Donna Egeland, ARM, PHR  
Director, Employee Medical Relations  
Alaska Airlines  
19300 Pacific Highway South  
Seattle, Washington 98188  

Dear Ms. Egeland,

This letter is in response to a request by the Association of Flight Attendants-CWA (AFA), for the National Institute for Occupational Safety and Health (NIOSH) at the Centers for Disease Control and Prevention (CDC) to conduct a health hazard evaluation (HHE) at Alaska Airlines. The request concerned skin; eye; ear, nose, and throat (ENT); and respiratory symptoms among flight attendants that they attributed to uniforms introduced in December 2010. Over the course of our evaluation, the AFA expressed concern about tributyl phosphate, dimethyl fumarate, textile dyes, heavy metals (including hexavalent chromium), and other chemicals that might be present in the uniforms and might be causing symptoms among the flight attendants.

**Background on Alaska Airlines**

Alaska Airlines, headquartered in Seattle, Washington, is a major U.S. west coast air carrier. The airline serves 61 destinations in the United States, Mexico, and Canada and has hubs in Seattle, Washington, Anchorage, Alaska, Los Angeles, California, and Portland, Oregon. As of July 2012, the airline had 9,617 employees, which included approximately 2,880 flight attendants and 1,570 customer service agents.

**Information about Alaska Airlines Uniforms**

According to airline management and the AFA, the uniform used prior to December 2010 was made from a lined, polyester/wool blend. According to the airline, no complaints or workers' compensation claims regarding these uniforms had been filed by any employee between January 1, 2008 and December 31, 2010.

The current uniform was introduced to flight attendants and customer service agents between December 2010–February 2011. During this time period, approximately 90,000 uniform pieces were delivered to approximately 4,500 employees. There are 12 uniform pieces for male flight attendants and 19 uniform pieces for female flight attendants. Table 1 provides a description of the uniform piece, fabric content of each piece, and fabric content of the lining. Flight attendants have the option to have unlined pieces lined with a 100% polyester lining at no cost to them.
Table 1. Alaska Airlines current uniform types and fabric content

<table>
<thead>
<tr>
<th>Uniform pieces</th>
<th>Uniform Fiber content</th>
<th>Lining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jackets (3 styles)</td>
<td>53% polyester/43% wool/4% elastane</td>
<td>98% Polyester/2% spandex</td>
</tr>
<tr>
<td>Gilet</td>
<td>53% polyester/43% wool/4% elastane</td>
<td>None</td>
</tr>
<tr>
<td>Trousers (4 styles)</td>
<td>53% polyester/43% wool/4% elastane</td>
<td>None</td>
</tr>
<tr>
<td>Dress</td>
<td>53% polyester/43% wool/4% elastane</td>
<td>98% Polyester/2% spandex</td>
</tr>
<tr>
<td>Vest</td>
<td>53% polyester/43% wool/4% elastane</td>
<td>100% polyester</td>
</tr>
<tr>
<td>Skirt</td>
<td>60% cotton/40% polyester</td>
<td>98% Polyester/2% spandex</td>
</tr>
<tr>
<td>Solid broadcloth shirt (2 styles)</td>
<td>60% cotton/40% polyester</td>
<td>None</td>
</tr>
<tr>
<td>Tropical print shirt/blouse</td>
<td>55% cotton/45% polyester</td>
<td>None</td>
</tr>
<tr>
<td>Wing collar blouse (2 styles)</td>
<td>60% cotton/40% polyester</td>
<td>None</td>
</tr>
<tr>
<td>Gramercy stripe shirt/blouse</td>
<td>60% cotton/40% polyester</td>
<td>None</td>
</tr>
<tr>
<td>Royal oxford shirt/blouse</td>
<td>100% cotton</td>
<td>None</td>
</tr>
<tr>
<td>Double button maternity blouse</td>
<td>66% cotton/34% polyester</td>
<td>None</td>
</tr>
<tr>
<td>Open neck maternity blouse</td>
<td>60% cotton/40% polyester</td>
<td>None</td>
</tr>
<tr>
<td>Sweaters</td>
<td>55% acrylic/23% wool/22% nylon</td>
<td>None</td>
</tr>
<tr>
<td>Koko coat</td>
<td>100% bonded polyester</td>
<td>Fleece lined</td>
</tr>
<tr>
<td>Fly front coat</td>
<td>100% bonded polyester</td>
<td>100% polyester</td>
</tr>
</tbody>
</table>

Some uniform pieces provided to customer service agents are the same as those provided to flight attendants; a few are different. However, the fiber content of the fabrics in these uniform pieces is the same as those listed in Table 1 for flight attendants.

