effects but to prevent symptoms, a conclusion inconsistent with the purpose of TLVs. On the contrary, the respondent submits that the scientific opinion is that exposure at or below the TLV level does not create an unreasonable risk of disease or injury. Dr. Weisel admitted discounting several scientific authorities and studies examining cabin air quality and the odours and compounds at issue, and even the Muir study during which they took measurements during an unplanned bleed air event on a commercial aircraft, because the odour descriptors used were different from the present case.

[139] The respondent points out that even though Dr. Weisel discounts these studies he agreed in cross-examination that descriptions of odours are subjective and may vary from person to person. The respondent also expresses concern that

both experts also dismissed the Schindler study[5], where 332 pilots and cabin crew were tested within 12 hours of exposure and reported that an occupational exposure of air crews to TCP isomers and particularly O-TCP after fume events was not evident". According to the respondent, Dr. Weisel and Dr. Harrison summarily dismiss the UK Science and Technology Report, the Cranfield Study[6], the Schindler Study and other relevant scientific studies that are incompatible with their opinions. The respondent is of the opinion that these are very relevant to forming an expert opinion in the fields of exposure science, occupational medicine and/or toxicology and that there is no reasonable or rational basis for the appellants' experts to dismiss them without due consideration. The respondent also believes that there is a reasonable apprehension that Dr. Harrison may be biased towards workers in general and therefore his evidence and expert opinion is not objective, impartial or uninfluenced. In summary, the respondent submits that the appellants' expert evidence does not establish that the cabin odours presented a danger as defined in the Code.

[140] Air Canada submits that the Tribunal should prefer the evidence of Dr. Pleus over that of Dr. Harrison in the field of toxicology. Unlike Dr. Harrison, Dr. Pleus has a PhD in Environmental Toxicology and a wealth of experience conducting toxicological assessments for human exposure to chemicals in the workplace and other environments.

[141] Dr. Pleus provides independent and rigorous assessments and therefore his expert opinions are unbiased and there is no evidence that he acted "as something of an advocate for Air Canada", as alleged by the appellants. Furthermore he rigorously applied the standard toxicological risk assessment methodology unlike Dr. Harrison and Dr. Weisel. In reaching the conclusion that the dose and exposure duration in these appeals cases were insufficient to endanger the health or safety of the refusing employees, Dr. Pleus assumed that employees were exposed to hydraulic fluid and jet engine oil in the air of the cabin. He assumed that exposure was for eight hours, and that exposure was of low dose concentrations because there were no reports of vapour or mist on the flights.

[142] Dr. Pleus maintained that these assumptions were necessary because there were no air measurements or other objective data collected to support the presence of dose or occurrence of exposure of any kind. The respondent also submits that Dr. Pleus arrived at his opinion by following the standard toxicological risk assessment: (i) hazard assessment (ii) exposure assessment; (iii) dose-response assessment, and (iv) risk characterization. The CUPE experts did not follow this standard scientific approach. In his opinion Dr. Pleus reviewed Skydrol LD 4 and Mobil Jet Oil II and reviewed data for toxicity endpoints and evaluated the toxicity of TCP. The respondent submits that contrary to the statement of the appellants that TCP and

[5] Schindler et al., 2011. Occupational Exposure of air to Tricresyl Phopate isomers and organophosphate flame retardants after fume events.
[6] Institute of Environment and Health (Cranfield Ref No YE29016V), 2011, Aircraft Cabin Air Sampling Study; Part 1 of the Final Report, Cranfield University, Great Britain.

TOCP are not at issue in this case, the Harrison health care provider guide as well as many peer-reviewed articles including the HEPA filter study have tested for these compounds in connection with cabin air quality events. Dr. Pleus maintains that testing on animals is necessary for toxicologists and other scientists to understand the effect of substances on living organisms in order to estimate chemical exposure and dose thresholds with may be harmful to humans. Moreover, as Dr. Pleus stated in his testimony, the animals used in the studies he referenced are as sensitive if not more sensitive than humans to the chemicals being tested.

[143] The respondent believes that Dr. Pleus provided a thorough risk assessment and used assumptions and postulated exposure and dose scenarios from relevant studies, since there was no samples data and other objective evidence collected from the flights and aircraft at issue. Employing these assumptions, Dr. Pleus concludes that hypothetical exposures and dose levels in the present appeals were below the occupational exposure limits, and the published lowest observable adverse effect levels and would be unlikely to cause human health effects.

