National Institute for Occupational Safety and Health National Personal Protective Technology Laboratory P.O. Box 18070 Pittsburgh, PA 15236		
Procedure No. RCT-ASR-STP-0121A	Revision: 1.1	Date: 21 September 2005

DETERMINATION OF RATED SERVICE TIME - CLOSED-CIRCUIT, DEMAND AND PRESSURE-DEMAND, SELF-CONTAINED BREATHING APPARATUS STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedures for ensuring that the level of protection provided by the rated service time requirements on Closed-Circuit, Demand and Pressure-Demand, Self-Contained Breathing Apparatus (SCBA) submitted for Approval, Extension of Approval, or examined during Certified Product Audits, meet the minimum certification standards set forth in 42 CFR, Part 84, Subpart F, Section 84.53, Subpart G, Section 84.63(a)(c)(d), and Subpart H, Section 84.96, 84.97(d), 84.99, 84.100, and 84.103; Volume 60, Number 110, June 8, 1995.

2. GENERAL

This STP describes the Determination of Rated Service Time - Closed-Circuit, Demand and Pressure-Demand, Self-Contained Breathing Apparatus test in sufficient detail that a person knowledgeable in the appropriate technical field can select equipment with the necessary resolution, conduct the test, and determine whether or not the product passes the test.

3. EQUIPMENT/MATERIALS

3.1. The list of necessary test equipment and materials follows:

3.1.1. One B-D Yale (2317 100YL) 100cc (Becton, Dickson and Co.) syringe "Luer-Lok", Becton Dickson & Company, Rutherford, NJ. or equivalent.

Approvals:	1st Level	2nd Level	3rd Level

3.1.2. Doric Series 400A Digital Trendicator, Doric Scientific Division, Emerson Electric Company, 3883 Ruffin Road, San Diego, CA 92123 or equivalent.

3.1.3. Validyne Digital Readout - Model CD23 or equivalent.

3.1.4. Temperature compensated pressure transducer (Validyne Engineering Model No. DP45) or equivalent.

3.1.5. Electric timer, calibrated to l00ths of a minute (Precision Scientific Co.) or equivalent.

3.1.6. Multiple outlet box with 6 receptacles or equivalent.

3.1.7. Timer, Digital stopwatch, calibrated to hundredths of a minute (Cronus Precision Products, Inc.) to hand carry. or equivalent.

3.1.8. Applied Electrochemistry CO_2 Analyzer - Model CD-3A or equivalent.

3.1.9. Applied Electrochemistry Oxygen Analyzer - Model S-3A or equivalent.

3.1.10. Oxygen - U.S.P or equivalent.

3.1.11. Carbon dioxide - calibration gas, 4-5%, 1-2%, 3-4% Matheson Scientific Company, E. Rutherford, NJ or equivalent.

3.1.12. Carbon dioxide calibration curve or equivalent.

3.1.13. Fifty-pound sack or equivalent.

3.1.14. Forty-five pound pipe weight or equivalent.

3.1.15. Forty-five pound weight pulling machine (U.S. BOM) or equivalent.

3.1.16. Knee pads or equivalent.

3.1.17. Matheson Gas Products Model # 8320 carbon dioxide regulator, East Rutherford, NJ or equivalent.

3.1.18. Dwyer Slant Manometer 0-3", F. W. Dwyer Manufacturing Co., Michigan City, Indiana or equivalent.

3.1.19. Model 18-49B Horizontal Treadmill, 0-6 MPH, Quinton Instruments, 3051 44th Avenue, West Seattle, Washington 98199 or equivalent.

3.1.20. National Draeger Endless Ladder, 0-130 feet/minute S/N181-2486 or equivalent.

3.1.21. A crash cart with current dated drugs and equipment at the test scene.

3.1.22. Two test subjects meeting requirements of the NIOSH Human Subject Review Board (HSRB) approved Protocol. Refer to HSRB-73-DSR-01, “Protocol for the Testing of Respiratory Protective Devices” for the proper consent form and complete details on the use of human test subjects in respirator certification testing.

