REFERENCE MANUAL

METHYL BROMIDE COMMODITY FUMIGATION

August 8, 1994

STATE OF CALIFORNIA
Environmental Protection Agency
Department of Pesticide Regulation
1020 N Street, Sacramento, California 95814

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This Reference Manual will assist the County Agricultural Commissioners in issuing site specific permit conditions for methyl bromide fumigations and has been designed to aid the evaluation of Work Site Plans. Suggested step-by-step procedures for evaluating Work Site Plans are given. In addition, reasoning and alternatives for each of the suggested permit conditions are discussed. The manual also contains all of the test procedures required by the permit conditions and a list of various consultants who can assist permit applicants in complying with the permit conditions. The Reference Manual is meant to be used in conjunction with the Suggested Permit Conditions, including the Work Site Plan, and the Final Permit Conditions to issue a site specific set of permit conditions. To help navigate between the various documents, a Quick Reference Guide is given on the following page.

These permit conditions are necessary because the preliminary risk characterization for methyl bromide conducted by the Department of Pesticide Regulation (DPR) pursuant to the Birth Defects Prevention Act (SB950) revealed a low margin of safety with current use practices. The goal of these permit conditions is to provide a 100-fold margin of safety for all people in areas around methyl bromide commodity fumigations. DPR has estimated that a 100-fold margin of safety is achieved if air concentrations do not exceed 0.21 ppm measured as a 24-hour time weighted average. This exposure is equivalent to 0.63 ppm as an 8-hour time weighted average or 20 ppm as a 15-minute time weighted average.

The permit conditions are based on four concepts which should be kept in mind when alternative conditions are considered: **containment**, **dilution**, **distance** and **time**. First, high concentrations of methyl bromide should be contained. This means that fumigation equipment and the fumigation structures or enclosures should not leak. Second, when methyl bromide is not fully contained, dilute it with fresh air. Third, keep as much distance as possible between methyl bromide and people. Fourth, minimize the time people are exposed to methyl bromide. The permit conditions use the interaction of these four concepts to minimize exposure. When one is not achieved, the other three can be used to compensate.

The mention of commercial products or services, their source or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such product.

Questions or comments concerning the permit conditions or the Reference Manual should be directed to any of the following DPR staff:

Randy Segawa, Environmental Monitoring Branch - (916) 324-4137
Dennis Gibbons, Worker Health and Safety Branch - (916) 445-4270
Lisa Quagliaroli, Pesticide Enforcement Branch - (916) 445-3887

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Three separate documents deal with issuing permits for methyl bromide commodity fumigations. The first document, Suggested Permit Conditions, contains guidelines for setting permit conditions. The Suggested Permit Conditions should be used as a starting point for developing permit conditions for a specific site. The last part of the Suggested Permit Conditions contains the Work Site Plan which documents the characteristics and procedures for a specific site. The second document, the Reference Manual, contains procedures for evaluating Work Site Plans. Evaluation of individual Work Site Plans may reveal that one or more of the Suggested Permit Conditions are inappropriate for a specific site. The Reference Manual gives possible alternatives that may be more appropriate. After evaluating individual Work Site Plans and developing appropriate permit conditions for a specific site, the permit conditions are recorded on the third document, the Final Permit Conditions. The Final Permit Conditions is the document issued to the permit applicant and details the equipment and procedural requirements that must be followed in order to use methyl bromide.

There are four general steps in issuing a permit for methyl bromide commodity fumigations:

First step: the County Agricultural Commissioner asks the permit applicant the questions on the Screening Questionnaire (see page 5). These questions will indicate which parts of the Work Site Plan must be completed and which test procedures need to be provided.

Second step: the permit applicant reads the Suggested Permit Conditions and completes the Work Site Plan.

Third step: the County Agricultural Commissioner evaluates the Work Site Plan. Suggested procedures for evaluating Work Site Plans are given on pages 9 through 20 of the Reference Manual. This evaluation should show those permit conditions the permit applicant can meet under standard compliance and those permit conditions requiring alternate conditions for compliance. The Reference Manual gives suggestions on alternatives for almost all of the permit conditions. If the alternatives are exhausted, consult with DPR using the procedure given on page 7.

Fourth step: the Agricultural Commissioner issues the Final Permit Conditions. The Final Permit Conditions document the conditions applying to a specific site.

Prior to giving a permit applicant a Work Site Plan to fill out, he/she should be asked the following questions to determine which sections of the Work Site Plan must be completed and which test procedures are required.

The permit conditions will be greatly simplified if there is compliance with the largest possible buffer zones. Questions 1 through 5 are used to determine if the permit applicant can comply with the largest possible buffer zones.

1. Will the application rate exceed 8 pounds per 1000 cubic feet?

☐ YES - Buffer zones must be computed. The entire Work Site Plan must be completed. DPR will have to be consulted and Section E of the Work Site Plan must be completed. Skip to question 6.

☐ NO

2. Will more than 1000 pounds of methyl bromide be used in any 24-hour period?

☐ YES - Buffer zones must be computed. The entire Work Site Plan must be completed. DPR will have to be consulted and Section E of the Work Site Plan must be completed. Skip to question 6.

☐ NO

3. Is there an area surrounding each enclosure large enough so that people can be excluded for 1075 feet in all directions during the treatment or holding period?

☐ YES

☐ NO - Buffer zones must be computed. The entire Work Site Plan must be completed. Skip to question 6.

4. Is there an area surrounding each enclosure large enough so that people can be excluded for 2100 feet in all directions during the first 4 hours of aeration?

☐ YES

☐ NO - Buffer zones must be computed. The entire Work Site Plan must be completed. Skip to question 6.

5. *Were questions 1 and 2 answered NO <u>and</u> questions 3 and 4 answered YES?*

   ☐ YES - The enclosure will comply with the largest possible buffer zones, Section C of the Work Site Plan does not need to be completed and buffer zone sizes do not need to be computed.

   ☐ NO - The buffer zone sizes must be computed. The entire Work Site Plan must be completed.

6. *Before the treated commodity is moved from the fumigation enclosure, are the air concentrations inside the enclosure checked according to a DPR-approved procedure?*

   ☐ YES

   ☐ NO - Give the test procedure to the permit applicant.

7. *Is the treated commodity stored indoors?*

   ☐ YES - The storage area must be checked according to a DPR-approved procedure before people can enter; give the test procedure to the permit applicant.

   ☐ NO

8. *Is there more than one enclosure at the work site?*

   ☐ YES - Sections C and D may need to be completed for each individual enclosure; give additional copies of Sections C and D of the Work Site Plan to the permit applicant.

   ☐ NO

9. *The size of the buffer zones may be smaller if the enclosure is pressure tested or retention tested; give these test procedures to the permit applicant if desired.*

10. *Is the permit being requested for a new or modified chamber within 1000 feet of a school?*

    ☐ YES - The permit applicant must contact the local air pollution control district. The air pollution control officer must notify residents in the area as specified in Health and Safety Code section 42301.6. Any modifications which reduce the hazard of the emissions may be exempted.

    ☐ NO

If the proposed application differs from the suggested permit conditions or the alternate conditions listed in the Reference Manual, the County Agricultural Commissioner may consider granting another alternative. County staff must gather all pertinent information and consult with the appropriate Branch of DPR prior to approval of the alternative request. All approved alternative conditions must be identified in the Final Permit Conditions.

The following special situations, due to the potential hazards they pose, must be evaluated jointly by the County Agricultural Commissioner and DPR to determine if the hazard(s) can be mitigated and the request approved:

Application rate exceeds 8 pounds per 1000 cubic feet, or

The total amount of methyl bromide used in any 24-hour period exceeds 1000 pounds, or

The volume to be treated in any 24-hour period exceeds 250,000 cubic feet.

When alternative conditions are <u>required</u>, contact DPR and provide the following information:

1. The specific condition(s) for which alternatives are needed,

2. A listing of all alternatives considered,

3. A completed copy of the Work Site Plan, including Section E.

Once an alternate request is granted subsequent requests may be granted without consulting DPR, provided all conditions (e.g. application rate, volume treated, treatment duration, commodity treated, etc.) remain the same.

Notify your Senior Pesticide Use Specialist of all requests for alternative conditions approved by your office.

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Overview - This section of the Reference Manual describes the suggested procedures for evaluating the information given in the Work Site Plans. In many cases, the results of the evaluation from one section are needed in a later part of the evaluation. It is important to evaluate each Work Site Plan in the sequence given here. It is probably easiest to conduct the evaluations by reading this section of the Reference Manual and then referring to the Work Site Plan when prompted, rather than reading from the Work Site Plan and referring to the Reference Manual.

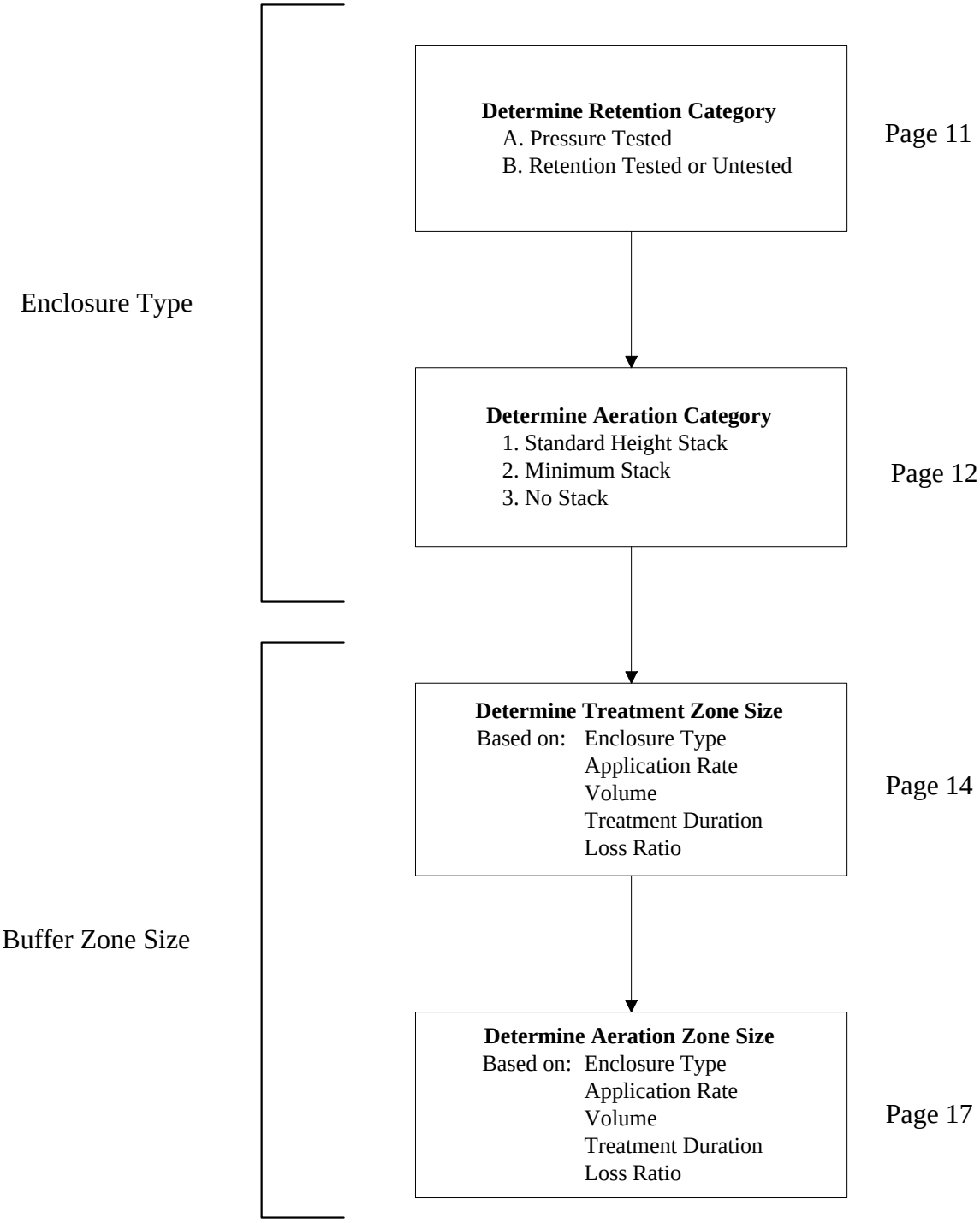
Each question must be answered. A restricted materials permit cannot be issued unless all questions are answered.

Work Site Plan Section A (General Information) - The information given in this section is self-explanatory.

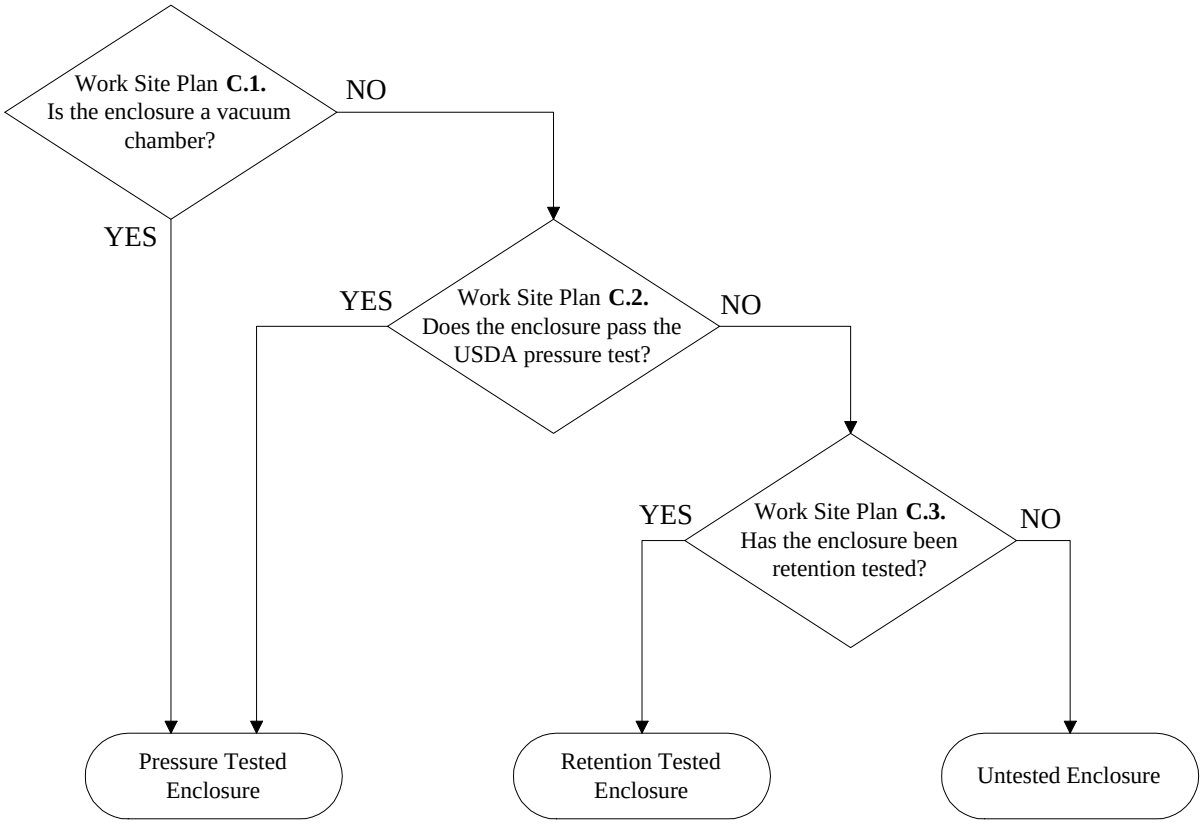
Work Site Plan Section B (General Conditions) - The standard answer to all questions in section B of the Work Site Plan is yes or "does not apply." If any of the questions in this section are answered no, alternative conditions are necessary. Consult the Reference Manual for possible alternative conditions. Check the appropriate box for each condition on the Final Permit Conditions. If all alternatives have been exhausted, consult with DPR using the procedure given on page 7.

See the appropriate section of the Reference Manual for more information. The Quick Reference Guide on page 2 gives specific references for each question in this section.

The following chart shows an overview of the procedure to determine the size of the buffer zones and references for the detailed instructions.



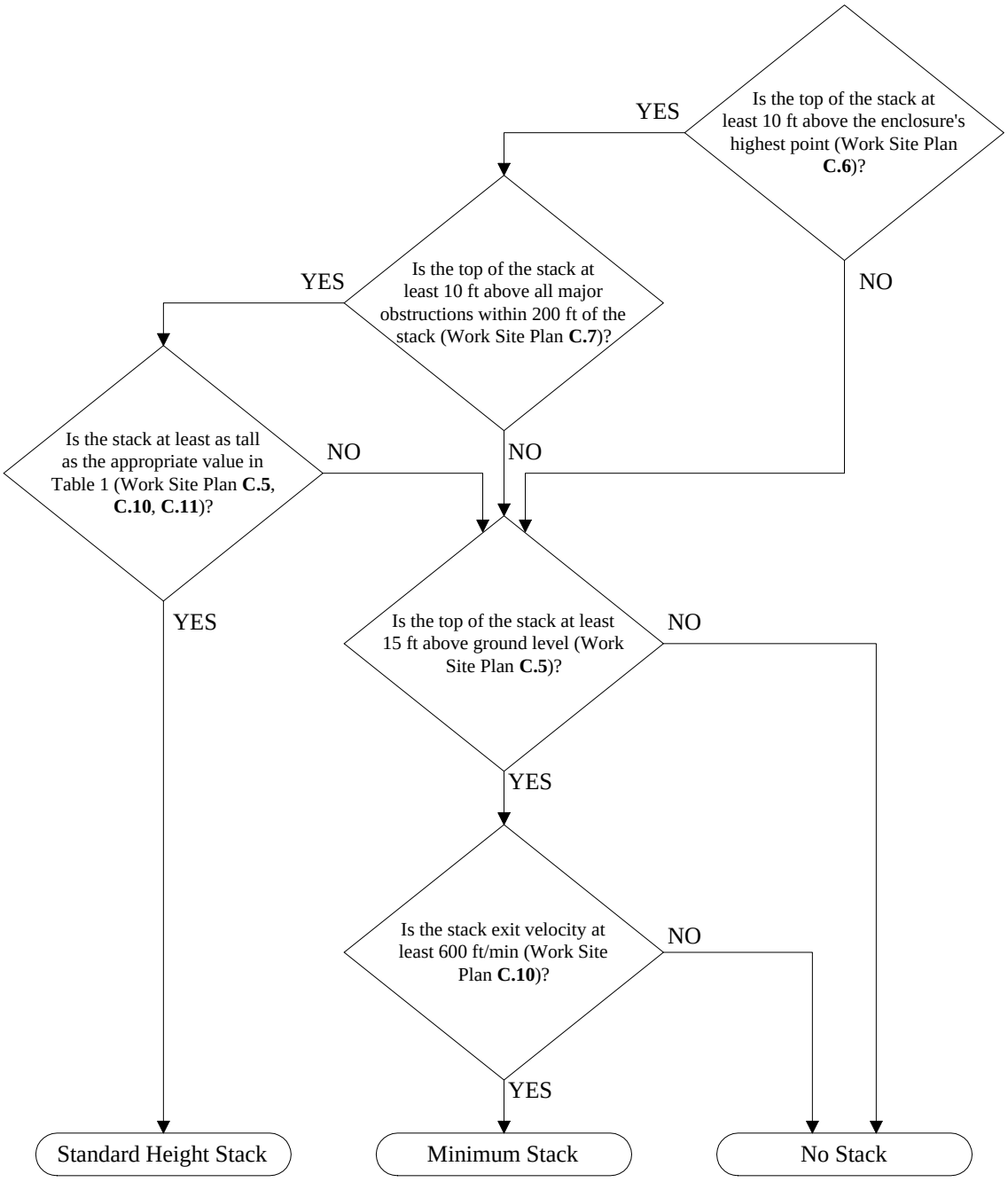
There are three possible categories: pressure tested, retention tested, and untested. Questions C.1 through C.3 are used to determine the appropriate retention category. The following chart will assist you in determining the retention category.



Check for pressure test and/or retention test certification, if necessary.

See pages 57 - 65 of the Reference Manual for more information.

There are three possible categories: standard height stack, minimum stack, and no stack. If the enclosure has no stack (question C.4 is answered no), the enclosure is classified as no stack. If the enclosure has a stack (question C.4 is answered yes), use the following chart to determine the aeration category.