[144] Dr. Pleus's expert evidence concludes that odour is not a reliable indicator of toxicity potential because, among other things, odours may be detected at concentrations that are lower than levels associated with toxicity. He explained that it is a dose to which a person is exposed that determines whether a chemical agent is hazardous. After reviewing the circumstances of each of the present appeals, he concluded that any doses that the flight attendants who exercised their right to refuse could possibly have received were insufficient to endanger their health or safety. The Cranfield Study and the Schindler Study support his conclusions, and do not support Dr. Harrison and Dr. Weisel's conclusions.

[145] Finally, Air Canada takes the position that there is no objective evidence of danger in connection with Ms. Martinez's work refusal or Mr. LaPorte work refusal, both cases being the object of the parallel appeals and decision mentioned above.

[146] Air Canada submits that, if the mere presence of the transient odours reported by the flight attendants in these appeals presents a danger, which Air Canada denies, then it constitutes a normal condition of employment and does not justify a work refusal.

[147] The respondent requests that the Tribunal not give weight to Dr. Harrison's and Dr. Weisel's opinions about remedial engineering and maintenance measures. As Mr. Supplee confirmed in his testimony, the only practicable approach in such cases is for maintenance personnel to troubleshoot for specific concerns, validate the integrity of the aircraft and rule out any potential engine oil or hydraulic fluid contamination, which is actually the approach that was followed by Air Canada Maintenance when investigating the odours reported in all of the appellants' and Air Canada's appeals.

[148] It is Air Canada's position that no remedial measures are warranted, given that there is no reasonable expectation of danger in the circumstances of these appeals. However, should the Tribunal consider making recommendations with respect to investigating the type of cabin odours that gave rise to the refusals, the respondent requests that consideration be given to the fact that there are no known detection devices that can be effectively used in the aftermath of a fume event to determine potential exposure. The respondent also submits that it has already taken steps to address cabin air quality issues including the type of odours in this appeal.

[149] In this regard, the respondent submits that there is no reasonable basis for the appellants' remedial request that any aircraft with an unserviceable air pack not be dispatched. The respondent refers to the *Rivers* decision previously mentioned where it was accepted that weather and environmental conditions on the ground at departure have a major influence on the cabin environment on any flight with an unserviceable air pack and concluded that symptoms are only likely to occur in an environment that is mainly a hot and humid day. In Ms. Blaize's case, these were not the weather conditions.

[150] Air Canada therefore requests that the undersigned confirm the no danger decisions issued by HSOs Pollock and Blain in all three cases and dismiss the appeals.

C) Reply

[151] The appellants reiterate that Air Canada has not advanced any evidence to suggest that operating with malfunctioning equipment that contaminates cabin air is a normal condition of employment. All of the evidence suggests that these events are rare and of serious concern, triggering maintenance action. The appellants point out the following flaws in Air Canada's arguments:

- Science is not only toxicology, but rather includes medicine and exposure science;
- Air Canada ignores the specific correlation between the odours in these cases with contamination of cabin air by oil and pyrolyzed oil products;
- There are many contaminants produced by pyrolyzation of jet oil and it cannot be assumed that there is only one relevant contaminant: TCP and particularly TOCP.

[152] Contrary to assertions by Air Canada, there are no contradictions between Dr. Harrison's opinion and the expert in the *Rivers* case: in fact, both saw a similar constellation of symptoms resulting from a workplace exposure to constitute an illness. Also, the appellants believe that there is a flaw in Air Canada's assertion that because Dr. Harrison did not consider aero-toxic syndrome to be a recognized illness, that necessarily meant that flight attendants suffering from the same symptoms could not be ill. The appellants also clarify that Air Canada did not ask Dr. Harrison whether or not he considered the psychogenic effect of foul odours and thus it cannot be said that he failed to consider the effect.

[153] It is also the appellants' position that there is no evidence that traditional peer review must be a blind peer review, or that Dr. Harrison's understanding of such was wrong. The appellant therefore asks the Tribunal to take judicial notice of the fact that sometimes peer review in academic and scientific writing is blind; sometimes it is not.

[154] The appellants do not dispute toxicological principles and methodology, but assert that toxicology is of limited value in scientific analysis of the circumstances of these refusals, where flight attendants were exposed to a mixture of compounds known to have adverse health effects. It is the appellant's position that Dr. Pleus was looking at irrelevant exposures and health outcomes. The appellants reiterate that animal studies do not assess the kinds of symptoms at issue in fume event exposure such as headaches, dizziness or inability to concentrate. The appellants add that the exclusive focus of Air Canada and Dr. Pleus on TCPs and TOCP ignores the real issue: the pyrolysis products of not just additives but the jet engine oil base, which makes up over 90% of the oil.

[155] Also, the appellants clarify that the refusals were based on unusual smells which they as well as pilots and maintenance staff attributed to contamination of cabin air because of oil leaks in the APU or engines. In some cases, the flight attendants had suffered symptoms on previous flights on the same aircraft, or were aware of other crew or passengers who reported symptoms.

