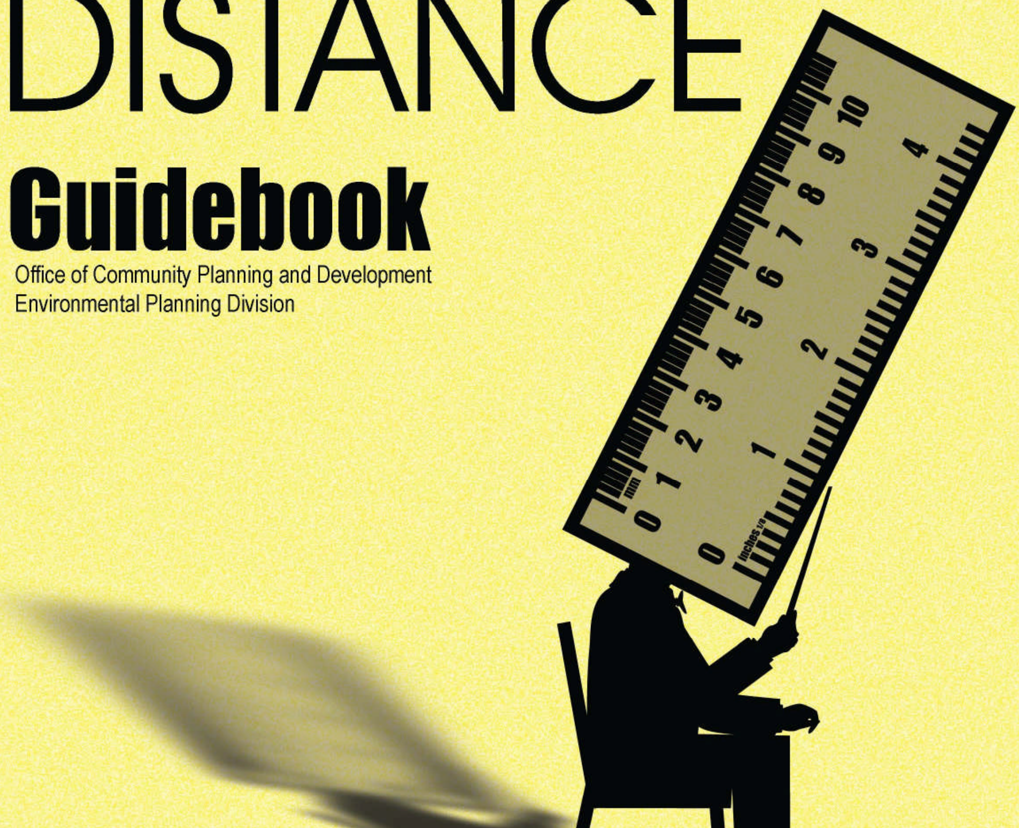
ACCEPTABLE SEPARATION DISTANCE

Guidebook

Office of Community Planning and Development
Environmental Planning Division



U.S. Department of Housing and Urban Development

Table of Contents

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Region 3 – Mid Atlantic
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1. The South Hill play area and homes are located near above ground stationary storage containers in the South Hill neighborhood of Chesapeake, Virginia.

Introduction

This *Guidebook* focuses on the hazardous operations that can potentially harm HUD-assisted projects and the people who live or work there. It reflects the parameters established by 24 CFR Part 51 Subpart C, which regulates the technical requirements of determining Acceptable Separation Distances (ASDs) from HUD-assisted projects in proximity to hazardous operations.

Purpose

This *Guidebook* provides HUD staff, planners, developers, engineers and grantees with specific steps to determine the Acceptable Separation Distance (ASD) between a HUD-assisted project and a hazardous operation. It provides environmental review professionals with information about the implementation of regulation 21 CFR Part 51 Subpart C. The *Guidebook* also provides both the analytical foundation and recommended strategy for determining the distance between a proposed HUD-assisted project and a hazardous operations site.

Background

The technical material referenced in previous editions of this *Guidebook* was obtained from a December 1975 study[1] by Arthur D. Little, Inc., and a December 19, 1981 study[2] by Rolf Jensen and Associates (RJ&A), Deerfield, Illinois, for HUD. The previous iterations of these guidelines are:

- Urban Development Siting with Respect to Hazardous Commercial/ Industrial Facilities – HUD –777-CPD)
- Regulation 24 CFR Part 51C;HUD Handbook 1390.2, “Environmental Assessment Guide for Housing Projects”
- HUD Handbook 1390.4, ‘ A Guide to HUD Environmental Criteria and Standards contained in 24 CFR Part 51” and,
- Siting of HUD-Assisted Projects Near Hazardous Facilities.