3.1.23. A hospital type gurney (or a bed for test subject to lay on) or equivalent.

3.1.24. A 4' by 8' pad for test subject to crawl on or equivalent.

4. TESTING REQUIREMENTS AND CONDITIONS

4.1. Prior to beginning any testing, all measuring equipment to be used must have been calibrated in accordance with the manufacturer's calibration procedure and schedule. At a minimum, all measuring equipment utilized for this testing must have been calibrated within the preceding 12 months using a method traceable to the National Institute of Standards and Technology (NIST).

4.2. The compressed gas cylinder must meet all applicable Department of Transportation Requirements for cylinder approval as well as for retesting/requalification.

4.3. Normal laboratory safety practices must be observed. This includes all safety precautions described in the current ALOSH Facility Laboratory Safety Manual.

4.3.1. Safety glasses, lab coats, and hard-toe shoes must be worn during all testing.

4.3.2. Work benches must be maintained free of clutter and non-essential test equipment.

4.3.3. When handling any glass laboratory equipment, lab technicians and personnel must wear special gloves which protect against lacerations or punctures.

5. PROCEDURE

Note: Reference Section 3 for equipment, model numbers and manufacturers. For calibration purposes use those described in the manufacturer's operation and maintenance manuals.

5.1. The Man Test Number Four is conducted in duplicate as outlined in the Standard Test

Procedure RCT-ASR-STP-0140 for the specific duration requested for the self-contained breathing apparatus by the manufacturer.

5.2. During the sampling periods, the following elements are sampled/monitored:

A. Oxygen in inhalation tube.

B. Carbon-Dioxide-Inspired.

C. Temperature in Mask.

D. Gauge Pressure.

E. Subject pulse rate.

F. Subject respiration rate.

G. Breathing Resistance-Inhale/Exhale.

5.3. Data Analysis

All sample values must be within the regulations requirements. The Closed-Circuit Self-Contained breathing apparatus must perform for the period of time requested by the manufacturer's submittal, on Man Test # 4, or the Closed-Circuit Self-Contained breathing apparatus fails the test. The duration of the Closed-Circuit Self-Contained breathing apparatus will be set in accordance with Section 84.53 Service Time; Classification.

Note: This test should be done on a minimum of two respirators, or more if additional testing is required (42 CFR, Part 84, Sections 84.12, 84.30, and 84.60).

6. PASS\FAIL CRITERIA

6.1. The criterion for passing this test is set forth in 42 CFR, Part 84, Subpart F, Section 84.53, Subpart G, Section 84.63(a)(c)(d), and Subpart H, Section 84.96, 84.97(d), 84.99, 84.100, and 84.103; Volume 60, Number 110, June 8, 1995.

6.2. This test establishes the standard procedure for ensuring that:

84.53 Service time; classification.

(a) Respirators described in subparts H through L of this part shall be classified, where applicable, as approved for use during the following prescribed service times:

(1) Four hours;
(2) Three hours;
(3) Two hours;
(4) One hour;

(5) Forty-five minutes;
(6) Thirty minutes;
(7) Fifteen minutes;
(8) Ten minutes;
(9) Five minutes; or
(10) Three minutes.

(b) Other service times may be prescribed by the Institute.

84.63 Test requirements; general.

(a) Each respirator and respirator component shall when tested by the applicant and by the Institute, meet the applicable requirements set forth in subparts H through L of this part.

(c) In addition to the minimum requirements set forth in subparts H through L of this part, the Institute reserves the right to require, as a further condition of approval, any additional requirements deemed necessary to establish the quality, effectiveness, and safety of any respirator used as protection against hazardous atmospheres.

(d) Where it is determined after receipt of an application that additional requirements will be required for approval, the Institute will notify the applicant in writing of these additional requirements, and necessary examinations, inspections, or tests, stating generally the reasons for such requirements, examinations, inspections, or tests.

