

Is It Safe to Wear Contact Lenses with a Full-Facepiece Respirator?

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The Federal OSHA regulation that prohibits the wearing of contact lenses while using a respirator is being challenged by users. We surveyed 9100 fire fighters around the U.S. and Canada to determine if the wearing of contacts while using a self-contained breathing apparatus (SCBA) had caused any serious problems to warrant this strict regulation. Of the 1405 questionnaires returned, 403 fire fighters do wear contacts with SCBA, despite the regulation. Of these, only six responded that contact-lens related problems had caused them to remove the facepiece in an environment in which the facepiece would normally be worn. In contrast, the safety-related problems caused by eyeglasses in SCBA—which are legal—are proportionately higher. Over half of the supervisors returning the questionnaire admitted that some of their employees wear contacts with SCBA; however, these supervisors knew of only eight cases when contact-lens problems had caused the facepiece to be removed when it should not have been. Our investigation has indicated that these problems were not significantly hazardous. We believe that the use of contacts with a respirator should not be prohibited.

Introduction

Dennis Hirschfelder, Director of Eye Safety Programs of the National Society to Prevent Blindness, writes that, "While contact lenses have proven a boon to millions of Americans, their use has created a serious dilemma that pits occupational safety and health professionals against prescribers and fitters of contact lenses—with the worker in the middle. The dilemma is this: should workers be permitted to wear contact lenses on the job? Should contacts be prohibited in any industrial areas and, if so, which ones? The controversy smolders because of a continuing lack of hard data after 25 years of rumors and misinformation.

"Today, 15 million people in the United States wear contact lenses, and a million more are fitted for them each year. For persons who suffer from certain rare conditions such as kerataconus, monocular aphakia, bullous keratopathy and cornea scarring, contacts provide better vision than glasses. Most people, however, choose contacts as a cosmetic alternative to glasses. As the popularity of contact lenses has grown over the past several decades, so has concern about their safety by agencies, organizations and individuals responsible for occupational health and safety programs."^{1,2}

Hirschfelder goes on to review the history of known accidents involving contact-lens use in an industrial environment, and the recommendations and regulations that have been issued regarding the use of contacts. No accidents had been reported to indicate that contacts should not be worn in any industrial environment, as long as standard eye protection is also worn. However, the organizations making recommendations and regulations preferred to err on the conservative side, resulting in a federal regulation stating that "the wearing of contact lenses in contaminated environments with a respirator shall not be allowed."³

The use of contacts by fire fighters has been studied by Mark Kartchner, O.D., a practicing optometrist in Salt Lake City, UT.^{4,5} His study compared the advantages and disadvantages of spectacles and contacts worn while performing all routine duties. For the first six weeks, his 12 subjects wore their eyeglasses and were asked to report weekly all their emergency runs and routine fire duties and whether or not they had had difficulties with their spectacles for each task.

At the end of the first six weeks, each subject received extended-wear contact lenses along with

the appropriate care kit. For the following six weeks, the fire fighters returned weekly and reported all their emergency runs and routine fire duties and any "on-the-job" difficulties with the contacts. Upon completion of the study, the types of runs were tabulated and the incidence of problems was determined. Kartchner found a significant decrease of vision-related problems for the fire fighters once they had begun to use the extended-wear contacts.

Two earlier papers discussed the protective character of contacts. Guthrie and Seitz demonstrated that, for certain liquid irritant exposures, eyes were more protected when wearing hard

contacts than without them. Acetic acid, n-butylamine, and acetone were used in their experiment.⁶ William Dixon reviewed several cases documented in the ophthalmic literature in which hard contacts protected the cornea from injury by flying splinters, metal chips, and a B.B. pellet.⁷

Because of a growing interest in contacts and the regulation mentioned above, the Federal Occupational Safety and Health Administration (OSHA) asked the Safety Science Group at the Lawrence Livermore National Laboratory (LLNL) to determine the facts regarding the safety of wearing contacts while using a full-facepiece respirator.

Experiment Design

After discussing with our sponsor the possible methods of conducting this research, we decided to use the survey method to determine if fire fighters who wear contacts have had any significant problems while wearing self-contained breathing apparatus (SCBA). Fire fighters using SCBA were chosen because of (1) the large number available for our survey, (2) the interest of the OSHA Office of Fire Protection Engineering, and (3) the belief that a full facepiece—which SCBA always have—and tank breathing air provide a safe environment for contact-lens use. Questionnaires were sent to fire fighters via three different routes. Table 1 lists the number of questionnaires sent and the number of returns received.

The three groups of questionnaires were identical except that the CAL group envelopes were addressed to the chief fire official by name, and a

post-paid addressed envelope was enclosed. The International Society of Fire Service Instructors (ISFSI) inserted the questionnaire as a loose sheet in their monthly newsletter, and the International Association of Firefighters (IAFF) attached an introductory letter on their own letterhead asking the recipient to fill out the questionnaire and enclosed a post-paid addressed envelope. We found that the percent of questionnaires returned was much higher when they were personally addressed and when a post-paid envelope was enclosed.