Authority

HUD’s authority to implement the information in this *Guidebook* is found in 24 CFR Part 51, Subpart C, “Siting of HUD – Assisted Projects Near Hazardous Operations Handling Conventional Fuels or Chemicals of an Explosive or Flammable Nature.”
HUD-assisted projects are required to meet criteria, standards and guidelines for site acceptability and a suitable living environment as provided under the following statues:

a) The National Housing Act, which was enacted “to encourage improvements in housing standards and conditions, to provide a system of mutual mortgage insurance, and for other purposes, “thus

[1] Safety Considerations in Siting Housing Projects
[2] Urban Development in Siting with Respect to Hazardous Commercial/Industrial Facilities

providing the basis for HUD's Minimum Property Standards (MPS) which have evolved as required by legislation over the past 44 years;

b) The Housing and Community Development Act of 1974, as amended, which sets forth the national goal of "a decent home and a suitable living environment for every American family"; and

c) The National Environmental Policy Act of 1969, as amended, which directs Federal agencies to develop procedures to carry out the purposes of the Act.

The information in this *Guidebook* can be applied to the following activities:

- HUD-assisted projects as defined in 24 CFR 51.201.
    - Generally speaking, these are projects that are intended for residential, institutional (this category includes public and government buildings), recreational, commercial or industrial use that are planned for development, construction, rehabilitation, modernization or conversion (change of one state of phase to another) with HUD subsidy, grant assistance, loan, loan guarantee, or mortgage insurance.
    - The interpretation of the terms "rehabilitation" and "modernization" refer only to such repairs and renovation of the proposed HUD-assisted project that will result in an increased number of people being exposed to hazardous operations by increasing residential densities, converting the use of a building to human habitation, or making a vacant building habitable.

<u>Exclusions</u>

The information contained in this *Guidebook* and in the ASD assessment tool **do not apply** in the following situations, which are excluded from Part 51 Subpart C:

a. **<u>Underground Storage Containers</u>**: If the container is buried (see glossary), there is no need for an ASD.

b. **<u>Stationary above-ground containers of 100 gallons or less capacity that hold *common liquid industrial fuels*</u>**: Results from the December 19, 1981 study[3] by Rolf Jensen and Associates (RJ&A), Deerfield, Illinois, demonstrated that stationary containers of 100 gallons or less capacity that store common liquid industrial fuels (such as gasoline, fuel oil, kerosene and crude oil) do not emit thermal radiation heat flux effects at levels that would pose a danger to HUD-assisted projects. **Note:** This exception ***<u>does not apply</u>*** to above-ground stationary containers that store hazardous gases, such as those listed in Appendix I of the Regulation or in Appendix C of this guidebook.

c. **<u>Natural gas holders with floating tops</u>**: These are stationary above-ground storage containers used to store natural gas. These containers are less susceptible to corrosion and tank perforations that can cause Bleves (rupture explosions).

[3] Urban Development in Siting with Respect to Hazardous Commercial/Industrial Facilities

d. **Mobile conveyances *(tank trucks, barges, railroad tank cars)***: These are containers that are mobile and have the capacity to store common liquid industrial fuels or hazardous gases as listed in Appendix I of the regulation 24 CFR Part 51 Subpart C and in Appendix C of this *Guidebook*.

e. **Pipelines, such as high pressure natural gas transmission pipelines or liquid petroleum pipelines**: Pipelines that transmit hazardous substances are not considered a hazard under 24 CFR Part 51 Subpart C if they are located underground or if they comply with applicable Federal, State or local safety standards.

Applications

Regulation 24 CFR Part 51, Subpart C, the ASD assessment tool, and the information in this *Guidebook* apply only to above-ground stationary containers of more than 100 gallon capacity that hold common liquid industrial fuels (for more information, please see Appendix I of the Regulation and Appendix C of this *Guidebook);* and above-ground stationary containers of any capacity that hold hazardous liquids or gases (see glossary) that are not common liquid industrial fuels (see also the list of hazardous substances in Appendix C of this *Guidebook*).

Frequently Asked Questions

To help you understand and apply the information in this *Guidebook*, what follow are questions HUD-field environmental officers ask most frequently.

1. 1a. Is there a list of steps to assess whether a proposed HUD-assisted project is too close to a hazardous facility?
1b. Is there a procedure for calculating the ASD?