84.96 Service time test; closed-circuit apparatus.

(a) The closed-circuit apparatus will be classified according to the length of time it supplies adequate breathing gas to the wearer during man test No. 4 described in Table 4 of this subpart.

(b) The service time obtained on man test No. 4 will be used to classify the closed-circuit apparatus in accordance with 84.53.

84.97 Test for carbon dioxide in inspired gas; open- and closed-circuit apparatus; maximum allowable limits.

(d) In addition to the test requirements for closed-circuit apparatus set forth in paragraph

(b) of this section, gas samples will be taken during the course of the man tests described in Tables 1, 2, 3, and 4 of this subpart. These gas samples will be taken from the closed-circuit apparatus at a point downstream of the carbon dioxide sorbent, and they shall not contain more than 0.5 percent carbon dioxide at any time, except on apparatus for escape only, using a mouthpiece only, the sample shall not contain more than 1.5 percent carbon dioxide at any time.

84.99 Man tests; testing conditions; general requirements.

(a) The man tests described in Tables 1, 2, 3, and 4 represent the workload performed in the mining, mineral, or allied industries by a person wearing the apparatus tested.

(b) The apparatus tested will be worn by personnel trained in the use of self-contained breathing apparatus, and the wearer will, before participating in these tests, pass a physical examination conducted by a qualified physician.

(c) All man tests will be conducted by the Institute.

(d) The apparatus will be examined before each man test to ensure that it is in proper working order.

(e) Breathing resistance will be measured within the facepiece or mouthpiece and the wearer's pulse and respiration rate will be recorded during each 2-minute sample period prescribed in tests 1, 2, 3, and 4.

(f) Man tests 1, 2, 3, 4, 5, and 6 will be conducted in duplicate.

(g) If man tests are not completed through no fault of the apparatus, the test will be repeated.

84.100 Man tests 1, 2, 3, and 4; requirements.

Man tests 1, 2, 3, and 4, set forth in Tables 1, 2, 3, and 4 respectively, prescribe the duration and sequence of specific activities. These tests will be conducted to:

(a) Familiarize the wearer with the apparatus during use;

(b) Provide for a gradual increase in activity;

(c) Evaluate the apparatus under different types of work and physical orientation; and

(d) Provide information on the operating and breathing characteristics of the apparatus during actual use.

84.103 Man tests; performance requirements.

(a) The apparatus shall satisfy the respiratory requirements of the wearer for the classified service time.

(b) Fogging of the eyepiece shall not obscure the wearer's vision, and the wearer shall not experience undue discomfort because of fit or other characteristics of the apparatus.

(c) When the ambient temperature during testing is 24 degrees $\pm$ 6 degrees C. (75 degrees $\pm$ 10 degrees F.), the maximum temperature of inspired air recorded during man tests shall not exceed the following, after correction for deviation from 24 degrees C. (75 degrees F.):

Where service life of apparatus is--	Where percent relative humidity of inspired air is--	Maximum permissible temperature of inspired air shall not exceed--	
1/4 hour or less	0-100	135	57
1/2 hour to 3/4 hour	0-50 50-100	125 [1]110	52 [1]43
1 to 2 hours	0-50 50-100	115 [1]105	46 [1]41
3 hours	0-50 50-100	110 [1]100	43 [1]38
4 hours	0-50 50-100	105 [1]95	41 [1]35

[1]Where percent relative humidity is 50-100 and apparatus is designed for escape only, these maximum permissible temperatures will be increased by 5°C (10°F).

7. RECORDS\TEST SHEETS

7.1. All test data will be recorded on the RATED SERVICE TIME, CLOSED-CIRCUIT, SELF-CONTAINED BREATHING APPARATUS Man Test # 4 test data sheets as listed in Section 8.