Our questionnaire contained 26 questions divided into three groups: one group for supervisors, regarding the fire fighters in their department or station; a second group for those who personally use SCBA; and third group of general questions to be answered by both users and supervisors. The key questions for supervisors were:

Table 1. Distribution and return of questionnaires.

Mailing list	CAL	IAFF	ISFSI	Total
Number sent	1,200	2,300	5,600	9,100
Number returned	400	604	401	1,405
Percent returned	33	26	7	15
Average number in department	77	90	128	97
Median number of SCBA users in department	27	30	34	30
Total fire fighters in all departments	29,701	52,041	48,672	130,414
Number of supervisors responding	361	316	333	1,010
Number of SCBA users responding	351	550	385	1,286

CAL—California State Fire Service directory.

IAFF—International Association of Fire Fighters.

ISFSI—International Society of Fire Service Instructors.

(1) How many fire fighters under your supervision wear SCBA while wearing contact lenses? (2) How many cases of safety problems with contact-lens use while wearing an SCBA has your fire department had? (3) How many of these have caused the wearer to remove the SCBA facepiece in an environment in which a respirator would normally be worn? The questionnaire contained several choices for the answers.

The group of questions for SCBA users includes queries on both contacts and eyeglasses. The key questions were: (4) Do you wear corrective lenses while using an SCBA? (5) Have you ever had any safety problems caused by your corrective lenses while wearing an SCBA? (6) How many times have these problems caused you to remove the SCBA facepiece in an environment in which it would normally be worn?

Results and Discussion

Population and Response

The responses from the California State Fire Service Directory mailing list give a good measure of the number of fire fighters covered in this survey. The total number in the response to Question 1, "How many fire fighters are in your department?," was 29,701 out of 386 returns. This gives an average of 77 fire fighters per department. Only one questionnaire was sent to the departments listed in the Fire Service Directory, which eliminates the possibility for redundant answers to Question 1. The other mailings, however, were not restricted to one per department, and often the questionnaire was duplicated and distributed throughout the department. Thus several surveys returned from these other mailing lists could all list the total number of fire fighters in the same

department, making our total appear incorrectly high. However, often the respondent would change the question to read, "...under my supervision," which would then be a non-redundant number.

A different measure of the number of fire fighters covered in the supervisors' portion of the survey is taken from Question 13, "How many fire-suppression fire fighters use SCBA in your department?" A distribution of department sizes is obtained from the responses to this question. This distribution is plotted in Fig. 1 as the percent of departments (or responses) with more than N fire fighters versus N, the number of fire fighters using SCBA in the department. The curves are all similar, and the 50%-more-than point falls in the same data bin for all three questionnaire distributions. Thus, the department size distribution is about the

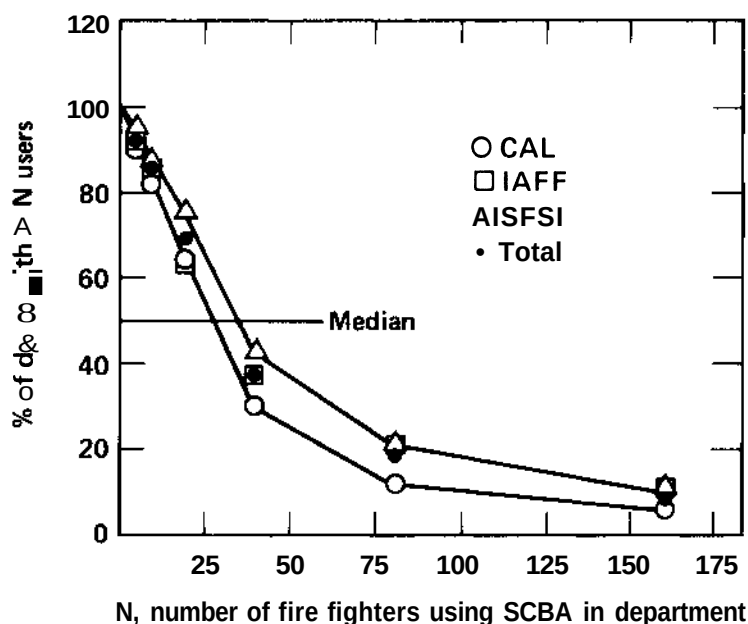


Figure 1. Distribution of number of fire fighters using SCBA in department.

same as for the California mailing, and the total number of fire fighters covered is about 130,000. Table 1 gives details on the questionnaire distribution, responses, and number of fire fighters represented.

The responses to the survey came from all parts of the United States and also from Canada. We entered the state and zip code of each identified return into the database. The zip codes were then sorted in ascending numerical order so that the total number of responses from each of the 10 major zip-code areas could be determined. This distribution is shown in Fig. 2.