Check the appropriate type of enclosure on the Final Permit Conditions. *See pages 66 - 78 of the Reference Manual for more information.*

This table is used to determine the "standard height" (feet) of a stack. A "standard height" exhaust stack is one which is:

1. at least 10 feet above the enclosure's highest point, and
2. at least 10 feet above any major obstruction within 200 feet of the stack, and
3. at least as tall (above ground level) as the appropriate value in the table below

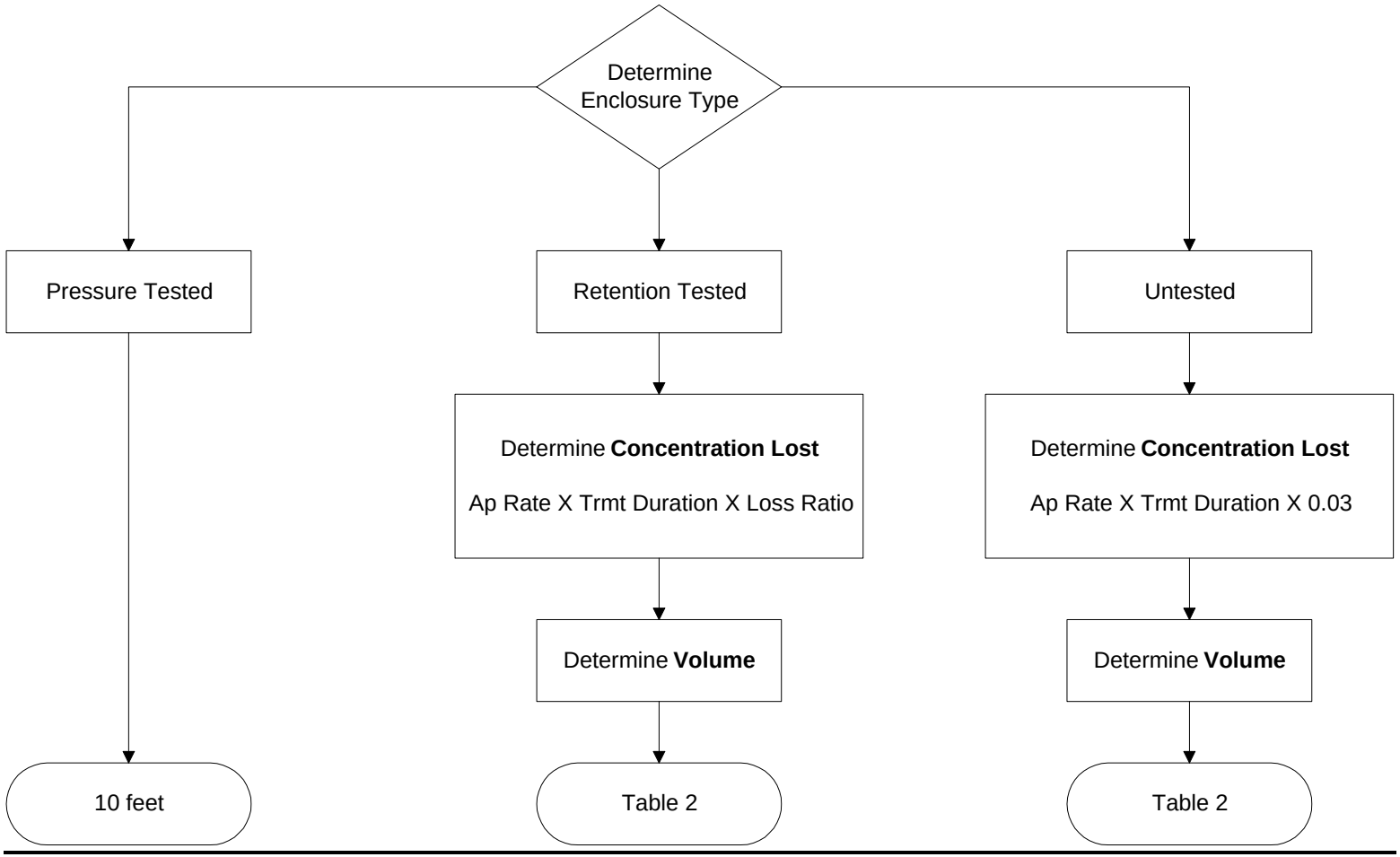
Total Amount of Methyl Bromide Applied (pounds) at the Work Site in a 24-hour Period ROUND UP

Exit Velocity (feet per minute)* ROUND DOWN	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
600	21	23	26	28	30	32	34	37	39	41	43	45	48	50	52	54	57	59	61	63
700	19	21	23	25	28	30	32	34	36	39	41	43	45	47	50	52	54	56	58	61
800	16	18	21	23	25	27	30	32	34	36	38	41	43	45	47	49	52	54	56	58
900	15	16	18	20	23	25	27	29	31	34	36	38	40	43	45	47	49	51	54	56
1000	15	15	16	18	20	22	25	27	29	31	33	36	38	40	42	45	47	49	51	53
1100	15	15	15	16	18	20	22	24	27	29	31	33	35	38	40	42	44	46	49	51
1200	15	15	15	15	15	18	20	22	24	26	29	31	33	35	37	40	42	44	46	48
1300	15	15	15	15	15	15	17	19	22	24	26	28	31	33	35	37	39	42	44	46
1400	15	15	15	15	15	15	15	17	19	21	24	26	28	30	32	35	37	39	41	44
1500	15	15	15	15	15	15	15	15	17	19	21	23	26	28	30	32	34	37	39	41
1600	15	15	15	15	15	15	15	15	15	17	19	21	23	25	28	30	32	34	36	39
1700	15	15	15	15	15	15	15	15	15	15	16	19	21	23	25	27	30	32	34	36
1800	15	15	15	15	15	15	15	15	15	15	15	16	18	20	23	25	27	29	32	34
1900	15	15	15	15	15	15	15	15	15	15	15	15	16	18	20	22	25	27	29	31
2000	15	15	15	15	15	15	15	15	15	15	15	15	15	16	18	20	22	24	27	29
2100	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	18	20	22	24	26
2200	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	20	22	24
2300	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	19	21
2400	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	19
2500	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17

$$\text{*Exit Velocity} = \frac{\text{Rated Fan Capacity (cubic feet per minute)}}{\text{Stack Cross-Sectional Area (square feet)}}$$

area of circle = $3.14 \times \text{radius}^2$

The following chart shows an overview for determining the size of the treatment zone. Detailed instructions are given on page 15.



If the enclosure is pressure tested (Work Site Plan C.1 or C.2 is answered yes) the required treatment zone size is 10 feet. For all retention tested or untested enclosures (B1, B2, B3), use the following procedure. Disregard the pressure tested enclosures and the methyl bromide used within them when performing these calculations.

1. Calculate the Concentration Lost

(Work Site Plan **C.12 × C.16 × C.17**)

When more than one enclosure will be fumigated in a 24 hour period (as indicated by Work Site Plan C.20), use the highest application rate (C.12), longest treatment duration (C.16; if duration exceeds 24 hours, use 24 hours), and highest loss ratio (C.17) given for the enclosures fumigated in a 24-hour period.

Rate (C.12) ____ × Treatment Duration (C.16) _____ × Loss Ratio (C.17)* _____ =

Concentration Lost _____ pounds per 1000 cubic feet

*The loss ratio is determined from the DPR-approved retention test. If the enclosure(s) is not retention tested, assume the loss ratio is **0.030**.

If the treatment duration is longer than 12 hours (Work Site Plan C.16) also calculate a Concentration Lost specifically for workers. The Concentration Lost calculated above should be used to determine the treatment zone for residents. Determine a second treatment zone specifically for workers based on the Concentration Lost using the following equation:

Rate (C.12) ____ × Work Shift Duration 12 hrs × Loss Ratio (C.17)* _____ =

Concentration Lost (for workers) _____ pounds per 1000 cubic feet

2. Calculate total volume fumigated in a 24-hour period

(Work Site Plan **C.13 × C.14**)

Number of Fumigations (C.13) _____ × Volume (C.14) _____ =

Enclosure Volume Fumigated _____ cubic feet

Total Volume Fumigated** _____ cubic feet

**Where more than one enclosure will be used in a 24-hour period, add all individual volumes (check Work Site Plan C.20).

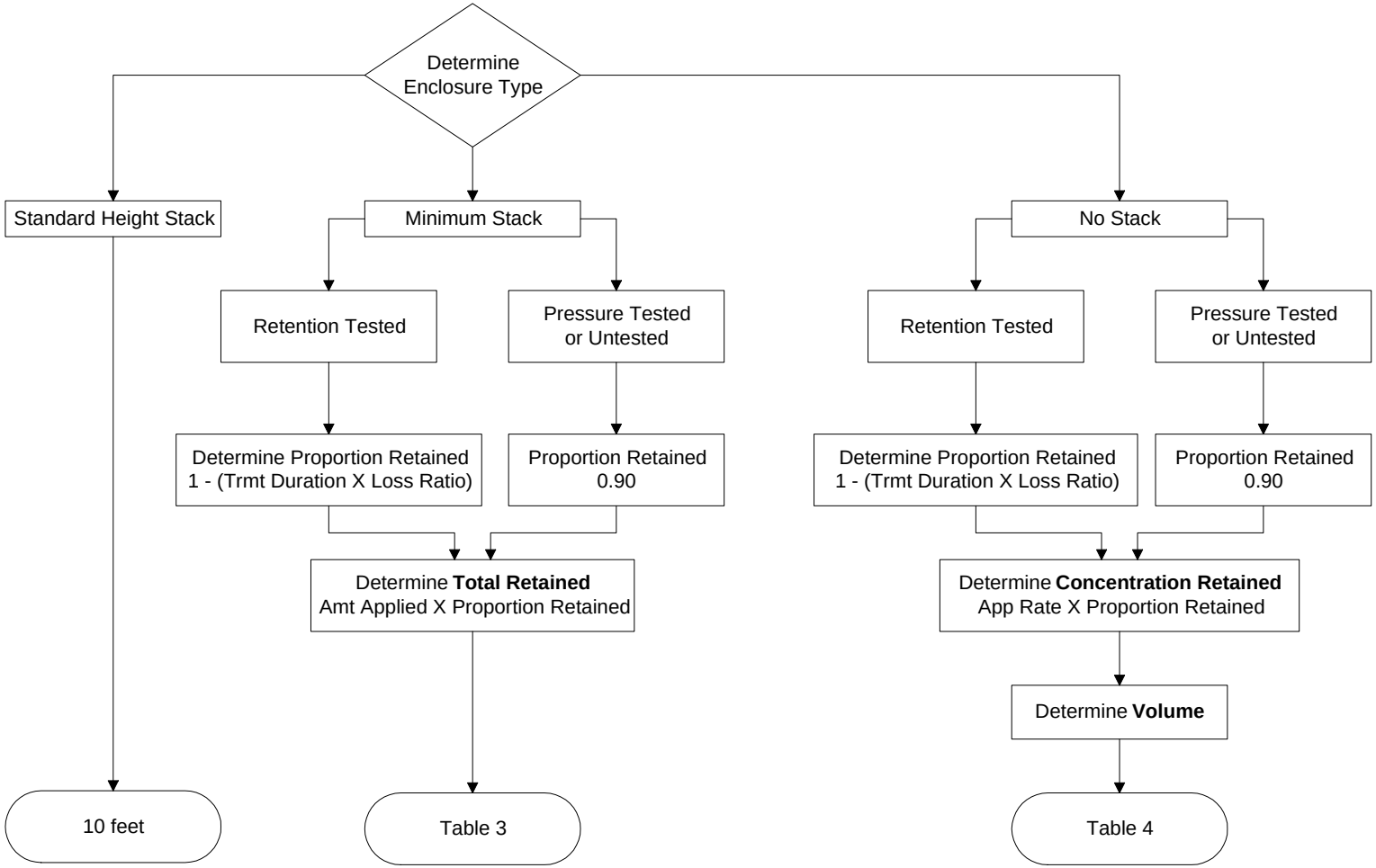
3. Look up the required treatment zone in Table 2, page 93 using the adjusted Concentration Lost and total volume (round up to the nearest values in the table). This treatment zone is required for each enclosure at the work site. If necessary, determine separate treatment zones for residents and workers with different Concentration Lost values.

4. Record the treatment zone requirements on the Final Permit Conditions-page 7.

The following information is required: treatment zone size, treatment duration, maximum application rate, maximum volume, and list of other enclosures.

See page 85 of the Reference Manual for more information and examples for determining treatment zone size.

The following chart shows an overview for determining the size of the aeration zone. Detailed instructions are given on page 18.



An aeration zone of 10 feet is required for enclosures with standard height stacks. Use the following procedure for all other enclosures with and without stacks. This procedure will calculate the required aeration zone for a single enclosure or an aggregate of enclosures. Only those enclosures aerated within a 24-hour period need to be aggregated. Disregard all enclosures with standard height stacks when performing these calculations.

1. Calculate the methyl bromide proportion retained

(**1 – [**Work Site Plan **C.16 × C.17]**)

If the treatment duration (C.16) exceeds 24 hours, use 24 hours for this calculation.

1 – [Duration (C.16) _____ × Loss Ratio (C.17) _____]* =

Proportion Retained _____*

*The loss ratio is determined from the DPR-approved retention test. If the enclosure(s) is not retention tested, assume the proportion retained is **0.90**.

For enclosures with minimum stacks calculate Step 2a, then proceed to Step 3.

For enclosures with no stacks calculate Steps 2b and 2c, then proceed to Step 3.

If both types of enclosures will be aerated within a 24-hour period, calculate 2a, 2b, and 2c.

2a. Calculate the Total Retained

(Work Site Plan **C.15 × Step 1**)

Total Applied (C.15) _____ × Proportion Retained (Step 1) _____ =

Total Retained for This Enclosure _____ pounds

Total Retained for All Enclosures Aerated Within 24 Hours _____ pounds**

** Check C.20 and add the Total Retained for all enclosures aerated within a 24-hour period.

2b. Calculate the Concentration Retained

(Work Site Plan **C.12 × Step 1**)

Check C.20 and if more than one enclosure will be aerated within 24 hours, use the highest values stated in C.12 and Step 1.

Application Rate (C.12) _____ × Proportion Retained (Step 1) _____ =

Concentration Retained _____ pounds per 1000 cubic feet

2c. Calculate total volume aerated in a 24-hour period

(Work Site Plan **C.13 × C.14**)

Number of Fumigations (C.13) _____ × Volume (C.14) _____ =

Volume Aerated for This Enclosure _____ cubic feet

Total Volume of All Enclosures Aerated _____ cubic feet***

*** Check C.20 and add the volumes for all enclosures aerated within a 24-hour period.

3. For enclosures with minimum stacks, look up the required aeration zone in Table 3, page 111 (using the total retained for all enclosures combined calculated in step 2a).

For enclosures with no stacks, look up the required aeration zone in Table 4, page 112 (using the concentration retained from step 2b and the total volume for all enclosures combined in step 2c).

If a work site will be aerating both types of enclosures in a 24-hour period, choose the largest of the two aeration zones. This aeration zone is required for each enclosure at the work site.

4. Record the aeration zone requirements on the Final Permit Conditions-page 7.

The following information is required: aeration zone size, treatment duration, maximum application rate, maximum volume, and list of other enclosures.

See page 99 of the Reference Manual for more information and examples for determining aeration zone size.

The buffer zone distances do not increase in a linear fashion (doubling the volume does not double the buffer zone). Therefore, linear interpolation will not give the exact buffer zone distance required. However, the following simplified interpolation procedure will give a close approximation for in-between values on the tables:

If one parameter value needs to be interpolated (Table 2, 3, or 4) use the following procedure.

1. Calculate the **exact** buffer zone parameters: volume and concentration, or total retained.
   *Example: Table 2 - concentration lost **1.83**, volume **80,000***

2. Determine the **closest** parameter values. If equally spaced, use either value.
   *Example: Table 2 - concentration lost **1.8**, volume **80,000***

3. Look up buffer zone distance for the **closest** parameter values.
   *Example: Table 2 - **400** feet*

4. Multiply the **closest** buffer zone distance by the **exact** parameter value and divide by the **closest** parameter value.
   *Example: (400 × 1.83) ÷ 1.8 = **407** feet*

If both parameter values need to be interpolated (Tables 2 or 4) use the following procedure.

1. Calculate the **exact** buffer zone parameters: volume and concentration.
   *Example: Table 4 - concentration retained **3.1**, volume **27,000***

2. Determine the **closest** parameter values. If equally spaced use either one.
   *Example: Table 4 - concentration retained **3.2**, volume **25,000***

3. Look up buffer zone distance for the **closest** parameter values.
   *Example: Table 4 - **520** feet*

4. Multiply the **closest** buffer zone distance by the **exact** concentration and divide by the **closest** concentration.
   *Example: (520 × 3.1) ÷ 3.2 = **504** feet*

5. Multiply the buffer zone distance determined in step 4 by the **exact** volume and divide by the **closest** volume.
   *Example: (504 × 27,000) ÷ 25,000 = **544** feet*

For buffer zone calculations, the normal criterion for multiple fumigation enclosures to be considered independent is for the enclosures to be located at different work sites (a work site is defined as a single address). For example, two sea/land containers located at the same address would need to be aggregated to determine the buffer zones; two containers located at different addresses would not. This definition is easy to administer, but has technical drawbacks. Under this definition two containers separated by 500 feet are aggregated if they are at the same work site, but two containers separated by 50 feet are independent if they are located at different work sites.

For situations where the normal criterion is undesirable, the following alternative criteria can be used. Applications to more than one enclosure must be separated by a specified time or distance in order to be considered independent for buffer zone calculations. SEPARATION MUST BE FROM OTHER COMMODITY APPLICATIONS AS WELL AS ANY OTHER METHYL BROMIDE APPLICATIONS, SUCH AS FIELD OR NURSERY FUMIGATIONS. Applications (fumigation and aeration) must be separated by at least 24 hours or the distance determined below.

For individual enclosures greater than 20,000 cubic feet, the separation distance is 1300 feet.

For individual enclosures 20,000 cubic feet or less use the following procedure:

1. Compute the largest resident treatment zone for any individual enclosure.

2. Compute largest aeration zone for any individual enclosure.

3. Choose the larger of the two values and multiply by 3. This value or 1300 feet is the separation distance, whichever is shorter.

The following special situation requires a separation of 30 feet: applications that do not require an aeration zone AND volume does not exceed 3000 cubic feet AND application rate does not exceed 2 lbs/1000 cubic feet.

If these separation requirements cannot be met, the individual enclosures must be aggregated to determine the buffer zone sizes.

The standard answer to questions D.1 and D.2 is yes or "does not apply." If either of these questions are answered no, alternative conditions are necessary. For question D.3, only enclosures with standard height stacks (types A1 and B1) can aerate at any time. All other enclosures must initiate aeration during daylight hours. Consult the Reference Manual for possible alternative conditions. Check the appropriate boxes in the Final Permit Conditions. If all alternatives have been exhausted, consult with DPR using the procedure given on page 7.

See the appropriate section of the Reference Manual for more information. The Quick Reference Guide on page 2 gives specific references for each question in this section.

Condition 1

A maximum application rate of 8 pounds per 1000 cubic feet or the rate specified by the label may be used, whichever is less.

Reasoning

Application rates greater than 8 pounds per 1000 cubic feet involve the use of very high concentrations of methyl bromide. Even small flaws in the introduction equipment or procedure may cause unacceptable exposures.

Procedure for Determining Compliance

The application rate should be clearly stated on the Work Site Plan.

NOTE: Users also cannot exceed the application rate and volume that were used to determine the size of the buffer zone. See page 10 for determining the size of the buffer zones.

Possible Alternative Conditions

DPR must be consulted before determining alternative conditions. See page 7 for the procedure for requesting alternate conditions from DPR.

Condition 2

The total amount of methyl bromide per work site must not exceed 1000 pounds in a 24-hour period.

Reasoning

The use of more than 1000 pounds of methyl bromide will require the fumigation of a large area. Other types of fumigations in the vicinity, such as soil or greenhouse, may alter the size of the buffer zones. In addition, either a large number of small cylinders must be handled or a few very large cylinders must be handled. Special precautions may be necessary.

Procedure for Determining Compliance

The total amount of methyl bromide that could be used in a 24-hour period should be stated on the work site plan.

Example: A work site has three chambers, each requiring 400 pounds of methyl bromide for a single fumigation. No more than two fumigations can be done at this work site in a single day without exceeding the 1000 pound limit.

NOTE: Users also cannot exceed the application rate and volume that were used to determine the size of the buffer zone. See page 10 for determining the size of the buffer zones.

Possible Alternative Conditions

DPR must be consulted before determining alternative conditions. See page 7 for the procedure for requesting alternate conditions from DPR.

Condition 3

No other types of methyl bromide applications (e.g. field, greenhouse, potting soil, structural) can occur at the work site for the preceding 48 hours or the following 24 hours of a commodity application. Other commodity fumigations can be conducted.

Reasoning

The calculation of the buffer zone sizes becomes very complex if there is a mixture of fumigation types.

Procedure for Determining Compliance

Any other type of fumigation at the work site other than a commodity fumigation is prohibited. Other types of fumigations would also include fumigations not covered by permit conditions, such as structural or tree hole applications. If the other types of fumigations are very small it may be possible to do them at the same time, but consult with DPR first.

There must be 48 hours between the end of the other application (e.g. field, greenhouse) to the start of the commodity fumigation and 24 hours from the end of the commodity aeration to the start of the other fumigation. NOTE: Applications do not end until aeration is completed.

Example: If a chamber fumigation is started on June 10 at 9:00 AM and aeration is completed by June 11, 11:00 AM, a greenhouse aeration must end by June 8, 9:00 AM and a potting soil fumigation can start no sooner than June 12, 11:00 AM.

Possible Alternative Conditions

DPR must be consulted before determining alternative conditions. See page 7 for the procedure for requesting alternate conditions from DPR.

Condition 4

The following types of fumigations are prohibited unless mitigation options are identified in the Work Site Plan:
- those inside an enclosed area with people present

See page 31 for permit condition 4 pertaining to common walls.

Reasoning

An enclosed area does not allow the methyl bromide to dissipate; concentrations can build up rapidly.

NOTE: If a standard height stack may be used to aerate an enclosure within a secondary enclosed area, the standard height requirements may need to be modified if the secondary enclosed area is very large.

Procedure for Determining Compliance

The fumigation is prohibited if it is done in an enclosed area which has a gas-confining roof and walls. Enclosures surrounded by mesh screen or other porous barriers would not be considered an enclosed area.

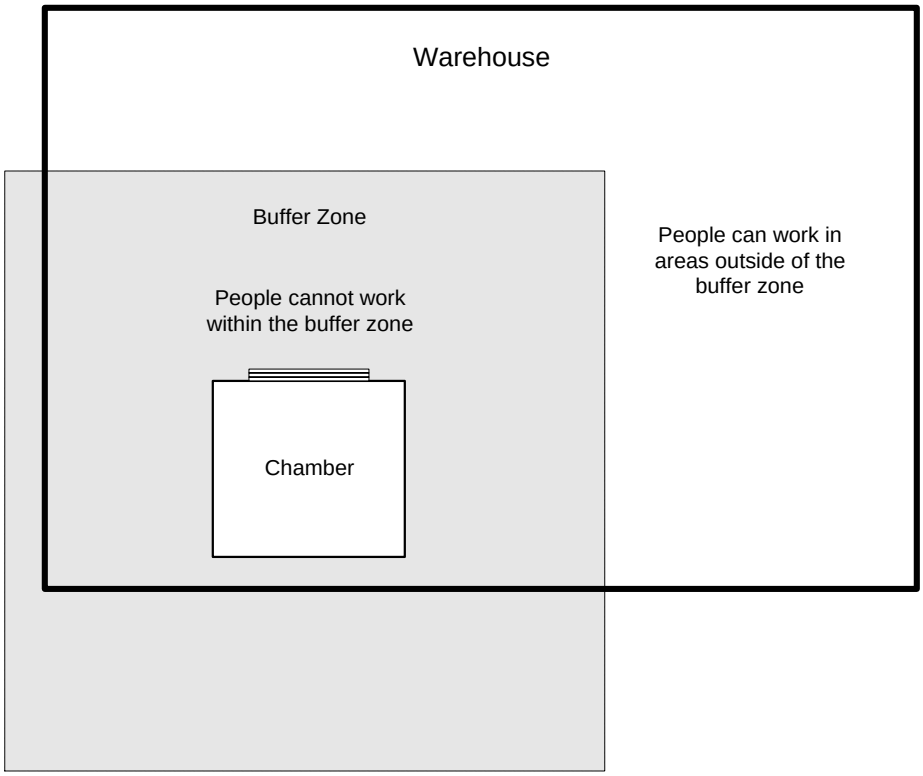
This condition does not apply to partially enclosed areas. Partially enclosed areas do not pose the same potential for exposure concerns as enclosed areas. However, an exposure risk may still exist due to gas confining physical conditions at the site. Partially enclosed areas should be carefully evaluated for the extent of potential exposure. For example, look at the number, size and location of the openings. Check to see if the openings allow free flow of air. Compare the size of the fumigation to the size of the secondary area. Observe the activities, location and duration of work within the secondary area. An individual site may need some ventilation, testing, or some other mitigation measure (remember the four concepts) to insure an adequate margin of safety. Some partially enclosed spaces may need to be considered enclosed spaces for the purposes of the permit conditions.

Consult with DPR if a standard height stack will be used with a secondary enclosed space. The standard height requirements may need to be modified. See page 68 for normal standard height requirements.

Examples: A tarpaulin fumigation inside a warehouse with all doors and windows closed is considered enclosed and is prohibited. A warehouse with several roll-up doors kept open would be considered partially enclosed.