[156] With respect to normal conditions of employment, the appellants submit that apart from the rarity of fume events, a key reason why circumstances of these work refusals were not normal conditions of employment was that the employer could take and did take further steps to mitigate the danger after the work refusals. After the work refusal action was taken, measures were taken to correct the air quality and the filters were replaced. In support of this argument the appellants cite *Eric V. and al. and Correctional Service of Canada*, Decision no. 09-009 (February 27, 2009), and reiterate the definition held in the Federal Court decision *P & O Ports Inc.* v. *International Longshoremen's and Warehousemen's Union, Local 500*, 2008 FC 846 to the effect that a normal condition of employment is a "residual" danger that exists only after all measures have been taken by the employer to reduce or control it. The appellants reiterate that the Federal Court has affirmed that an employer must meet the Code's extremely high standard to implement safety measures pursuant to 122.1 and 122.2 before a danger can be considered a normal condition of employment.

[157] Concerning the remedy, the appellants reply that Air Canada's submissions on remedy misstate the evidence and, noting the distinction made by Mr. Supplee that airworthiness and occupational safety should be distinguished, argue that the latter's recommendations be followed, namely that: crew surveys be taken, aircrafts with multiple complaints be taken out of service and that pack burns not be undertaken until the source of contamination is known. Mr. Supplee also testified that Air Canada's standard operating procedures were not sufficient to determine

the source of contamination in all cases. He noted that Air Canada's procedures and conclusions overlooked residual contamination that could occur throughout the system because of the use of the APU and/or cross bleeding.

[158] Also, in response to Air Canada's submissions, the appellants submit that it is evident that there were either none or insufficient investigations of the fume events. Also, the reliance on the *Rivers* case is not appropriate because it dealt with the level of cabin air contamination occurring on an otherwise normally functioning aircraft due to the reduction in ventilation of cabin air, such that ventilation is even more critical. Therefore, the appellants reiterate their remedial requests.

Analysis

[159] The question to be decided by the undersigned in the present appeals is whether at the time of Air Canada employees Delgado, Liang and Blaize's work refusals, they were exposed to a danger, as defined by subsection 122(1) of the Code. For lack of a better description, I would qualify this as being the "generic" question to be addressed in these appeals. However, while the circumstances of each refusal may vary slightly from one refusing employee to another, and this includes the refusals by flight attendants LaPorte and Martinez dealt with in the parallel decision mentioned at the outset, central to all cases is the fact that all those refusals originated with the employees either smelling or being informed of an odour on the aircrafts described as "smelly wet gym bag" or "dirty socks". All the evidence that has been presented in all of these cases has dealt singularly with these events and thus, the specific issue to be determined is whether the said odour served to indicate a danger to those employees that justified their refusal to work.

[160] Consideration of this issue requires taking particular account of two provisions of the Code. First, there is the actual definition of "danger" at subsection 122(1) and second, the statement of purpose of the Code at section 122.1.

[161] In the case of the purpose statement of the legislation at section 122.1, it is meant to: "prevent accidents and injury to health arising out of, linked with or occurring in the course of employment". What prevention actually entails according to the Code is set out at section 122.2 which is commonly designated as the hierarchy of controls, a concept that requires taking all possible preventive measures in respect of hazards. Specifically, section 122.2 states that:

> Preventative measures consist first of the elimination of hazards, then the reduction of hazards and finally, the provision of personal protective equipment, clothing, devices or materials, all with the goal of ensuring the health and safety of employees.

[162] Section 122(1) defines danger as:

> "danger" means any existing or potential hazard or condition or any current or future activity that could

> reasonably be expected to cause injury or illness to a person exposed to it before the hazard or condition can be corrected, or the activity altered, whether or not the injury or illness occurs immediately after the exposure to the hazard, condition or activity, and includes any exposure to a hazardous substance that is likely to result in a chronic illness, in disease or in damage to the reproductive system.

[163] There have been numerous decisions from this Tribunal and its appeals officers, as well as from the Federal Court and Federal Court of Appeal, addressing the question of what factually constitutes a "danger" and the manner to determine its existence. Both sides have, for the most part, based their arguments on the same cases. Thus in making my determination as to whether "danger" existed in the circumstances of the work refusals, I will address the various elements from previous decisions such as *Verville, Martin* v. *Canada (Attorney General),* 2003 FC 1158, *Martin* v. *Canada (Attorney General),* 2005 FCA 156, *Darren Welbourne and Canadian Pacific Railway Company,* Decision 01-008 (March 22, 2001) and *Canada Post Corporation* v. *Pollard,* 2008 FCA 305. Specifically, in my analysis I will consider:

- the likelihood that the hazard invoked will present itself;
- the likelihood that an employee will be exposed to the hazard, condition or activity in circumstances that can reasonably be expected to cause injury;
- that the exposure is capable of causing injury or illness to an employee at any time but not necessarily every time;
- the injury or illness is likely to occur before the hazard can be corrected;
- that determination of danger cannot be based on speculation or hypothesis and while such determination necessarily implies a prospective approach, what is expected to transpire in the future can be inferred from past and present circumstances;
- the time of occurrence of a hazard, condition or activity need not be established precisely, only that the circumstances causing potential injury or illness be ascertained and that their future occurrence not be a mere possibility;
- that the reasonable expectation that circumstances can cause injury or illness may be based on expert opinions and even be established through inference arising logically or reasonably from known facts.

[164] In light of these principles and the definition of danger, in order to resolve this matter, I will need to firstly determine whether there was an existing or potential hazard or condition on the Airbus aircrafts bearing numbers Fin 415 and 214 to which the employees were exposed and, secondly, whether such hazard or condition could reasonably be expected to cause injury or illness to the refusing employees, whether immediately or at a future time before it could be corrected.

[165] I hasten to add in this respect that while the experts who were heard in these cases offered various opinions as to whether the conditions that the refusing

employees encountered on the aircrafts were normal conditions of employment, consideration and determination as to whether this was the case comes within the exclusive purview of my jurisdiction as appeals officer and thus largely exceeds the mandate given to the said experts.

Were the employees exposed to a hazard?

[166] Given that the central element of these cases is the odour perceived by or reported to the refusing employees, I find it necessary to dispel a suggestion made by the respondent as to the nature of the hazard raised by the refusing employees. According to the agreed statements of facts in evidence, all the refusing employees reported either smelling an odour at the time of their refusals or being informed of an odour on previous flights of the same aircraft they were to work on, with only one of those employees reporting any symptoms as a result, which were eventually described by the doctor consulted as being a reaction to nauseous fumes, not carbon monoxide contamination. This prompted the expert for the respondent to suggest that the refusing employees had acted not in fear for their health but rather because they did not want to smell an unpleasant odour.

[167] I do not agree that those refusals occurred in order to avoid an unpleasant odour. As noted and agreed to by both sides and all expert witnesses, a “dirty sock” odour in the cabin of each aircraft served as the primary indicator that contaminant chemical substances may have been present in the cabin air as a result of a mechanical problem. Basically, while there may be differences of opinion between the various experts as to the potential consequences on the employees, there is a generally held opinion that this particular odour is associated with oil possibly leaking into the environmental control system and thus the bleed air distributed throughout the aircraft cabin. While no air samples were taken at the time of the refusals or at the time of the HSO investigations when the aircrafts were no longer available, Air Canada Maintenance was nonetheless aware of the occurrence of such odour and had processes in place to address them. As such, it was determined fairly early that the said fume events likely indicated the presence of Mobil Jet Oil and/or Skydrol LD4 hydraulic fluid in the air circulation system.

[168] Furthermore on this point, I retain the evidence and testimony provided by Mr. Supplee to the effect that the likely cause of the cabin air contamination could be attributed to faulty seals in the aircraft engines or APU, resulting in the leakage of jet oil, hydraulic fluid and other contaminants such as pyrolyzed compounds and residual contamination products, as well as other external fumes and de-icing substances. Based on the constituents of these fluids, which include TCP and TOCP among others, and those substances or compounds that may be the result of pyrolyzation, I am satisfied that the cabin air in Fin 415 and 214 that presented the odour was contaminated with chemical substances. It needs to be pointed out in this respect that while there may be differences of opinion between the expert witnesses as to the nature of those substances, they are of one mind as to the fact that there was contamination of the cabin air. Thus, for the purposes of my danger analysis, the hazard that could cause injury or illness is contaminated bleed air. However this

does not signify, in and of itself, that a danger to health was present to the employees.

Was there a reasonable expectation that an exposure to the hazard would have caused injury or illness to a person exposed to it?

[169] In his analysis, the expert retained by respondent Air Canada has suggested that the potential health effects resulting from exposure to chemical compounds would not be chronic illnesses and therefore would not satisfy the definition of "danger' as per the Code. The wording of the definition of "danger" in the Code however, by preceding its reference to chronic illness by the word "includes", indicates that other types of illnesses are not excluded and in fact the general terminology of the definition makes it very clear that it can apply to any illness, be it acute or chronic. Therefore, for the purposes of a danger analysis, it is not necessary for the undersigned to qualify the health effects that may result from exposure as either acute or chronic, nor temporary or permanent as all these types of illness are encompassed by the definition.