Supervisors' Input

Questions 4 through 13 were to be answered by supervisors, and cover information about all fire fighters in the department, not only the individual answering the questionnaire. Some fire departments made several copies of the questionnaire and asked each shift and/or station officer to answer one regarding his workers. These questions and responses are given in Table 2. To eliminate inconsistent answers, we applied several criteria to the responses before including them in the survey:

1. If Q2, "Do you supervise people?" was marked "no," then the responses to the following supervisors' questions were not used.

2. If Q3, "Do you use an SCBA?" was marked "no," then the responses to the SCBA-users' questions were not used.

3. If both Q7 and Q8 (regarding contact-related problems) were marked "none," any responses describing the nature of their problems were not used. Likewise, if both Q7 and Q8 were not marked at all, the responses describing the nature of their problems were not used.

The responses to Q4, 5, and 6 tell us that over half of the departments surveyed have some fire fighters who wear contact lenses while using SCBA. An estimate of the total number of such wearers can be obtained from Q6. If we multiply the number of marked responses for each bin (b, c, d, e, or f) times the middle of the bin range, using 40 for bin "f," then sum these up, we get 1,762 or 1.4% of the fire fighters covered in this survey, an average of 1.25 per fire department.

The key questions in this section are 7 and 8. There were 33 responses indicating that safety problems had occurred with contact-lens use while wearing an SCBA; of these 33, only eight marked that these problems had caused the wearers to remove their SCBA in an environment in which it would normally have been worn. Table 3 lists the answers these eight gave to some related questions, yielding further information. Note that respondent 331 did not consider the facepiece removal a safety problem ("a" response to Q7).

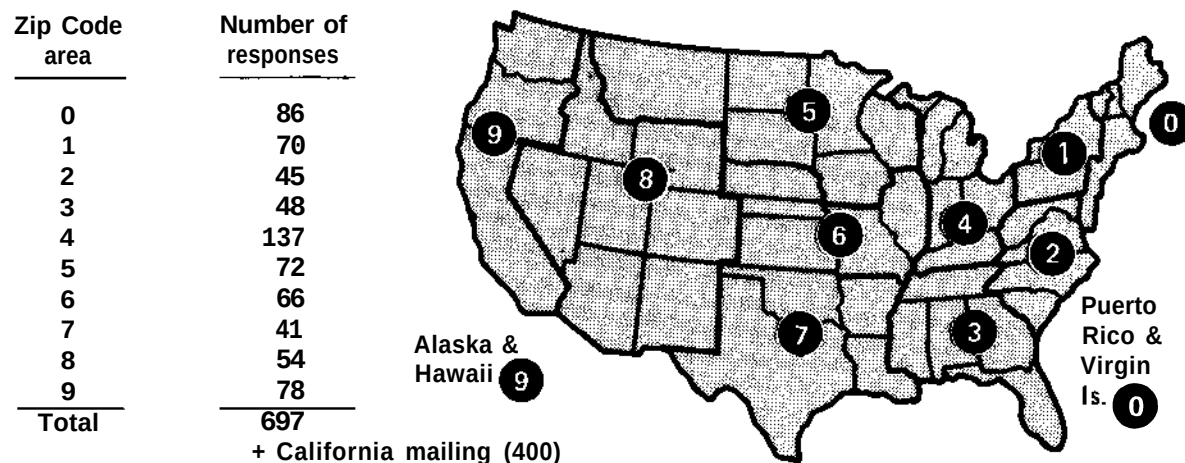


Figure 2. Distribution of returns by zip code.

Table 2. Response from supervisors of fire fighters.

4. What percent of your fire fighters wear contact lenses at any time?	No. Marking Response	9. What was the nature of the problem?	No. Marking Response
a. None b. 1 to 20% c. 21 to 40% d. 41 to 60% e. 61 to 80% f. 81 to 100%	355 618 26 — — 2	a. No problems b. Lens out of place c. Particle under lens d. Hair under lens e. Irritant fumes in eye f. Eyes too dry g. Eyes too wet h. Other (description given)	18 12 7 0 6 14 2 5
5. Of the above, what percent wear SCBA while wearing contact lenses?	No. Marking Response	10. How long had the fire fighters who encountered problems been wearing contact lenses?	Total No. of Cases
a. None b. 1 to 20% c. 21 to 40% d. 41 to 60% e. 60 to 80% f. 80 to 100%	413 415 13 5 8 115	a. Not applicable b. Less than 6 months c. 6 months to 1 year d. 1 to 2 years e. Greater than 2 years	24 2 2 17 13
6. How many fire fighters under your supervision wear SCBA while wearing contact lenses?	No. Marking Response	11. What type of contact lens was worn by those having problems?	Total No. of Cases
a. None b. 1 to 5 c. 6 to 10 d. 11 to 20 e. 21 to 40 f. Over 40	462 454 46 12 2 1	a. Hard b. Soft c. Extended wear d. Not applicable	16 13 13 17
7. How many cases of safety problems relating to contact-lens use while wearing an SCBA has your fire department had?	No. Marking Response	12. How many of your fire fighters prefer to wear contact lenses with SCBAs and also have had no problems?	No. Marking Response
a. None b. 1 to 5 c. 6 to 10 d. 11 to 20 e. 21 to 40 f. Over 40	944 32 0 1 — —	a. None b. 1 to 5 c. 6 to 10 d. 11 to 20 e. 21 to 40 f. Over 40	358 421 66 25 4 5
What time period does this cover? 8.1-year average	No. Marking Response	13. How many fire-suppression fire fighters use SCBA in your fire department?	No. Marking Response
8. How many of these problems have caused the wearer to remove the SCBA facepiece in an environment in which a respirator would normally be worn?	No. Marking Response	a. None b. 1 to 5 c. 6 to 10 d. 11 to 20 e. 21 to 40 f. 41 to 80 g. 81 to 160 h. Greater than 160	26 72 65 165 302 175 90 78
a. None b. 1 to 5 c. 6 to 10 d. 11 to 15 e. 16 to 20	910 8 — — —		

