MASTER

QUANTITATIVE RESPIRATOR MAN-TESTING
AT ROCKY FLATS

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Abstract

The dioctyl phthalate quantitative respirator man-testing method used at Rocky Flats is outlined. Using this method ninety three persons trained to use self contained breathing equipment were tested with eight respiratory protective devices. Test results obtained with the seven devices using high efficiency particulate filters are compared to the results obtained with the self contained breathing equipment. Also comparison is made for these results to test results for 1667 other employees.

Introduction

The respiratory protection program at Rocky Flats includes these major functions: (a) a quantitative man-testing program to determine and make mandatory the use of best fit equipment (b) a device maintenance, cleaning and inspection program (c) a quality assurance program for new and used equipment (d) a close control of the use of equipment and (e) a central coordination of all elements of the program.

The quantitative respirator man-test program was implemented in February, 1973. Prior to this time the fitting program at Rocky Flats was accomplished using an irritant smoke as the challenge aerosol.

Discussion

This paper briefly discusses the quantitative respirator man-test using DOP as the challenge aerosol. The man-test results for best fit determinations are shown with some emphasis given to a discussion of a 93 person test group. This group was fitted with air purifying half masks and full face masks as well as being fitted with self contained breathing equipment.

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Quantitative Respirator Man-Testing

This testing method uses DOP as the challenge aerosol. The leak rate is determined by comparing the concentration of aerosol inside the test mask to the concentration in the test chamber.

Each individual to be fitted is tested with four types of half masks and 3 types of full face masks. Only those persons who have been trained to use self contained breathing equipment are fitted with this type of respiratory protective device.

If any person, scheduled to be fitted, indicates a medical problem or if one is known a contact is made with the Medical Department before the test is started. The advice from Medical is followed.

An audio-visual training presentation is given to each person before testing. This describes the proper way to don and remove a mask, how to inspect and fit a mask, how the individual should care for and clean a mask and retention time based on type of use. Further training is accomplished on a one to one basis before testing begins.

Four facial measurements are taken and recorded of each person. They are: face length, face width, lip length relaxed, and lip length smiling.

A person being fitted with each of the available masks is required to perform nine exercises during the test. They are: normal breathing, deep breathing, smile, frown, cough, put hands on hips bend forward at the waist and move head from side to side, put hands overhead and move the head up and down, talk and walk on a treadmill.

While the nine exercises are being performed a continuous sample is taken from inside the mask, at a rate of 8 lpm. This sample is passed through a particle detecting apparatus that reads out in percent penetration. After the individual has been fitted with the 4 available half masks a determination, based on the average and maximum leak rates, is made as to the one mask that provides the highest degree of protection. A determination is made for the 3 full face masks, based on the same parameters. When all tests have been completed the individual is presented a card that lists the half and full face masks that must be worn when a situation or condition requires this type of respiratory protection.

An individual who cannot be fitted with a half mask and/or a full face mask is restricted from performing any job or being assigned to any area that may require the use of this type of respiratory protection. This restriction is a written notice to the individual and his supervisors.

Results

The 93 person test group is considered apart from other persons tested because this group allows comparison between fits with air purifying respirators as well as self contained breathing equipment. Table 1 shows the best fit half mask determined for each person. If one wishes to relate the indicated leak rates to protection factors ranges it may be done by starting with the first column on the left as representing a protection factor range of 10 to 100, the second column 100 to 1,000, the third column 1,000 to 10,000 and the fourth column as greater than 10,000. It should be noted that 93.5 percent of those tested received a protection factor of 100 or greater. Of the total test group 98.9 percent received a protection factor of 32 or greater. The test group of 93 persons is small enough that it does not allow statistical value to be associated with the one no fit recorded.

Table 1. Best Fit Half Mask Respirator For Each Person In The 93 Person Test Group.

Avg. Leak %	5 to 0.5	0.5 to 0.05	0.05 to 0.005	<0.005	
Max. Leak %	10 to 1	1 to 0.1	0.1 to 0.01	<0.01	Total
Mask Type					
1	1	16	21	0	38
2	1	10	14	2	27
3	1	6	4	0	11
4	2	5	8	1	16
Not tested					0
Not fit by any half mask					1
					<u>93</u>

Table 2 shows the best fit full face mask determined for each person of the 93 person test group. All persons in the test group received a protection factor of 100 or greater with at least one of the three full face masks available at Rocky Flats. In the 100 to 1,000 protection factor range 10 of the 15 persons in that column received protection factors of 500 or greater. Of the test group 88 or 94.6 percent obtained a protection factor of 500 or greater.

Table 2. Best Fit Full Face Respirator For Each Person In The 93 Person Test Group.

Avg. Leak %	0.5 to 0.05	0.05 to 0.005	<0.005	
Max. Leak %	1 to 0.1	0.1 to 0.01	<0.01	Total
Mask Type				
1	10	10	0	20
2	1	25	5	31
3	4	22	16	42
Not tested				0
Not fit by any full face mask				0
				<u>93</u>

Table 3 shows the protection factor ranges obtained by each person, of the 93 person test group, while wearing self contained breathing equipment. Each person was fitted with this equipment operated in both the demand and pressure demand modes. Each person, in this test group, was fitted with the 4 half masks first, the 3 full face masks next and then the self contained breathing equipment. The person being fitted was required to perform the previously mentioned set of exercises during each test, therefore it is felt that very good simulated working conditions were achieved. The tests performed with the equipment in the demand mode showed that 77 persons or 82.8 percent of those tested could not obtain a protection factor of at least 10,000. In the pressure demand mode all 93 persons obtained a protection factor of 10,000 or greater.