Twelve flight attendants (6 female and 6 male) and 9 customer service agents (4 female and 5 male) completed wear-tests of the current uniform prior to agency-wide roll-out. No complaints or workers’ compensation claims were filed by any of these 21 employees during this testing phase. However, according to airline records, one flight attendant reported that the fabric of the Moore trouser “was itchy,” and another flight attendant reported that the collar on the Gramercy Stripe shirt was “rough and stiff” and gave that flight attendant a rash, presumably where the collar rubbed against the neck. This rash was reported to have improved over time and with laundering of the shirt.

Since roll-out of the uniform, the airline and the AFA became aware of skin, eye, ENT, and respiratory symptoms reported by flight attendants that they attributed to the uniform. Flight attendants and the AFA expressed concern about possible chemical contamination of the uniforms. The AFA submitted an HHE request in January 2012.

**Information on Illness Clusters**

In light of the reported symptoms among Alaska Airlines flight attendants, we are providing information about clusters. Diseases and symptoms often appear to occur in clusters, which scientists define as an unusual concentration of cases in a defined area or time [CDC 1990]. The cases may have a common cause or may be the coincidental occurrence of unrelated causes. The number of cases may seem high, particularly among the small group of people who have something in common with the cases, such as working in similar conditions.
Our Methodology in Cluster Investigations

In investigating a perceived excess of symptoms among employees of the same workplace, we begin by gathering data on workers with reported symptoms. To assess whether symptoms among employees could be related to occupational exposures, we consider the type of symptoms, the number of employees with symptoms, and the likelihood of exposure to agents potentially causing symptoms. These issues are discussed below as they relate to our evaluation.

With the assistance of airline management and the AFA, we obtained and reviewed airline injury and illness forms, workers' compensation claims, and medical records gathered from the time of the request through August 28, 2012. These records covered 78 flight attendants. The median age of the 78 flight attendants was 49 years, with a range of 27–66 years. Seventy-one (91%) were female. These 78 flight attendants were based out of all four Alaska Airlines hub cities, and included 40 (2%) of the 1,742 out of Seattle, 27 (5%) of the 493 out of Los Angeles, 9 (3%) of the 341 out of Anchorage, and 2 (1%) of the 304 out of Portland.

Do Alaska Airlines flight attendants have more symptoms than other Alaska Airlines employees and other people who do not work at Alaska Airlines?

One of things we looked at was consistency of reported health symptoms across all employees who wear the uniform. According to information collected by the AFA, 281 (10%) of 2,880 flight attendants reported symptoms, which included skin, eye, ENT, and respiratory symptoms. According to airline records, as of April 2012, 80 (3%) of 2,880 flight attendants and 4 (0.3%) of 1,570 customer service agents had filed formal complaints and workers' compensation claims. Given that the approximately 4,400 flight attendants and customer service agents wear uniforms from the same manufacturer and with the same fabric content, we would expect the percentage of reports to be similar in the two groups of employees. The fact that flight attendants filed formal complaints 10 times more frequently than customer service agents suggests a cause for reported symptoms that is unrelated to the uniforms.

In our review of the records for 78 flight attendants, we found that 65 reported skin symptoms, 22 reported eye symptoms, 14 reported ENT symptoms, and 21 reported respiratory symptoms. In addressing the concerns about these symptoms among Alaska Airlines flight attendants, we find it helpful first to review some salient points about the occurrence of these symptoms in the general population and in the working population in the United States.

Skin symptoms are relatively common in the working population. Data from the 2010 National Health Interview Survey showed that overall prevalence of dermatitis reported among 17,524 current/recent workers in the previous 12 months was 9.8%, representing approximately 15.2 million workers with dermatitis [Luckhaupt et al. 2012]. This percentage of 9.8% is similar to the 10% of flight attendants found by the AFA to report dermal symptoms in an approximate but similar 12 month time frame.

Data on 26,409 working adults from the 1988 National Health Interview Survey (the last time this type of data was published) showed a relatively high prevalence of self-reported eye irritation (17.3%), nose irritation (28.5%), and sore or dry throat (14.4%) [Park et al. 1993].
Information from a more recent National Health Interview Survey revealed that on average each year, 13.8 million adults in the United States had asthma from 2001–2003. Asthma prevalence among adults was 6.7% (8.1% in females and 6.2% in males).