Question 9 should tell us what caused the problem. Four responded that a lens was out of place, which can blur the vision and may cause irritation. A particle under the lens can be caused by the SCBA having a dirty breathing hose or facepiece when it was put on; the air flow would then blow the particles around until some may get in the eye. Particles could also get under a contact lens if the SCBA wearer takes off his facepiece in the staging area, which is often smoky. The same is true for the common problems caused by irritating fumes. However, one fire department replied that they change bottles in the staging area without taking off the facepiece or disconnecting the hose, which would eliminate this problem. The latter procedure is also recommended in SCBA training films. Drying of the eyes or actual drying of the contact lens was marked three times. When dry, the contact lens becomes cloudy. This occurs even in a normal environment, and commercial eye drops will alleviate the problem. The potential for lens drying is accelerated, however, when an SCBA is worn. The air from the tank is very dry, and blows across the facepiece and then past the eyes. The drying effect seems to vary with mask make and whether or not a nose cup is used. Also, drying can be affected by the number of hours the lenses have been worn and the wearer's ability to produce tears. This drying problem is certainly not universal, as some wearers say their eyes get too wet.

Most of the fire fighters reporting problems have been wearing contacts for over a year. The split between hard, soft, and extended-wear lenses is fairly even. Four of the eight supervisors reporting the above problems favor not allowing contacts, two favor contacts, and two have no

opinion. To focus on the positive side of contact-lens use, however, see the responses to Q12 (above), which show that a large number of fire fighters prefer to wear contact lenses with SCBA and have not had any problems.

SCBA Users' Input

Questions 14 through 22 were to be answered by fire fighters who personally use an SCBA. The responses are shown in Table 4.

In Q14, we found that 947 out of the 1,357 respondents wear some type of corrective lenses in their daily activities, of which 418 wear contacts. Comparing these responses with Q15, we find that of the 418 who wear contacts, 403 also wear contacts while wearing an SCBA, despite the regulation against such use. A striking contrast to this is that of the 529 who wear eyeglasses in their daily activities, only 81 also wear eyeglasses with an SCBA. Of the 529, a total of 97 reported that they had had safety problems caused by wearing eyeglasses with an SCBA, while only 34 had reported safety problems caused by wearing contacts. The number of eyeglass-related problems is even greater than the number who actually wear eyeglasses with an SCBA. Some of those who have had trouble with eyeglasses now either wear contacts or suffer from poor vision due to not wearing corrective lenses.

The numbers of various responses do not always add up perfectly, often because one person may have had problems with eyeglasses but now wears contacts. When the questionnaires were first analyzed, we found that many respondents had marked Q17, 18, and 19 (concerning contact-lens problems), but they had indicated in Q15 or 16 that they wear eyeglasses—not contact lenses—with an SCBA. Such responses were removed from the data base, because this survey is aimed at (1) safety problems caused by wearing contacts with an SCBA, and (2) if these problems were ever severe enough to cause the wearer to remove the SCBA in an environment where it would normally be worn. We used several criteria to eliminate responses inconsistent with these aims:

1. If Q14 is marked "c" (does not wear contact lenses), then answers to Q15 through 22 are not valid.

2. If Q16 is "a" and Q21 is "a" (no problems relating to contacts), then answers to Q17 through 20 are not valid.

Table 3. Correlation of facepiece removal with problems (supervisor response).

Respondent	Response to question					25 ^a
	7	8	9	10	11	
305	b	b	e	c	b	c
331	a	b	f	d	b	c
1,077	b	b	bf	e	bc	a
1,175	b	b	be	e	a	b
1,176	b	b	c	e	a	b
1,487	b	b	eg	d	c	c
2,386	b	b	b	d	c	a
2,402	b	b	bcf	—	abc	c

^a See Table 7 for this Question.

Table 4. Response from SCBA users.