Possible Alternative Conditions

These alternatives will allow work to be conducted within the secondary enclosed area. However, the buffer zone requirements still apply. See page 79 for information on buffer zones. Work would only be allowed in regions of the enclosed area that are outside of the buffer zones. See accompanying diagram.



Vacuum chamber - Since a vacuum chamber is under negative pressure, methyl bromide cannot be released from any leaks. NOTE: buffer zones still apply.

Application scheduled when workers not present - If nobody is in the area, there is no hazard. No restrictions.

Respiratory Protection - Only self-contained breathing apparatuses are approved protection for methyl bromide. This is generally not a viable alternative when exposures will exceed a few minutes because of tank duration.

Possible Alternative Conditions, continued

Limited Access - Work within the secondary enclosed area is allowed for up to one hour if the concentration within the enclosed area is less than 5 ppm. Testing must be done using the procedure on page 27. NOTE: buffer zones still apply.

Mechanical Ventilation and Periodic Monitoring - Mechanical ventilation must be adequate to maintain methyl bromide concentrations at acceptable levels. Consultation with a ventilation engineer or a certified industrial hygienist with ventilation training is recommended to evaluate the adequacy of the ventilation system. In addition, periodic monitoring with colorimetric detector tubes must be conducted as specified in the procedure on page 27. NOTE: buffer zones still apply.

Mechanical Ventilation and Full-Shift Worker Monitoring - The work site must be surveyed by a licensed ventilation engineer or a certified industrial hygienist with training in ventilation to determine if the ventilation system provides an adequate margin of safety to methyl bromide air concentrations.

In addition, Full-Shift Worker Monitoring must be conducted at least one time. A monitoring plan must be developed in consultation with the DPR-Worker Health and Safety Branch or a certified industrial hygienist. This monitoring must use a sampling and analytical method that is capable of measuring less than 0.3 ppm as an 8-hour time-weighted average air concentration value **(colorimetric detector tubes cannot be used)**. DPR must review and approve the monitoring results. If the approved monitoring data show the work site levels are below 0.3 ppm (half of the 0.6 ppm target value), no further testing is necessary, unless fumigation scenario conditions change.

NOTE: buffer zones still apply.

Equipment:

1. Self-Contained Breathing Apparatus (SCBA)

2. Colorimetric Detector Tubes - These are tubes (approximately 1/4 X 6 inches) which produce a color change when methyl bromide is present. The length of this color change indicates the methyl bromide concentration. A specific pump must be used with these tubes; both must be purchased from the same manufacturer. The detection limit of these tubes varies with manufacturer and model. Select the tube model which best fits your needs.

The choice of detector tube is in part determined by the duration of exposure. If short term access (less than 1 hour) is necessary, a detector tube that measures to 5 ppm would be adequate. To determine entry for longer times or to document that control methods are adequate, a detector tube that measures to a lower detection limit would be appropriate.

Manufacturer	Model Number	Measurement Range	Comments
National Draeger (412) 787-8383	Methyl Bromide 5/b	5 to 50 ppm	one tube, 5 strokes
	5/b with Activation Tube	0.8 to 8 ppm	two tubes, 30 strokes
	Methyl Bromide 0.5/a	0.5 to 5 ppm	one tube, 5 strokes
	Methyl Bromide 3/a	3 to 35 ppm	two tubes, 5 strokes
Sensidyne (800) 451-9444	Methyl Bromide No. 136	2 to 10 ppm (0.5 ppm detection limit)	two tubes, 4 strokes
	Methyl Bromide No. 136LA	1 to 18 ppm (0.2 ppm detection limit)	two tubes, 2 strokes
Matheson-Kitagawa (510) 793-2559 (714) 987-4611	Methyl Bromide 8014-157SB	2.5 to 80 ppm	two tubes, 1 stroke
	Methyl Bromide 8014-157SC	0.5 to 10 ppm	two tubes, 1 stroke
MSA (800) MSA-2222	Methyl Bromide P/N 462135	2.5 to 90 ppm	two tubes, 4 strokes

Procedure:

1. Safety: If more than 2 hours has elapsed since the last test, SCBA must be worn or testing must be done remotely.

2. Test Location: Tests must be made of the air in the working area where concentrations will be highest. This location will depend on the proximity to the fumigation enclosure and ventilation patterns within the secondary enclosed area. If this location is not known or changes over time, several locations need to be tested.

3. Test Frequency: The first test must be performed before initial entry during each workshift. Additional tests are required if the work time within the enclosed area is greater than 2 hours. Tests must be made according to the schedule below.

4. Restrictions on Work Time: The results of the monitoring are used to determine the length of time work is allowed within the enclosed area. Work time is cumulative time spent within the enclosed area. This does not include time spent outside the enclosed area. Use the following work and testing schedule **for each workshift**. If any subsequent tests show higher concentrations than the initial test, the work schedule must be adjusted accordingly.

Work Time Restriction (per 24 hours)	Maximum Level Allowed Per Test	Colorimetric Tube Detection Limit	Tests Required
1 hour	5 ppm	5 ppm or less	initial test
2 hours	3 ppm	3 ppm or less	initial test
4 hours	1 ppm	1 ppm or less	initial test, repeat at 2 hrs
8 hours	ND*	0.5 ppm or less	initial test, repeat every 2 hrs

*ND - no detectable amount

Example: If an initial test shows no detectable methyl bromide with a 0.5 ppm detection limit, 8 hours of work can be planned. However, if the second test two hours later shows 1 ppm, work can only be conducted for an additional two hours within the enclosed area (4 hours total work time).

5. Test Duration: Testing and work time restrictions continue until the end of the treatment period and testing shows no detectable levels. During aeration, methyl bromide must be released outside of the enclosed area or the enclosed area cannot be occupied. Testing may be discontinued if no further work is required within the enclosed area.

6. Documentation: Record the test information on the accompanying form, or other substitute.

7. Testing History: In order to terminate periodic monitoring, this procedure must be repeated under worst-case scenario conditions (i.e. with the largest possible amount of fumigated commodity and maximum dosage used) to establish that the ventilation is completely effective. Once a documented testing history is established and fumigation conditions are not changed (i.e. increased dosage, change in commodity fumigated, increased fumigated volume), the testing can be discontinued. It will require data from 5 - 50 workshifts to establish a testing history, depending on the work time desired, the concentration detected, the variation in concentration and the detection limit of the colorimetric tube. A fewer number of tests would be required if a short work time is needed, or a low concentration is detected, or the concentration variation is low, or the detection limit is low. Testing history must be reviewed by DPR prior to discontinuing testing. The testing history must be reestablished annually.

Fumigation Site: _____

Address: _____

Type of Colorimetric Detector Tube: _____

Secondary Area Identification: _____

Date/Time of Test		
Person Testing		
Colorimetric Tube Sampling Location		
Commodity Fumigated		
Amount of Commodity Fumigated		
Application Rate		
Volume Fumigated		
Commodity Container/Packaging		
Type of Fumigation Enclosure		
Location of Fumigation Enclosure		
Date/Time of Start of Fumigation		
Date/Time of Start of Aeration		
Colorimetric Tube Reading		
Colorimetric Tube Detection Limit		
Comments		

Condition 4

The following types of fumigations are prohibited unless mitigation options are identified in the Work Site Plan:

- enclosures which share a common wall with another enclosed area with people present

See page 24 for permit condition 4 pertaining to secondary enclosed spaces.

Reasoning

The fumigation enclosure can leak methyl bromide into the adjacent building. An enclosed area does not allow the methyl bromide to dissipate; concentrations can build up rapidly.

Procedure for Determining Compliance

The fumigation is prohibited if the fumigation enclosure shares a common wall with an enclosed area that has people in it. If the adjacent building has no people present, the fumigation enclosure can be used.

This condition does not apply if a common wall is shared with a partially enclosed area. Partially enclosed areas do not pose the same potential for exposure concerns as enclosed areas. However, an exposure risk may still exist due to gas confining physical conditions at the site. Partially enclosed areas should be carefully evaluated for the extent of potential exposure. An individual site may need some ventilation, testing, or some other mitigation measure to insure an adequate margin of safety. Some partially enclosed spaces may need to be considered enclosed spaces for the purposes of the permit conditions.

Examples: Using a chamber which shares a wall with an office is prohibited. Using a chamber which shares a wall with a warehouse where other people work is prohibited. If several roll-up doors are kept open, the warehouse would be considered partially enclosed.

Possible Alternative Conditions

These alternatives will allow work to be conducted within the adjacent enclosed area. However, the buffer zone requirements still apply. See page 79 for information on buffer zones. Work would only be allowed in regions of the enclosed area that are outside of the buffer zones. See diagram on page 25.

Possible Alternative Conditions, continued

Pressure Tested Enclosure - Pressure tested enclosures leak a minimal amount of methyl bromide. NOTE: buffer zones still apply.

Application Scheduled When Workers Not Present - If nobody is in the area, there is no hazard. No additional restrictions.

Respiratory Protection - Only self-contained breathing apparatuses are approved protection for methyl bromide. This is generally not a viable alternative when exposures will exceed a few minutes because of tank duration.

Limited Access - Work within the adjacent enclosed area is allowed for up to one hour if the concentration within the enclosed area is less than 5 ppm. Testing must be done using the procedure on page 25. NOTE: buffer zones still apply.

Mechanical Ventilation and Periodic Monitoring - Mechanical ventilation must be adequate to maintain methyl bromide concentrations at acceptable levels. Consultation with a ventilation engineer or a certified industrial hygienist with ventilation training is recommended to evaluate the adequacy of the ventilation system. In addition, periodic monitoring with colorimetric detector tubes must be conducted as specified in the procedure on page 27. NOTE: buffer zones still apply.

Mechanical Ventilation and Full-Shift Worker Monitoring - The work site must be surveyed by a licensed ventilation engineer or a certified industrial hygienist with training in ventilation to determine if the ventilation system provides an adequate margin of safety to methyl bromide air concentrations.

In addition, Full-Shift Worker Monitoring must be conducted at least one time. A monitoring plan must be developed in consultation with the DPR-Worker Health and Safety Branch or a certified industrial hygienist. This monitoring must use a sampling and analytical method that is capable of measuring less than 0.3 ppm as an 8-hour time-weighted average air concentration value **(colorimetric detector tubes cannot be used)**. DPR must review and approve the monitoring results. If the approved monitoring data show the work site levels are below 0.3 ppm (half of the 0.6 ppm target value), no further testing is necessary.

NOTE: buffer zones still apply.

Condition 5

Application from outside the enclosure through a closed system is required. Releasing methyl bromide from inside the enclosure is prohibited unless mitigation options are identified in the Work Site Plan.

Reasoning

Releasing methyl bromide from inside the fumigated enclosure requires work in an atmosphere containing potentially lethal concentrations of methyl bromide. Special precautions must be taken.

Procedure for Determining Compliance

The methyl bromide cylinders must be outdoors. Plumbing lines must be used to deliver the methyl bromide from the cylinders to inside the enclosure. The plumbing lines must be gas-tight and the enclosure sealed before introduction of the methyl bromide.

Example: A warehouse or other building cannot be fumigated by placing and opening methyl bromide cylinders from the inside.

Possible Alternative Conditions

A written plan must describe how the enclosure will be fumigated and aerated, and safety precautions must include all of the following:

- Two person teams must be used to open cylinders, and

- The applicators must be able to communicate at all times with a person outside, and

- Self-contained breathing apparatus must be used during fumigation and aeration.

Condition 6

All fumigant lines must be gas-tight. Fumigant lines, valves, fittings, etc. which are routinely adjusted or changed must be checked for leaks after each adjustment.

Reasoning

Even small leaks in the fumigation plumbing system can cause very high air concentrations of methyl bromide in the immediate vicinity.

Procedure for Determining Compliance

Lines that will contain methyl bromide can be leak-checked by several methods. Assuming all plumbing connections are tight, lines can be checked with pressure or by monitoring for leaks with a detector. For pressurization, compressed air or nitrogen can be admitted to the system to the anticipated fumigation pressure and the pressure monitored over time with a pressure gauge. Any loss in pressure indicates a leak which can be located with a soap solution or other type of leak detector. If the pressure holds, the lines would be considered leak-checked and the fumigation would proceed. A less desirable method would involve pressurization with the fumigant while watching pressure or "sniffing" suspect places with a Halide torch or electronic leak detector sensitive to methyl bromide or "halogen-containing materials."

Examples: When changing methyl bromide cylinders, the connection between the introduction line and the cylinder must be checked for leaks. The cylinder valve must be checked for leaks after opening.

Possible Alternative Conditions

None

Condition 7

The enclosure must be sealed where instrument sampling lines pass through enclosure walls.

Reasoning

Any leaks in the fumigation enclosure can cause very high air concentrations in the immediate vicinity.

Procedure for Determining Compliance

The holes or ports in the enclosure wall must be sealed with some sort of caulking material. The seal should be checked for leaks.

Possible Alternative Conditions

None

Condition 8

Exhaust from sampling equipment must be vented away from people and to outside air or back into the enclosure.

Reasoning

The Fumiscope does not destroy or filter out methyl bromide. The Fumiscope exhaust has the same concentration as the space under fumigation; this is normally several thousand parts per million. No person should be near this exhaust.

Procedure for Determining Compliance

Tygon™, Teflon™ or some other type of tubing must be used to direct the Fumiscope exhaust away from all persons and preferably back into the enclosure. If the exhaust is vented to outside air, it must be vented outside the control room.

Possible Alternative Conditions

None

Condition 9

When introducing methyl bromide from an enclosed control room, applicators must use nitrogen gas or compressed air to purge fumigant lines prior to changing cylinders.

Reasoning

Purging is necessary to prevent the methyl bromide within the lines from escaping into the control room air. The enclosed space of a control room can trap high concentrations of methyl bromide. Extra precautions must be taken to prevent leaks.

Procedure for Determining Compliance

This condition only pertains to enclosed control rooms. If introduction is conducted in a partially enclosed area, the space is not considered a control room and this permit condition does not apply. However, an exposure risk may still exist due to gas confining physical conditions within the area. The site should be carefully evaluated for the extent of potential exposure. An individual site may need some ventilation and/or testing to insure an adequate margin of safety.

The lines can be purged by plumbing a source of compressed air or nitrogen into the fumigant delivery lines through a "T" fitting, usually placed near the methyl bromide supply cylinder. Before breaking any fitting connections, the source of methyl bromide is turned off and the lines are then purged by filling them with the compressed air or nitrogen.

Example: The changing of methyl bromide supply cylinder would require that a connection be broken to replace the spent cylinder with a full one.

Possible Alternative Conditions

Vacuum Chambers - Provided there is negative pressure throughout the system, the vacuum of a vacuum chamber would substitute for the line purge.

Respiratory Protection - Only self-contained breathing apparatuses are approved protection for methyl bromide.

Leak-proof Connections - Valves or other mechanisms which prevent leaks and release of methyl bromide when changing cylinders. Example: a valve at the disconnect point.

Condition 10

Enclosed control rooms must be mechanically ventilated during the fumigation if workers are present.

Reasoning

The enclosed space of a control room can trap high concentrations of methyl bromide; extra precautions must be taken to prevent leaks of methyl bromide within this space.

Procedure for Determining Compliance

There must be a fan or some other mechanical system to bring fresh air into or exhaust out of an enclosed control room when it is in use. Ventilation which provides at least 6 air changes per hour is recommended, but not required. Mechanical ventilation is not necessary when no fumigations are in progress or no people are in the control room.

If introduction is conducted in a partially enclosed area, the space is not considered a control room and this permit condition does not apply. However, an exposure risk may still exist due to gas confining physical conditions within the area. The site should be carefully evaluated for the extent of potential exposure. An individual site may need some ventilation and/or testing to insure an adequate margin of safety.

Examples: A room with 4 impermeable walls and a roof would be considered a control room. If the only opening is an open door, this would still be considered an enclosed control room. An introduction area cordoned off by mesh screen, chain-link fencing or 3 walls would be considered partially enclosed and not a control room.

Possible Alternative Conditions

Respiratory Protection - Only self-contained breathing apparatuses are approved protection for methyl bromide.

Condition 11

Methyl bromide cylinders must not be stored inside enclosed control rooms.

Reasoning

The enclosed space of a control room can trap high concentrations of methyl bromide; extra precautions must be taken to prevent leaks of methyl bromide within this space.

Procedure for Determining Compliance

Cylinders must not be stored within the control room, even if the room is used only for storage and introduction of methyl bromide. Cylinders should only be in the control room during introduction.

If cylinders are stored in a partially enclosed area, the space is not considered a control room and this permit condition does not apply. However, an exposure risk may still exist due to gas confining physical conditions within the area. The site should be carefully evaluated for the extent of potential exposure. Storage may still need to be prohibited.

Examples: A room with 4 impermeable walls and a roof would be considered a control room. If the only opening is an open door, this would still be considered an enclosed control room. An introduction area cordoned off by mesh screen, chain-link fencing or 3 walls would be considered partially enclosed and not a control room.

Possible Alternative Conditions

None

Condition 12

Persons who initiate aeration by manually breaking a seal must wear a self-contained breathing apparatus (SCBA). Exception: enclosures for which aeration is initiated remotely, such as chambers.

Reasoning

The methyl bromide concentration within the enclosure is normally several thousand ppm when aeration is initiated. When workers must be close to the enclosure to initiate aeration, high exposure for a short duration is possible.

Procedure for Determining Compliance

SCBA must be worn in the immediate vicinity of the enclosure when aeration is initiated. SCBA must be worn even if aeration can be initiated in a few seconds. After aeration is initiated and the worker moves away from the enclosure, the SCBA may be removed. If a worker is not near the open enclosure at the time of initiation, SCBA is not required.

Examples: SCBA must be worn when removing tarps from a tarpaulin fumigation, or opening the doors of a sea/land container, or opening the doors of a fumigated warehouse.

SCBA is not required to turn on the exhaust fan of a chamber. However, if the chamber is partially opened for make-up air, the enclosure must be opened and the fan started simultaneously.

Possible Alternative Conditions

Remote Aeration - If aeration can be initiated remotely, SCBA is not required. The person who initiates aeration must be at least 30 feet upwind from the enclosure. Example: use a rope to open a sea/land container.

Condition 13

Aeration must be initiated during daylight hours. Exception: Enclosures which aerate using an exhaust stack meeting the standard height requirements may exhaust at any time.

Reasoning

The less stable atmosphere during daylight hours dilutes and dissipates the methyl bromide much more rapidly relative to more stable nighttime conditions. The aeration zone sizes have been calculated assuming these daylight conditions. The "standard height" table has been calculated assuming more stable nighttime conditions.

Procedure for Determining Compliance

Aeration must be started during daylight hours, between one hour after sunrise and one hour before sundown. The great majority of the methyl bromide released during aeration is released during the first few minutes. This period must occur during daylight. The latter stages of aeration can occur at night.

Example: If aeration takes a total of 24 hours, only the first hour must be during daylight hours.

Possible Alternative Conditions

Nighttime Aeration - The aeration zone sizes can be calculated for nighttime release, but they would be much larger than the comparable daylight aeration zones, probably two to four times larger. Contact the Environmental Monitoring Branch for assistance.

Condition 14

Enclosures must be aerated for the following minimum duration:
a. 4 hours if mechanically ventilated using fans, or
b. 12 hours if passively ventilated

NOTE: This condition pertains to aeration of the fumigation enclosure, not aeration of areas where commodities are stored, except when they are the same.

Reasoning

Methyl bromide absorbed within the commodity can continue to off-gas for a long time. The rate of off-gassing depends on how tightly methyl bromide binds to the commodity. The amount of air which passes through the enclosure has a minimal effect on the rate of off-gassing.

Procedure for Determining Compliance

The minimum time periods for aerating enclosures are measured from the start of aeration to the end of aeration. The commodity cannot be moved from the enclosure during this period. People may not enter the enclosure without respiratory protection during this period.

Possible Alternative Conditions

Vacuum Chambers - Vacuum chambers accelerate the rate of desorption of the methyl bromide. At least 4 air washes must be done before the commodity can be moved from the chamber.

Aeration Outside of Fumigation Enclosure - Fumigated commodity may be removed from the fumigation enclosure as soon as the concentration of methyl bromide in the air spaces between the stacked commodity is less than 5 ppm (Permit Condition 15 is fulfilled) and at least ten air changes have been completed. However, the minimum aeration time (4 or 12 hours) must be provided before people handle (process, package) the treated commodity. In other words, the minimum aeration time must be provided before people can handle the treated commodity. The aeration can occur within the enclosure, storage area or some other holding area.

The aeration required outside of the enclosure can be prorated if the method of aeration is changed. For example, if two hours of mechanical aeration is completed before the commodity is removed from the enclosure, one-half of the required aeration has been achieved. Therefore, six hours of passive aeration outside of the enclosure is still required (the second half of the required aeration).

Possible Alternative Conditions, continued

Monitoring - Various types of monitoring may indicate that the minimum aeration times can be reduced. This may involve testing the rate of desorption for a specific commodity or monitoring workers with charcoal tubes (or some other sensitive method). This type of monitoring cannot be done with colorimetric detector tubes. Contact the Worker Health and Safety Branch for assistance.

Condition 15

The concentration of methyl bromide in the air spaces between the stacked commodity must be less than 5 ppm before the commodity can be moved from the enclosure. Testing of this air space must be done according to approved procedures.

NOTE: This condition pertains to aeration within the fumigation enclosure, not aeration of areas where commodities are stored, except when they are the same.

Reasoning

This is a label requirement. This condition will insure that the testing is done in an appropriate manner.

Procedure for Determining Compliance

See the following section. No test is required if the enclosure is moved from the work site prior to the start of aeration (labels prohibit movement in most circumstances).

Example: See the following section.

Possible Alternative Conditions

None, although a testing history of no detectable methyl bromide can be used to request that testing be discontinued. See page 46 for details.

The following procedure can be used to determine if the aeration period has been sufficient to allow movement of a treated commodity. This determination is based on measuring the amount of residual methyl bromide within the air space of the treated commodity. This is the same method used by the USDA to determine whether a treated commodity can be released or should have additional aeration.

Equipment:

1. Self-Contained Breathing Apparatus (SCBA)

2. Colorimetric Detector Tubes - These are tubes (approximately 1/4 X 6 inches) which produce a color change when methyl bromide is present. The length of this color change indicates the methyl bromide concentration. A specific pump must be used with these tubes; both tubes and pump must be purchased from the same manufacturer. The detection limit varies with manufacturer and model. Select the tube model which best fits your needs.