These data show that eye, ENT, and respiratory symptoms are also relatively common in the working population. It does not appear that the number of flight attendants reporting symptoms is higher than expected compared to the general working population.

Environmental stressors, including temperature, humidity, pressure, noise, vibration, and time-zone shifts, have been associated with the health and comfort complaints among flight attendants [Nagda and Koontz 2003]. Eye, ENT, and respiratory symptoms are common among flight attendants. A study of 1,824 flight attendants from 1999–2001 found a high self-reported prevalence of work-related eye (12.4%), nose (15.7%), and throat (7.5%) symptoms; these rates were significantly higher than those found in other working women [Whelan et al. 2003]. In addition, the self-reported prevalence of ever diagnosed asthma was 8.2% and of current physician diagnosed asthma was 4.9%.

A study of 1,513 Swedish airline cabin crew found that the aircrew had significantly more nasal, throat, and skin symptoms than office workers. Among those working on European or domestic flights in which smoking had been banned, the most common symptoms were fatigue (18%), nasal symptoms (14%), eye symptoms (10%), dry or flushed facial skin (11%), and hand skin symptoms (11%) [Lindgren et al. 2002]. Several other studies have also reported eye and respiratory symptoms among flight attendants [Pierce et al. 1999; De Ree et al. 2000; Lee et al. 2000; Lindgren et al. 2000; Wieslander et al. 2000].

Is there one piece of the uniform or one fabric of the uniform clothing that appears to be causing symptoms?
The hypothesis that the uniforms were contributing to the symptoms would be supported by establishing a link between symptoms and specific uniform pieces made of the same fabric. According to uniform manufacturer information as shown in Table 1, the jackets, gilet, trousers, dress, and vest are made of one type of fabric while the skirt and some of the shirts/blouses are made of another type of fabric. In addition, the jackets, dress, vest, skirt, and coats are lined with varying types of fabric, while the other pieces are not lined. The possibility that a causal agent was present on all uniforms regardless of their fabric content (e.g., a contaminant introduced during transport) was raised and is addressed below in the discussion of chemical analyses.

According to our review of 78 flight attendants’ records, the uniform piece reported to be causing symptoms was not specified by 55 (71%) of the 78 flight attendants. Of the 23 (29%) employees who did specify a uniform piece, the pieces specified included a shirt (n = 11), pants (n = 7), dress (n = 7), skirt (n = 6), gilet (n = 5), sweater (n = 4), and jacket (n = 1). These results show that neither one specific uniform piece nor a group of uniform pieces with the same fabric content were linked to symptoms.

Another way to look at the relationship between symptoms and specific pieces of clothing is to
assess the pattern and types of skin symptoms. Sixty-five (83%) of the 78 flight attendants reported skin symptoms. Among those that did, the reported locations varied widely (Table 2). Many flight attendants reported multiple locations for their skin symptoms, including six who reported a full body rash.

Table 2. Location of Skin Symptoms Reported by Flight Attendants

<table>
<thead>
<tr>
<th>Reported Location of Skin Symptoms*</th>
<th>No. (%) Flight Attendants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk (chest, back, abdomen)</td>
<td>37 (57)</td>
</tr>
<tr>
<td>Neck</td>
<td>26 (40)</td>
</tr>
<tr>
<td>Arms</td>
<td>25 (38)</td>
</tr>
<tr>
<td>Legs</td>
<td>19 (29)</td>
</tr>
<tr>
<td>Face</td>
<td>10 (15)</td>
</tr>
<tr>
<td>Axilla</td>
<td>6 (9)</td>
</tr>
<tr>
<td>Scalp</td>
<td>4 (6)</td>
</tr>
<tr>
<td>Hands</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Genital/groin area</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Feet</td>
<td>1 (2)</td>
</tr>
</tbody>
</table>

* Some flight attendants reporting skin symptoms.

Of the 65 flight attendants reporting skin symptoms, 39 (60%) had a rash documented by a healthcare provider. Documented rash locations were: trunk (n = 17); arms (n = 16); neck, (n = 12); legs (n = 8); face (n = 2); axilla (n = 1); and hands (n = 1). These reports are not consistent with known patterns of clothing dermatitis.

Clothing dermatitis generally occurs in areas where clothing fits snugly, and the lesions are sometimes symmetrical [Reitschel et al. 2008]. Friction, warmth, and moisture tend to increase the appearance of clothing dermatitis. The clinical pattern is generally described as affecting the neck, major skin folds, and inner thighs. The areas protected by underclothing or the lining of a skirt or pants are often free of symptoms [Le Coz 2011].