[170] Furthermore, I share the opinion expressed by the appeals officer in *Rathwell* that absent a "severity" criteria stated in the Code, it is not required that a potential injury be severe in order to arrive at a finding of "danger". In my opinion, the same rationale can apply to the notion of illness, meaning that it does not need to be permanent or recurring to meet the definition of "danger". Therefore, in the present cases, where it is put forth that the refusing flight attendants were or could have been exposed to certain substances, my evaluation of whether such exposure would cause injury or illness will encompass all possible illnesses, whether recurrent, long lasting, acute or chronic.

[171] The evidence was provided by experts whose expertise, for the most part, is in distinct, albeit obviously contiguous, scientific fields; a fact which in my opinion makes it possible for the undersigned to avoid drawing absolute distinctions between the opinions expressed. Stated differently, given the commonality of facts and information derived from each case and the opportunity afforded to each expert to draw conclusions according to their individual scientific specialty, some permeability between their opinions needs to be accepted and the appeals officer must decide how far such permeability can extend and the effect it may have on the final decision.

[172] In this respect and stated simply, it was submitted by the respondent's expert, Dr. Pleus, that in order for the undersigned to evaluate whether the exposure previously mentioned posed a "danger", one needs to consider the concentration of the contaminants, the level/duration/avenue of exposure, taking into account the Threshold Limit Value (TLV) set for many of those substances. In the case of the appellants' experts, the purpose of their testimony was complementary. Dr. Weisel concluded that the odour(s) reported indicated the presence of substances in the cabin air, those being the same as those identified by the respondent expert, as well as others resulting from pyrolyzation. These substances had to be looked at in

combination as opposed to being considered singularly and the said substances or the combination thereof "could present health effects". Dr. Harrison took this one step further by opining that a conclusion of danger could be drawn from Dr. Weisel's position since some pyrolyzed products are unknown and therefore it cannot be determined how harmful they are, and that very small concentrations of certain substances could affect health. Dr. Harrison also stated that in many instances no TLV exists for chemicals and that concentration measurements are not essential to draw a conclusion that the odour indicated sufficient concentration to put health at risk, thus pinning a "qualitative" approach against the "quantitative" approach favoured by the respondent.

[173] As indicated in the HSO reports, and in my opinion central to these cases, is the fact that no testing was conducted and no air samples were taken on the aircrafts involved. Furthermore, it does flow from the evidence that the said aircrafts may not have been available to the HSOs at the time of their investigations, a situation that in my opinion raises the question of the completeness of such. The result is that the substances, substance concentration, combination of substances or levels of exposure by the refusing employees have not been determined. However, both sides have submitted through their experts that, in any event, it would have been very difficult to determine exactly which contaminants and how much were in the cabin air or for how long because of a number of factors such as vaporization, pyrolysis, dissipation and also the various procedures conducted at times by Air Canada Maintenance.

[174] That being said, it is long established that an appeal pursuant to subsection 146(1) of the Code is a *de novo* proceeding, meaning that I am not restricted to the information collected by the HSO and can consider any relevant evidence submitted at the appeal. As stated, the evidence before the undersigned that refers to air contamination is opinion evidence put forth by the three experts, who were all faced with the same complication of not having air samples or test results from the aircraft at their disposal. Their assessments are thus a series of assumptions, albeit informed ones, based on data from other scientific studies regarding exposure to chemical constituents, including TCP and TOCP and other constituents, as well as case studies involving similar circumstances, including one with a simulated test flight on an aircraft where fume events took place. It bears also noting that the opinions of each expert witness were strongly challenged by the expert for the opposing side, specifically regarding the rationale and methodology used.

[175] The appellants have submitted that I should not retain Dr. Pleus's evidence because it is based on assumptions. However, to the extent that the opinions formulated by the expert followed or applied recognized scientific standards and appropriate methodology, the fact that assumptions were made out of necessity in these cases, does not undermine the validity of the expertise. On that point, I share the opinion formulated by the appeals officer in *Damian Azeez and Canada Border Services Agency,* 2013 OHSTC 8, regarding scientific assumptions made relative to the determination of a potential for radiation exposure:

> [69] […] I believe one should not confuse the methods used by scientists to collect data and make assessments in these types of situations with mere conjectures or assumptions. From the evidence that was presented during the hearing, it was made clear to me that the assessments provided by both Health Canada and the RPB were made according to well established scientific standards and the CBSA and HSO Iacobellis were justified to rely on those assessments to evaluate the risk at the Vista Mail Center.

I therefore have no difficulty considering the expert's scientific assumptions in my analysis to the extent that they were provided within the experts' field of expertise. I note however, that all three experts offered certain opinions that fell outside of their particular areas of expertise.