14. Do you wear corrective lenses in your daily activities?		19. How long have you been wearing contact lenses?	
	No. marking response		No. marking response
a. Eyeglasses	529	a. Do not wear contacts	2
b. Contact lenses	418	b. Less than 6 months	1
c. No	410	c. 6 months to 1 year	0
If No, please skip to question 23.		d. 1 to 2 years	10
15. Do you wear corrective lenses while wearing an SCBA?		e. Greater than 2 years	21
	No. marking response	20. What was the nature of the problem if with eyeglasses?	
a. Eyeglasses	81		No. marking response
b. Contact lenses	403	a. Not applicable	68
c. No	406	b. Fogging	44
16. Have you ever had any safety problems caused by your corrective lenses while wearing an SCBA?		c. Eyeglasses out of place	36
	No. marking response	d. Bad faceseal	86
a. No	562	e. Other (description given)	33
b. Yes, with eyeglasses	97	21. How many times have these problems caused you to remove the SCBA facepiece in an environment in which it would normally be worn?	
c. Yes, with contact lenses	34		No. marking responses
d. Poor vision due to not wearing corrective lenses	189	a. None	722
17. What was the nature of the problem if with contact lenses?		b. 1 to 5	50
	No. marking response	c. 6 to 10	6
a. Not applicable	2	d. 11 to 15	1
b. Lens out of place	8	e. 16 to 20	3
c. Particle under lens	13	22. Would you prefer to wear contact lenses instead of eyeglasses with an SCBA?	
d. Hair under lens	0		No. marking response
e. Irritant fumes in eye	7	a. Yes	618
f. Eyes too dry	13	b. No	177
g. Eyes too wet	1		
h. Other (description given)	5		
18. What type of contact lens were you wearing when the problem occurred?			
	No. marking response		
a. Hard	12		
b. Soft	11		
c. Extended wear	9		
d. Not applicable	3		

3. If the respondent did not mark Q16 "c" (safety problems caused by contacts), then Q17, 18, and 19 are not valid.

4. If Q16 is not marked "b" or "d" (problems caused by eyeglasses), then Q20 is not valid.

To do a detailed analysis of the respondents who had the worst safety problems due to wearing contacts with an SCBA, we correlated those marking Q16c with those marking Q21 either "b," "c," "d," or "e." Only six respondents marked both of these. Their responses to pertinent questions are given in Table 5. Our personal interviews with them are presented in the following section of this report. Out of 60 giving a positive response to Q21, only six wear contacts, and we checked to see what type of corrective lenses the others used. Table 6 shows that most of these wear eyeglasses, although many have had safety problems because of poor vision due to not wearing corrective lenses while using an SCBA.

General Questions

Several general questions were answered by both supervisors and SCBA users. These questions along with the tallied responses are shown

Table 5. Correlation of facepiece removal with problems (users) (respondents who marked both 16 "c" and 21 "b," "c," "d," or "e").

Respondent no.	Response to question no.							
	15	16	17	18	19	22	23 ^a	25 ^a
311	b	c	f	c	d	a	c	a
1,077	b	cd	bef	bc	e	a	d	a
1,580	bc	cd	cf	b	e	a	c	a
2,349	b	c	ce	a	e	a	e	a
2,352	ab	c	e	b	e	a	b	a
2,402	c	cd	ef	a	e	b	e	c

^a See Table 7 for this Question.

Table 6. Correlation between type of eyewear and removal of facepiece (respondents who marked 21 "b," "c," "d," or "e").

Response from Q16	No.
No problem	10
Eyeglasses	30
Contact Lenses	6
None Worn	24

in Table 7. From the responses to Q23, we learn that although contacts greatly improve vision over eyeglasses in a facepiece, they do not seem to eliminate the fogging problem. Specific comments from respondents (Q24) indicate that using a nose cup is most effective in reducing fogging. The large number of written responses to Q24 and "yes" responses to Q26 (permission to contact respondent for additional interview) indicate the high level of interest in this survey.

The great majority of responses to Q24 strongly support the use of contacts. Most respondents have had no problems. Most of those who have had problems are willing to tolerate them,

Table 7. General questions.

23. Does the use of contact lenses with an SCBA affect the fogging problem in the facepiece?

No. marking response

a. Eliminates fogging problem	31
b. Greatly improves vision over that when using corrective spectacles in the facepiece	145
c. No effect	282
d. Increases fogging problem	1
e. Do not know	758

24. Please describe any positive or negative experiences you have had or know of involving contact lenses and SCBA use.

829 responses

25. What is your opinion on the wearing of contact lenses with SCBA?

No. marking response

a. Should be allowed	764
b. No opinion	411
c. Should not be allowed	134

26. We would appreciate your contribution of greater detail to this study by having one of our staff contact you with reference to your experience with contact lenses. All information will be kept confidential and your participation will enable us to build a more accurate data base for fire fighters on contact-lens use with SCBA. May we contact you?

No. marking response

a. No	326
b. Yes	973

Name:

Address:

Phone No.:

and prefer contacts to the alternatives, which are: not using corrective lenses and thus not seeing clearly; wearing eyeglasses, which many claim will not fit in the facepiece of their SCBA, and which often move out of position or fog up; or stop being a fire-suppression fire fighter. A few of the written responses are given verbatim below. The first two are from a large city fire department of about 900 fire fighters. They indicate that over 40 fire fighters in the department wear contacts with SCBA and have not had any problems.

