

Solutions to Some Respirator Fit Test Problems

K. Paul Steinmeyer, NRRPT

Introduction

Within the past few weeks three questions have surfaced about respiratory protection programs, all of which have to do with the quantitative fit test protocol used with the TSI Portacount[®]. Two of them are old ones that pop up from time to time, but the third I have never heard asked before. The old questions have to do with what constitutes a failed Portacount test, and the grimace exercise performed as part of the quantitative fit test protocol. The new question involves the bending-over exercise in the fit test protocol. I am taking this opportunity to kill three birds with one stone.

Definition of Terms

- Ambient Aerosol Condensation Nuclei Counter (CNC) Quantitative Fit Test means a quantitative fit test using a TSI Portacount device.
- Generated Aerosol Quantitative Fit Test means a quantitative fit test using an aerosol generator (using corn oil, a sodium chloride solution or other substance) and a closed test booth where the fit test subject stands during the test and into which the challenge aerosol is injected.

Portacount Pass-Fail Criteria

The first question is “If a fit test subject gets a ‘fail’ on one or more of the exercises but gets a satisfactory overall fit, does (s)he pass or fail the fit test?” The simple answer is that the person

passes the test. The justification for this is in the OSHA regulation (below) and in NRC documents.

OSHA says¹ “The overall fit factor is what counts.” NRC says² “Requiring that the *overall* fit factor meet the acceptance criterion means that the fit factor for one or more of the individual test exercises might be less than the acceptance criterion, but a satisfactory overall fit test can still be achieved.” NRC goes on to say³ that “Protocols that can be used for developing QLFT and QNFT procedures may be found in Sections B1 through B5 and in Sections C1 through C3 of Appendix A to OSHA’s 29 CFR 1910.134, ‘Respiratory Protection.’ Fit-testing performed in accordance with these protocols will comply with NRC’s requirements.” This reinforces the statement that it is the overall fit factor that determines pass/fail in a Portacount fit test. Requiring that each individual test exercise achieve a pass exceeds the regulatory requirement. I believe that striving for “perfection” (i.e., a “pass” on all exercises) has a significant down side. It may encourage coaching on the part of the fit test administrator, which is prohibited⁴. It also increases the number of failed tests and therefore increases the amount of time (and the cost) required to fit test a group of workers. Finally, individuals knowing that a

¹ Appendix A *Fit Testing Procedures—Mandatory*, Part I *OSHA-Accepted Fit Test Protocols*, section C *Quantitative Fit Test (QNFT) Protocols*, paragraph 3 *Ambient Aerosol Condensation Nuclei Counter (CNC) Quantitative Fit Testing Protocol*, section (b)(1).

² Regulatory Guide 8.15, Rev. 1, paragraph 5.3.1.

³ Regulatory Guide 8.15, Rev. 1, paragraph 5.3.4.

⁴ Regulatory Guide 8.15, Rev. 1, paragraph 5.3 and NUREG/CR-0041, Rev. 1, section 5.3.2, p. 78.

“pass” has to be achieved on all exercises are likely to perform those exercises with less than full enthusiasm. These last two in effect defeat the purpose of the fit test, and compromise the reliability of the fit test program.

The “Grimace” Exercise

The person who most recently raised this question was of the opinion that the grimace should, in fact, be performed for 60 seconds, and that it should be included in the calculation of the overall fit factor. I disagree.

A careful reading of 29 CFR 1910.134 Appendix A: Fit Testing Procedures (Mandatory) makes it clear that the grimace exercise:

1. Must be included in the protocol⁵;
2. Has a duration of 15 seconds (not 60 seconds)⁶; and
3. Results of this exercise should not be included in calculating the overall fit factor⁷.

The requirements for points 1 and 2 above are clearly documented in the footnote citations. The

⁵ 29 CFR 1910.134, Appendix A, Part I, section A, paragraph 14 Test Exercises, section (a)(6) “Grimace. *The test subject shall grimace* by smiling or frowning. (This applies only to QNFT testing; it is not performed for QLFT.)”