7.2. All videotapes and photographs of the actual test being performed, or of the tested equipment shall be maintained in the task file as part of the permanent record.

7.3. All equipment failing any portion of this test will be handled as follows;

7.3.1. If the failure occurs on a new certification application, or extension of approval application, send a test report to the RCT Leader and prepare the hardware for return to the manufacturer.

7.3.2. If the failure occurs on hardware examined under an Off-the-Shelf Audit the hardware will be examined by a technician and the RCT Leader for cause. All equipment failing any portion of this test may be sent to the manufacturer for examination and then returned to NIOSH. However, the hardware tested shall be held at the testing laboratory until authorized for release by the RCT Leader, or his designee, following the standard operating procedures outlined in Procedure for Scheduling, and Processing Post-Certification Product Audits, RB-SOP-0005-00.

8. SAMPLING SCHEDULE AND WORK SCHEDULE:

Man Test #4 3-minutes

Man Test #4 5-minutes

Man Test #4 10-minutes

Man Test #4 15-minutes

Man Test #4 30-minutes

Man Test #4 45-minutes

Man Test #4 1-hour

Man Test #4 2-hour

Man Test #4 3-hour

Man Test #4 4-hour

MAN TEST # 4 - 3 MINUTES

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 3 Minute

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge

None

Work Schedule

Time/Min.	Exercise
0-1	vertical
1-2	rope pull - 15 times
2-3	walk - 3mph

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

MAN TEST # 4 - 5 MINUTES

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 5 Minute

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge

None

Work Schedule

Time/Min.	Exercise
0-1	vertical
1-2	walk - 3mph
2-4	rope pull - 30x2 min.
4-5	run - 6mph

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

MAN TEST # 4 - 10 MINUTES

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 10 Minute

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
5 – 7									

Work Schedule

Time/Min.	Exercise
0-1	vertical
1-2	walk - 3mph
2-4	rope pull - 30x2 min.
4-5	walk - 3mph
7-8	run - 6mph
8-9	overcast - 1x1min
9-10	walk - 3mph

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

MAN TEST # 4 - 15 MINUTES

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 15 Minute

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
0 - 2									
13 – 15									

Work Schedule

Time/Min.	Exercise
2-3	walk - 3mph
3-4	vertical
4-5	walk - 3mph
5-7	rope pull - 30x2 min.
7-8	walk - 3mph
8-9	overcast - 1x1min
9-10	walk - 3mph
10-11	run - 6mph
11-12	overcast - 1x1min
12-13	rope pull - 15x1min.

Test Engineer: _____ PASS_____ FAIL_____

MAN TEST # 4 - 30 MINUTES

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 30 Minute

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
0 – 2									
14 – 16									
28 – 30									

Work Schedule

Time/Min.	Exercise
2-4	walk - 3mph
4-5	vertical
5-7	walk - 3mph
7-12	rope pull - 60x5 min.
12-13	walk - 3mph
13-14	overcast - 1x1min
16-19	walk - 3mph
19-20	run - 6mph
20-23	overcast - 2x3min
23-28	rope pull - 60x5min.

Test Engineer: _____ PASS_____ FAIL_____

MAN TEST # 4 - 45 MINUTES

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 45 Minute

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
0 – 2									
17 – 19									
31 - 33									
43 - 45									

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

Work Schedule

Time/Min.	Exercise
2-4	walk - 3mph
4-5	vertical
5-7	walk - 3mph
7-12	rope pull - 60x5 min.
12-14	walk - 3mph
14-17	overcast - 2x3min
19-22	walk - 3mph
22-23	run - 6mph
23-29	overcast - 4x6min
29-31	rope pull - 30x2min.
33-35	walk - 3mph
35-40	rope pull - 60x5 min.
40-42	overcast - 1x2min.
42-43	carry 45lb weight & walk 3mph

MAN TEST # 4 - 1 HOUR

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 1 Hour

Unit weight: Initial - _____ Final - _____

Observers:

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
0 – 2									
23 – 25									
42 – 44									
58 – 60									

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

Work Schedule

Time/Min.	Exercise
2-4	walk - 3mph
4-5	vertical
5-7	walk - 3mph
7-12	rope pull - 60x5 min.
12-15	walk - 3mph
15-23	overcast - 4x8min
25-29	walk - 3mph
29-30	run - 6mph
30-39	overcast - 6x9min
39-42	rope pull - 36x3min.
44-50	walk - 3mph
50-55	rope pull - 60x5 min.
55-58	carry 45lb weight & walk 3mph

MAN TEST # 4 - 2 HOURS

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 2Hours

Unit weight: Initial - _____ Final - _____

Observers:

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
0 – 2									
10 – 12									
20 – 22									
28 – 32									
53 – 55									
72 – 74									
88 – 92									
100 – 102									
110 – 112									
118 – 120									

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

Work Schedule

Time/Min.	Exercise
2-10	walk - 3mph
12-20	walk - 3mph
22-28	walk - 3mph
32-34	walk - 3mph
34-35	vertical
35-37	walk - 3mph
37-42	rope pull - 60x5 min.
42-45	walk - 3mph
45-53	overcast - 4x8min
55-59	walk - 3mph
59-60	run - 6mph
60-69	overcast - 6x9min
69-72	rope pull - 36x3 min.
74-80	walk - 3mph
80-85	rope pull - 60x5 min.
85-88	carry 45lb weight & walk 3mph
92-100	walk - 3mph
102-110	walk - 3mph
112-118	walk - 3mph

MAN TEST # 4 - 3 HOURS

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 3Hours

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
0 – 2									
20 – 22									
40 – 42									
58 – 62									
83 – 85									
102 – 104									
118 – 122									
140 – 142									
160 – 162									
178 – 180									

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

Work Schedule

Time/Min.	Exercise
2-20	walk - 3mph
22-40	walk - 3mph
42-58	walk - 3mph
62-634	walk - 3mph
64-65	vertical
65-67	walk - 3mph
67-72	rope pull - 60x5 min.
72-75	walk - 3mph
75-83	overcast - 4x8min
85-89	walk - 3mph
89-90	run - 6mph
90-99	overcast - 6x9min
99-102	rope pull - 36x3 min.
104-110	walk - 3mph
110-115	rope pull - 60x5 min.
115-118	carry 45lb weight & walk 3mph
122-140	walk - 3mph
142-160	walk - 3mph
162-178	walk - 3mph

MAN TEST # 4 - 4 HOUR

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 4 hour

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min.	Gas Percent		Pulse	Resp.	Resistance		Temperature		Press.
	CO_2	0_2	bpm	rpm	inh.	exh.	unit	amb.	gauge
0-2									
20-22									
40-42									
58-62									
83-85									
102-104									
118-122									
140-142									
160-162									
178-182									
200-202									
220-222									
238-240									

Work Schedule

Time/Min.	Exercise
2-20	walk - 3mph
22-40	walk - 3mph
42-58	walk - 3mph
62-64	walk - 3mph
64-65	vertical
65-67	walk - 3mph
67-72	rope pull - 60x5min
72-75	walk - 3mph
75-83	overcast - 4x8min
85-89	walk - 3mph
89-90	run - 6mph
90-99	overcast - 6x9min
99-102	rope pull - 36x3min
104-110	walk - 3mph
110-115	rope pull - 60x6min
115-118	carry 45lb weight & walk 3mph
122-140	walk - 3mph
142-160	walk - 3mph
162-178	walk - 3mph
182-200	walk - 3mph
202-220	walk - 3mph
222-238	walk - 3mph

Comments :

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Test Engineer: _____ PASS_____ FAIL_____