Manufacturer	Model Number	Measurement Range	Comments
National Draeger (412) 787-8383	Methyl Bromide 5/b	5 to 50 ppm	one tube, 5 strokes
	5/b with Activation Tube	0.8 to 8 ppm	two tubes, 30 strokes
	Methyl Bromide 0.5/a	0.5 to 5 ppm	one tube, 5 strokes
	Methyl Bromide 3/a	3 to 35 ppm	two tubes, 5 strokes
Sensidyne (800) 451-9444	Methyl Bromide No. 136	2 to 10 ppm (0.5 ppm detection limit)	two tubes, 4 strokes
	Methyl Bromide No. 136LA	1 to 18 ppm (0.2 ppm detection limit)	two tubes, 2 strokes
Matheson-Kitagawa (510) 793-2559 (714) 987-4611	Methyl Bromide 8014-157SB	2.5 to 80 ppm	two tubes, 1 stroke
	Methyl Bromide 8014-157SC	0.5 to 10 ppm	two tubes, 1 stroke
MSA (800) MSA-2222	Methyl Bromide P/N 462135	2.5 to 90 ppm	two tubes, 4 strokes

Procedure:

1. Don the SCBA equipment.

2. Turn-off the ventilation equipment of the fumigation enclosure.

3a. Commodity in Bins - Insert detector tube into the air space of the bulk of treated commodity. Test at a minimum of two locations.

3b. Commodity in Boxes/Cartons - Obtain detector tube measurements within the commodity by sampling at a height of four feet from the floor and 12 inches inside the air space of the treated commodity stack, between the boxes or cartons. Test at a minimum of two locations.

3c. Commodities in Bulk - For large confinements where access is limited, test the air within the exhaust duct to determine completeness of aeration.

4. If all test readings show the concentration is less than 5 ppm, the commodity may be released from the fumigation area for further processing, provided the minimum aeration time specified in the permit conditions is met.

5. Record the test information on the accompanying form, or substitute.

In order to discontinue routine testing, this procedure must be repeated under worst-case scenario conditions (i.e. with the largest possible amount of fumigated commodity and maximum dosage used) to establish that the aeration procedure is completely effective. Once a documented testing history is established and fumigation conditions are not changed (i.e. increased dosage, change in commodity fumigated, increased fumigated volume), the testing can be discontinued. It will require 5 - 25 tests to establish a testing history, depending on the concentration detected, the variation in concentration and the detection limit of the colorimetric tube. A fewer number of tests would be required if a short work time is needed, or a low concentration is detected, or the concentration variation is low, or the detection limit is low. Testing history must be reviewed by DPR prior to discontinuing testing. The testing history must be reestablished annually.

Fumigation Site: _____

Address: _____

Type of Colorimetric Detector Tube: _____

Enclosure Identification:_____

Date/Time of Test		
Person Testing		
Colorimetric Tube Sampling Location		
Commodity Fumigated		
Amount of Commodity Fumigated		
Application Rate		
Volume Fumigated		
Commodity Container/Packaging		
Date/Time of Start of Fumigation		
Date/Time of Start of Aeration		
Colorimetric Tube Reading		
Colorimetric Tube Detection Limit		
Comments		

Condition 16

Methyl bromide concentrations in enclosed areas (i.e. buildings, warehouses, silos, etc.) where fumigated commodities are stored must be less than 5 ppm before persons may enter. Testing of the air concentration must be done according to approved procedures. No individual may be inside the enclosed area for more than one hour in a 24-hour period.

NOTE: This condition pertains to areas where commodities are stored, not the fumigation enclosure, except when they are the same.

Reasoning

Enclosed storage areas can have high concentrations if methyl bromide continues to off-gas from the treated commodity. High concentrations in the storage area may result even if the commodity is aerated below 5 ppm in the fumigation enclosure. Off-gassing can be slow and high concentrations may not build up for several hours or several days. It is also possible that the load from one fumigation will not cause a problem, but the storage of several loads will produce unacceptable concentrations of methyl bromide.

Procedure for Determining Compliance

See following section for test procedure. Testing is not necessary under the following circumstances:

if no one is working within the storage area, or
no commodity is fumigated, or
the commodity is not stored at the work site (a statement indicating that the commodity has been fumigated with methyl bromide should accompany the commodity if it will be stored within an enclosed area at another site)

Procedure for Determining Compliance, continued

This condition applies if an enclosed area is used for storage as a secondary function. Even if the majority of a building is devoted to processing, packaging or some other function if it is also used for storage of treated commodity this condition applies. This condition does not apply to areas that are used solely for processing or other enclosed areas where treated commodity may be handled. However, an exposure risk may still exist under some circumstances. For example, if treated commodity is not stored, but sent immediately to an enclosed processing area. Also, if a large amount of treated commodity is being handled within a small, enclosed area. Also, if the processing area is poorly ventilated. Some processing areas may need to be considered as enclosed storage areas for the purposes of the permit conditions.

This condition does not apply to partially enclosed storage areas. Partially enclosed areas do not pose the same potential for exposure concerns as enclosed areas. However, an exposure risk may still exist due to gas confining physical conditions at the site. Partially enclosed areas should be carefully evaluated for the extent of potential exposure. For example, look at the number, size and location of the openings. Check to see if the openings allow free flow of air. Compare the amount of treated commodity to the size of the storage area. Observe the activities, location and duration of work within the storage area. An individual site may need some ventilation, testing, or some other mitigation measure (remember the four concepts) to insure an adequate margin of safety. Some partially enclosed spaces may need to be considered enclosed spaces for the purposes of the permit conditions.

Examples: If the commodity is stored in a silo or bin where no one works, no testing is necessary. If a facility such as a food processing plant contains no fumigated commodity, no testing is necessary. If a sea/land container is fumigated and then shipped off the work site, no testing is required. If the commodity is stored underneath a roof, but has no confining walls, testing is not necessary.

The work time restrictions are cumulative time spent within the enclosed area. This does not include time spent outside the enclosed area. There are no restrictions on time spent outside of the enclosed area.

Possible Alternative Conditions

Respiratory Protection - Only self-contained breathing apparatuses are approved protection for methyl bromide. This is generally not a viable alternative when exposures will exceed a few minutes because of tank duration.

Mechanical Ventilation and Periodic Monitoring - Mechanical ventilation must be adequate to maintain methyl bromide concentrations at acceptable levels. Consultation with a ventilation engineer or a certified industrial hygienist with ventilation training is recommended to evaluate the adequacy of the ventilation system. In addition, periodic monitoring with colorimetric detector tubes must be conducted as specified in the procedure on page 52.

Mechanical Ventilation and Full-Shift Worker Monitoring - The work site must be surveyed by a licensed ventilation engineer or a certified industrial hygienist with training in ventilation to determine if the ventilation system provides an adequate margin of safety to methyl bromide air concentrations.

In addition, Full-Shift Worker Monitoring must be conducted at least one time. A monitoring plan must be developed in consultation with the DPR-Worker Health and Safety Branch or a certified industrial hygienist. This monitoring must use a sampling and analytical method that is capable of measuring less than 0.3 ppm as an 8-hour time-weighted average air concentration value **(colorimetric detector tubes cannot be used)**. DPR must review and approve the monitoring results. If the approved monitoring data show the work site levels are below 0.3 ppm (half of the 0.6 ppm target value), no further testing is necessary.

Equipment:

1. Self-Contained Breathing Apparatus (SCBA)

2. Colorimetric Detector Tubes - These are tubes (approximately 1/4 X 6 inches) which produce a color change when methyl bromide is present. The length of this color change indicates the methyl bromide concentration. A specific pump must be used with these tubes; both tubes and pump must be purchased from the same manufacturer. The detection limit varies with manufacturer and model. Select the tube model which best fits your needs.

The choice of detector tube is in part determined by the duration of exposure. If short term access (less than 1 hour) is necessary, a detector tube that measures to 5 ppm would be adequate. To determine entry for longer times or to document that control methods are adequate, a detector tube that measures to a lower detection limit would be appropriate.

Manufacturer	Model Number	Measurement Range	Comments
National Draeger (412) 787-8383	Methyl Bromide 5/b	5 to 50 ppm	one tube, 5 strokes
	5/b with Activation Tube	0.8 to 8 ppm	two tubes, 30 strokes
	Methyl Bromide 0.5/a	0.5 to 5 ppm	one tube, 5 strokes
	Methyl Bromide 3/a	3 to 35 ppm	two tubes, 5 strokes
Sensidyne (800) 451-9444	Methyl Bromide No. 136	2 to 10 ppm (0.5 ppm detection limit)	two tubes, 4 strokes
	Methyl Bromide No. 136LA	1 to 18 ppm (0.2 ppm detection limit)	two tubes, 2 strokes
Matheson-Kitagawa (510) 793-2559 (714) 987-4611	Methyl Bromide 8014-157SB	2.5 to 80 ppm	two tubes, 1 stroke
	Methyl Bromide 8014-157SC	0.5 to 10 ppm	two tubes, 1 stroke
MSA (800) MSA-2222	Methyl Bromide P/N 462135	2.5 to 90 ppm	two tubes, 4 strokes

Procedure:

1. Safety: If more than 2 hours has elapsed since the last test, SCBA must be worn or testing must be done remotely.

2. Test Location: Tests must be made of the air in the working area where concentrations will be highest. This location will depend on the proximity to the treated commodity, elapsed time since the commodity was treated and ventilation patterns within the storage area. If this location is not known or changes with time, several locations need to be tested.

3. Test Frequency: The first test must be performed before initial entry during each workshift. Additional tests are required if the work time within the enclosed area is greater than 2 hours. Tests must be made according to the schedule below.

4. Restrictions on Work Time: The results of the monitoring are used to determine the length of time work is allowed within the enclosed area. Work time is cumulative time spent within the enclosed area. This does not include time spent outside the enclosed area. Use the following work and testing schedule **for each workshift**. If any subsequent tests show higher concentrations than the initial test, the work schedule must be adjusted accordingly.

Work Time Restriction (per 24 hours)	Maximum Level Allowed Per Test	Colorimetric Tube Detection Limit	Tests Required
1 hour	5 ppm	5 ppm or less	initial test
2 hours	3 ppm	3 ppm or less	initial test
4 hours	1 ppm	1 ppm or less	initial test, repeat at 2 hrs
8 hours	ND*	0.5 ppm or less	initial test, repeat every 2 hrs

*ND - no detectable amount

Example: If an initial test shows no detectable methyl bromide with a 0.5 ppm detection limit, 8 hours of work can be planned. However, if the second test two hours later shows 1 ppm, work can only be conducted for an additional two hours within the enclosed area (4 hours total work time).

5. Test Duration: If no additional treated commodity is added to the storage area and testing shows no detectable methyl bromide for three consecutive days, testing may be discontinued and work time restrictions lifted until new commodity is added. Testing may be discontinued if no further work is required within the enclosed area.

6. Documentation: Record the test information on the accompanying form, or other substitute.

7. Testing History: In order to terminate periodic monitoring, this procedure must be repeated under worst-case scenario conditions (i.e. with the largest possible amount of fumigated commodity and maximum dosage used) to establish that ventilation is completely effective. Once a documented testing history is established and fumigation conditions are not changed (i.e. increased dosage, change in commodity fumigated, increased fumigated volume), the testing can be discontinued. It will require data from 5 - 50 workshifts to establish a testing history, depending on the work time desired, the concentration detected, the variation in concentration and the detection limit of the colorimetric tube. A fewer number of tests would be required if a short work time is needed, or a low concentration is detected, or the concentration variation is low, or the detection limit is low. Testing history must be reviewed by DPR prior to discontinuing testing. The testing history must be reestablished annually.

Fumigation Site: _____

Address: _____

Type of Colorimetric Detector Tube: _____

Storage Area Identification: _____

Date/Time of Test		
Person Testing		
Colorimetric Tube Sampling Location		
Commodity Fumigated and Stored		
Amount of Fumigated Commodity in Storage		
Application Rate		
Commodity Container/Packaging		
Date/Time Last Fumigated Load Stored		
Colorimetric Tube Reading		
Colorimetric Tube Detection Limit		
Comments		

Condition 17

The enclosure operator and/or pest control business must complete or revise a Work Site Plan before receiving a permit. A completed Work Site Plan must be submitted to the County Agricultural Commissioner for evaluation before a Restricted Materials Permit will be approved.

Reasoning

Specific information about each work site and each fumigation enclosure is needed to issue the permit.

Procedure for Determining Compliance

The Work Site Plan is contained in the Suggested Permit Conditions. All questions of the Work Site Plan must be completed. If only one of the questions is not answered, there will be insufficient information to issue the permit. See page 9 for procedures to evaluate Work Site Plans.

Possible Alternative Conditions

None

Condition 18

The enclosure operator must keep records of all test results for 2 years and make them available to the County Agricultural Commissioner and workers (pursuant to Labor Code Section 6408 and Cal-OSHA regulations Title 8, Section 3204) upon request.

Reasoning

A record of the testing is necessary to document to the County Agricultural Commissioner that the testing was conducted and to document that the airborne levels were found to be acceptable.

Procedure for Determining Compliance

Site operator must maintain a booklet showing date, time, purpose of test, testing result and initials of person performing test. Additional information is needed to demonstrate a testing history. Suggested forms accompany each procedure.

Example:
1/23/94, 13:00, prior to movement of #3, less than 5 ppm, R.B.J.

Possible Alternative Conditions

Existing Records - Site operator may incorporate testing documentation in existing records kept for fumigation operation.

Introduction

There are two retention categories: pressure tested, and retention tested/untested. The size of the treatment zone is dictated by the retention category. See the sections on Treatment Zones, pages 82 - 93 for more information.

Pressure Tested

Pressure tested enclosures are one of two types: vacuum chambers or enclosures which pass the USDA pressure test. Vacuum chambers are usually small, metal chambers in which fumigations are conducted under reduced atmospheric pressure. The reduced pressure allows fumigations to proceed much more quickly, because methyl bromide penetrates the commodity faster during treatment and fresh air penetrates faster during aeration. Fumigation and aeration can be completed in a few hours with vacuum chambers.

An enclosure which passes the USDA pressure test is completely constructed of rigid material and must also be well-sealed and impermeable to methyl bromide. This type of enclosure is usually made of metal, concrete or wood coated with epoxy paint. All joints are caulked and the seals on the doors and aeration ducts are gas-tight. This type of enclosure is normally a chamber, but some silos or storage bins may also pass the test.

Retention Tested/ Untested

Retention tested/untested enclosures can look very different from pressure tested enclosures. Most chambers, silos, storage bins, sea/land containers, tarpaulin fumigations and buildings are in this category. Many of these enclosures will retain methyl bromide very well. The greater the retention, the smaller the treatment zone. On the other hand, the greater the retention, the more methyl bromide will be released during aeration. Therefore, the greater the retention, the larger the aeration zone. The retention of methyl bromide can be measured and documented by following the retention test procedure on page 62.

Definition K

A "pressure tested enclosure" is either a vacuum chamber or an enclosure which is pressure tested following the procedures of the US Department of Agriculture Plant Protection and Quarantine Manual.

Reasoning

This is one of two retention categories for methyl bromide enclosures. The conditions required for this type of enclosure are very different from the other category.

Procedure for Determining Compliance

The enclosure must be tested following the USDA procedure. Any knowledgeable person may conduct the test, including the enclosure operator. Either a copy of the USDA certification or the form on page 60 must be submitted with the Work Site Plan. The test must be repeated annually. A vacuum chamber which passes the pressure test by design, requires no documentation.

Note: Not all USDA-certified enclosures are pressure tested. For example, USDA will certify tarpaulin fumigations, but tarpaulin enclosures will not pass the pressure test.

Examples: vacuum chamber, USDA quarantine chamber.

Possible Alternative Conditions

None. If an enclosure does not pass this test, it is classified as retention tested or untested.

Excerpted from the US Department of Agriculture's Plant Protection and Quarantine (PPQ) Treatment Manual (8/93).

EQUIPMENT
Open Arm Manometer

The manometer is a U-shaped tube partially filled with kerosene or water. The tube may be of glass or transparent plastic tubing. A ruler calibrated in millimeter (mm) divisions or carefully measured lines on a background is used to measure the difference in level of the kerosene in the two arms (or the level in one arm).

When fumigant is volatilized in a chamber at atmospheric pressure, a positive pressure is created, which may then be continuously reduced by leakage of the air-fumigant mixture. PPQ approved chambers must be sufficiently tight to retain the fumigant during the exposure period. The manometer is used during the pressure-leakage test as a measure of tightness. An opening (usually 1 inch diameter) should be provided in the chamber for the use of the blower or other means for the introduction of air to create a positive pressure in the chamber. An additional opening, such as a gas sampling line opening, must be provided for the manometer. The procedure for testing is as follows:

- Close chamber as for fumigation
- Attach one end of the manometer to the chamber opening
- Use vacuum cleaner blower or similar apparatus to create pressure in excess of 50 mm as measured on an open-arm, kerosene or water filled manometer; consider 50 mm as the difference between the levels of kerosene in the two arms of the manometer (or a rise of 25 mm in the open arm)
- Discontinue blower and close its entry
- Observe time for pressure to recede from 25 to 2.5 mm in the open arm

The time lapse for the chamber pressure to recede from 50 to 5 mm must be 22 or more seconds for minimum approval. Chambers shall be reinspected every 6 months when 22 to 29 seconds are recorded. Chambers which retain the pressure for 30 seconds or longer should be tested annually. Inability to develop or maintain adequate pressure indicates considerable leakage. In such cases, the chamber operator may use a smoke bomb or other device in an effort to determine the areas of leakage.

Electronic manometers are also available and may be used in lieu of the open-arm (U-tube) type.

A copy of the USDA certification may be substituted for this form.

Fumigation Site: _____

Address: _____ City: _____ Zip: _____

Person Performing Test: _____ Phone: _____

Company of Person Performing Test: _____

Date of Test: _____

Enclosure Description (chamber, silo, etc.): _____

Enclosure Volume (cubic feet): _____

Initial Pressure Reading: _____

Final Pressure Reading: _____

Elapsed Time Between Readings: _____

I VERIFY THAT THIS INFORMATION IS ACCURATE AND TRUE TO THE BEST OF MY KNOWLEDGE.

Signature:_____ Date:_____

Title:_____

This certification must be attached to the Work Site Plan.

Definition L

A retention tested enclosure is one that has been measured for loss of methyl bromide over time according to an approved procedure.

Reasoning

This is one of two retention categories for methyl bromide enclosures (retention tested and untested are grouped together). The conditions required for this type of enclosure are very different from the other category.

The retention test will determine the "loss ratio" of the enclosure. The loss ratio is the fraction of methyl bromide per hour that leaks out of the enclosure during the treatment period. For example, if the loss ratio is 0.013, this means that 1.3% of the applied methyl bromide leaks out for every hour of treatment. Knowing this value allows buffer zone sizes computed with much greater accuracy.

Procedure for Determining Compliance

The enclosure should be tested using the procedure in the following section. Any knowledgeable person may conduct the test, including the enclosure operator. The attached form must be filled out and signed by the person performing the test. The test must be repeated annually. Alternative test methods must be approved by DPR. Contact the Worker Health and Safety Branch for approval of alternative methods.

Examples: well-sealed chamber, well-sealed silo, well-sealed sea/land container

Possible Alternative Conditions

If an enclosure passes this test, it may also pass the pressure test if it is a rigid structure.

Equipment:

1. Measuring Instrument - This will usually be a Fumiscope, although other instruments such as infrared spectrometers and photoionization detectors can be used. A Fumiscope is an instrument designed specifically for measuring high concentrations of methyl bromide. Fumiscope calibration within the last year is suggested, but not required since this test measures a relative difference.

2. Tubing - This can be Tygon™, Teflon™, or any other flexible tubing.

3. Methyl Bromide and Introduction Equipment - Use the amount of methyl bromide which will give a concentration of 1 pound per 1000 cubic feet (16 oz/1000 cu ft or 4100 ppm or 0.41%).

Procedure:

This test may be done with no commodity within the enclosure.

1. Place the sampling lines into the enclosure. There should be at least two and as many as five sampling lines, depending on the volume of the enclosure. The larger the volume, the more lines are needed to get a precise reading. The exhaust of the instrument must be vented away from all people or back into the enclosure.

2. Follow the startup instructions for the measuring instrument.

3. Introduce the minimum test dosage into the enclosure following the label directions and precautions for a space fumigation.

4. Measure the concentration inside the enclosure within the first few minutes of introduction to insure that the initial concentration is correct.

5. Wait for 24 hours. Rezero the instrument and take the next reading. If alternative buffer zones will be requested, additional readings at other times may assist DPR in the evaluation.

6. Aerate the enclosure following label directions.

7. Fill out the attached certification.

Fumigation Site: _____

Address: _____ City: _____ Zip: _____

Person Performing Test: _____ Phone: _____

Company of Person Performing Test: _____

Enclosure Description (chamber, tarpaulin): _____

Enclosure Volume (cubic feet): _____

Measuring Instrument: _____

Units of Measurement (ounces per 1000 cubic feet, or ppm, or %): _____

Application Rate (ounces per 1000 cubic feet, or ppm, or %): _____

Treatment Period (hours): _____

Date and Time of Introduction: _____

Instrument Readings for Each Sampling Line

Date	Time	1	2	3	4	5	Average

Compute the loss ratio using the average initial reading and the average 24-hour reading:

$$\textbf{Loss Ratio} = \frac{\textbf{Initial Reading - Final Reading}}{\textbf{24} \times \textbf{Initial Reading}}$$

Example: If the initial or starting fumiscope reading was 16 ounces per 1000 cubic feet and the reading 24 hours later was 11, the Loss Ratio is:

$$\frac{16 - 11}{24 \times 16} = 0.013$$

NOTE: Give 3 places after the decimal.

Loss Ratio: 0.0 __ __ per hour

I VERIFY THAT THIS INFORMATION IS ACCURATE AND TRUE TO THE BEST OF MY KNOWLEDGE.

Signature:_____ Date:_____

Title:_____

This certification must be attached to the Work Site Plan.

Definition M

An untested enclosure is one that has not been pressure tested or retention tested.

Reasoning

This is one of two retention categories for methyl bromide enclosures (retention tested and untested are grouped together). The conditions required for this type of enclosure are very different from the other category.

Procedure for Determining Compliance

The enclosure must comply with all label requirements.

Examples: typical building, sea/land container, tarpaulin fumigation

Possible Alternative Conditions

The enclosure can be upgraded to pass the pressure test or tested for retention.

Introduction

There are three aeration method categories: standard height stack, minimum stack, and no stack. The size of the aeration zone depends on the aeration category. See the section on Aeration Zones, pages 79 and 94 - 114 for more information.

Advantages and Disadvantages of Stacks

A properly designed exhaust stack has many advantages. It serves both to dilute the released methyl bromide and to increase the distance between the source of methyl bromide and people. In addition, most stacks use large capacity fans to exhaust the methyl bromide at a high velocity. This high exit velocity serves to increase the effective stack height.

In contrast, a poorly designed exhaust stack has many disadvantages. Most stacks exhaust a large amount of methyl bromide in a short time. This high emission rate can result in high downwind concentrations. In addition, most exhaust stacks have small openings which concentrate the methyl bromide into a small area. Anyone exposed to the undiluted exhaust can receive an exposure Immediately Dangerous to Life or Health (IDLH) of 2000 ppm. The small, high concentration area at the source also results in a small high concentration area downwind. This high concentration area can extend for long distances downwind.

Standard Height Stack

A standard height stack is tall enough so that the methyl bromide plume coming from it is not diverted by the enclosure structure or any other downwind obstruction. The stack is also tall enough so that when the plume reaches the ground, the methyl bromide concentration is low and no special aeration zone is required.