Dermatitis from blouses and dresses typically involves the back. In addition, dress dermatitis affects the neck, elbows, and axillae, and can involve the forearms and wrists. Dermatitis from jackets affects the dorsum of the hands, wrists, and forearms. Dermatitis from trousers occurs in the thighs and lower legs and in the popliteal fossa, or back of the knees. Dermatitis from socks affects the feet and lower legs. Dermatitis from stockings or tights affects the lower legs, dorsum of the feet and toes, and can also involve the popliteal fossa [Le Coz 2011].

Descriptions of documented rashes for the 39 flight attendants with them included scaly patches, urticaria or hives, vesicles or blisters, maculopapular rashes, plaques, and excoriations. Forty-eight (74%) of the 65 flight attendants reporting skin symptoms were given a skin-related diagnosis by a healthcare provider. These diagnoses included contact dermatitis (n = 25), an unspecified or other dermatitis (n = 14), atopic dermatitis (n = 4), urticaria (n = 3), and other skin
disorders (n = 12), many of which were unrelated to the uniforms such as shingles, rosacea, and fungal infection.

No skin patch testing results were identified among the medical records reviewed for the 78 flight attendants. In addition, only 2 flight attendants had skin biopsy results accompany their records. One flight attendant’s skin biopsy showed granuloma annulare, and the other’s showed superficial perivascular lymphocytic dermatitis. Both diagnoses have multiple potential etiologies. The occurrence of multiple skin-related diagnoses does not suggest one occupationally-related etiology.

*Is exposure to a specific agent known or suspected of causing reported symptoms occurring?*

In order to learn more about whether or not a specific agent is causing the reported symptoms in employees, we obtained and reviewed fabric testing results from several organizations that have been involved in other investigations of this issue. We have summarized the results of these efforts below.

**Formaldehyde and pH**

After reports by flight attendants were initially filed, a series of tests on the uniform fabrics was sponsored by the uniform manufacturer (Twin Hill), Alaska Airlines management, and the AFA. Specialized Technology Resources (STR) (contracted by Twin Hill) tested several fabric pieces on March 22, 2011, including samples of jackets, gilet, trouser dress, skirt, three blouses, and a shirt. Testing revealed formaldehyde levels ranging from below the limit of detection to 24.3 parts per million (ppm) using a standard method for measuring formaldehyde in textiles (Japanese method JIS L 1041-1983) [STR 2011a]. Formaldehyde release levels from these fabrics were below the Japanese formaldehyde limit in clothing (75 ppm), which is currently the most conservative international standard for formaldehyde in clothing. The United States does not have a regulatory limit for formaldehyde in clothing. The pH of water extracted from these materials was between 5.2 and 7.3 as measured by AATCC Method 81 [AATCC 1954; STR 2011a].

**Tributyl Phosphate**

Follow-up testing completed by STR on March 31 on several different uniform fabric pieces qualitatively identified tributyl phosphate using gas chromatography/mass spectrometry (GC/MS) and ion chromatography [STR 2011b]. It is unclear why this chemical was on the fabric. However, it was reported by Twin Hill that since tributyl phosphate is known to cause skin irritation and rash, additional testing was done to quantify the concentrations in the fabric. Tests done by STR [2011c] and Bureau Veritas Consumer Product Services, Inc. (BVCPS) (contracted by Alaska Airlines) [BVCPS 2011a] showed tributyl phosphate concentrations in the fabrics at least two orders of magnitude below concentrations that are known to cause skin irritation, according to risk assessments performed by Environ (contracted by Twin Hill) and BVCPS.
However, BVCPS indicated in a technical opinion on October 18, 2011, that the STR data could not be used for quantitative assessment for tributyl phosphate concentrations because results were described in “percent area response” only [BVCPS 2011b].

Commercially available clothing purchased at department stores and an alternative polyester uniform offered to employees also were tested by BVCPS. Tests showed detectable concentrations of tributyl phosphate, though these concentrations were lower than those found in the uniform fabric [BVCPS 2011c; BVCPS 2012a].

Additional testing for tributyl phosphate on uniform fabrics was conducted by the University of Washington (sponsored by AFA) on 78 pieces of uniform fabrics [University of Washington 2012]. Samples were extracted in methanol and analyzed using GC/MS and electron ionization-select ion monitoring. Tributyl phosphate was detected in 57% of the fabric samples tested. The University of Washington concluded that all tributyl phosphate samples were less than one-fifth of the Levi-Strauss Restricted Substances List value of 1000 milligrams per kilogram. However, they also concluded that the presence of tributyl phosphate, a potential skin irritant, could increase the chance for allergic reaction to azo dyes (also detected in the fabrics) by altering the skin’s barrier properties.