⁶ 29 CFR 1910.134, Appendix A *Fit Testing Procedures—Mandatory*, Part I *OSHA-Accepted Fit Test Protocols*, section A *Fit Testing Procedures—General Requirements*, paragraph 14 *Test Exercises*, section (b) “Each test exercise shall be performed for one minute *except for the grimace exercise which shall be performed for 15 seconds.*” And NUREG/CR-0041, Rev. 1, section 5.6.4.

⁷ NUREG/CR-0041, Rev. 1, section 5.6.3, p. 82. “The grimace exercise is designed to break the face-to-facepiece seal to ensure that the seal is reestablished for the final two exercises. Therefore the fit factor results of the grimace exercise are not used to calculate the overall fit factor.

perceived problem emerges when a person reads 29 CFR 1910, Appendix A, Section C, paragraph 3 *Ambient aerosol condensation nuclei counter (CNC)* (i.e., Portacount) *quantitative fit testing protocol*, subparagraph (b). This paragraph reads as follows:

“(b) Portacount Test Instrument.

“(1) The Portacount will automatically stop and calculate the *overall fit factor* for the entire set of exercises. *The overall fit factor is what counts.* The Pass or Fail message will indicate whether or not the test was successful. If the test was a Pass, the fit test is over.

“(2) Since the pass or fail criterion of the Portacount is user programmable, the test operator shall ensure that the pass or fail criterion meet the requirements for minimum respirator performance in this Appendix. [Author’s Note: In NRC programs refer to 10 CFR 20.1703(c)(6)]

“(3) A record of the test needs to be kept on file, assuming the fit test was successful. The record must contain the test subject’s name; *overall fit factor*; make, model, style, and size of respirator used; and date tested.”

Unfortunately, there is no specific mention in this section of the OSHA rules eliminating the grimace results from the overall fit factor calculation. Buried in the Generated Aerosol QNFT protocol section, however, are the words “The test subject shall be instructed to perform the exercises in section I. A. 14 of this appendix.⁸” As the footnote says, the grimace is performed for only 15 seconds, but there is still no mention of not using the grimace fit factor in the calculating

⁸ 29 CFR 1910.134, Appendix A *Fit Testing Procedures—Mandatory*, Part I *OSHA-Accepted Fit Test Protocols*, section A *Fit Testing Procedures—General Requirements*, paragraph 14 *Test Exercises*. Section (b), footnoted above, states “Each test exercise shall be performed for one minute *except for the grimace exercise which shall be performed for 15 seconds.*”

overall fit factor, so here we have to apply some basic logic to the situation.

In Appendix A (C. 2. (b)(8)(iii)(C)), when describing how to calculate an overall fit factor when using a generated aerosol quantitative fit test device⁹ (e.g., a corn oil booth), OSHA specifically tells the fit test operator to ignore the results of the grimace exercise, even if a computer is doing the calculation. The OSHA rule¹⁰ that specifically addresses the Portacount says:

“(1) The Portacount will automatically stop and calculate the overall fit factor for the entire set of exercises. The overall fit factor is what counts. The Pass or Fail message will indicate whether or not the test was successful. If the test was a Pass, the fit test is over.

“(2) Since the pass or fail criterion of the Portacount is user programmable, the test operator shall ensure that the pass or fail criterion meet the requirements for minimum respirator performance in this Appendix.”

OSHA simply tells us that the Portacount will do the calculation. The standard Portacount method *excludes* the grimace results from the overall fit factor calculation as OSHA specifically instructs those using hand calculation and other computerized methods. It is logical to conclude, therefore, that the OSHA method wants us to exclude the grimace fit factor.

⁹ Appendix A Fit Testing Procedures—Mandatory, Part I OSHA-Accepted Fit Test Protocols, section C Quantitative Fit Test (QNFT) Protocols, paragraph 2 Generated Aerosol Quantitative Fit Testing Protocols, section (b)(8)(iii)(C) “Integration by calculation of the area under the individual peak for each exercise except the grimace exercise. This includes computerized integration.”

¹⁰ Appendix A *Fit Testing Procedures—Mandatory*, Part I *OSHA-Accepted Fit Test Protocols*, section C *Quantitative Fit Test (QNFT) Protocols*, paragraph 3 *Ambient Aerosol Condensation Nuclei Counter (CNC) Quantitative Fit Testing Protocol*, section (b)(1) and (b)(2).