Minimum Stack

A minimum stack is shorter than the standard height, but tall enough so that no one is exposed to the undiluted exhaust. As discussed above, a small high concentration area can extend for a long distance from the stack. Therefore, some of the aeration zones required for these types of enclosures are large.

No Stack

Enclosures that are exhausted with no stack are difficult to regulate because the characteristics of the release cannot be generalized. The amount of methyl bromide released over time or the emission rate varies greatly because a large percentage of the methyl bromide can be released quickly or a small percentage can be released slowly. The size of the area of methyl bromide release also varies greatly. For example, methyl bromide can be released from a small door or from several thousand square feet of bins. Since health-protective assumptions were used to calculate the size of the aeration zones for this category, some zones are large.

Definition N

A "standard height" exhaust stack is one which is at least 10 feet above the enclosure's highest point, and at least 10 feet above any major obstruction within 200 feet of the stack, and at least as tall as the appropriate value in Table 1.

Reasoning

This is one of three possible aeration methods. The conditions required for this aeration method are very different from the other categories.

Basis/Key Assumptions

This condition takes advantage of the fact that as the exhaust stack increases in height, the methyl bromide concentration at ground level decreases. Similarly, the higher the vertical velocity of the methyl bromide as it comes out of the exhaust stack, the lower the concentration at ground level (the higher the exit velocity, the higher the effective stack height). The goal of this condition is to insure the methyl bromide is released at a high enough altitude, so that by the time the plume reaches anyone the exposure would be minimal.

A computer simulation model, Industrial Source Complex-Short Term model (ISCST), was used to predict downwind concentrations for methyl bromide released at various heights and at various stack exit velocities. The combinations of stack height, exit velocity, and amount of methyl bromide resulting in minimal downwind exposure are shown in Table 1. The combinations in Table 1 were calculated with the following assumptions: aeration occurs under worst-case weather conditions of high nighttime stability and low wind speed, no variation in wind direction, 90% of the applied methyl bromide is emitted, and exit velocity is calculated using one-half the rated fan capacity. The combinations in Table 1 are valid provided no downwind obstructions cause the plume to come down earlier than predicted (downwash). The requirements for 10 feet above the roof and 10 feet above any obstruction within 200 feet are designed to avoid downwash. See "Description of the Computer Modeling," page 115 for more details.

Procedure for Determining Compliance

1. Ten feet above the facility's highest point. The goal of this condition is to avoid the building's downwash. If the roof is slanted, the stack must be 10 feet above the roof's apex. If there are pipes, conduits, walkways, or other small protuberances, these can probably be ignored. If the protuberance can cause downwash, the stack should be 10 feet above the protuberance. This requirement may be inadequate for very large or very tall enclosures (e.g. 250,000 cubic feet or 50 feet tall). Very large or tall enclosures may require more than 10 feet of clearance for exhaust to escape the building's downwash, especially when the enclosure is housed within a secondary enclosed space. It may be possible to use a smoke bomb to determine if the stack is high enough to escape the downwash. Contact the Environmental Monitoring Branch if you have a concern with a specific facility.

2. Ten feet above any major obstruction within 200 feet of the stack. The term major obstruction is very subjective. Generally, if the obstruction is large enough to divert a significant portion of the plume toward the ground, it should be considered a major obstruction. Examples of major obstructions include houses, mature orchards, and silos. Examples of obstructions that would not be major include telephone poles, and antennas. Obstructions that would be in the gray area include billboards, water tanks on legs, trees with no leaves, and buildings with slanted roofs. It is important to consider if anyone will be in the vicinity of the obstruction during aeration. If no one will be within several hundred feet of the obstruction during aeration, then the obstruction can be ignored. However, keep in mind that high exposure can occur in a very short time during aeration. In some cases, even a ten minute exposure may be too much. If anyone can spend even a few minutes near the obstruction, the stack should be at least 10 feet above it.

Procedure for Determining Compliance, continued

3. At least as tall as the appropriate value in Table 1. Measure the height of the lowest stack from ground level to the top of the stack. Three items of information are needed to use Table 1: the amount of methyl bromide used, the rated fan capacity, and the stack cross-sectional area. The amount of methyl bromide should be based on the total amount used at the work site in a 24-hour period. The rated fan capacity can be obtained from the manufacturer. If the rated fan capacity cannot be determined, the actual flow rate inside the stack must be measured. This should be done by a certified industrial hygienist. The stack cross-sectional area is most accurately measured using the inside area, but the outside area can also be used (area of circle = $3.14 \times \text{radius}^2$, [radius is one-half the diameter and must be in feet]). If the stack is some unusual shape, the Environmental Monitoring Branch can help determine its area. Enclosures which use more than one fan or stack can be allowed provided each individual stack meets the height requirement resulting from the aggregate fan capacities and aggregate stack areas. Examples of calculations for multiple fans and stack are given below. It is difficult to calculate the size of the aeration zone for a mixture of aeration methods in a 24-hour period, such as aerating one enclosure with a standard height stack and a second enclosure with no stack. To help avoid such difficulties, use the total amount of methyl bromide which might be used in a 24-hour period for the entire work site to determine the stack height for each enclosure. When using Table 1, round up to the nearest methyl bromide value and round down to the nearest exit velocity value.

***Example 1**: One chamber fumigated twice in a 24-hour period*

Fumigation Specification
- *80 pounds of methyl bromide for each fumigation*
- *10,000 cubic feet per minute fan capacity*
- *9 square feet stack area*

Amount of Methyl Bromide =
80 lbs (app1) + 80 lbs (app2) = 160 lbs

$$\text{Exit Velocity} = \frac{10{,}000 \text{ cfm}}{9 \text{ square feet}} = 1111 \text{ feet per minute}$$

Required Stack Height = 16 feet (from Table 1, 200 lbs, 1100 ft/min)

Procedure for Determining Compliance, continued

***Example 2**: One chamber with two stacks*

Fumigation Specification
- *270 pounds of methyl bromide*
- *stack 1: 5,000 cubic feet per minute fan capacity*
  5 square feet stack area
- *stack 2: 7,000 cubic feet per minute fan capacity*
  8 square feet stack area

$$\text{Exit Velocity} = \frac{5000 \text{ cfm} + 7000 \text{ cfm}}{5 \text{ square feet} + 8 \text{ square feet}} = 923 \text{ feet per minute}$$

Required Stack Height (for each stack) = 25 feet
(from Table 1, 300 lbs, 900 ft/min)

***Example 3**: Two separate chambers and a tarped pile aerated within 24 hours*

Chamber #1 - 50 pounds methyl bromide
- 3,000 cubic feet per minute fan capacity
- 4 square feet stack area

Chamber #2 - 60 lbs
- 4,000 cfm
- 6 sq ft

Tarped Pile - 70 lbs

Amount of Methyl Bromide = 50 lbs + 60 lbs + 70 lbs = 180 lbs

$$\text{Chamber \#1 Exit Velocity} = \frac{3{,}000 \text{ cfm}}{4 \text{ sq ft}} = 750 \text{ ft/min}$$

$$\text{Chamber \#2 Exit Velocity} = \frac{4{,}000 \text{ cfm}}{6 \text{ sq ft}} = 667 \text{ ft/min}$$

Stack Height for Chamber #1 = 25 feet
*(from Table 1, **200** lbs, 700 ft/min)*

Stack Height for Chamber #2 = 28 feet
*(from Table 1, **200** lbs, 600 ft/min)*

Possible Alternative Conditions

Minimum Stack - Use the conditions required for minimum stacks.

Decrease Application Rate - Decreasing the application rate decreases the height required by Table 1. However, the minimum requirements for 10 feet above the roof and 10 feet above obstructions within 200 feet would still apply.

Decrease Volume Fumigated - Decreasing the volume fumigated decreases the height required by Table 1. However, the minimum requirements for 10 feet above the roof and 10 feet above obstructions within 200 feet would still apply. For rigid structures, impermeable material can be placed in open spaces inside the enclosure. This "volume displacement" decreases the amount of methyl bromide that is needed to fumigate the enclosure.

Daylight Restriction - The values in Table 1 were calculated assuming stable, nighttime conditions. If aeration were restricted to daylight hours, the Table 1 values would be considerably smaller. However, the minimum requirements for 10 feet above the roof and 10 feet above obstructions within 200 feet would still apply. Contact the Environmental Monitoring Branch for alternative Table 1 values.

Recovery/Destruction System - If an enclosure is equipped with a system to recover or destroy the exhausted methyl bromide, it would probably be exempted from the standard height stack and aeration zone requirements. This assumes that the system is very efficient in recovering or destroying the methyl bromide. Contact the Environmental Monitoring Branch to determine if the enclosure can be exempted.

Wind Direction Restrictions - Allowing fumigations because there are no people in the predominant downwind direction is not a viable alternative in most cases. While the wind may blow predominantly in one direction, there are always short term variations in wind direction. With these types of enclosures the great majority of methyl bromide is released in a few minutes. The wind may be blowing in a different direction during the crucial phase of aeration. In addition, even small changes in wind direction at the stack can lead to large changes in the location of the plume downwind.

Possible Alternative Conditions, continued

Access Restrictions - For those enclosures which cannot meet the 10 foot height requirement above any major obstruction within 200 feet, it may be possible to allow fumigations if there were no people in the vicinity of the obstruction during aeration. Unfortunately, the size of the area that would have to be vacated around the obstruction cannot be reliably predicted. Very high concentrations could be present for short periods around these obstructions. All people would have to be excluded and transit through the area may be unacceptable.

Slow Release - Aerating slowly is not a viable alternative in most cases, since aeration would have to occur over several days to be effective.

High Exit Velocity - A very high exit velocity may substitute for stack height. However, the exit velocity would need to be in excess of 5000 feet per minute. Even then it may not be enough to get over large obstacles. Consult with the Environmental Monitoring Branch before implementing this alternative.

Special Fans/Stacks - Some fans and stacks, specially designed to exhaust toxic gases, may be suitable for some methyl bromide enclosures. Contact the Environmental Monitoring Branch before installing such a system.

Dilution Air - A secondary air system can be installed to dilute stack emissions. A large amount of dilution air would probably be required, at least 10 to 1 dilution. Consult with the Environmental Monitoring Branch before implementing this alternative.

This table is used to determine the "standard height" (feet) of a stack. A "standard height" exhaust stack is one which is:

1. at least 10 feet above the enclosure's highest point, and
2. at least 10 feet above any major obstruction within 200 feet of the stack, and
3. at least as tall (above ground level) as the appropriate value in the table below

Total Amount of Methyl Bromide Applied (pounds) at the Work Site in a 24-hour Period

Exit Velocity (feet per minute)*	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
600	21	23	26	28	30	32	34	37	39	41	43	45	48	50	52	54	57	59	61	63
700	19	21	23	25	28	30	32	34	36	39	41	43	45	47	50	52	54	56	58	61
800	16	18	21	23	25	27	30	32	34	36	38	41	43	45	47	49	52	54	56	58
900	15	16	18	20	23	25	27	29	31	34	36	38	40	43	45	47	49	51	54	56
1000	15	15	16	18	20	22	25	27	29	31	33	36	38	40	42	45	47	49	51	53
1100	15	15	15	16	18	20	22	24	27	29	31	33	35	38	40	42	44	46	49	51
1200	15	15	15	15	15	18	20	22	24	26	29	31	33	35	37	40	42	44	46	48
1300	15	15	15	15	15	15	17	19	22	24	26	28	31	33	35	37	39	42	44	46
1400	15	15	15	15	15	15	15	17	19	21	24	26	28	30	32	35	37	39	41	44
1500	15	15	15	15	15	15	15	15	17	19	21	23	26	28	30	32	34	37	39	41
1600	15	15	15	15	15	15	15	15	15	17	19	21	23	25	28	30	32	34	36	39
1700	15	15	15	15	15	15	15	15	15	15	16	19	21	23	25	27	30	32	34	36
1800	15	15	15	15	15	15	15	15	15	15	15	16	18	20	23	25	27	29	32	34
1900	15	15	15	15	15	15	15	15	15	15	15	15	16	18	20	22	25	27	29	31
2000	15	15	15	15	15	15	15	15	15	15	15	15	15	16	18	20	22	24	27	29
2100	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	18	20	22	24	26
2200	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	20	22	24
2300	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	19	21
2400	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	19
2500	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17

$$\text{*Exit Velocity} = \frac{\text{Rated Fan Capacity (cubic feet per minute)}}{\text{Stack Cross-Sectional Area (square feet)}}$$

area of circle = $3.14 \times \text{radius}^2$

Definition P

A "minimum" exhaust stack is one that is less than standard height, but at least 15 feet above the ground and which has an exit velocity of at least 600 feet per minute.

NOTE: "Exit velocity" is the air speed inside the exhaust stack during ventilation. The exit velocity can be measured directly or estimated by dividing the rated fan capacity (cubic feet per minute) by the stack cross-sectional area (square feet).

Reasoning

This is one of three possible aeration methods. The conditions required for this type of enclosure are very different from the other two categories.

Basis/Key Assumptions

The basis for this condition is similar to the basis for standard height requirements. This condition takes advantage of the fact that as the exhaust stack increases in height, the methyl bromide concentration at ground level decreases. Similarly, the higher the vertical velocity of the methyl bromide as it comes out of the exhaust stack, the lower the concentration at ground level (the higher the exit velocity, the higher the effective stack height). Unlike enclosures meeting the standard height requirements, enclosures with minimum stacks may create small areas with high levels of methyl bromide downwind. To compensate for this, aeration zones (shown in Table 3, page 111) are required.

The same ISCST computer model and similar assumptions were used to predict downwind concentrations for minimum stacks as for the standard height stack requirements. Downwind concentrations were calculated with the following assumptions: aeration occurs under daylight weather conditions and low wind speed, no variation in wind direction, and exit velocity was calculated using one-half the rated fan capacity. Table 3 uses the amount of methyl bromide retained in the enclosure rather than the amount applied used by Table 1. The calculations also assumed that the enclosure structure influenced the movement of air around the stack. The influence of downwind obstructions cannot be predicted with the ISCST model.

See "Description of the Computer Modeling," page 115 for more details.

WARNING

The aeration zone associated with a minimum stack may not provide an adequate margin of safety for certain situations. For example, people residing in a multi-story building just outside the aeration zone may have an inadequate margin of safety. Additionally, downwind obstructions may create pockets of high concentrations outside the aeration zones; these situation cannot be reliably predicted with the model. Because of these shortcomings, enclosures within this category should be evaluated carefully.

The 15 foot height requirement and 600 feet per minute requirement were chosen for two reasons. This combination will protect people from the undiluted exhaust. Also, this combination requires a small aeration zone for work sites which retain no more than 50 pounds of methyl bromide within the enclosure in a 24 hour period.

Procedure for Determining Compliance

1. Fifteen feet above the ground. The distance is measured from the ground to the top of the stack.

2. Exit velocity at least 600 feet per minute. The exit velocity can be measured directly or estimated. Measuring the exit velocity requires some special techniques. Consult an industrial hygienist or DPR before attempting this. The exit velocity can also be estimated by using the rated fan capacity and the stack cross-sectional area according to the following equation:

$$\text{Exit Velocity (feet per minute)} = \frac{\text{rated fan capacity (cubic feet per minute)}}{\text{stack cross-sectional area (square feet)}}$$

area of circle = $3.14 \times \text{radius}^2$
radius is one-half the diameter and must be in feet

Example: One chamber with two stacks

- stack 1: 5,000 cubic feet per minute fan capacity
5 square feet stack area

- stack 2: 7,000 cubic feet per minute fan capacity
8 square feet stack area

$$\textit{Exit Velocity} = \frac{5000\ \text{cfm} + 7000\ \text{cfm}}{5\ \text{square feet} + 8\ \text{square feet}} = 923\ \text{feet per minute}$$

Possible Alternative Conditions

Standard Height Stack - Upgrade the enclosure to meet the standard height requirements.

No Stack - Use the conditions required for enclosures which aerate with no stack.

Recovery/Destruction System - If an enclosure is equipped with a system to recover or destroy the exhausted methyl bromide, it would probably be exempted from the minimum stack and aeration zone requirements. This assumes that the system is very efficient in recovering or destroying the methyl bromide. Contact the Environmental Monitoring Branch to determine if the enclosure can be exempted.

Wind Direction Restrictions - Allowing fumigations because there are no people in the predominant downwind direction is not a viable alternative in most cases. While the wind may blow predominantly in one direction, there are always short term variations. With these types of enclosures the great majority of methyl bromide is released in a few minutes. The wind may be blowing in a different direction during the crucial phase of aeration. In addition, even small changes in wind direction at the stack can lead to large changes in the downwind location of the plume.

High Exit Velocity - High exit velocity cannot substitute for stack height in this case. The 15 foot stack is required to protect people from direct exposure to the exhaust.

Special Fans/Stacks - Although some fans and stacks are specially designed to exhaust toxic gases, these systems are not suitable in this case since the 15 foot stack is required to protect people from direct exposure.

Definition Q

"No stack" refers to stacks which do not meet the "standard height" or "minimum" qualifications, or which use methods other than a stack for aeration.

Reasoning

This is one of three possible aeration methods. The conditions required for this type of enclosure are very different from the other two categories.

Procedure for Determining Compliance

The enclosure must comply with all label requirements.

Possible Alternative Conditions

Minimum Stack - Upgrade the enclosure to meet the minimum stack requirements.

Standard Height Stack - Upgrade the enclosure to meet the standard height stack requirements.

Introduction

There are two types of buffer zones: treatment zones and aeration zones. The size of the buffer zones depends on which of the six types of fumigations are being conducted. See Chart 1, page 80 for a summary of the size the buffer zones and Chart 2, page 81 for a summary of the access restrictions.

Treatment Zone

The size of the treatment zone depends on the retention category. The greater the enclosure retention, the smaller the treatment zone. Pressure tested enclosures require a treatment zone of 10 feet. Retention tested enclosures require a treatment zone of 30 to 1075 feet, depending on the percentage of methyl bromide retained, application rate, volume fumigated and the duration of exposure. The lower the percentage retained, the larger the treatment zone. The higher the application rate or the larger the volume fumigated or the longer the exposure period, the larger the treatment zone. Since untested enclosures are assumed to leak a large percentage of methyl bromide, the treatment zones for these enclosures can be large. Again, the higher the application rate or the larger the volume fumigated or the longer the exposure period, the larger the treatment zone.

Aeration Zone

The size of the aeration zone depends on the method of aeration, the volume fumigated, the application rate and the percentage of methyl bromide retained. Enclosures which aerate using a standard height stack require an aeration zone of 10 feet. Enclosures which aerate using a minimum stack have aeration zones from 10 to 1790 feet, depending on the amount of methyl bromide applied and the percentage retained. The size of the aeration zone for enclosures which aerate with no stack varies from 30 to 2625 feet, depending on the application rate, volume fumigated, and the percentage retained. The higher the application rate or the larger the volume fumigated or the more methyl bromide retained, the larger the aeration zone.

Buffer Zones for Untested Enclosures

For untested enclosures, it is assumed that much more than half of the applied methyl bromide is released during both the treatment and aeration periods. Untested enclosures are almost certain to have treatment zones or aeration zones or both that are larger than necessary. If these enclosures were pressure tested or retention tested, more suitably sized buffer zones could be prescribed.

Retention Category	Aeration Method	Class	Treatment Zone Size	Aeration Zone Size	Aerate Daylight Hours Only
Pressure Tested *(USDA pressure test)*	Standard Height Stack *(Table 1 requirements)**	A1	10 feet	10 feet	NO
	Minimum Stack *(stack 15 ft above ground & exit velocity >600 ft/min)*	A2	10 feet	Table 3	YES
	No Stack	A3	10 feet	Table 4	YES
Retention Tested or Untested *(DPR-approved test or no test)*	Standard Height Stack *(Table 1 requirements)**	B1	Table 2	10 feet	NO
	Minimum Stack *(stack 15 ft above ground & exit velocity >600 ft/min)*	B2	Table 2	Table 3	YES
	No Stack	B3	Table 2	Table 4	YES

* The stack must be at least 10 feet above the enclosure's highest point and at least 10 feet above any major obstruction within 200 feet of the stack and at least as tall as the appropriate value listed in Table 1.

The following chart summarizes who is restricted and when they are restricted from areas in and around fumigations.*

Area Restricted	When Restrictions Begin	When Restrictions End	Description of Restrictions
Enclosure	Start of injection	1. After active aeration for 4 hours, or 2. After passive aeration for 12 hours, and 3. Concentration less than 5 ppm	1. No person allowed inside, and 2. Commodity cannot be moved
Control Room	Start of injection	End of aeration	Mechanical ventilation
Treatment Zone	Start of injection	Start of aeration	Only applicators inside zone
Aeration Zone	Start of aeration	1. 4 hours after start of aeration, or 2. Concentration less than 5 ppm	Only applicators inside zone
Enclosed Storage Area	Treated commodity first placed within enclosed area	No detectable methyl bromide within enclosed area for 3 days	Reduced work schedule

* Fumigations involving secondary enclosed areas or common walls are prohibited unless alternative conditions are implemented.

Definition R, Condition 19

Only persons supervising and performing fumigation activities are permitted in the treatment zone during the treatment period. Exceptions: Limited transit is allowed if unavoidable. Regulatory personnel monitoring the fumigation are allowed.

Reasoning

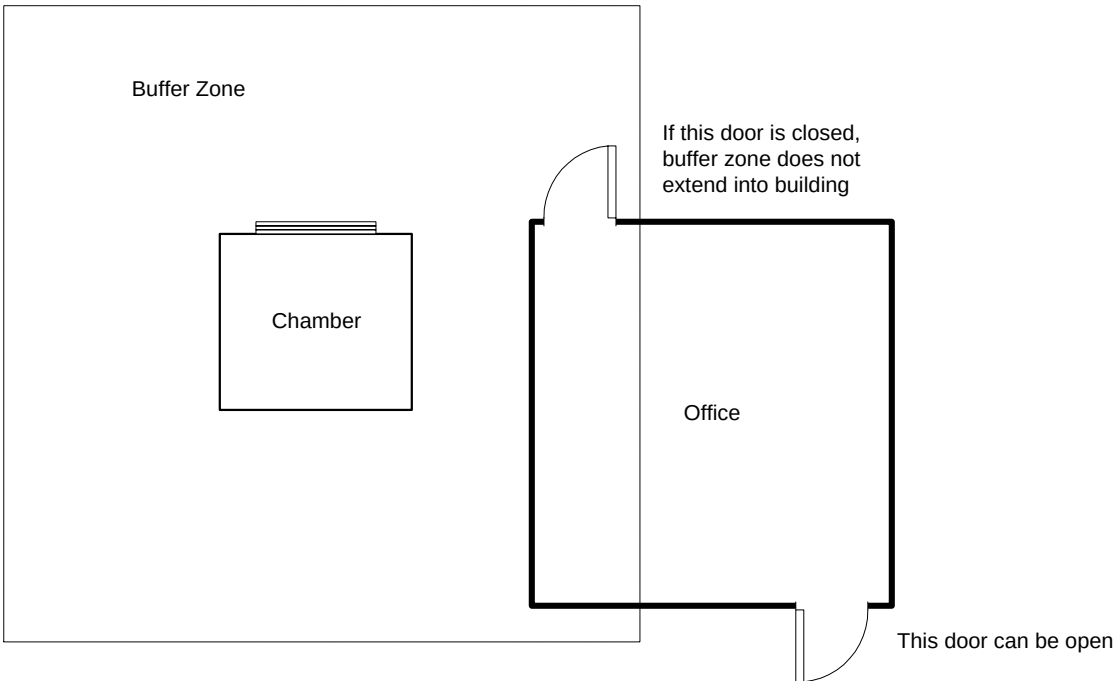
Methyl bromide can slowly leak or permeate out of an enclosure during the treatment period. Since the concentration inside the enclosure is several thousand parts per million, even small leaks from the enclosure can produce significant methyl bromide concentrations downwind. While exposure for a few minutes near an enclosure under treatment would be low, exposure for several hours may be of concern.
Only people with proper training and equipment should be in this area.