**Other Chemicals**

Other chemicals in the uniform fabrics have been identified as possible contributors to the skin reactions reported by flight attendants. STR conducted testing on several worn fabric samples suspected by flight attendants of causing their skin symptoms. Headspace air samples were collected at room temperature and 70°C, and emissions were analyzed using GC/MS analysis [STR 2011d]. Chemical extractions of uniform samples using methanol and chloroform followed by GC/MS analysis were also performed [STR 2011d]. Several chemicals were identified, including “quite low” levels of volatiles such as ketones, silicones, and aromatics such as toluene. The results are difficult to interpret, however, because only qualitative results were reported. The report also indicated that the chemicals detected may have been contaminants introduced during shipping since the samples were received in open bags. Additionally the report stated that the methanol and chloroform extracts indicated the presence of dominant glycol oligomers, silicone oligomer, hydrocarbons, and a mix of minor components. This report also stated that two samples collected from a dress indicated the presence of color fragments including 4-chloro-2-nitroaniline, benzeneamine-2,6-dichloro-4-nitro, and benzeneamine-2-bromo-4,6-dinitro. STR indicated that chloroform extracts from this sample were “highly colored indicating that the dyes are not completely colorfast.”

BVCPS [2011b] provided a technical opinion on skin irritation or sensitization from chemicals that were qualitatively identified in uniform fabrics by STR [STR 2011d]. They initially identified four chemicals [alpha hexyl cinnamaldehyde, 2-(2-butoxyethoxy) ethanol, propylene glycol, and p-toluenesulfonamide] that are known to cause skin irritation or sensitization. However, after further discussion, they indicated that these four chemicals were only found in “a single garment or in ‘normal’ uniform samples (i.e., uniforms not previously worn and not
known to cause skin problems); thus “it is highly unlikely that the presence of these chemicals in the tested garments warrants further testing.”

BVCPS conducted a qualitative analysis on 16 uniform samples in various sizes and colors using heated headspace and GC/MS analysis [BVCPS 2011d]. Uniform samples included those from employees complaining of skin rashes, and new, unworn fabric. This analysis identified several chemicals including heptadecafluorodecyl acrylate isomers, nonanal, tetrachloroethylene, and trimethylsilanol. These data were compared to concentrations associated with long-term and short term toxicity. BVCPS concluded that the likelihood of irritation resulting from exposure to these chemicals was very low [BVCPS 2011d].

Several compounds including metals and formaldehyde were identified in fabric testing conducted by the University of Washington (sponsored by AFA) in June 2012. However, the analytical methods used to test fabric samples were not those typically used for textiles, so it is difficult to interpret the results.

Follow-up testing for comparison to OEKO-TEX® Standard 100 limit values for metals was completed by BVCPS [BVCPS 2012b]. In this testing, 35 uniform swatch samples, provided by the University of Washington, were analyzed according to OEKO-TEX Standard 200, which uses an acidic synthetic sweat solution as the extract medium. Samples were leached in the synthetic sweat solution for 12 hours, then leachate was analyzed for 28 metals using inductively coupled plasma-mass spectrometry. Hexavalent chromium was found using ion chromatography. All but one result were determined to be below OEKO-TEX Standard limit values or less than the limit of detection. One fabric sample from a blue sweater (worn, unwashed, not dry cleaned) was determined to have a hexavalent chromium level of 0.067 μg/in². The OEKO-TEX Standard 100 indicated that hexavalent chromium should not be present above the limit of detection. BVCPS indicated that “the single hexavalent chromium exceedance is not considered significant since it is not associated with a consistent pattern of hexavalent chromium and effects and as such cannot explain the widespread effects” [BVCPS 2012b]. Although it is unclear how hexavalent chromium was introduced in the sweater fabric, we agree with BVCPS that this likely does not suggest an explanation for the reported symptoms, since the majority of fabrics tested (97%) did not have detectable levels of hexavalent chromium.

Additional testing by the University of Washington was conducted for dimethyl fumarate and azo dyes in uniform fabrics [University of Washington 2012]. According to the University of Washington report, dimethyl fumarate can be used as an antifungal agent with textiles, but recently has been banned in the European Union due to a potential to cause allergic skin reactions. Sixteen azo dyes known to cause skin sensitization or allergic reaction were also included in the analysis. Samples were extracted in methanol and analyzed using GC/MS and electron ionization-select ion monitoring. None of the 54 samples analyzed had detectable levels of dimethyl fumarate.