1a. Yes. That information is located in Chapter 4. There you will find the steps necessary for assessing the proposed HUD-assisted project and examples using the Nomographs (Worksheets #1 through #4).
1b. Yes. Chapter 4 has manual calculation procedures. Chapter 4 and Appendix A provide detailed flowcharts on how to calculate the ASD for blast-overpressure, thermal radiation or both. You can also calculate the ASD by using the ASD assessment tool available on HUD's environmental webpage at
http://www.hud.gov/offices/cpd/environment/asdcalculator.cfm .

2. 2a. Which guidelines apply when the proposed HUD-assisted project site does not meet the standard and mitigation is required?
2b. Is there detailed information available on mitigation analysis?

2a. Chapter 5 (Mitigation Options) provides the basic information and steps required for a mitigation analysis. The results of this analysis provide key information that will help you determine if mitigation is required. Chapter 5 also provides flowcharts on the mitigation analysis for a site that has natural and man-made barriers if the ASD cannot be achieved between the site and the hazard being assessed.

2b. Yes. Key information on mitigation analysis can be found in Chapter 5.

3. Are there guidelines for chemicals that are held in above-ground stationary containers?

Yes. These guidelines can be found in Appendix C (Data Resources).

4. Aside from the manual calculation procedure (Nomographs) or the ASD assessment tool, is there another way to access already calculated ASD results based on the volume of the container?

Yes. There are 2 charts with ASD results (one for blast-overpressure, the other for thermal radiation) based on the volume of the container. These charts are located in Appendix C.

5. Is there a form to request a 51 C analysis regarding a potential hazardous site near a proposed HUD-assisted project?

No, however, there is a form in Appendix C to Request for Headquarters Analysis of Potential Hazardous Site, that details the information required to begin a 51 C analysis.

6. Is there a list of commonly asked questions on Regulation 24 CFR Part 51 Subpart C?

Yes. Those questions and answers can be found in Chapter 4, Evaluations and Guidelines. This section will also help you understand important changes that have occurred since the publication of the September 1996 "Siting of HUD-Assisted Projects Near Hazardous Facilities."
This edition of the *Guidebook* updates information and unresolved policy statements and principles. There are no 24 CFR Part 51 Subpart C policy changes in this guidebook.

7. How are Self-Contained Above Ground Containers (SCAC's) evaluated for calculation of the ASD?

For calculation of the ASD, SCAC's have two external walls. The first wall serves to contain the product; the second serves to prevent spills outside of the container if the first wall ruptures. The interstitial space (the space between the first and the second wall) serves to control spillage if a rupture in the container's internal wall occurs. **Note:** SCAC's are considered containers without a dike, **and calculations must be done for containers without a dike area**.

Chapter 1 – Overview: Organization of the *Guidebook*

Petrochemical gases and liquids are used worldwide. Their demand varies depending on the consumer. Domestic household consumers use petrochemicals to cook, heat their homes and water tanks and run appliances. Commercial consumers such as restaurants, office buildings, hotels and gas stations use petrochemicals to run their businesses. Industrial consumers such as power stations, material manufacturers, pharmaceutical and medical researchers, automotive and tool manufacturers use petrochemicals to support the demands of purpose of their industries.

Regulation 24 CFR Part 51 Subpart C applies specifically to the petrochemical liquids and gases that could ignite and explode and that are stored in above-ground, stationary containers such as those ones listed in Appendix I of the Regulation and in Appendix C of this *Guidebook*.

This *Guidebook*, as well as 24 CFR Part 51 Subpart C and the ASD assessment, are tools designed to determine whether a proposed HUD-assisted project site is too close to a facility with potentially hazardous stationary above-ground containers. They are tools that also help environmental review professionals understand and implement the regulation 24 CFR Part 51 Subpart C.

This latest edition of the *Guidebook* is a revision of the September 1996 "Siting of HUD-Assisted Projects Near Hazardous Facilities." This latest edition corrects inconsistencies and removes either questionable or unresolved policy statements and principles. There are no changes in this *Guidebook* to 24 CFR Part 51 Subpart C.

Additional features in this revision include:

- Flowcharts that illustrate

    1. Site analysis steps for ASD calculation (procedures and findings for a HUD-assisted project);
    2. Procedural calculation of the ASD for thermal radiation (fire) or blast-overpressure (explosion);
    3. Procedural calculation of the ASD for blast-overpressure (explosion) and thermal radiation provided the substance being assessed has flammable or combustible properties and is pressurized; and
    4. Mitigation analysis for a proposed HUD-assisted project.

- Examples of multiple mitigation options involving natural and man-made barriers.

- A section on "Frequently Asked Questions" about 24 CFR Part 51 Subpart C.