Selected Responses

Respondent 1332—"The City of _____ Fire Department has realized that this ruling is non-enforceable. Since 1974 we have not had a reported problem nor have I been aware of any problems. Positive comments are that wearers of soft-lens contacts feel they have better eye protection than non-users, i.e., from tear gas and onions. Contacts prevent tearing when in an atmosphere when SCBA is not normally in use. Protection from particles or foreign objects that damage contacts only."

Respondent 1330—"I am a Fire Captain of 14 years and have been on the fire department over 20 years; as a part-time job, I have fitted contact lenses for three ophthalmologists in _____. We currently have several patients wearing contacts who are active fire fighters using SCBAs. Since 1971 when I began fitting, there have been no reports of injury or problems relating to contacts and SCBA. In fact, many wearers (of soft lenses especially) have told me of times the soft lens protected their eyes from tear gas, smoke, etc."

The next two comments are typical of many individuals.

Respondent 1388—"From 1978 to 1981 I wore contact lenses in all of my fire fighting duties. In 1981 I was told by my department that I could no longer wear my lenses with SCBA. Therefore I could not wear lenses at all. So I stopped. In the years 1978 to 1981, I had no real problems with my use of contact lenses (the hard lenses)." He attached a letter which states,

"I started the Fire Department 8/23/78. When I was hired, the Dept. knew I wore contact lens. There was no problem then. In 1981, the city of _____ told me that it was against OSHA to wear lenses, and asked me to stop. I did. But, from 1978 to 1981 I had no real problems. I was wearing contact lenses at [two major fires]. I wore SCBA at [one] fire for about 8 hours and about 2-1/2 hours at the [other], with no problems. Plus all other fires in that time period. I found the advantages to wearing the lens were the fact I had better vision at all times. Also water and sweat did not affect them like it does glasses. We use MSA positive pressure air packs.

"I tried to pursue the reasons for not allowing lens use, but the only reason that would stop me was OSHA rule. MSA said they saw no real problems but would not say "okay" because of possible legal liabilities.

"There are about 35% of glasses wearers that would like to wear lenses.

"Any questions please contact me."

Respondent 1414—"After joining department in 1975, I was 'condemned' to blind firefighting because I was not able to wear my glasses and get a seal with the SCBA. In 1979 I was fitted for soft contact lenses and now have the 'gift of sight' while using SCBA's. I and all the personnel I've talked to in this department use 'soft contacts' and have no complaints and have experienced no problems. It's much safer to fight fire with sight."

Respondent 1607—"Great to have vision and SCBA protection. Have used hard contact lenses in *extreme* firefighting conditions for over 25 years with absolutely no problem. Likely *all* contact lens problems are caused by improper fit or wearer rejection. Users should have annual M.D. inspection for their own protection."

The responses to Q25 show 764 in favor of allowing the use of contacts and only 134 against the use of contacts. The following comments are typical of those against the use of contacts: "Removal of contact lens when in a toxic atmosphere

using SCBA could be fatal" (Respondent 2103), or "Contact lenses are not permitted to be worn by persons who wear SCBA or other types of gas masks at this installation" (Respondent 2095).

Follow-up on Problems

Those respondents who gave the strongest indication of safety problems with contacts are listed in Table 3 (if they answered as a supervisor) or Table 5 (if they answered as an SCBA user). In order to find first-hand cases of these problems, we interviewed those individuals listed in Tables 3 and 5. We were able to contact seven out of the eight supervisors and all of the SCBA users. The pertinent parts of the interview are summarized below.

Respondent 305 (supervisor)—Comment under Q24 was, "Have had one man off-duty for five shifts due to caustic smoke/contact lens exposure, and one man who voluntarily quit wearing contacts due to drying and irritation problems." Also, Q25c, should not allow contacts' was checked. Upon interviewing the respondent, we learned that the "caustic smoke/contact lens exposure" was suffered by an engineer under the fire truck checking smoking/overheated brakes. Upon interviewing the engineer, we found that he was not wearing an SCBA at the time. The respondent—who writes up incident reports—admitted that, after thinking over the contact lens situation and various SCBA problems, the problems he mentioned would not have been worse with contacts than without.

Respondent 311 (supervisor, user)—Uses extended-wear lenses, which dry out and blur while he is sleeping. He needs to blink his eyes for 3-5 minutes, or use drops to re-wet and clear the lenses. His lenses dry due to the strong air flow in his SCBA facepiece, and the dry lenses irritate his eyes. His MSA "pressure-demand" dries the lenses more than his old "demand" SCBA. The respondent has tried several brands of lenses, and some do not dry as much as others. He has not had to remove his facepiece, but thinks someone else had to. He wears contacts regularly.