Procedure for Determining Compliance

Access - Only people involved with the fumigation should work in the treatment zone during the treatment period. Limited transit is allowed if unavoidable. Routine or repeated transit is prohibited. Other workers and residents may transit through the area, such as cars on a roadway, but people may not work or reside inside the zone. People may not transit through the zone for more than 30 cumulative minutes in a 24-hour period. Transit through the **aeration zone** is more restrictive (see page 94). The treatment zone extends into nearby buildings unless the opening (e.g. open window, open door, air conditioning intake) closest to the enclosure is outside of the treatment zone. When the enclosure is not in use there are no access restrictions. A requirement to mark or cordon off a buffer zone is at the discretion of the Ag Commissioner.

Work and Resident Examples: People may not take breaks inside the treatment zone. Repeated forklift trips are prohibited. No person may be inside a house, apartment, hospital, hotel/motel room, mobile home, campground, dormitory, store, office building, warehouse or other similar place within the treatment zone during the treatment period.

Adjacent Building Example: If a chamber has a treatment zone of 50 feet and a nearby office has a wall within 10 feet of the chamber, the treatment zone extends 40 feet into the office. If all doors and windows of the warehouse within 50 feet of the chamber are well-sealed, the treatment zone does not extend into the office. See accompanying diagram.



Procedure for Determining Compliance, continued

Duration - The duration of the treatment zone is normally the duration of the treatment period. However, if the treatment period is several days, the treatment zone may be terminated sooner. If the application rate is no more than 4 pounds per 1000 cubic feet and the volume is no more than 50,000 cubic feet, the duration of the treatment zone would be no longer than **9 days**. To calculate a more precise duration, use the following equation:

$$\text{\# Days} = \frac{\log (Z/\text{app rate})}{\log (24 \times \text{loss ratio})}$$

Z = 0.6 if the volume is no more than 10,000 cubic feet
Z = 0.2 if the volume is no more than 50,000 cubic feet
Z = 0.1 if the volume is no more than 250,000 cubic feet

The loss ratio is determined from a DPR-approved test. Assume the loss ratio is **0.030** for untested enclosures. An aeration zone would still be required unless the treatment period were very long (see page 110).

Possible Alternative Conditions

Respiratory Protection - Only self-contained breathing apparatuses are approved protection for methyl bromide. This is generally not a viable alternative when exposures will exceed a few minutes because of tank duration.

Wind Direction Restrictions - Allowing fumigations because there are no people in the predominant downwind direction is not a viable alternative in most cases. While the wind may blow predominantly in one direction, there are always short term variations. Even small changes in wind direction at the source can lead to large changes in the downwind location of the plume.

Full-Shift Worker Monitoring - If people must transit through the area for more than 30 minutes in a 24-hour period, continuous sampling for a full shift under worst-case conditions must document that methyl bromide is controlled at the work site. Full-Shift Worker Monitoring must be conducted at least one time. A monitoring plan must be developed in consultation with the DPR-Worker Health and Safety Branch or a certified industrial hygienist. This monitoring must use a sampling and analytical method that is capable of measuring less than 0.3 ppm as an 8-hour time-weighted average air concentration value **(colorimetric detector tubes cannot be used)**. DPR must review and approve the monitoring results. If the approved monitoring data show the work site levels are below 0.3 ppm (half of the 0.6 ppm target value), no further testing is necessary.

Comprehensive Ambient Monitoring - One or more of the following monitoring activities must be conducted: 1. Continuous sampling for the treatment duration or 24 hours in areas surrounding the enclosure. This sampling must use a sampling and analytical method that is capable of measuring at least 0.1 ppm as a 24-hour time-weighted average air concentration value (colorimetric detector tubes **cannot** be used). 2. Periodic sampling for the treatment duration of the air concentration within the enclosure. 3. Continuous recording of wind speed, wind direction, and temperature. DPR must review and approve the results of the comprehensive monitoring before access restrictions can be modified. The site operator should consult with the Environmental Monitoring Branch before conducting this monitoring.

Condition 19

A treatment zone of <u>XX feet</u> must be established around the enclosure during the fumigation treatment period. Only persons supervising and performing fumigation activities are permitted in the treatment zone during the treatment period. Exceptions: Limited transit is allowed if unavoidable. Regulatory personnel monitoring the fumigation are allowed.

Reasoning

Areas in the immediate vicinity of the enclosure may have high concentrations of methyl bromide. Only people who know how and when to take precautions should be in this area.

A computer simulation model was used to predict downwind concentrations with various methyl bromide emission rates and volumes. The computer model was verified by comparing the predicted concentrations with actual methyl bromide field data. The distances at which 210 ppb occurs for a 24-hour average are the values in Table 2.

Table 2 was calculated with the following assumptions: height of the enclosure varies from 10 to 25 feet, the enclosure is square, daytime neutral atmospheric stability, low wind speed, and no variation in wind direction. Consult with the Environmental Monitoring Branch if there are significant deviations from these assumptions. The limit of 250,000 cubic feet was established because of the assumptions regarding the dimensions of the enclosure. If there are significant deviations from the assumptions of the enclosure dimensions, the size of the treatment zone may be inaccurate.

See "Description of Computer Modeling," page 115 for more details.

Procedure for Determining Compliance

The size of the treatment zone is 10 feet for pressure tested enclosures (Work Site Plan C.1 or C.2 is answered yes) and is determined from Table 2 for all retention tested or untested enclosures (B1, B2, B3). The distance is measured from the wall of the enclosure to the potentially affected person or **any mechanical air intake** used to bring air into an area occupied by people. If there is more than one fumigation in a 24-hour period, the size of the zone must be computed using aggregate values. A requirement to mark or cordon off a buffer zone is at the discretion of the County Agricultural Commissioner.

Procedure for Determining Compliance, continued

1. Calculate the Concentration Lost

(Work Site Plan C.12 × C.16 × C.18)

When more than one enclosure will be fumigated in a 24 hour period (as indicated by Work Site Plan C.20), use the highest application rate (C.12), longest treatment duration (C.16), and highest loss ratio (C.17) given for the enclosures fumigated in a 24-hour period.

Rate (C.12) × Treatment Duration (C.16) × Loss Ratio (C.17)*

= Concentration Lost

*The loss ratio is determined from the DPR-approved retention test. If the enclosure(s) is not retention tested, assume the loss ratio is **0.030**.

If the treatment duration is longer than 12 hours (Work Site Plan C.16) also calculate a Concentration Lost specifically for workers. The Concentration Lost calculated above should be used to determine the treatment zone for residents. Determine a second treatment zone specifically for workers based on the Concentration Lost using the following equation:

Rate (C.12) × 12 hours × Loss Ratio (C.17)*

= Concentration Lost (for workers)

The Concentration Lost can be thought of as the amount of application rate emitted from the enclosure during the time someone could be exposed. For example, if the application rate is 4 pounds per 1000 cubic feet, and the loss ratio is 0.025 per hour, the enclosure is leaking 2.5% of the applied amount or 0.1 pounds per 1000 cubic feet during each hour of the treatment period. If the treatment period lasts for 24 hours, then the Concentration Lost <u>during the treatment period</u> is 24 times 0.1 or 2.4 pounds per 1000 cubic feet. The workshift is assumed to be 12 hours, the Concentration Lost <u>during the workshift</u> is 12 times 0.1, or 1.2 pounds per 1000 cubic feet. If the workshift duration (for both the enclosure's work site and adjacent work sites) is known to be longer or shorter, a more appropriate duration should be used. Complete examples are given beginning on page 88.

Procedure for Determining Compliance, continued

2. Calculate total volume fumigated in a 24-hour period

(Work Site Plan C.13 × C.14)

Number of Fumigations (C.13) × Volume (C.14)

= Total Volume Fumigated**

**Where more than one enclosure will be used in a 24-hour period, add all individual volumes.

For example, if a 10,000 cubic feet chamber will be fumigated twice and a 15,000 cubic feet chamber will be fumigated once on the same day, the total volume fumigated is 35,000 cubic feet. Complete examples are given beginning on page 88.

3. Look up the required treatment zone in Table 2 using the adjusted Concentration Lost and total volume.

This treatment zone is required for each enclosure at the work site.

If the calculated values are not listed on the table, round up to the next largest value given. For example, if the Concentration Lost is 0.9 for a 12 hour exposure round up to 1.0, and if the volume is 17,000 round up to 20,000. This will require a treatment zone of 115 feet for an 8 hour exposure. Complete examples are given beginning on page 88.

4. Record the treatment zone requirements on the Final Permit Conditions-page 7.

The following information is required: treatment zone size, treatment duration, maximum application rate, maximum volume, and a list of other enclosures.

Procedure for Determining Compliance, continued

***Example 1**: Single Fumigation*

Enclosure Volume: 22,000 cubic feet

Application Rate: 3 pounds per 1000 cubic feet

Work Shift Duration: 12 hours
Treatment Duration: 24 hours

Loss Ratio: 0.015 per hour (from retention test)

Concentration Lost (Workers)
= (3 lbs/1000 cu ft) × (12 hours) × (0.015 per hr)
= 0.54 lbs/1000 cu ft

Concentration Lost (Residents)
= (3 lbs/1000 cu ft) × (24 hours) × (0.015 per hr)
= 1.08 lbs/1000 cu ft

Required Treatment Zone (Workers)
(Table 2 - 25,000 cu ft, 0.6 lbs/1000 cu ft) = 80 feet

Required Treatment Zone (Residents)
(Table 2 - 25,000 cu ft, 1.2 lbs/1000 cu ft) = 150 feet

Procedure for Determining Compliance, continued

***Example 2**: Two fumigations in one chamber (Chamber 1) and one fumigation in a second chamber (Chamber 2)*

Enclosure Volume for Chamber 1: 23,000 cubic feet
Enclosure Volume for Chamber 2: 11,000 cubic feet

Application Rate for Chamber 1: 2 pounds per 1000 cubic feet
Application Rate for Chamber 2: 2.5 pounds per 1000 cubic feet

Work Shift Duration (both chambers): 12 hours
Treatment Duration (both chambers): 4 hours

Loss Ratio (Chamber 1): 0.020 per hour (from retention test)
Loss Ratio (Chamber 2): 0.025 per hour (from retention test)

Volume = 23,000 cu ft + 23,000 cu ft + 11,000 cu ft = 57,000 cu ft

Concentration Lost (Workers and Residents)
= (2.5 lbs/1000 cu ft) × (4 hrs) × (0.025/hr)
= 0.25 lbs/1000 cu ft

Required Treatment Zone (Workers and Residents)
(Table 2 - 60,000 cu ft, 0.4) = 95 feet

Possible Alternative Conditions

Pressure Tested Enclosure - Upgrade the enclosure to meet the pressure test requirements.

Upgrade Enclosure - The enclosure can be upgraded to retain more methyl bromide. The greater the retention, the smaller the treatment zone. Joints and cracks should be sealed, the enclosure should be made of an impermeable material. The retention test would have to be conducted to decrease the size of the treatment zone.

Schedule Change - If there is more than one fumigation in a 24-hour period, change the schedule so fewer fumigations are conducted. Scheduling the fumigation for later in a workshift may decrease the size of the treatment zone for workers.

Comprehensive Ambient Monitoring - One or more of the following monitoring activities must be conducted: 1. Continuous sampling for the treatment duration or 24 hours in areas surrounding the enclosure. This sampling must use a sampling and analytical method that is capable of measuring at least 0.1 ppm as a 24-hour time-weighted average air concentration value (colorimetric detector tubes **cannot** be used). 2. Periodic sampling for the treatment duration of the air concentration within the enclosure. 3. Continuous recording of wind speed, wind direction, and temperature. DPR must review and approve the results of the comprehensive monitoring before treatment zone size can be modified. The site operator should consult with the Environmental Monitoring Branch before conducting this monitoring.

Shorter Workshift Duration - A shorter treatment zone for workers can be computed if it is known that all workers within the proposed treatment zone (including workers at other work sites) work less than 12 hours. In this case, use the longest workshift duration to calculate the Concentration Lost (page 15 or 86). For example, 8 hours can be used instead of 12 hours.

Possible Alternative Conditions, continued

Secondary Containment - Use two enclosures rather than one. For example, double tarping or conducting a tarpaulin fumigation inside a chamber. The retention test would have to be modified to account for the secondary containment. There may be additional worker safety precautions needed with this option.

Move Enclosure - If possible, move the enclosure so that no one is within the treatment zone.

Decrease Application Rate - Decreasing the application rate decreases the size of the treatment zone.

Decrease Volume Fumigated - Decreasing the volume fumigated decreases the size of the treatment zone. For rigid structures, impermeable material can be placed in open spaces inside the enclosure. This "volume displacement" decreases the amount of methyl bromide needed to fumigate the enclosure.

Elevate Enclosure - Generally, the size of the treatment zone decreases as the height of the emission increases. However, the enclosure would have to be elevated at least 10 feet above ground level to significantly change the size. Contact the Environmental Monitoring Branch for treatment zone sizes for elevated enclosures.

Wind Direction Restrictions - Allowing fumigations because there are no people in the predominant downwind direction is not a viable alternative in most cases. While the wind may blow predominantly in one direction, there are always short term variations. Even small changes in wind direction at the source can lead to large changes in the downwind location of the plume.

Clean Air - Providing clean air to people inside the treatment zone would be acceptable, but probably very difficult to implement.

Possible Alternative Conditions, continued

Site Specific Modeling - The size of the treatment zones was computed using assumptions that may differ for an individual enclosure. If modeling were done for a specific enclosure, it is possible that the size of the treatment zone could be smaller than the one prescribed by the permit conditions. A list of consultants familiar with air pollution modeling is given on page 133. The Environmental Monitoring Branch should be consulted to determine if a specific site may result in a significantly smaller treatment zone and what assumptions are appropriate for a particular situation. The description of the computer modeling given on page 115 should be used as a guide.

Urban Areas - The buffer zones have been calculated assuming that the enclosure is in a rural area. Urban areas tend to have less stable atmospheric conditions. Buffer zones may be smaller for enclosures in urban areas. This option would probably be used in conjunction with the Site Specific Modeling option discussed above. Contact the Environmental Monitoring Branch for more information.

Multiple Enclosures Layout - If multiple enclosures are being fumigated (e.g. several sea/land containers), it may be possible to arrange the enclosures so that the buffer zone is a different size in different directions (e.g. 200 feet to the north and south, but 100 feet to the east and west). This option would probably be used in conjunction with the Site Specific Modeling option discussed above. Contact the Environmental Monitoring Branch for more information.

This table is used to determine the treatment zone size (feet) for retention tested or untested enclosures. Consult with the Agricultural Commissioner to determine the sizes for multiple fumigations in a 24-hour period.

Concentration Lost (pounds per 1000 cubic feet)* ROUND UP

Volume Fumigated in a 24-hour Period (cubic feet) ROUND UP	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
1000	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
2000	30	30	30	30	30	30	30	30	30	35	40	45	50	55	60
3000	30	30	30	30	30	30	35	40	50	55	60	65	70	75	80
4000	30	30	30	30	30	40	50	55	65	70	80	85	90	95	100
6000	30	30	30	35	50	60	70	80	90	95	105	110	120	125	130
8000	30	30	30	50	65	80	90	100	110	120	125	135	140	150	155
10000	30	30	45	65	85	100	115	125	135	145	160	165	175	185	195
15000	30	30	60	80	100	120	130	145	160	170	180	190	200	210	220
20000	30	40	70	95	115	135	150	170	180	195	205	220	230	240	250
25000	30	45	80	105	130	150	170	185	200	215	230	240	255	265	275
30000	30	55	90	120	145	165	185	205	220	235	250	265	280	290	305
35000	30	60	100	130	160	180	200	225	240	255	275	290	300	315	330
40000	30	65	110	145	175	200	220	240	260	280	295	310	325	340	355
45000	30	75	120	155	185	210	235	260	280	295	315	335	350	365	380
50000	35	80	130	165	200	230	250	275	300	320	340	355	370	390	405
60000	40	95	145	185	225	255	285	310	335	355	380	400	420	440	455
70000	45	105	165	210	250	285	315	345	370	395	420	440	460	485	505
80000	50	115	180	225	270	305	340	375	400	425	455	480	500	525	545
90000	55	125	190	240	290	330	365	400	430	455	485	510	535	560	585
100000	60	135	205	260	310	355	390	430	460	490	525	550	575	605	625
110000	65	145	220	280	335	380	420	460	490	525	560	585	615	645	670
120000	70	155	235	295	350	400	440	485	520	555	590	620	650	680	705
130000	75	165	245	310	370	420	465	510	545	580	620	650	680	715	740
140000	80	175	260	325	390	440	485	535	570	610	650	680	715	745	775
150000	85	180	270	340	405	460	505	555	595	635	675	710	745	780	810
170000	90	195	295	370	435	495	545	600	640	685	730	765	800	840	870
190000	95	210	315	390	465	530	580	640	685	730	775	815	850	895	930
210000	100	225	330	415	490	560	615	675	725	770	820	860	900	945	980
230000	105	235	350	435	515	585	645	710	760	810	860	905	945	990	1030
250000	110	250	365	455	540	615	675	740	795	845	900	945	990	1035	1075

* The Concentration Lost is calculated from the application rate, exposure duration and loss ratio (proportion of methyl bromide leaked from the enclosure), according to the formula below. The exposure duration for workers is 12 hours or the treatment duration, whichever is less. The exposure duration for residents is the duration of treatment (24 hours maximum). The loss ratio is determined from a DPR-approved test; for untested enclosures use **0.030**.

Concentration Lost = [Application Rate (pounds per 1000 cubic feet)] × [Exposure Duration (hours)] × [Loss Ratio]

Definition S Condition 20

Only persons supervising and performing fumigation activities are permitted in the aeration zone. Exceptions: Transit along public thoroughfares is allowed. Regulatory personnel monitoring the fumigation are allowed. The aeration zone must remain in place for the first four hours of aeration or until the exhaust concentration is less than 5 ppm. The aeration period itself may be of longer duration. Testing must be done according to approved procedures.

Reasoning

During the first part of aeration, large amounts of methyl bromide can be released in a short time. Downwind air concentrations can be very high during this period; concentrations as high as 15 ppm have been detected. Since concentrations can be so high, the exposure period must be limited to a few minutes.

There are two phases of aeration. The first phase is the evacuation of methyl bromide from the air spaces. This occurs quickly, normally within the first few hours even with passive aeration. Air concentrations are particularly high during this first phase. The second phase is the off-gassing of methyl bromide from inside the commodity. This process can be very slow if the commodity retains methyl bromide well.

NOTE: The aeration zone is in place for the first phase, but not the second. The aeration period encompasses both phases; the two different time requirements should not be confused.

Procedure for Determining Compliance

Access - For the reasons stated above, exposure inside the aeration zone during aeration should be very limited, especially during the first hour. This means no other workers can be inside the aeration zone, either at the work site or off-site. The only transit allowed is along public thoroughfares, such as cars on a roadway or walking on a sidewalk outside of the work site. Transit through the **treatment zone** is not as restrictive (see page 82). Persons supervising or performing fumigation activities are free to carry out their duties. The aeration zone extends into nearby buildings unless the opening (e.g. open window, open door, air conditioning intake) closest to the enclosure is outside of the aeration zone. A requirement to mark or cordon off a buffer zone is at the discretion of the County Agricultural Commissioner.

Procedure for Determining Compliance, continued

Example: If a chamber has an aeration zone of 100 feet and a nearby warehouse has a wall within 30 feet of the chamber, the treatment zone extends 70 feet into the warehouse. If all doors and windows of the warehouse within 100 feet of the chamber are well-sealed, the treatment zone does not extend into the warehouse. See diagram on page 83.

Duration - The aeration zone must remain in place until emissions from the enclosure are less than 5 ppm. For enclosures that use fans to aerate, the emission rate may be greatly reduced after a few minutes of aeration. As soon as the concentration of the exhaust is less than 5 ppm the aeration zone can be terminated. The exhaust concentration can be measured with a colorimetric detector tube. See page 96 for the procedure to test the exhaust concentration.

Do not confuse the time that the aeration zone is in place with the time requirements for the aeration period. The aeration period must be at least four hours for mechanically ventilated enclosures and at least 12 hours for passively aerated enclosures. The aeration zone is in place for only the first portion of the aeration, four hours at most.

Examples: No one may remain inside the aeration zone during aeration for more than a few minutes, including persons in houses, apartments, hospitals, motels, offices, stores, warehouses, parks, entertainment facilities, and restaurants.

Possible Alternative Conditions

see Aeration Zone Size, page 99.

The following procedure should be used to determine when to terminate the aeration zone.

Equipment

1. Self-Contained Breathing Apparatus (SCBA)

2. Colorimetric Detector Tubes - These are tubes (approximately 1/4 X 6 inches) which produce a color change when methyl bromide is present. The length of this color change indicates the methyl bromide concentration. A specific pump must be used with these tubes; both must be purchased from the same manufacturer. The detection limit of these tubes varies with manufacturer and model. Select the tube model which best fits your needs.

Manufacturer	Model Number	Measurement Range	Comments
National Draeger (412) 787-8383	Methyl Bromide 5/b	5 to 50 ppm	one tube, 5 strokes
	5/b with Activation Tube	0.8 to 8 ppm	two tubes, 30 strokes
	Methyl Bromide 0.5/a	0.5 to 5 ppm	one tube, 5 strokes
	Methyl Bromide 3/a	3 to 35 ppm	two tubes, 5 strokes
Sensidyne (800) 451-9444	Methyl Bromide No. 136	2 to 10 ppm (0.5 ppm detection limit)	two tubes, 4 strokes
	Methyl Bromide No. 136LA	1 to 18 ppm (0.2 ppm detection limit)	two tubes, 2 strokes
Matheson-Kitagawa (510) 793-2559 (714) 987-4611	Methyl Bromide 8014-157SB	2.5 to 80 ppm	two tubes, 1 stroke
	Methyl Bromide 8014-157SC	0.5 to 10 ppm	two tubes, 1 stroke
MSA (800) MSA-2222	Methyl Bromide P/N 462135	2.5 to 90 ppm	two tubes, 4 strokes

Procedure

1. Don the SCBA equipment.

2. Obtain detector tube measurements from the exhaust of the aerated commodity, as described below.

    a. For enclosures aerated with a stack, measure the concentration of the stack exhaust. Measurements may be taken from a port within the stack or at the top of the stack. Only a single measurement is necessary.

    b. For enclosures aerated with no stack, measure the concentration at the downwind edge of the fumigated commodity. Sample at a single point located at a height of four feet from the floor and against the middle of the treated commodity stack. Only a single measurement is necessary.