Five of the 16 azo dyes were detected in 80 samples that were analyzed. The dyes that were detected included, Disperse Orange 37, Disperse Orange 3, Disperse Brown 1, Disperse Blue 3,
and Disperse Blue 102. None of the samples containing these dyes exceeded the quantitative limit used by OEKO-TEX. However, the University of Washington indicated that they had lower limits of detection for these dyes compared to the OEKO-TEX methodology. They concluded that “it is not possible to say whether the measured concentrations of the dyes in the fabric are “safe” for individuals that are already sensitized to these dyes. There is also the possibility for cross sensitization between dyes and they could be additive in effect.” They also indicated that “to truly understand whether the potential sensitizers in the textiles are causing the effects experienced by the flight attendants, the flight attendants would need to undergo skin patch testing by a qualified dermatologist to determine whether they were sensitive to the agents in the textiles.”

Additional qualitative analysis was conducted on 54 uniform fabrics by the University of Washington to identify other potential contaminants in the fabrics. This information was provided to us as a Microsoft Excel file in an email from an AFA representative on September 11, 2012. The analytical methods for this testing were not provided. The results identified 98 unique chemicals in the fabrics. No conclusions regarding these data were provided by the University of Washington.

Other exposures
Possible causes of symptoms reported by the flight attendants and cabin crew include the cabin environment itself (e.g., cabin pressure and relative humidity), contaminants in the cabin air (e.g., ozone, pesticides, constituents of engine lubricating oils, and hydraulic fluids), and physiologic stressors (e.g., fatigue, cramped space, and disrupted circadian rhythms) [National Research Council 2001]. Other symptoms could be due to the perception of hazardous exposures, which may or may not be related to an actual health hazard. These symptoms can be severe enough to be distressing and are sometimes disabling. In addition, there was heightened awareness of the suspected uniform problem among the flight attendants from the communication that they received from airline management and AFA about the matter. Such heightened awareness might lead individuals to notice symptoms they might otherwise overlook and to attribute them to the work environment. Care must be taken when attributing common symptoms to particular exposures, because the association is as likely to be coincidental as to be causal.

Conclusions
The number of flight attendants reporting skin, eye, ENT, and respiratory symptoms does not appear to be unusual. These symptoms are common among flight attendants and the general population. In addition, the varied rash distributions, descriptions, and diagnoses, as well as the variety of uniform pieces implicated as causes of symptoms suggest that there is neither one uniform-related etiology nor even one occupational etiology. Finally, while the same uniforms are worn by customer service agents, the customer service agents had a paucity of reports related to the uniforms. Although we learned, through multiple rounds of fabric testing, that the fabrics used in the uniforms contained many chemicals and that one sample (for hexavalent chromium) out of hundreds of samples collected exceeded an established limit value, it is not likely that a specific agent is responsible for all of the symptoms reported by the flight attendants. The
chemicals found are commonly used in garment manufacturing. Although we do not believe that the uniforms contributed to a widespread outbreak of symptoms, it is possible that some symptoms among some flight attendants could be related to a uniform-related contact dermatitis. Thus, individual cases consistent with persistent contact dermatitis warrant clinical evaluation.

We understand that Alaska Airlines flight attendants may have continued concerns about the work-relatedness or uniform-relatedness of their skin symptoms. The appendix to this letter contains detailed information about contact dermatitis, the most common form of occupational skin disease. We suggest that you use an approach similar to the Mathias criteria in responding to these concerns [Mathias 1989]. It is important to answer these key questions:
1. Is the clinical appearance consistent with dermatitis?
2. Is there a workplace exposure to irritants and/or allergens?
3. Is the anatomic distribution consistent with reported exposures in the job task?
4. Is there a consistent temporal relationship of exposure and disease?
5. Have non-occupational exposures been excluded as possible causes?
6. Is there clinical improvement of the condition away from the exposure?
7. Have skin patch tests or use tests identified a probable causal agent?

Recommendations
Even though we are not able to relate the symptoms reported by flight attendants to the uniform, we provide the following recommendations to improve the health and safety of Alaska Airlines flight attendants.