[176] Given the volume and complexity of the expert evidence, I find it helpful to identify the common elements surrounding the circumstances of these appeals. In all cases it is most likely that the dirty sock smell came from the presence of vapourized Mobil Jet Oil and Skydrol in the cabin air (although Dr. Pleus questions this because the source of the odours was not determined during the HSO investigation). This likely occurred as the result of a mechanical failure with the oil seals. In all cases the employee exposure to the fume events were of short duration and the route of their exposure was inhalation, as pointed out by both parties. Air Canada maintenance generally followed Airbus recommended procedure in seeking and correcting the causes of the air contamination. Also, in all cases each expert gave opinion evidence within their individual scientific field of expertise with respect to the health effects that could result from exposure.

[177] The union's expert Dr. Weisel concluded that where there was a smell present, there was a reasonable expectation that the cabin crew working on the aircraft would be exposed to a mixture of hazardous compounds associated with oil leakage into the bleed air of the aircraft if it did not receive proper maintenance to identify and repair the oil leakage. He points out that the contents of the mixture likely contained isomers of TCP, DPP, various hydrocarbons and pyrolysis products of the engine oil. He also relies on information from the Golder Associate report which indicates that the APU was emitting compounds that reduced the cabin air quality in the test flight that was conducted for that study.

[178] I am satisfied by the evidence presented that there was indeed a mixture of chemicals in the cabin air, as a result of pyrolysis of engine oil and that the employees were exposed to this mixture. However, given that it was not determined with any specificity what compounds were in that mixture or in what concentration, it does not necessarily follow that the mixture was toxic to the employees. Indeed, Dr. Weisel admits in his report that epidemiological studies have not been conducted to document whether cabin crew or passengers become ill when exposed to air containing odours related to oil entering bleed air. Furthermore he concedes that a large number of flights would have to be evaluated in order to determine if

health effects are in fact related to these episodes. Absent this information, I find that it would be somewhat of a leap to conclude that such employee exposure to contaminated bleed air results in health effects that would qualify as an illness or injury.

[179] Similarly, Dr. Harrison who was qualified as both a medical expert and an expert in toxicology did not convince me that there is a link with the circumstances surrounding the exposure to contaminated air and the illnesses that employees can reasonably expect to suffer. Speaking from a medical perspective, Dr. Harrison focused his analysis on a qualitative evaluation of case studies of patients who have experienced similar exposure to contaminated cabin air on aircrafts. In his report, he relies on his experience with these patients as well as his published guide for healthcare providers relating to exposure to aircraft bleed air contaminants to establish the symptoms that can arise and the toxic effects these contaminants can have. Dr. Harrison concludes that it simply takes an odour for the employees to reasonably suspect that a condition exists that constitutes a danger to their health. I realize that this conclusion is based on his experience with patients who suffered similar symptoms to the refusing employees, however it is difficult for me to treat those case studies as determinative of the present appeals, since it is unclear what the circumstances of those exposures were (i.e. whether there was oil leakage, pyrolysis, faulty air packs etc.).

[180] Dr. Harrison also states that the mechanical investigations alone were sufficient to reasonably expect that toxic air contaminants were released into the cabin air and could result in health problems. I am not persuaded by this reasoning. The definition of danger provided by the Code establishes a causal relationship between a hazard, condition or activity in the work place and the effect that it can have on an employee's health and safety. It follows that, for me to arrive at a conclusion of danger in circumstances of air contamination there must be either medical or scientific evidence that points to a causal link between the environmental conditions of the work place and the possibility of injury or illness to an employee; without this, such a conclusion is simply speculative.

[181] Counsel for the appellants has argued that a number of employees incurred or suffered from a number of symptoms, such as nausea, burning eyes or scratchy throat, and I am not suggesting that this was not the case. Dr. Harrison described those as illnesses and while the listing of what constitutes illness in the scientific literature may serve to characterize factual states as illness, this is not sufficient in the present context to arrive at a finding of danger where one does not have the necessary information to establish a cause and effect relationship between those symptoms and the factual conditions on the involved aircrafts. One needs to repeat here that Dr. Weisel, the other expert witness for the appellants, could not go beyond concluding that the odour complained of served to demonstrate the presence of contaminants in the cabin air, and in fact noted that to take the extra step of concluding to harm to health would require considerable and extensive testing under a variety of circumstances, something that has not occurred.