Why Eliminate the Grimace Fit Factor in QNFT?

If a respirator seal is going to fail, it will do so during the grimace exercise. OSHA put it in the protocol to challenge the fit in an extreme way *and try to get a seal break*. This is why only a 15-second exercise is specified—either the seal is going to break or it isn’t. The real test, then, is to establish whether or not the face seal will be *reestablished* during the final two exercises (bending and normal breathing). Anybody familiar with respirator use knows that intermittent seal breaks sometimes occur in the work place. The important thing to try to evaluate during fit testing is whether or not an adequate seal is likely to be reestablished after such intermittent seal breaks. That’s why the exercise isn’t counted in the calculation. It’s only intended to set up the conditions for the final two measurements¹¹. If the average overall fit factor, without the grimace fit factor included, meets the acceptance criteria, the fit test is satisfactory.

Note that the grimace exercise is specifically *excluded* from all qualitative fit test (QLFT) protocols. Why? Because a seal break during QLFT constitutes a test failure. There is no way to recover from a seal break during QLFT since the test subject can’t reliably clear the taste or smell adequately to resume the same test.

Conclusion

Quantitative fit test protocols should include a 15-second grimace exercise, but the fit factor obtained for that exercise should be excluded from the calculation of the overall fit factor.

¹¹ NUREG/CR-0041, Rev. 1, section 5.6.3, p. 82. “The grimace exercise is designed to break the face-to-facepiece seal to ensure that the seal is reestablished for the final two exercises. Therefore the fit factor results of the grimace exercise are not used to calculate the overall fit factor. *This exercise should not be used during QLFT.*”

The Bending Over Exercise

I'll have to admit that this one took me by surprise. Apparently some people are interpreting the OSHA fit test protocol instructions to mean that the bending exercise entails bending over and holding that position (upper torso parallel to the floor) for the 60-second duration of the exercise. NRC has clearly described their version of the bending exercise¹² as an up and down series of movements. The instructions in the OSHA rule¹³ state: "Bending over. The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type QNFT or QLFT units that do not permit bending over at the waist." While the instruction doesn't specifically say to repeatedly bend and stand up straight, some logic has to apply here, too. Since all of the other specified exercises are dynamic rather than static, and since the substitute exercise stated in the rule for those situations where bending is not feasible is also a dynamic exercise (i.e., running in place), it is reasonable to conclude that the bending exercise is also intended to be dynamic.

Conclusion

The test subject should bend, then come back to the vertical position, and then bend again, and so on for the duration of the 60-second exercise¹⁴.

¹² NUREG/CR-0041, Rev. 1, Section 5.6.3, number 7, p. 82.

¹³ 29 CFR 1910.134, Appendix A *Fit Testing Procedures—Mandatory*, Part I *OSHA-Accepted Fit Test Protocols*, section A *Fit Testing Procedures—General Requirements*, paragraph 14 *Test Exercises*, subparagraph (7).

¹⁴ See Steinmeyer, K. Paul. "Respirator Fit Testing and the Exercise Protocol." *Radiation Protection Management*, Vol. 6, No. 5, pp. 72-77; and NUREG/CR-0041, Rev. 1, Section 5.6.3, Paragraph 7, p. 82.

The Author

K. Paul Steinmeyer is the founder and president of Radiation Safety Associates., Inc., and president of RSA Laboratories. He began his career more than 30 years ago as a reactor operator on a nuclear-powered submarine. His experience in the nuclear industry includes consulting work for the U.S. Nuclear Regulatory Commission, the United Nations Development Programme, the International Atomic Energy Agency, and numerous materials licensees. He is a Registered Radiation Protection Technologist (NRRPT), a member of the Health Physics Society, and serves as editor for *Radiation Protection Management* and *RSO Magazine*. Paul is the co-author of *Mathematics Review for Health Physics Technicians*.

Radiation Safety Associates, Inc.
19 Pendleton Drive, PO Box 107
Hebron, CT 06248

Phone 860/228/0487; fax 860/228-4402
Email: kpstein@radpro.com

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