1. Encourage flight attendants to seek evaluation by a qualified medical professional for a rash or other perceived work-related symptom. Although a visual examination by a family physician or internist may suffice for an initial diagnosis, a persistent rash should be evaluated by a dermatologist. The dermatologist may then decide if skin patch testing is clinically indicated. Flight attendants should ensure that their physicians are certified by appropriate medical specialty boards by checking the American Board of Medical Specialties website at http://www.abms.org. It may be helpful for airline management and the union to work together and locate appropriate physicians for flight attendants at the four locations and facilitate contact.

2. Instruct flight attendants to wash new clothes, both uniform and off-duty personal items, before wearing them for the first time. Follow garment label instructions when laundering uniforms.


4. Continue to offer an alternative uniform upon request.
5. Instruct flight attendants to notify their supervisor about any possible work-related health problems.

6. Base the decision to perform additional fabric testing on whether or not documented health symptoms are consistent with a uniform-related etiology. Continued general testing of the uniform fabrics is not warranted. Additional testing would only be productive on a case-by-case basis when clinical suspicion is high for a uniform relationship and when done in conjunction with skin patch testing. It is important to continue to use reliable and recommended testing methods so that data can be accurately interpreted.

7. Recommend flight attendants evaluate the quality of the health information that they find. It is important to ensure that health information is reliable, up-to-date, and unbiased. The National Library of Medicine and the National Institutes of Health offer guidelines for evaluating the quality of health information on the Internet on their website at http://www.nlm.nih.gov/medlineplus/evaluatinghealthinformation.html.

This letter closes our file on this health hazard evaluation request. NIOSH recommends that employers post a copy of this letter for 30 days at or near work areas of affected employees. A copy of this letter is being provided to the AFA.

Thank you for your cooperation with this evaluation. More information on the health of flight attendants can be found on the NIOSH website, “The Flight Crew Research Program,” at http://www.cdc.gov/niosh/topics/flightcrew/. If you have any questions, please do not hesitate to contact Marie de Perio at (513) 841-4116 or Todd Niemeier at (513) 841-4317.

Sincerely yours,

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Medical Officer

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Occupational Health Services
Appendix: Information on contact dermatitis and clothing-related dermatitis

Since 25 flight attendants were given the diagnosis of contact dermatitis, the most common diagnosis on our record review, we are providing information on contact dermatitis.

Contact dermatitis is the most common occupational skin disease. Epidemiologic data show that contact dermatitis makes up 90%–95% of all occupational skin diseases [Fregert 1975; Keil and Shmunes 1983; Mathias 1988]. Contact dermatitis (both irritant and allergic) is an inflammatory skin condition caused by skin contact with an exogenous agent or agents, with or without a concurrent exposure to a contributory physical agent (e.g., ultraviolet light). It is widely accepted that 80% of all contact dermatitis is due to a nonimmunologic reaction to chemical irritants (irritant contact dermatitis) and 20% to allergic reactions (allergic contact dermatitis). Only certain chemicals are allergens and only a small proportion of people are susceptible to them.

In dermatitis, the skin initially turns red and can develop small, oozing blisters (vesicles), and bumps (papules). After several days, crusts and scales form. Stinging, burning, and itching may accompany the rash. With no further contact, the rash usually disappears in 1–3 weeks. With chronic exposure, deep cracking (fissures), scaling, and discoloration of the skin (hyperpigmentation) can occur. It is often not possible to clinically distinguish irritant from allergic contact dermatitis, as both can have a similar appearance and both can be clinically evident as an acute, subacute, or chronic condition.

Employees with previous atopic dermatitis (eczema) may be at higher risk for developing occupational skin diseases, usually of an irritant nature. The most frequent causes of irritant contact dermatitis include soaps/detergents, glass fibers (fiberglass) and particulate dusts, food products, cleaning agents, solvents, plastics and resins, petroleum, products and lubricants, metals, and metalworking fluids [Mathias 1988; Mathias 1990]. Causes of allergic contact dermatitis include metallic salts, organic dyes, plants, plastic resins, rubber additives, and germicides/biocides [Mathias 1990].

A variety of allergens, including dyes and formaldehyde-related textile finishing resins, are present in textiles. Reports of clothing-related contact dermatitis are frequently individual and rarely epidemic [Le Coz 2011]. Clothing dermatitis is more frequently irritant than allergic [Le Coz 2011]. Inducers of dermatitis include textile fibers, textile resins and formaldehyde, textile dyes, rubber, and other components such as chromium salts, cleaners, softeners, and other auxiliaries.