[182] In this case, it is clear to me that the "dirty sock" odour was an indicator of contaminated air. However, in and of itself, that is not sufficient to conclude that it is dangerous to the employee's health. The likelihood (that is to say, the reasonable expectation) of the contaminated air being able to cause an injury or illness needs to be evaluated. I believe that such an evaluation requires an understanding of levels and concentrations of the contaminants that were present in the cabin air. In this respect, Dr. Harrison's report points out that TOCP, one of the components present in the jet oil is actually present at a detectible level in the flight deck of the aircraft during routine flight operations. Dr. Harrison opines that knowing that there is TOCP present on the aircrafts causes the employees to feel like they have a reasonable expectation that they will suffer injury or illness. In this regard I find that Dr. Harrison has focused on the employees' subjective belief instead of the objective standard that is required to evaluate whether danger existed at the time. The cabin crew may indeed have had an apprehension that led them to refuse to work, but that belief must withstand an objective review, as held in *Martin* v. *Canada (Attorney General),* 2003 FC 1158.

[183] It seems to me that if TOCP is present on routine flight operations, then cabin crew and passengers would be exposed to it on a regular and routine basis, even when there is nothing wrong with the air quality on the aircraft. Contrary to Dr. Harrison's opinion, this tells me that this particular compound is not harmful to employees when they are exposed to the amount that is routinely present on the aircrafts, even for a significant duration, and that it would take a higher amount and concentration to be potentially harmful to the cabin crew. Dr. Harrison provides no comment as to what those amounts and concentrations would need to be, or whether it is possible that those amounts were likely present on the aircrafts. While I agree with the premise that very small amounts of certain substances may result in health effects, the fact remains that there is no data available to determine whether the substances present in the cabin air were of that nature.

[184] I am not convinced that Dr. Harrison's medical opinion establishes whether it is the contaminants that triggered the symptoms. I have already determined that the potential hazard in these cases is not the "smelly sock odour" but rather the chemical substances that contaminated the air. In light of this it is not sufficient to conclude that the employees suffered symptoms as a result of being exposed to a smelly sock odour; it must be demonstrated that their symptoms were a result of the chemical constituents in the air. This was not demonstrated by Dr. Harrison's evidence, as he did not address the needed level of exposure to result in illness, which is, from a toxicological perspective, the crux of the issue. The only expert that provides insight into the issue of levels of exposure is Dr. Pleus who explains the toxicological principle that the dose makes the poison and his conclusion that the toxicity level of the chemical compounds in jet oil and hydraulic fluid present in the cabin air were not high enough to cause health effects.

[185] In these appeals, I accept, as the appellants have submitted that the odour is not the hazard, rather that it indicates an existing or potential hazard, but it does not follow that the odour indicates a danger *per se*. I tend to agree with Dr. Pleus's

assertion that foul odours are not good indicators of adverse health effects when it comes to chemical exposure as odour does not correlate with toxicity. The smelly sock odour indicated air contamination and it is that contamination that should be evaluated for potential for harmful effects. I am further persuaded by Dr. Pleus's comment that odourless chemicals can in fact be very dangerous to health. This is bolstered by Mr. Koroneos, manager of industrial hygiene for Air Canada who concludes in his occupational hygiene assessment that "though odours can be very useful in determining the presence of a particular gas or vapor in the environment, the variable relationship of odour threshold and the minimum concentration which would reduce toxic effects renders odour an unreliable indicator of toxicity."

[186] Each expert has discredited certain elements of the other's report, the reasons for which are summarized in both parties' submissions. It is indeed understandable that experts in differing fields will have differing opinions and will place weight on different circumstances surrounding the appeals. However, while I do not find it useful to retain or discard each contentious point of each expert report, I note that in many respects the reports of Dr. Weisel and Dr. Pleus coincide. Namely, both give credence to the idea that low level and low frequency exposure to contaminated bleed air will not likely result in illness.

[187] Dr. Pleus concludes that the exposures to these chemicals would not be of sufficient air concentrations and durations to cause adverse health effects. He notes that if the chemical substances were present in a large enough amount to cause health effects there would be a visual indicator such as a vapour or a mist of jet oil. Specifically, the exposure levels of oil in the air sufficient to cause OPIDN would produce a haze that accompanied the smell. He asserts that the absence of such indicates that the compounds were not of alarming concentrations. Dr. Pleus also points out that once the chemicals enter the cabin air, they are diluted and the air is recirculated through the air packs and thus the concentration of the compounds lessen very quickly.

[188] In support of his conclusions, Dr. Pleus considered air concentrations, and duration of possible exposure. His report provided a chemical exposure assessment where he assumed that an employee would be exposed to contamination for an eight hour period and then evaluated whether the chemical exposure would meet or exceed the threshold for an adverse effect based on toxicological data from human and animal studies. He looks particularly at toxicity data for TCP and TOCP and uses TLVs and occupational exposure limits (OELs) which indicate permissible work place exposures that would be unlikely to cause harm if a worker were exposed for an 8 hour day, 5 days a week, for many years of employment. Furthermore, for a single exposure, he says the OEL for compounds such as TOCP and TCP is extremely high (40mg/m) because it would take a large concentration to create adverse health effects. Dr. Pleus concludes that based on the data consulted, the measured concentrations are well below the established OELS for TCP, and its isomers are unlikely to cause human effects.