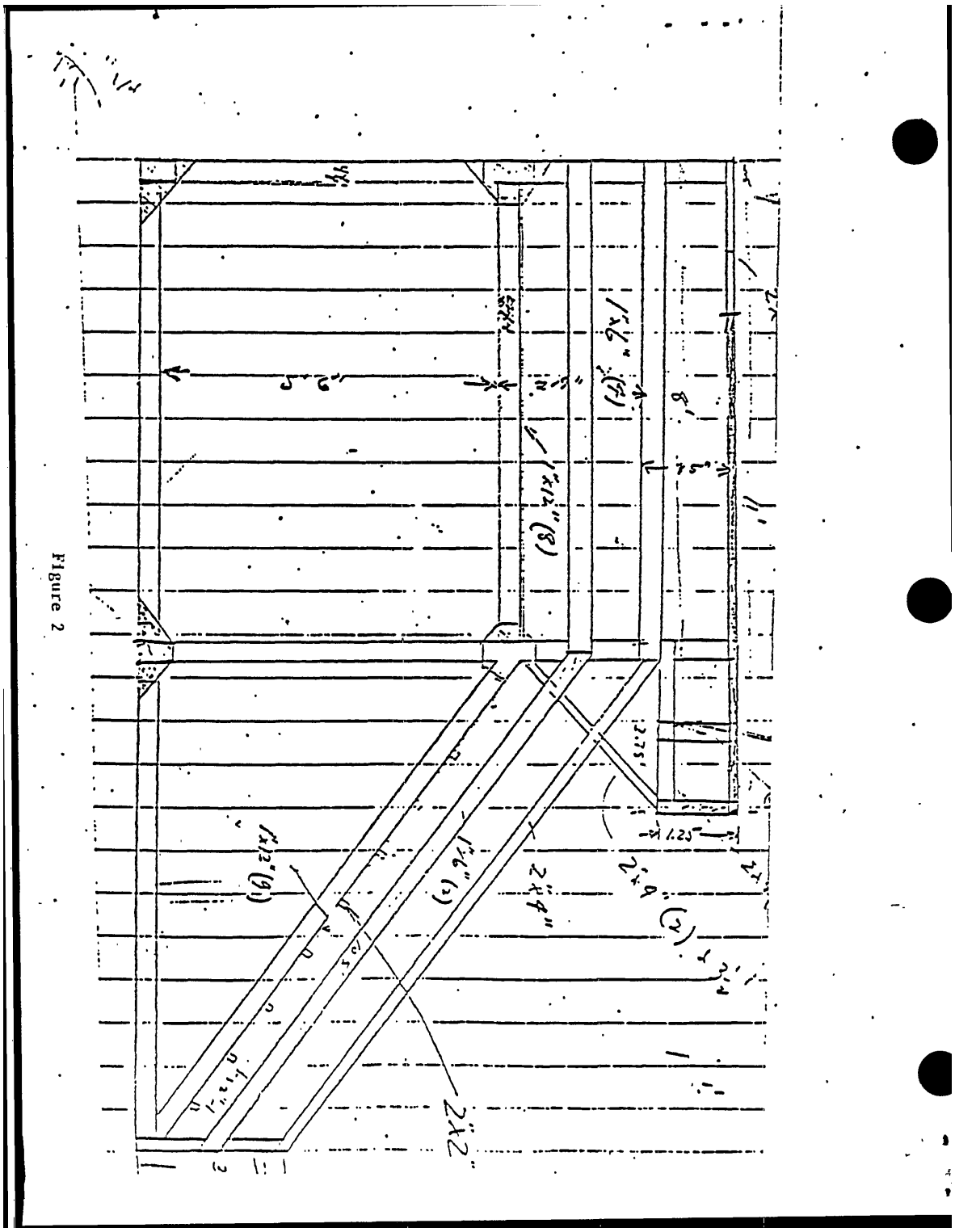

Figure 2

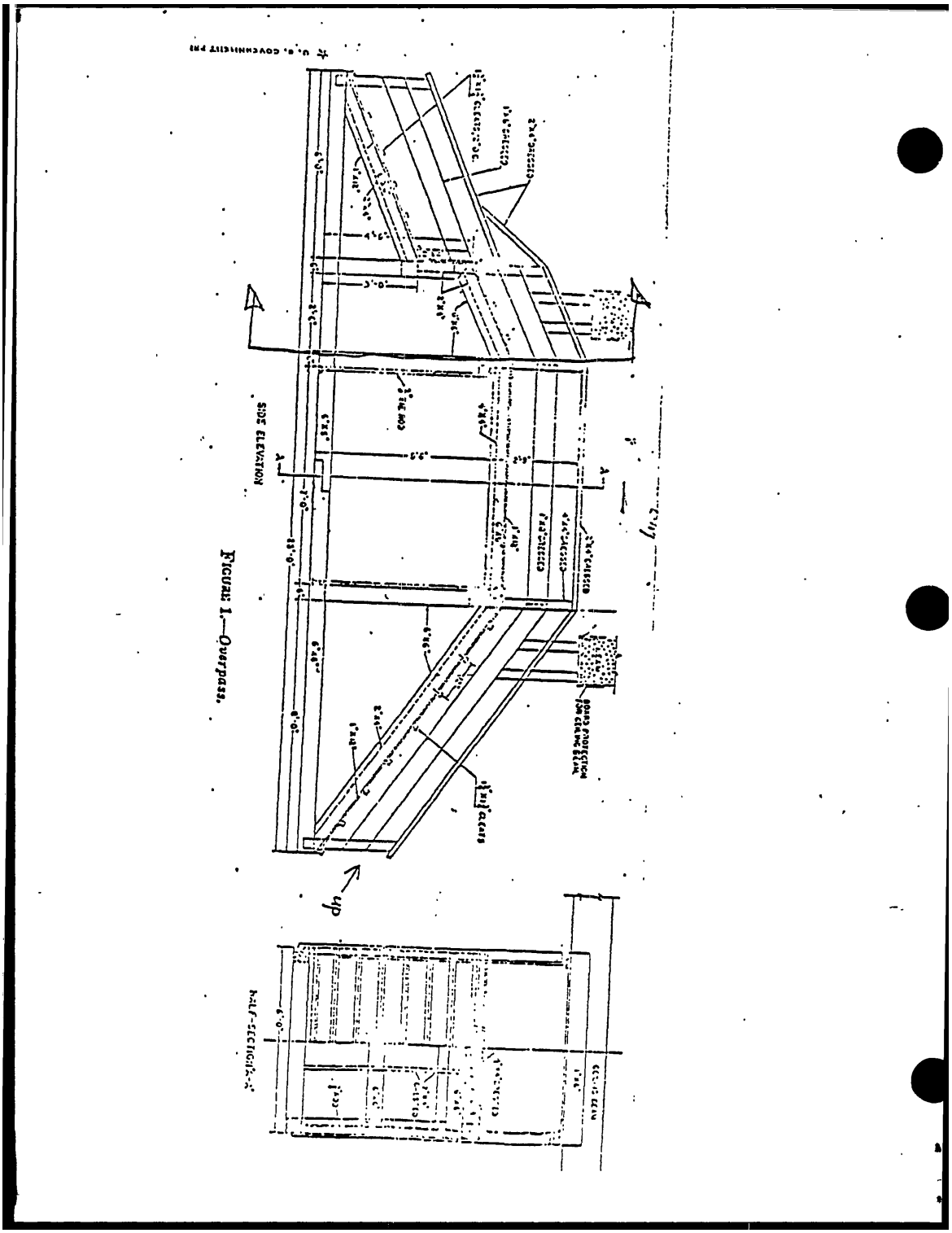

FIGURE 1.—*Overpass.*

Revision History

Revision	Date	Reason for Revision
1.0	14 February 2001	Historic document
1.1	21 September 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method