3. If the test reading shows the concentration is less than 5 ppm, the aeration zone may be terminated.

4. Record the test information on the accompanying form, or a substitute.

This procedure must be repeated under worst-case scenario conditions (i.e. with the largest possible amount of fumigated commodity and maximum dosage used) to establish that the aeration procedure is completely effective. Once a documented history is established and fumigation conditions are not changed (i.e. increased dosage, change in commodity fumigated, increased fumigated volume), the testing can be discontinued. It will require 5 - 25 tests to establish a testing history, depending on the concentration detected, the variation in concentration and the detection limit of the colorimetric tube. A fewer number of tests would be required if a short work time is needed, or a low concentration is detected, or the concentration variation is low, or the detection limit is low. Testing history must be reviewed by DPR prior to discontinuing testing. The testing history must be reestablished annually.

Fumigation Site: _____

Address: _____

Type of Colorimetric Detector Tube: _____

Enclosure Identification:_____

Date/Time of Test		
Person Testing		
Commodity Fumigated		
Amount of Commodity Fumigated		
Application Rate		
Volume Fumigated		
Commodity Container/Packaging		
Date/Time of Start of Fumigation		
Date/Time of Start of Aeration		
Colorimetric Tube Reading		
Colorimetric Tube Detection Limit		
Comments		

Condition 20

An aeration zone of <u>XX feet</u> must be maintained around an enclosure during the first portion of the aeration period. Only persons supervising and performing fumigation activities are permitted in the aeration zone. Exceptions: Transit along public thoroughfares is allowed. Regulatory personnel monitoring the fumigation are allowed. The aeration zone must remain in place for the first four hours of aeration or until the exhaust concentration is less than 5 ppm. The aeration period itself may be of longer duration. Testing must be done according to approved procedures.

Reasoning

A computer simulation model was used to predict downwind concentrations with various methyl bromide emission rates and volumes. The computer model was verified by comparing the predicted concentrations with actual methyl bromide field data. The distances at which 20 ppm occur for a 15-minute emission are the values in Tables 3 and 4.

Table 3 was calculated with the following assumptions: Stack height 15 feet above ground level, exit velocity 600 feet per minute, daytime neutral atmospheric stability, low wind speed, and no variation in wind direction.

Table 4 was calculated with the following assumptions: height of the enclosure varies from 10 to 25 feet, the enclosure is square, daytime neutral atmospheric stability, low wind speed, and no variation in wind direction. The limit of 250,000 cubic feet was established because of the assumptions regarding the dimensions of the enclosure. If there are significant deviations from the assumptions of the enclosure dimensions the size of the treatment zone may be inaccurate. See "Description of the Computer Modeling," page 115 for more details.

Procedure for Determining Compliance

The aeration zone for standard height stacks is 10 feet from the perimeter of the enclosure. The aeration zone for enclosures with minimum stacks is determined from Table 3, page 111. The aeration zone for enclosures with no stacks is determined from Table 4, page 112. The distance is normally measured from the point of emission to the nearest potentially affected person or **any mechanical air intake** used to bring air into an area occupied by people. However, there must be a buffer zone of at least 10 feet around the perimeter of the enclosure during aeration. If there is more than one fumigation in a 24-hour period, the size of the zone must be computed using aggregate values. A requirement to mark or cordon off a buffer zone is at the discretion of the County Agricultural Commissioner.

1. Calculate the proportion of methyl bromide retained

$(1 - [\text{Work Site Plan } C.16 \times \text{Work Site Plan } C.18])$

1 – [Duration (C.16) × Loss Ratio (C.18)]*

= Proportion Retained *

*The loss ratio is determined from the DPR-approved retention test. If the enclosure(s) is not retention tested, assume the proportion retained is **0.90**.

The Proportion Retained represents the fraction of the applied methyl bromide remaining inside the enclosure just before aeration. In many ways it is the opposite of the Loss Ratio. For example, if the proportion retained is 0.85, the enclosure has 85% of the applied methyl bromide inside the enclosure when aeration is initiated. This also means that 15% leaked out during treatment. Complete examples are given beginning on page 103.

Procedure for Determining Compliance, continued

For enclosures with minimum stacks calculate Step 2a, then proceed to Step 3.

For enclosures with no stacks calculate Steps 2b and 2c, then proceed to Step 3.

If both types of enclosures will be aerated within a 24-hour period, calculate 2a, 2b, and 2c.

2a. Calculate the Total Retained

(Work Site Plan C.15 × Step 1)

Total Applied (C.15) × Proportion Retained (Step 1)

= Total Retained

Add the Total Retained for each enclosure fumigated within a 24-hour period. For example, if 100 pounds is used in a chamber that retains 90% of the methyl bromide and 80 pounds is used in a chamber that retains 75%, the Total Retained is 150 pounds. Complete examples are given beginning on page 103.

Procedure for Determining Compliance, continued

2b. Calculate the Concentration Retained

(Work Site Plan C.12 × Step 1)

If more than one enclosure is fumigated within a 24-hour period, use the highest values stated in C.12 and Step 1.

Application Rate (C.12) × Proportion Retained (Step 1)

= Concentration Retained

The Concentration Retained can be thought of as the amount of application rate emitted during aeration. For example, if the application rate is 4 pounds per 1000 cubic feet and the enclosure retains 75% (Proportion Retained = 0.75) of the applied amount, 3 pounds per 1000 cubic feet is released during aeration. Complete examples are given beginning on page 103.

2c. Calculate total volume fumigated in a 24-hour period

(Work Site Plan C.13 × C.14)

Number of Fumigations (C.13) × Volume (C.14)

= Total Volume Fumigated

Add all individual volumes fumigated within a 24-hour period.

For example, if a 10,000 cubic feet chamber will be fumigated twice and a 15,000 cubic feet chamber will be fumigated once on the same day, the total volume fumigated is 35,000 cubic feet. Complete examples are given beginning on page 103.

Procedure for Determining Compliance, continued

3. For enclosures with minimum stacks, look up the required aeration zone in Table 3, page 111 (using the total retained for all enclosures combined calculated in step 2a). For enclosures with no stacks, look up the required aeration zone in Table 4, page 112 (using the concentration retained from step 2b and the total volume for all enclosures combined in step 2c).

If a work site will be aerating both types of enclosures in a 24-hour period, choose the largest of the two aeration zones. This aeration zone is required for each enclosure at the work site.

If the calculated values are not listed on the table, round up to the next largest value given. For example, if the Concentration Retained is 2.1 round up to 2.4, and if the volume is 17,000 round up to 20,000. This will require an aeration zone of 390 feet using Table 4.

4. Record the aeration zone requirements on the Final Permit Conditions-page 7.

The following information is required: aeration zone size, treatment duration, maximum application rate, and maximum volume.

***Example 1**: Single aeration with a minimum stack*

Total Amount Applied: 150 pounds

Treatment Duration: 12 hours

Loss Ratio: 0.010 per hour (from retention test)

Proportion Retained = 1 – [(12 hrs) × (0.010/hr)] = 0.88

Total Retained = (150 lbs) × (0.88) = 132 pounds

Required Aeration Zone (Table 3, 150 lbs) = 360 feet

Procedure for Determining Compliance, continued

***Example 2**: Two aerations of one chamber (Chamber 1) and one aeration of a second chamber (Chamber 2)*

Amount Applied (Chamber 1): 110 pounds
Amount Applied (Chamber 2): 160 pounds

Treatment Duration (both chambers): 24 hours

Loss Ratio (Chamber 1): 0.013 per hour (from retention test)
Loss Ratio (Chamber 2): 0.022 per hour (from retention test)

Proportion Retained (Chamber 1) = 1 – (24 hrs × 0.013/hr) = 0.69
Proportion Retained (Chamber 2) = 1 – (24 hrs × 0.022/hr) = 0.47

Total Retained (chamber 1)= (110 lbs + 110 lbs) × (0.69) = 152 lbs
Total Retained (chamber 2)= (160 lbs) × (0.47) = 75 lbs
Total Retained (sum) = 152 lbs + 75 lbs = 227 lbs

Required Aeration Zone (Table 3, 250 lbs) = 610 feet

***Example 3**: Single aeration with no stack*

Enclosure Volume: 22,000 cubic feet

Application Rate: 3 pounds per 1000 cubic feet

Treatment Duration: 12 hours

Loss Ratio: 0.025 per hour (from retention test)

Proportion Retained = 1 – [(12 hrs) × (0.025/hr)] = 0.70

Concentration Retained = (3 lbs/1000 cu ft) X (0.70)
= 2.10 lbs/1000 cu ft

Required Aeration Zone (Table 4, 25,000 cu ft, 2.4) = 440 feet

Procedure for Determining Compliance, continued

***Example 4**: Two aerations of one sea/land container and one aeration of a tarped pile, both with no stack*

Enclosure Volume for Container: 2300 cubic feet
Enclosure Volume for Tarped Pile: 11,000 cubic feet

Application Rate for Container: 3 pounds per 1000 cubic feet
Application Rate for Tarped Pile: 4 pounds per 1000 cubic feet

Treatment Period for Container: 12 hours
Treatment Period for Tarped Pile: 24 hours

Loss Ratio (Container): 0.018 per hour (from retention test)
Loss Ratio (Tarped Pile): 0.023 per hour (from retention test)

Proportion Retained (Container) = 1 – (12 hrs × 0.018/hr) = 0.78
Proportion Retained (Tarped Pile) = 1 – (24 hrs × 0.023/hr) = 0.45

Total Volume = 2300 cu ft + 2300 cu ft + 11,000 cu ft = 15,600 cu ft

Concentration Retained = (4 lbs/1000 cu ft) X (0.78)
= 3.20 lbs/1000 cu ft

Required Aeration Zone (Table 4, 20,000 cu ft, 3.2) = 460 feet

Procedure for Determining Compliance, continued

***Example 5**: Two chambers with minimum stacks and two tarped piles with no stacks*

Enclosure Volume for Chamber 1: 22,000 cubic feet
Enclosure Volume for Chamber 2: 18,000 cubic feet
Enclosure Volume for Tarped Pile 1: 14,000 cubic feet
Enclosure Volume for Tarped Pile 2: 11,000 cubic feet

Application Rate (Chambers 1 & 2): 3 pounds per 1000 cubic feet
Application Rate (Tarped Piles 1 & 2): 4 pounds per 1000 cubic feet

Amount Applied (Chamber 1): 66 pounds
Amount Applied (Chamber 2): 54 pounds
Amount Applied (Tarped Pile 1): 56 pounds
Amount Applied (Tarped Pile 2): 44 pounds

Treatment Duration (all enclosures): 24 hours

Loss Ratio (Chamber 1): 0.012 (from retention test)
Loss Ratio (Chamber 2): 0.018 (from retention test)
Loss Ratio (Tarped Pile1): 0.020 (from retention test)
Loss Ratio (Tarped Pile 2): 0.024 (from retention test)

Proportion Retained (Chamber 1) = 1 – (24 hrs × 0.012) = 0.71
Proportion Retained (Chamber 2) = 1 – (24 hrs × 0.018) = 0.57
Proportion Retained (Pile 1) = 1 – (24 hrs × 0.020) = 0.52
Proportion Retained (Pile 2) = 1 – (24 hrs × 0.024) = 0.42

Total Retained (Chamber 1) = (66 lbs) × (0.71) = 47 pounds
Total Retained (Chamber 2) = (54 lbs) × (0.57) = 31 pounds
Total Retained (Pile1) = (56 lbs) × (0.52) = 29 pounds
Total Retained (Pile 2) = (44 lbs) × (0.42) = 18 pounds
*Total Retained (all enclosures) = 47 + 31 + 29 + 18 = 125 lbs**

Procedure for Determining Compliance, continued

Example 5, continued

Concentration Retained (Chamber 1) = (3 lbs/1000 cu ft) × (0.71)
*= 2.1 lbs/1000 cu ft***
Concentration Retained (Chamber 2) = (3 lbs/1000 cu ft) × (0.57)
= 1.7 lbs/1000 cu ft
Concentration Retained (Pile 1) = (4 lbs/1000 cu ft) × (0.52)
= 2.1 lbs/1000 cu ft
Concentration Retained (Pile 2) = (4 lbs/1000 cu ft) × (0.42)
= 1.7 lbs/1000 cu ft

*Total Volume = 22000 +18000 + 14000 + 11000 = 65,000 cu ft****

*Required Aeration Zone from Table 3 (*150 lbs) = 360 feet*

Required Aeration Zone from Table 4
*(***70,000 cu ft, **2.4 lbs/1000 cu ft) = 765 feet*

Required Aeration Zone = 765 feet

Possible Alternative Conditions

Standard Height Stack - An aeration zone of 10 feet is required for exhaust stacks which meet the standard height requirements.

Wind Direction Restrictions - Allowing fumigations because there are no people in the predominant downwind direction is not a viable alternative in most cases. While the wind may predominantly blow in one direction, there are always short term variations in the direction. During aeration the great majority of methyl bromide is released in a few minutes. The wind may be blowing in a different direction during the crucial phase of aeration. In addition, even small changes in wind direction at the enclosure can lead to large changes in the location of the plume downwind.

Possible Alternative Conditions, continued

Comprehensive Ambient Monitoring - One or more of the following monitoring activities must be conducted: 1. Continuous sampling during aeration in areas surrounding the enclosure. This sampling must use a sampling and analytical method that is capable of measuring at least 0.1 ppm as a 24-hour time-weighted average air concentration value (colorimetric detector tubes **cannot** be used). 2. Continuous monitoring of the emission rate (air concentration and air flow rate) during aeration. 3. Continuous recording of wind speed, wind direction, and temperature. DPR must review and approve the results of the comprehensive monitoring before aeration zone size can be modified. The site operator should consult with the Environmental Monitoring Branch before conducting this monitoring.

Clean Air - Providing clean air to people inside the aeration zone would be acceptable, but probably very difficult to implement.

Slow Release - Aerating slowly is not a viable alternative in most cases. Aeration would have to occur over several days for this alternative to be effective.

Respiratory Protection - Only self-contained breathing apparatuses are approved for methyl bromide. This is an alternative when exposures will not exceed a few minutes.

Move Enclosure - If possible, move the enclosure so that no one is within the aeration zone.

Decrease Application Rate - Decreasing the application rate decreases the size of the aeration zone.

Decrease Volume Fumigated - Decreasing the volume fumigated decreases the size of the aeration zone. For rigid structures, impermeable material can be placed in open spaces inside the enclosure. This "volume displacement" decreases the amount of methyl bromide that is needed to fumigate the enclosure.

Possible Alternative Conditions, continued

Elevate Enclosure - Generally, the size of the aeration zone decreases as the height of the emission increases. However, the enclosure would have to be elevated at least 10 feet to significantly change the size. The larger the fumigation, the higher the elevation must be to make a difference. Contact the Environmental Monitoring Branch for treatment zone sizes for elevated enclosures.

Recovery/Destruction System - If an enclosure is equipped with a system to recover or destroy the exhausted methyl bromide, it would probably be exempted from the standard height stack and aeration zone requirements. This assumes that the system is very efficient in recovering or destroying the methyl bromide. Contact the Environmental Monitoring Branch to determine if the enclosure can be exempted.

Site Specific Modeling - A number of private companies are capable of doing the type of computer modeling that was used to compute the size of the treatment areas. The size of the treatment areas was computed using assumptions that may differ for an individual enclosure. If modeling were done for a specific enclosure, it is possible that the size of the treatment zone could be smaller than the one prescribed by the permit conditions. A list of consultants familiar with air pollution modeling is given on page 133. The Environmental Monitoring Branch should be consulted to determine if a specific site may result in a significantly smaller treatment zone and what assumptions are appropriate for a particular situation. The description of the computer modeling given on page 115 should be used as a guide.

Urban Areas - The buffer zones have been calculated assuming that the enclosure is in a rural area. Urban areas tend to have less stable atmospheric conditions. Buffer zones may be smaller for enclosures in urban areas. This option would probably be used in conjunction with the Site Specific Modeling option discussed above. Contact the Environmental Monitoring Branch for more information.

Possible Alternative Conditions, continued

Multiple Enclosures Layout - If multiple enclosures are being fumigated (e.g. several sea/land containers), it may be possible to arrange the enclosures so that the buffer zone is a different size in different directions (e.g. 200 feet to the north and south, but 100 feet to the east and west). This option would probably be used in conjunction with the Site Specific Modeling option discussed above. Environmental Monitoring Branch for more information.

Long Fumigation Period - Treatment/holding periods of several days or weeks release methyl bromide slowly over a long period. At the end of a long treatment period the amount of methyl bromide left inside the enclosure may be very small and a small or no aeration zone may be necessary. The following alternatives can be used:

Minimum Stack: 10 foot aeration zone if:

a. the treatment period is 28 days or longer, or

b. the measured concentration within the enclosure is less than 100 ppm.

No Stack: 30 foot aeration zone if:

a. the treatment period is 35 days or longer and the application rate is 4 lbs/1000 cu ft or less, or

b. the measured concentration within the enclosure is less than 100 ppm.

Other combinations can be calculated using the following equations, contact the Environmental Monitoring Branch for assistance.

Minimum Stack:

$$\#\text{Days} = \frac{\log (50/\text{pounds applied})}{\log (\text{Proportion Retained for 24 hrs})}$$

No Stack:

$$\#\text{Days} = \frac{\log (0.1/\text{application rate})}{\log (\text{Proportion Retained for 24 hrs})}$$

This table is used to determine the aeration zone size (feet) required **during the aeration** of enclosures with exhaust stacks having the following characteristics:

1. The top of the exhaust stack is at least 15 feet above ground level, and
2. The exit velocity is at least 600 feet per minute

$$\text{Exit Velocity} = \frac{\text{Rated Fan Capacity (cubic feet per minute)}}{\text{Stack Cross-Sectional Area (square feet)}}$$

Total Retained in a 24-hour Period (pounds)*	Aeration Zone (feet)
50	10
51	220
100	220
ROUND UP 150	360
200	490
250	610
300	720
350	820
400	920
450	1000
500	1090
550	1170
600	1250
650	1320
700	1390
750	1460
800	1530
850	1600
900	1670
950	1730
1000	1790

* The Total Retained is calculated from the amount of methyl bromide, treatment duration and loss ratio (proportion of methyl bromide leaked from the enclosure), according to the formulas below. The loss ratio is determined from a DPR-approved test.

Proportion Retained** = 1 – [Treatment Duration (hours) × Loss Ratio]

For untested enclosures, use **0.90 for the Proportion Retained

Total Retained = [Amount of Methyl Bromide Applied in a 24-hour Period (pounds)] × [Proportion Retained]

This table is used to determine the aeration zone size (feet) of enclosures that have no stack. Consult with the Agricultural Commissioner to determine the aeration zone size when aerating multiple enclosures in a 24-hour period.

Concentration Retained (pounds per 1000 cubic feet)* ROUND UP

Volume Aerated in a 24-hour Period (cubic feet) ROUND UP	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0
1000	30	30	30	30	30	30	40	50	60	70	75	85	90	95	105
2000	30	30	30	40	60	75	90	100	115	125	135	145	155	160	170
3000	30	30	45	70	90	110	125	140	155	165	180	190	200	210	220
4000	30	30	65	95	115	135	155	170	185	200	215	225	240	250	260
6000	30	55	100	130	160	180	205	225	240	260	275	290	305	320	335
8000	35	80	125	165	195	220	245	265	290	305	325	345	360	375	390
10000	50	105	155	195	225	255	285	310	330	350	375	390	410	430	445
15000	65	140	200	250	290	330	360	395	420	450	475	500	525	545	565
20000	80	175	240	300	345	390	425	460	495	525	560	585	615	640	665
25000	95	200	275	340	390	440	480	520	560	595	630	660	695	725	750
30000	110	225	305	375	430	485	530	575	615	655	695	730	765	795	830
35000	125	245	335	410	470	525	575	625	670	710	750	790	830	865	900
40000	135	265	360	440	505	565	620	670	720	765	810	850	890	930	965
45000	145	285	385	470	540	600	660	715	765	815	860	905	945	990	1030
50000	160	305	410	495	570	635	700	755	810	860	910	955	1000	1045	1090
60000	180	340	455	550	630	705	770	835	895	950	1005	1060	1110	1155	1205
70000	200	370	495	600	685	765	840	910	975	1035	1095	1150	1205	1260	1315
80000	220	400	535	645	740	830	905	980	1050	1120	1180	1245	1305	1360	1420
90000	235	430	575	690	795	885	970	1050	1125	1195	1265	1330	1395	1460	1520
100000	255	460	615	735	845	945	1035	1120	1200	1275	1350	1420	1485	1555	1620
110000	270	490	650	780	895	1000	1095	1185	1270	1350	1425	1500	1575	1645	1710
120000	285	515	685	820	945	1050	1155	1245	1335	1420	1505	1580	1660	1730	1805
130000	300	545	720	865	990	1105	1210	1310	1400	1490	1575	1660	1740	1820	1895
140000	315	570	750	905	1035	1155	1265	1370	1465	1560	1650	1735	1820	1900	1980
150000	330	595	785	945	1080	1205	1320	1425	1530	1625	1720	1810	1895	1980	2065
170000	360	640	845	1015	1160	1295	1420	1535	1640	1745	1845	1940	2035	2125	2215
190000	385	685	905	1080	1240	1380	1510	1630	1745	1855	1960	2065	2165	2260	2355
210000	410	725	955	1140	1305	1450	1590	1715	1835	1950	2060	2165	2270	2370	2470
230000	430	760	995	1190	1360	1515	1655	1785	1910	2030	2140	2250	2355	2460	2560
250000	450	785	1030	1230	1405	1560	1705	1840	1965	2085	2200	2315	2420	2525	2625

* The Concentration Retained is calculated from the rate, treatment duration and loss ratio (proportion of methyl bromide leaked from the enclosure), according to the formulas below. The loss ratio is determined from a DPR-approved test.

Proportion Retained** = 1 – [Treatment Duration (hours) × Loss Ratio]

For untested enclosures, use **0.90 for the Proportion Retained

Concentration Retained = [Application Rate (pounds per 1000 cubic feet)] × [Proportion Retained]

Condition 21

The stack must be vented vertically to the outside air. When exhausting, the top of the stack must be free of overhead obstructions.

Reasoning

One of the main advantages of using a stack to aerate is to increase the effective height at which the methyl bromide is released. This advantage is negated if the exhaust is not directed upward. The stack height requirements have been calculated assuming the exhaust is directed upward.

Procedure for Determining Compliance

The top of the stack must be pointed straight up. The top cannot be angled in any way. The duct leading to the top of the stack does not have to be vertical, only the release point must be straight up. There can be no overhead obstructions, such as rain caps at the top of the stack during aeration. Rain caps which are retractable are acceptable. The stack must be free only during aeration.