Textile fibers are mainly responsible for irritant contact dermatitis, and patients with atopic dermatitis or dry skin often complain of intolerance to garments [Le Coz 2011]. The irritant potential of wool and that of synthetic fibers is higher while cotton garments are best tolerated. Smooth and soft fabrics worn between the atopic skin and wool can minimize aggravation.

Textile resins, also named durable-press resins or permanent press clothing finishes, are widely used for cotton, cotton/polyester, or wrinkle-resistant linen. They are used to enhance the touch and quality of clothing. The two major types of textile resins are formaldehyde-based resins and
cyclized urea derivatives. Industrial washing decreases the presence of unreacted formaldehyde and resins at the surface of the garment. The threshold rate for allergic contact dermatitis is 500 or 700 ppm free formaldehyde in the garment [Fowler et al. 1992]. The formaldehyde-based resins more commonly produce a smoldering, chronic dermatitis [Cohen et al. 2001; Reitschel et al. 2008].

Sensitization to textile dyes in clothing necessitates a transfer of the dye from the garment to the skin. As of 1995, 49 separate textile colorant dyes had been linked to allergic contact dermatitis, and future research will undoubtedly find more [Hatch and Maibach 1995]. Attributing an allergy to a textile dye is a difficult process. Even if a textile dye is found to be positive on patch testing, the precise identification of the sensitizer in the garment is extremely difficult [Le Coz 2011]. Disperse dyes, which are the principle source of allergic contact dermatitis, are partially soluble in water and are used to color synthetic fibers such as polyester, acrylic, and acetate. They are not used for natural fibers. The disperse dyes most commonly found to be positive on patch testing are Disperse Blue 124 and Disperse Dye 106 [Hatch and Maibach 1995; Pratt and Taraska 2000]. Dermatitis from dyes tends to be acute and rapid in onset [Cohen et al. 2001; Reitschel et al. 2008].

A mordant is an organic or inorganic molecule which combines with a dye to deposit and fix an insoluble color on a fiber. Various acids, such as tannic acid and metal salts including chromium are used as mordants. Chemically, mordant dyes can be considered a subset of acid dyes. Allergic contact dermatitis has been attributed to chrome in military textiles [Wilson and Cronin 1971; Hatch and Maibach 1985].

Allergy to rubber additives or natural rubber latex may produce dermatitis around the waist and brassiere straps at sites of elastic contact [Reitschel et al. 2008]. Elasticized clothing may also cause skin eruptions as a consequence of mechanical pressure. Pressure urticarial, acneiform eruptions, exaggeration of preexisting dermatoses, and nondescript erythematous changes may develop at skin sites at which clothing fits too snugly [Mihan and Ayres 1968].

The work-relatedness of skin diseases often is difficult to prove. The accuracy of the diagnosis is related to the skill level, experience, and knowledge of the medical professional who makes the diagnosis and confirms the relationship with a workplace exposure. Guidelines are available for assessing the work-relatedness of dermatitis and include the following criteria: (1) clinical appearance consistent with a dermatitis, (2) workplace exposures to irritants/allergens, (3) anatomic distribution consistent with reported exposures in the job task, (4) consistent temporal relationship of exposure and disease, (5) non-occupational exposures excluded as possible causes, (6) clinical improvement of the condition away from the exposure, and (7) skin patch tests or use tests identifying a probable causal agent [Mathias 1989]. Further follow-up and diagnostic testing of affected employees would be necessary to meet all of the criteria listed above.

Even with guidelines, the diagnosis may be difficult. The diagnosis is based on the medical and occupational histories and physical findings. The importance of the patient's history of exposures
and disease onset is clear. In irritant contact dermatitis, there are no additional confirmatory tests. Patch tests or provocation tests for irritants are discouraged because of a high false-positive rate. In many instances, allergic contact dermatitis can be confirmed by skin patch tests using specific standardized allergens or, in some circumstances, by provocation tests with nonirritating dilutions of industrial contactants [Reitchel and Fowler 2001].

It is estimated that the incidence of contact dermatitis, both irritant and allergic, is 13.2 cases per 1,000 people [Martin 1999]. Patch testing by a dermatologist could determine if an individual is sensitized to an agent, but, as mentioned above, if they had irritant contact dermatitis, patch testing would not be indicated. Avoidance is the prudent approach to help reduce skin reactions when allergic contact dermatitis has been identified as the cause of skin rashes. In most cases of allergic contact dermatitis to fabric components, it is nearly impossible for the consumer to determine at point of sale what compounds were used in the fabric manufacture when purchasing garments and a trial and error approach should be adapted.
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