Respondent 331 (supervisor)—A fire fighter was wearing soft contact lenses with a Scott 9000 SCBA. The constant flow of air dried his eyes and the contact lenses then irritated his eyes to the point that he had to leave the emergency scene. Our follow-up interview showed that he had tried wearing contact lenses for about two years, but had never adapted well to them. He could not keep them in for more than eight hours, and his lenses began to dry out after approximately five

minutes of SCBA use. When the SCBA bypass was open, the strong air flow made the lens move out of place, causing severe pain. Any dust in the air also gets under the lens, causing further irritation. He believes, as do some other respondents, that the positive-pressure SCBAs give a constant flow and higher velocity of air than do the demand type, which do not give a constant flow. (Note, however, that according to the manufacturer the velocity of air is the same; neither type gives constant flow unless the bypass is open.)

Respondent 1077 (supervisor, user)—The positive-pressure SCBAs dry out the lenses, making them cloud up. This can happen while using the first bottle of air or not at all. Using a nose cup with his Scott 4.5 SCBA reduces the drying. He has tried different types of lenses. The daily lenses dry and fall out of his eyes; the 14-day lenses fall out occasionally; the 30-day lenses seldom fall out. When the respondent's lenses fall out, he cannot see as well, but he has never taken off his facepiece inside the fire area. He has worn contact lenses for six years and has lost two lenses during that time. In one instance the respondent accidentally received a sliver in his contact lens, and the optometrist said the lens had saved his pupil from injury.

Respondent 1175 (supervisor)—In instances when a fire fighter needs to remove the facepiece rapidly, such as when his tank runs out of air, he will raise the facepiece from the chin area without loosening the straps. This causes excessive pressure on the temple area and has caused hard contact lenses to pop loose or get out of place. This has not specifically caused a safety problem, although it is difficult to find the lenses again. However, the new net-type mask holder on the Scott 4.5 SCBA does not cause this problem. The respondent had tried contacts but did not prefer them, even in daily activities. The respondent is aware of two other fire fighters who do like their contacts and have had no problems.

Respondent 1176 (supervisor)—No address or phone number given.

Respondent 1487 (supervisor)—This problem is the opposite of most others. The respondent's eyes tear a great deal, which washes the lenses out of place. Also, sweat runs into his eyes and moves the lenses. Often when he is standing in a smoky environment, his eyes start tearing even before he dons the SCBA. He tried to wear contacts for one year before giving up. He would like to try wearing eyeglasses in his facepiece, but does not have the manufacturer's spectacle kit to hold them in place.

Respondent 1580 (user)—Wears three-year-old Bausch and Lomb daily wear contacts. His Scott 4.5 SCBA makes dry air rush past his eyes, causing the lenses to dry and his vision to blur. Occasionally, blinking corrects this condition, but sometimes drops of saline solution are needed. The blurring occurs slowly and may be in only one eye. This is not a critical problem, however, according to the respondent. He has never had to remove the facepiece and lenses in a fire environment. Note that lenses slowly dry out even in normal room conditions. If the respondent uses an SCBA shortly after putting in the lenses, he claims to have no trouble; however, if he has already worn the lenses for 12 hours, they are likely to dry out.

Respondent 2349 (user)—Wears hard contact lenses. He normally has sufficient tears so that his lenses do not dry out. If awakened by an alarm during his sleeping hours, occasionally he experiences some blurriness; but he is able to function, and the blurriness clears up shortly. Sometimes his contact lens will move off the eye center and into a corner of the eye; this causes irritation and is somewhat distracting. At times this irritation has been great enough that he has removed the facepiece to correct the problem by rubbing the corner of his eye. He has done this only when he feels that the atmosphere is safe enough. This irritation has never been such a large problem, however, that he would have removed his facepiece in an IDLH or HAZMAT situation. He thinks that the smoke/fume effect in the bottle-change area is just as bad with or without contact lenses. He notes that if he does get a particle in his eye while wearing contacts, it is worse than without the contacts.

Respondent 2352 (user)—Relatively new fire fighter. Out of eight fires, he has had trouble once.

The problem occurred in an area near a fire with very irritating fumes, and he observed that he experienced more eye irritation than the people without contact lenses. After putting the SCBA back on and re-entering the fire area, his eyes were still irritated enough that he removed the mask to rub his eyes. After this questionnaire was circulated, his chief told him he could no longer wear contact lenses. At present, the respondent wears eyeglasses with a suction-cup-type holder, but would prefer to wear contacts because they greatly improve his vision over wearing eyeglasses in the facepiece.

Respondent 2386 (supervisor)—One of his fire fighters had a lens fall out while wearing an SCBA. Nevertheless, the fire fighter continued his work until he came out of the hazardous environment, then took off the facepiece to get the lens. The respondent himself wears contacts and has had no problem.

Respondent 2402 (supervisor, user)—Previously wore hard contacts, but the lenses tended to get dry during the second bottle of air. In one instance while working in a high-SO₂ atmosphere, he bumped his mask and broke the seal temporarily. He used the bypass to flush out the mask, but the fumes still irritated his eyes. He left the scene and removed his contacts; the irritation then stopped. Another time, during an overhaul he got dust under a lens and removed the facepiece to get it out. His experience is that a large amount of road grit accumulates in the SCBAs as the fire truck drives around; during use of the SCBA, this grit gets blown around, especially when the bypass valve is open, and can get under the lens. He considers this frequent risk to be the biggest problem with contacts, and he has subsequently switched to eyeglasses. The bypass air can also blow the lens off center.