Possible Alternative Conditions

Alternative Rain Caps - Alternatives to rain caps which are shown on the next page.

No Stack Category - The enclosure can follow the permit conditions for a No Stack enclosure (A3 or B3). However, under no circumstances can a stack exhaust vertically downward (e.g. U-shaped stack).

Rain cap alternatives excerpted from "Industrial Ventilation" by the American Conference of Governmental Industrial Hygienists, 1986.

Background

The size of the treatment and aeration zones was computed using field monitoring data in conjunction with computer simulations. The computer simulations were performed with the Industrial Source Complex-Short Term (ISCST) model developed by the US Environmental Protection Agency and commonly used for air pollution prediction (Wagoner, 1987). The ISCST model is a Gaussian plume model, which means it assumes that the concentration of air pollutants decreases with distance from the source in a bell-shaped pattern, in both the crosswind and vertical directions. The ISCST model has the ability to predict downwind air concentrations from stack, area, or volume sources.

The ISCST model predicts air concentrations based on characteristics of the pollution source (e.g., rate and dimensions of emission), weather conditions at the time of emission (e.g., wind speed, wind direction, atmospheric stability), and terrain over the downwind area (elevation, urban or rural geography). For the treatment and aeration zone calculations, the values of these parameters were determined from field data or assumptions that produce the largest treatment and aeration zones.

Method for Computing Standard Height Stack Values

Table 1 gives the minimum stack height required for a fumigation chamber to prevent concentrations from exceeding the health limit concentration of 210 ppb for 24 hours (or the equivalent for some shorter period). The health limit is based on acute exposure because during this type of release high concentrations occur within a very tight effluent plume that lasts a short period of time. The minimum stack heights were found by using ISCST model results in combination with multiple linear regression.

Combinations of emission source characteristics (stack heights, exit velocities and emission rates) were used as input to run the ISCST model under worst case meteorological conditions. Model inputs for the source characteristics were:

Stack height - the stack heights used in the runs were 10 ft, 20 ft, 30 ft, and 40 ft. These heights cover the range of stack height used at most fumigation facilities.

Stack diameter - the stack diameter was assumed to be 5 feet. This would be considered a large stack and the larger the stack, the higher the required stack height.

Emission rate - the emission rates were calculated from the fumigation volume and application rate. Flux rates of 62 g/s, 185 g/s, 308 g/s and 357 g/s for 1 hour were used. It is assumed that 90% of the methyl bromide mass applied is vented in the first hour and that the emission rate after 1 hour is zero. This assumption was based on actual stack measurements taken at several chamber facilities (Segawa et al, 1992).

Exit velocity - exit velocity is calculated assuming volume flow out of the stack is 50% of the rated fan capacity. This assumption was derived from actual measurements taken at chamber facilities (Segawa et al, 1992) It is assumed that the stack is not covered by a rain cap. The permit conditions will specify that no rain hoods are to be used. Exit velocities used for the runs varied between 0.25 m/s and 23.0 m/s. This range of exit velocities was chosen based on observed exit velocities at the monitored facilities.

Effluent temperature - the air exiting the stack is assumed to be at ambient temperature. This is the usual case for chamber aeration. Temperature does not affect the effluent plume when the plume is at ambient temperature.

Weather - Weather conditions were assumed to be worst-case (assumptions which gave the highest stack requirements). The worst-case weather conditions were different from what are commonly used for modeling this type of situation, because the objective was different. The objective for these permit conditions was not to exceed a target concentration at any point downwind. The more common objective of determining the highest concentration was not applicable. A California Air Resources Board screening model, PTPLU-2 (DaMassa, 1991), was used to confirm these assumptions about worst case meteorological conditions.

> **Wind speed** - the wind speed was assumed to be four miles per hour because this results in the tallest stacks.
>
> **Wind direction** - the direction was assumed to be constant for the first hour of aeration because this results in the tallest stacks.
>
> **Atmospheric stability** - the stability, a critical variable used by the ISCST model, is normally classified by the wind speed, proportion of cloud cover, and intensity of solar radiation. Atmospheric stability ranges from A to F, with A being the least stable and F being the most stable. The stability commonly changes with time of day, with unstable conditions during the middle of the day (A or B stability) and very stable conditions during the late night or early morning hours (E or F stability). Weather conditions such as inversions, heavy overcast or fog create more stable daylight conditions and limit the diurnal variation. The atmospheric stability was assumed to be F because this results in the tallest stacks.

The following assumptions were used about the receptor characteristics:

Terrain - the downwind terrain was assumed to be flat in a rural area because this is the typical situation and gives the tallest stacks.

Receptor (person, building, air intake, etc.) height - The receptor heights were 3 to 9 m, depending on the stack height. Occasionally there are multi-storied buildings near a fumigation chamber. The concentrations will be higher at the elevation of the second or third floor of a building than at ground level. This is because the elevated receptors are closer to the center of the effluent plume.

Building effects - No building effects were used in these model runs because building characteristics are site specific. In this particular application, generalization of building dimensions was not practical.

Target concentration - The target concentration was 20 ppm as a time weighted average for 15 minutes. This concentration is the equivalent of 210 ppb as a time weighted average for 24 hours.

Several generalizations about the stack emission model results may be made:

1) The downwind concentrations are directly proportional to the emission rate. If the emission rate increases, the air concentrations predicted by the model increase uniformly at all points downwind. Therefore, larger fumigation volumes or higher application rates will have higher downwind concentrations.

2) As exit velocity increases, the downwind concentrations decrease. This is because of the greater mixing of stack effluent with air. Exit velocity increases as the diameter of the stack decreases or the fan capacity increases.

3) As stack height increases, ground level concentrations decrease. This is because there is more mixing and dilution of the plume before it contacts the ground.

4) As the height of an elevated receptor nears the height of the plume centerline, the concentrations increase. This is why downwind multi-story buildings are of concern.

5) The maximum ground level concentration occurs under very unstable meteorological conditions. Under stable conditions, the maximum concentration is lower but it occurs much farther away from the stack than under very unstable conditions.

Method for Computing Treatment Zone Sizes

Treatment zone sizes during the fumigation of enclosures that are retention tested or untested were determined with the ISCST model. The following assumptions were used:

Emission rate - The emissions were modeled as an area source. For the model runs it was assumed that the mass lost during the treatment period is released at a constant rate over 24 hours. The size of the emission area varied with the assumed dimensions of the enclosure. The height was adjusted to reflect realistic dimensions as the fumigated volume changed. The emission rates were calculated for various application rates, assuming the dimensions shown below:

Volume (ft^3)	Height (ft)
1000	10
2000	12
3000	14
4000	16
6000	18
8000	22
10000	25
25000	25
50000	25
80000	25
110000	25
150000	25
210000	25
250000	25

Emission height - This was assumed to be 3.0 feet (0.91 m) because this was the lowest height expected and the lower the height the greater the treatment zone size.

Receptor height - This was assumed to be 4.0 feet (1.2 m).

Stability class - This was assumed to be C. This stability was chosen because monitoring from methyl bromide soil applications showed this to produce buffer zones with an adequate margin of safety.

Target concentration - This was 210 ppb as a time weighted average for 24 hours.

All other model inputs were the same as those used for the standard height stack calculations.

Method for Computing Aeration Zone Sizes for Minimum Stacks

There are some cases where it is not possible for a facility to meet the stack height requirements given in Table 1. The health limit may be exceeded during aeration if a stack is shorter than that required in Table 1. For these cases the ISCST model was used to calculate required aeration buffer zones. Table 3 shows the required buffer zones for a range of masses of methyl bromide retained during the fumigation period. Table 3 is based on the "proportion retained" as determined by a DPR-approved retention test. A portion of the methyl bromide applied will leak out of the facility during the holding period. Theoretically, the longer the holding period, the less methyl bromide will be present to vent through the stack at the commencement of aeration.

ISCST Model inputs for the minimum stack facility runs were:

Emission Rate - ranges from 50 lbs to 1000 lb in 15 minutes

Atmospheric Stability - Class D (daytime release only)

Stack Height - 15 ft (4.57 m)

Exit Velocity - 300 ft/min (1.53 m/s), therefore, a minimum exit velocity of 600 ft/min (3.06 m/s), calculated from the rated fan capacity (cfm) and stack area, is required to meet these permit conditions. This is because the rated capacity is reduced by 50% for air flow resistance.

Building Effects Specifications - building dimensions: 25 ft tall X 50 ft X 50 ft.

All other model inputs were the same as those used for the treatment zone table.

The addition of building effects significantly complicates generalization of the model results. However, the inclusion of building effects was necessary because it is these effects that produce the high ground level concentrations if the stack does not meet the height required in Table 1.

Method for Computing Aeration Zone Sizes for No Stacks

Table 4 is used to determine the aeration zone size (feet) during the aeration of enclosures that do not have actual exhaust stacks. This category includes but is not limited to some types of fumigation chambers, space fumigations, tarped commodities and sea/land containers. These enclosures may be retention tested or untested.

The emissions were modeled as an area source. For the model runs it was assumed that 100% of the mass retained at the end of fumigation is released in the first 15 minutes of the aeration event. The size of the emission area varied with the assumed dimensions of the enclosure. The height was adjusted to reflect realistic dimensions as the fumigated volume changed. The emission rates were calculated for various application rates, assuming the dimensions shown below:

Volume (ft^3)	Height (ft)
1000	10
2000	12
3000	14
4000	16
6000	18
8000	22
10000	25
25000	25
50000	25
80000	25
110000	25
150000	25
210000	25
250000	25

All other model inputs were the same as those used for the treatment zones table.

References

California Department of Water Resources (CDWR). 1991. California Irrigation Management Information System (CIMIS). Agricultural Technology Information Network (ATI-NET).

DaMassa, J. 1991. User's Guide to the California Air Resources Board Version of PTPLU-1 (Version 3.0). Modeling Support Section. Modeling and Meteorology Branch. Technical Support Division. California Air Resources Board (CARB). January 1991.

Jandel Scientific. 1992. TableCurve Automated Curve Fitting Software for Windows, User's Manual. Version 1.0. San Rafael, Ca.

Segawa, R., T. Barry and C. Gana. 1992. Results of Off-Site Air Monitoring Following Methyl Bromide Chamber Fumigations and Evaluation of the ISCST Model. Memorandum to John Sanders dated September 3, 1992. Cal EPA-Department of Pesticide Regulation, Sacramento, Ca.

Wagoner, C.P. 1987. Industrial Source Complex (ISC) Dispersion Model Users Guide - Second Edition (Revised). Volume I. U.S. EPA Report No. EPA - 450/4-88-002a.

Aeration — The process of providing fresh air to an enclosure following fumigation.

Aeration methods/ categories — There are three methods or categories of aeration: standard height stack, minimum stack and no stack. The size of the aeration zone is dictated by the aeration category.

Aeration period — The time required to remove methyl bromide from the air inside an enclosure and absorbed to the commodity. This differs from the **aeration zone duration**.

Aeration zone — A buffer zone maintained around an enclosure during the first portion of the aeration period (4 hours or less depending on the emission concentration). Only persons supervising and performing fumigation activities are permitted in the aeration zone. All other people including residents and workers must be excluded from this zone.

Aeration zone duration — The time required to remove methyl bromide from the air inside an enclosure. This differs from the **aeration period**.

Air changes per hour — The number of times in an hour that the air within a specified volume is diluted with clean air.

Air washes — An alternating cycle of pressurizing and depressurizing a vacuum chamber to achieve aeration.

Buffer zones — There are two types of buffer zones: treatment zones and aeration zones. These buffer zones are used to limit the access or time a person spends in areas near fumigations. The size of the buffer zones depends on which of the six types of fumigations are being conducted.

Colorimetric detector tubes — These are tubes (approximately 1/4 inch diameter X 6 inches) which produce a color change when methyl bromide is present. The length of this color change indicates the methyl bromide concentration. These are not suitable for comprehensive monitoring.

Commodity absorption testing — Testing the residual amount of methyl bromide within a commodity over time.

Comprehensive ambient monitoring — Conducting three types of monitoring: 1. Continuous sampling in areas surrounding the enclosure. This sampling must use a sampling and analytical method capable of measuring at least 0.1 ppm as a 24-hour time-weighted average air concentration value (colorimetric detector tubes **cannot** be used). 2. Continuous monitoring of the emission rate. 3. Continuous recording of wind speed, wind direction, and temperature.

Concentration Lost — Concentration of methyl bromide which leaks out of an enclosure during the treatment period. The Concentration Lost is determined from the application rate and proportion of methyl bromide retained within the enclosure.

Control room — A small **enclosed area** adjoining some enclosures (e.g. primarily chambers) used exclusively for introducing methyl bromide into an enclosure and/or monitoring its concentration.

Daylight hours — For aeration purposes, the time from one hour after sunrise to one hour before sundown.

Downwash — The downward movement of air as it passes over a building or other large object.

Emission rate — The amount of methyl bromide released to the environment over time.

Enclosed area — A gas-confining area surrounded by non-porous walls and a roof. There are restrictions on fumigations within **secondary enclosed areas**, **control rooms**, and enclosed storage areas.

Enclosure — A single fumigated volume.

Examples: a single chamber, single silo, single warehouse, single sea/land container, or a single group of bins under one tarpaulin.

Exit velocity The air speed through the exhaust stack during aeration. The exit velocity is determined by dividing the rated fan capacity (cubic feet per minute) by the stack cross-sectional area (square feet).

Fan capacity See **rated fan capacity**.

Full-Shift Worker Monitoring Continuous sampling for a full shift under worst-case conditions. This sampling must use a sampling and analytical method capable of measuring less than 0.3 ppm as an 8-hour time-weighted average air concentration value (colorimetric detector tubes **cannot** be used).

Fumigant lines Tubing used to carry methyl bromide from the storage cylinder to the enclosure. Same as **plumbing lines**.

Fumiscope Test equipment which reads the concentration of methyl bromide in ounces per 1000 cubic feet inside a fumigation enclosure.

Holding period The time that methyl bromide is contained within the enclosure. Same as **treatment period**.

Industrial hygienist A person trained in occupational health and safety.

Industrial Source Complex-Short Term Model (ISCST) A computer simulation model used for air pollution prediction. Developed by the USEPA for various types of air pollution. Comparison of the model predictions to concentrations measured in the field showed good agreement for methyl bromide.

Introduction The process of injecting the methyl bromide into the enclosure.

ISCST See **Industrial Source Complex-Short Term Model**.

Load The percentage of the enclosure filled with commodity.

Loss ratio The proportion of methyl bromide which leaks out of the enclosure during the treatment period. This ratio is determined from a DPR-approved retention test.

Major obstruction — An object large enough to divert the direction of a significant portion of a methyl bromide plume.

Examples: houses, mature orchards, silos

Margin of safety — The ratio of the concentration known to have no adverse effects to the exposure concentration. The estimated no-effect level for human exposure to methyl bromide is 21,000 ppb as a time-weighted average for 24 hours. An exposure of 210 ppb provides a 100-fold margin of safety.

Mechanical ventilation — The use of fans or any other mechanical device to ventilate a fumigation enclosure or an enclosed area where fumigated commodities are stored.

Minimum exhaust stack — One that is less than standard height, but at least 15 feet above the ground, and has an exit velocity of at least 600 feet per minute.

Mitigation measures — The use of modified work practices or engineering controls to comply with the stated permit conditions or alternative permit conditions.

Nighttime hours — For aeration purposes, the time from one hour before sundown to one hour after sunup.

No stack — Enclosures whose stacks do not meet the standard height or minimum qualifications, or which use methods other than a stack for aeration.

Off-gassing — The slow release of methyl bromide from commodity that has been fumigated.

Passive ventilation — Non-mechanical ventilation (i.e. opening doors and removing tarpaulin cover) of a fumigation enclosure.

Plumbing lines — Tubing used to carry methyl bromide from the storage cylinder to the enclosure. Same as **fumigant lines**.

Pressure tested enclosure — Either a vacuum chamber or an enclosure which has been pressure tested following the procedures stated in the U.S. Department of Agriculture Plant Protection and Quarantine Treatment Manual.

Proportion Retained — The fraction of methyl bromide retained within an enclosure during the treatment period. The Proportion Retained is calculated from the **Loss Ratio**.

Rated fan capacity — The air flow rate generated by a fan under optimal conditions. The actual air flow rate is approximately one-half of the rated capacity when used for methyl bromide fumigations.

Respiratory protection — The use of a self-contained breathing apparatus (SCBA).

Retention categories — There are two retention categories: pressure tested and retention tested/untested. The size of the treatment zone depends on the retention category.

Retention tested enclosure — One that has been measured for loss of methyl bromide over time according to an approved procedure.

Sampling lines — Tubing used to carry methyl bromide from the enclosure to test equipment.

SCBA — See **self-contained breathing apparatus**.

Sea/land container — An enclosed trailer which can be towed with a truck or transported on a ship.

Secondary containment — Surrounding a fumigation with two enclosures to provide better containment of methyl bromide.

Secondary enclosed area — An **enclosed area** surrounding a fumigation enclosure. This is usually a structure (warehouse, production facility, etc.) that houses the fumigation enclosure. This does not include mesh screen or other porous barriers.

Self-contained breathing apparatus (SCBA) — Respiratory protection device approved for protection against methyl bromide. Required if levels exceed 5 ppm.

Stack — Two meanings:
1. A duct used to exhaust methyl bromide from an enclosure.
2. A pile of commodity.

Standard height exhaust stack — One which is at least 10 feet above the enclosure's highest point, and at least 10 feet above any major obstruction within 200 feet of the stack, and at least as tall as the appropriate value in Table 1.

Tarpaulin — A plastic sheet, generally at least 6 mil thick.

Testing history — Documentation of repeated testing under worst-case scenario conditions (i.e. with the largest possible amount of fumigated commodity and maximum dosage used) that shows a procedure is completely effective. Testing history must be reviewed by DPR prior to discontinuing testing.

Time-weighted average (TWA) — The average concentration over a stated period of time.

Total retained — Amount of methyl bromide retained within the enclosure during the treatment period. It is determined from the amount and proportion of methyl bromide retained within the enclosure.

Treated commodity — Commodity that has been fumigated with methyl bromide.

Treatment period — The time that methyl bromide is contained within the enclosure. Same as **holding period**.

Treatment zone — A buffer zone maintained around an enclosure during the fumigation treatment period (exposure or holding period). Only persons supervising and performing fumigation activities are permitted in the treatment zone. All other people including residents and workers must be excluded from this zone.

Untested enclosure — One that has not been pressure tested or retention tested.

Vacuum chamber — A metal structure in which fumigations are conducted under reduced atmospheric pressure.

Volume displacement — Placing impermeable objects within an enclosure to reduce the free air space, thus allowing less methyl bromide to be used.

Work site — A location where an individual or a group of enclosures is fumigated.

Example: several chambers or sea/land containers at one address.

Work Site Plan — This form is filled out by methyl bromide users and enables the County Agricultural Commissioner to evaluate each fumigation for compliance with the permit conditions. The form is also used to evaluate requests for alternative conditions.

The mention of commercial products or services, their source or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such product.

Methyl Bromide Suppliers

Ameribrom, Inc.
52 Vanderbilt Avenue
New York, NY 10017

Ethyl Corporation
451 Florida Street
Baton Rouge, LA 70801

Great Lakes Chemical Corporation
P.O. Box 2200
West Lafayette, IN 47906

Soil Chemical Corporation
P.O. Box 782
Hollister, CA 95024

Tri Cal
P.O. Box 1327
Hollister, CA 95024

Colorimetric Detector Tubes

National Draeger
101 Technology Drive
P.O. Box 120
Pittsburg, PA 15230
(412) 787-8383

Sensidyne
16333 Bay Vista Drive
Clearwater, FL 34620
(800) 451-9444

Matheson-Kitigawa
6775 Central Avenue
Newark, CA 94560
(510) 793-2559
or
8800 Utica Avenue
Cucamonga, CA 91730
(714) 987-4611

MSA
P.O. Box 426
Pittsburg, PA 15230
(800) MSA-2222

Fumiscopes

Key Chemical & Equipment Company
13195 49th Street N. #A
Clearwater, FL 34622
(813) 572-1159

Comprehensive Monitoring Equipment

SKC-West, Inc.
P.O. Box 4133
Fullerton, CA 92634-4133
(714) 992-2780

MSA
P.O. Box 426
Pittsburg, PA 15230
(800) MSA-2222

Certified Industrial Hygienists

Look in the Yellow Pages under "Industrial Hygiene Consultants"

Ventilation Engineers

Look in the Yellow Pages under "Industrial Hygiene Consultants" and "Environmental Services" specializing in indoor air quality.

Fumigation and Monitoring Consultants

These people are familiar with commodity fumigation methods and/or have conducted methyl bromide monitoring.

Robin Hobart - specialized linings for chambers
Gaco Western, Inc.
1499 67th Street
Emeryville, CA 94608
(510) 547-6632

Ed Hosoda
Cal Ag Industrial Supply, Inc.
1233 E. Beamer Street, Suite G
Woodland, CA 95695
(800) 548-2223

Fumigation and Monitoring Consultants, continued

John Sansone
Soil Chemical Corporation
1152 North Knollwood Circle
Anaheim, CA 92801
(714) 761-3292

Sid Siemer
Siemer & Associates, Inc.
4672 W. Jennifer , Suite 103
Fresno, CA 93722
(209) 275-0911

Frank Stegmiller
11815 Borden Road
Herald, CA 95638
(209) 748-2314

Jeff Tarter
Jeff Tarter Consulting Services
1897 W. Hedding Street
San Jose, CA 95126
(408) 243-6355

Eric Winegar
Air Toxics, Ltd.
11325 Sunrise Gold Circle, Suite E
Rancho Cordova, CA 95742
(916) 638-9892

In addition a number of insurance companies have the capability for evaluating workplace safety and monitoring air concentrations.

The yellow pages also list a variety of environmental consulting companies. Look under Chemists, Environmental, or Laboratories.

Computer Modeling Consultants

These people are familiar with air pollution modeling. They may or may not be familiar with the techniques used by DPR to compute the size of the buffer zones. The description of the computer modeling given on page 115 should be used as a guide by the consultants.

Advanced Environmental Controls
Bill Woyshner
4063 Birch Street, Suite 230
Newport Beach, CA 92660
800-439-9599
714-756-3160

IWG
Larry Gratt
1940 5th Avenue, Suite 200
San Diego, CA 92101
619-531-0092

Lee & Pierce
596 Abbott
Salinas, CA 93901
408-758-0096

Precise Environmental Consultants
David Suder
591 Reheem Blvd.
Moraga, CA 94556
510-376-4874

Sampson Engineering Associates
6 Hangar Way
Watsonville, CA 95076
408-761-6221

Vector Environmental
Michael Kelly
PO Box 10447
Bakersfield, CA 93889-0447
805-835-1075

Also check with the local Air Pollution Control District for companies that are familiar with the Industrial Source Complex-Short Term (ISCST) model and/or do modeling for the Toxic Hot Spots Program.

This list of companies is not to be construed as an actual or implied endorsement of their services.