[189] I believe that the use of OELS and TLVs in the field of toxicology indicates that certain levels of work place exposures to certain chemical compounds (namely TCP and TOCP) are not likely to cause illness. Furthermore, according to Dr. Pleus TCP can be found in commercial aircrafts at low quantities within the permissible OELS during routine flight operations and is also found in many consumer products in low concentrations. I understand from these facts that there is a potential that employees will be exposed to TCP, TOCP and other unidentified or unidentifiable compounds in the chemical mixtures mentioned by Dr. Weisel. However, I do not take this to mean that the risk of exposure to this variety of chemicals is likely to result in illness. As held *in Parks Canada Agency and Mr. Doug Martin and Public Service Alliance of Canada* Decision No. 02-009 (May 23, 2002), risk must be distinguished from danger as defined by the Code. Risk is exposure to the possibility of injury or illness. A danger requires not only exposure to injury or illness but also a reasonable expectation that an injury or illness will occur before the hazard or condition can be corrected or the activity altered. Based on everything in front of me it is still simply too uncertain what circumstances would be needed in order for the compounds in the cabin air to cause injury or illness to the employees.

[190] Furthermore, in order to find danger in these circumstances I would need to be convinced that the illness could occur before the hazard can be corrected. The respondent has submitted evidence of the steps taken to address cabin air quality issues, including cabin fume events which include a hazardous substances investigation from their Industrial Hygiene Manager, who is consulted in situations where hazardous substances may be present. In addition, each time a flight attendant is concerned about exposure to a hazardous substance on board an aircraft, an investigation is conducted and the flight attendant advised of appropriate medical care, as necessary. It is also clear to me that the action was taken quickly after each report of the odour on the aircrafts at the time of the refusals. Air Canada Maintenance is aware that these fume events occur on the Airbus aircrafts as well as the fact that they likely indicate the presence of jet oil compounds in the air. I believe the actions taken can correct the hazard before it can cause illness or injury to the employees.

[191] In summary, I conclude that the contaminated air can create a potential hazard on the aircraft, notably given the fact that the exact nature of the compounds present is not and apparently cannot be fully known and I am also sensitive to the fact that exposure to these substances in the bleed air might last longer on longer flights. The appellants relied on *Rehab Rivers, supra* to support their position that it is not necessary that the exact nature of a hazardous substance be completely known. While I grant that it may be impossible to determine the exact constituents of a hazardous substance (as was the case in *Rivers* and the present appeals, according to Dr. Harrison's testimony), I believe it is imperative to know enough about the substance to determine its potentially hazardous properties. I find support for this position in the definition of "hazardous substance" at subsection 122(1) of the Code which states:

> "hazardous substance" includes a controlled product and a chemical, biological or physical agent that, by reason of a property that the agent possesses, is hazardous to the safety or health of a person exposed to it;

[192] Based on the above, I am persuaded that in the circumstances of these appeals, there is not a reasonable expectation that the refusing employees would suffer injury or illness as a result of contaminated bleed air. Namely I find that there is insufficient evidence that the concentration of the chemicals and the duration of the exposure were significantly high and without that I am not convinced that a danger existed on Fin 214 and Airbus 320.

[193] There may indeed be a mere possibility that exposure to contaminated bleed air would result in illness or injury, depending on factors such as duration of exposure and concentration and toxicity of the contaminants. However, I must be convinced that the potential for illness comes from the fact that the employees were exposed to chemical substances in the cabin air.

[194] In that respect, the evidence convinces me that the contaminants are unlikely to remain in the cabin air for very long because of vaporization, that certain compounds would need to be present in a significantly large quantity to cause adverse effects, which is unlikely on these aircrafts given the amount of jet oil required for the engine and that the aircrafts are routinely maintained. Thus, it was not demonstrated that the symptoms that the flight attendants experienced were the direct result of being exposed to the contaminated air.

[195] Finally, in all of the cases where fume events were reported, Air Canada Maintenance took the appropriate action to address and resolve the issue. Therefore it is even less likely that injury or illness would occur before the hazard could be corrected. Consequently I find that there was no danger for the flight attendant employees in the present appeals.

[196] Given that I find that the employees were not exposed to a danger as that term is defined in subsection 122(1) of the Code, the issue regarding normal conditions of employment need not be addressed.

Decision

[197] For all the reasons above, the decisions that a danger does not exist rendered by HSOs Pollock and Blain on March 26, 2012 and July 18, 2011 are confirmed.

Jean-Pierre Aubre
Appeals Officer