Table 3. Fitting Results For the 93 Person Test Group Fitted With Self Contained Breathing Equipment

Avg. Leak %	>0.5	0.5 to 0.05	0.05 to 0.005	<0.005	
Max. Leak %	>1.0	1 to 0.1	0.1 to 0.01	<0.01	Total
Test Mode					
Demand	12	29	36	16	93
Pressure Demand	0	0	8	85	93

To permit a better interpretation of Tables 1 and 2 the terms "No fit" and "Not tested" are used as follows:

1. No fit as used in Table 1 indicates the average leak rate is greater than 5 percent or the maximum leak rate is greater than 10 percent. As used in Table 2 it indicates the average leak rate is greater than 0.5 percent and the maximum leak rate is greater than 1 percent.
2. Not tested as used in Tables 1 and 4 indicates that a medical restrictions has been imposed. As used in Tables 2 and 5 it indicates that there is either a medical restriction or the person was not tested due to the nature of the job assignment not requiring the use of this type of respiratory protection devices.

Table 4 shows the protection factor ranges obtained by each person fitted with half masks since the fitting program was started in February, 1973. Only the best fit mask for each person has been included in this table. It is interesting to note that in both table 1 and 4 that approximately 94 percent of those tested with the 4 types of half masks available obtained a protection factor of 100 or greater.

Table 4. Best Fit Half Mask Respirator. Total Persons Fitted 1667.

Avg. Leak %	5 to 0.5	0.5 to 0.05	0.05 to 0.005	<0.005	
Max. Leak %	10 to 1	1 to 0.1	0.1 to 0.01	<0.01	Total
Mask Type					
1	33	241	481	71	826
2	36	142	227	22	428
3	22	79	87	2	190
4	23	75	97	20	215
Not tested					3
Not fit by any half mask					5
					<u>1667</u>

Table 5 shows the protection factor ranges obtained by each person fitted with full face masks since the fitting program was started in February 1973. Only the best fit mask for each person has been included in this table.

Table 5. Best Fit Full Face Respirators. Total Persons Fitted 1667.

Avg. Leak %	0.5 to 0.05	0.05 to 0.005	<0.005	
Max. Leak %	1. to 0.1	0.1 to 0.01	<0.01	Total
Mask Type				
1	86	147	4	237
2	140	404	117	661
3	108	400	165	673
4	22	20	2	44
Not tested				42
Not fit by any full face mask				10
				<u>1667</u>

Observations

The quantitative respirator man-testing program has two main objectives. The first is to assure the individual that he is using the best fitting masks that are available. The second is to provide the individual with training on a one-to-one basis in the best methods of donning, removing, and maintaining a respirator and the limitations of these devices.

Close association with a quantitative respirator man-test program and with the total respiratory protection program at Rocky Flats has provided. The opportunity for making certain observations. The program is designed for operational application of respiratory protective devices. Since the plant has a large group using respirators (largely for precautionary reasons) considerable data has been recorded and procedures developed on performance and fitting relative to the users.

From evaluations and experiences with different types of respirators, it appears that the technical development of respiratory protective devices lags behind the users' needs.

Findings over the years have substantiated the need for an the benefits that can be gained from a good quality assurance program. One of the major findings showed that a new mask should never be used before it has been laundered. The presence of a mold release compound can cause large leaks particularly in the exhalation valve area. Even small groups using masks should have a minimum quality assurance program even if it consists only of a trained person performing a visual inspection.

The evidence presented in the 5 tables substantiates the need for a fitting program. Small group users should employ at least a qualitative fitting program and have available more than one type of device. The discovery of one poor-fit or one no-fit emphasizes these needs.

To assure the necessary performance of respiratory protective devices, one should not rely completely on NIOSH-TC-approval to assure that a device meets your operational requirements. It may require development of your own more strict performance criteria.

For a task that requires the wearing of respiratory protective devices, a strict criterion should be that a person is clean shaven.

During the fitting of the 93 person test group with the self-contained breathing equipment, it was shown that one cannot assume a positive pressure face mask will always provide good respiratory protection. All persons in this test group had to be and were trained to use the equipment. To achieve the results shown in table 3, additional training on a one-to-one basis on the proper method for donning and adjusting the face mask was required.

Typically full face masks provide a slightly higher degree of protection. However, poor fits and no fits do exist due to the variations in contour of the human face. For example, the most common point for leakage is in the temple area. Thus emphasis must be placed on the need for variety in the sizes of respirators made available.

Suggestions have been made that for testing and certification of respiratory protective devices only 5 exercises should be performed. They are: normal breathing, deep breathing, move the head side to side, move the head up and down and talking. Since the operational application of respiratory protection is quite different than controlled laboratory tests, the set of nine exercises used at Rocky Flats is strongly recommended as having a greater impact on determining respirator performance. We feel the nine tests are absolutely necessary to simulate actual conditions the worker will encounter on the job.