Summary

This questionnaire was sent to 9,100 fire fighters or fire departments, covering all parts of the country. The sizes of the fire departments ranged from 2 to 3,000 fire fighters. The large fraction of respondents who wear contact lenses with an SCBA—403 out of 1,405 returns—indicate a strong interest in the issue by contact-lens wearers. This report has presented a numerical analysis of the responses.

We designed our questionnaire to help us locate any instance where the wearing of contact lenses with an SCBA had caused injury or death to the wearer. The 1,010 supervisors responding reported no deaths or serious injury due to a fire fighter removing his facepiece because of a problem with his contacts. In our interviews with respondents, no one claimed to have had a problem so severe that he could not leave the hazardous

atmosphere area before adjusting the lenses. Respondents who experienced their lenses popping out did not consider this a serious problem. Usually, the lenses that fall out are recovered later from inside the facepiece, although one interviewee said he has lost about one lens per year for the last six years. The number of problems reportedly caused by using eyeglasses in an SCBA—which is legal—was proportionately much higher than those caused by contacts.

The dry air from the tank of compressed breathing air has a tendency to dry out contact lenses. The time for this to cause clouding of the lens or irritation of the eye varies greatly. One user reported clouding in five minutes, other users have had only one lens cloud, and many never experience clouding. From our responses, it seems also that the time varies with the type and make of contact lens.

Interestingly, those respondents who reported rapid drying and irritation, or too much tearing, sweating, and washing of the lens from the eye, had never adapted well to daily off-duty use of contacts. They have since quit wearing contacts.

The other problem frequently reported was dirt, smoke, particles, or fumes getting in the SCBA facepiece, hose, or fittings, either directly in the staging area or (when not in use) on the truck or in storage. The particles later got into the eyes after the facepiece was put on. This response indicates that some fire departments do not use the manufacturer's recommended bottle-changing

techniques in the staging area. It was reported that SCBAs have been contaminated in the staging area with particles so large that they wedged the exhalation valve open. This implied lack of protection of the SCBA itself, especially the facepiece and open hose connections, from dirt while on the truck or in storage is an indication of inadequate maintenance procedures. The fire fighter needs to give only a modest amount of attention to prevent dirt from contaminating his breathing equipment.

Those fire fighters who have adapted well to contact-lens use in their daily activities, those fire departments subscribing to maintenance procedures that protect the SCBA from dirt, and those fire departments using recommended bottle-changing procedures in the staging area have not experienced problems with the wearing of contacts when using SCBA. Similarly, those fire departments that provide spectacle kits for the proper fitting of eyeglasses into the facepiece do not have problems with the wearing of eyeglasses when using SCBA. Those fire fighters who try to wear eyeglasses with standard temple bars under a full facepiece do not get an adequate seal or proper protection. Interviews indicate, however, that with certain combinations of facepiece and facial shape, it is not physically possible to get eyeglasses in their proper position. Kartchner also mentioned that some fire fighters were unable to wear spectacles under SCBA.³ If contact lenses were not prohibited, there would be fewer safety problems due to eyeglasses and poor vision.

Recommendations

Based on a numerical analysis of the responses to the questionnaire, our follow-up interviews with those indicating the worst problems, and reading the 829 comments on positive or negative experiences with contacts, we believe the prohibition against wearing contacts while using a full-facepiece respirator should be revoked or withdrawn.

Wearers of corrective lenses should have the option of wearing either contacts or eyeglasses with their full-facepiece respirators. One must keep in mind, however, that some people do not adapt well to contacts. If the person cannot comfortably wear contacts in everyday non-work situations, then he will probably not adapt well to using them with a full-facepiece respirator. Also, a person's facial shape and eyeglass prescription

may be such that he cannot obtain and retain a proper alignment of his eyeglasses inside the full facepiece. In this case, he would have to wear contacts, or no corrective lenses at all.

Respirator users should be sure their respirators are stored and maintained in a clean environment. Keeping the full facepiece in a disposable plastic bag when not in use and capping the connection to the regulator would eliminate the problem of dirt blowing into the facepiece, and subsequently irritating the eyes of a contact-lens wearer, when the SCBA is first turned on.

Problems with particles and fumes in a fire-suppression staging area should be considered by the individual corrective lens user or fire department. The comments on this situation vary widely, from opinions that contacts protect the

eyes, to those who believe contacts cause increased irritation. Variations in routine work procedures can also improve the use of contact lenses, such as changing air bottles without removing the facepiece, so that cinders or dust cannot fall into it.

Considering the severe conditions under which fire fighters must work, we believe it is unlikely that the working conditions of any other SCBA users would preclude the similar use of contact lenses. This would also include negative-pressure air-purifying respirators.

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