This *Guidebook* contains an Introduction, 6 Chapters and 6 Appendices.

Introduction: Outlines purpose, background, authority, exclusions, applications and limitations and frequently asked questions.

Chapter 1: *Overview* reviews the purpose and background of the *Guidebook,* providing important basic information, as well as frequently asked questions.

Chapter 2: *Regulatory Framework* discusses the foundation and structure of 24 CFR Part 51 Subpart C and the need to develop the standards of blast-overpressure and thermal radiation from which the ASD is calculated for the proposed HUD-assisted project.

Chapter 3: *Compliance Process* outlines the process to follow in order to comply with the Regulation.

Chapter 4: *Evaluations and Findings* explains and outlines the procedures required to evaluate proposed HUD-assisted projects that are in close proximity to a potentially hazardous site.

Chapter 5: *Mitigation Options* provides information about mitigation analysis and how to determine if mitigation is required on a proposed HUD-assisted project.

Chapter 6: *Extraordinary Circumstances* identifies extraordinary circumstances under which proposed HUD-assisted projects are subject to consultation by HUD-Regional and Field Environmental Officers. Under these circumstances, additional detailed information and procedures that are not provided in 24 CFR Part 51 Subpart C would be required.

2. A house sits near storage tanks in the South Hill neighborhood of Chesapeake, Virginia

Chapter 2 - Regulatory Framework

History:

Before the development of 24 CFR Part 51 Subpart C, HUD received inquiries from developers, planners, engineers, HUD field staff and grantees about how to determine Acceptable Separation Distances (ASDs) for HUD-assisted projects near stationary facilities that store, handle or process explosive or fire prone substances. Answering those inquiries involved determining the potential blast-overpressure and thermal radiation effects of the hazard. The "area impacted from the blast-overpressure or thermal radiation" was called a "hazard to buildings or people zone." Most of the proposed HUD-assisted projects were either greatly reduced in scope by the need to eliminate the "hazards to buildings or people zone" of the project or not approved.

The analysis involved in determining how the hazard might delay HUD-assisted project approval because there were no standards established from which an ASD could be determined for explosives or fire-prone substances. As a result, HUD decided that there was a need for the development of two standards:

1. Thermal Radiation – Applicable to people and buildings
2. Blast Overpressure – Applicable to buildings, building occupants and outdoor unprotected facilities

HUD researched the most relevant sources of information at the time regarding how stored flammable substances affect people and structures. The research, which included a review of federal agencies, professional organizations, regulatory agencies, and councils and boards, revealed that the existing standards specific to each entity's function and purpose were limited in both scope and application.

The following are some of the entities that were involved in the research study:

1. Federal Fire Safety Standards: The Federal Fire Safety standards for Liquified Natural Gas (LNG) Facilities establish thermal radiation standards that are applicable only to LNG facilities.
2. National Fire Protection Association (NFPA): The NFPA fire standards are limited to fire hazards and are for the specific use of industry in the determination the internal configuration of petrochemical facilities.

The first research project was meant to develop appropriate standards for blast-overpressure and thermal radiation and a method for calculating Acceptable Separation Distances (ASD's) for HUD-assisted projects. The study,[4] prepared by Arthur D. Little, Inc. and titled "A Notice of Proposed Rulemaking (NPR)," was completed in December of 1975. After extensive review and commentary, the standards for blast-overpressure and thermal radiation were established and published in the Federal Register on August 19, 1980.

[4] Safety Considerations in Siting Housing Projects

Due to additional comments gathered from the NPR, as well as comments from other industry experts, HUD decided to do a second research study,[5] with the purpose of addressing two concerns:

1. Simplifying the method of calculating of the Acceptable Separation Distance (ASD) between HUD-assisted projects and stationary hazards and,
2. Modifying standards already developed by the first study to include additional substances that were mostly used as fuels in the industry.

A second research project, done by Rolf Jensen and Associates, Inc., of Deerfield, Illinois, under contract to HUD, provided the required technical support and was used to address HUD concerns and to complete the current 24 CFR Part 51 Subpart C and the previous editions of this *Guidebook*. Regulation 24 CFR Part 51 Subpart C became effective on February 10, 1984, and amended on March 26, 1996. The research from the Rolf Jensen and Associates study were encapsulated in a report titled *Urban Development Siting with Respect to Hazardous Commercial/ Industrial Facilities*.

Average fire data at stationary bulk liquid fuel storage facilities from 1994 to 1998. Data[6] provided from the National Fire Protection Association (NFPA).

Total :	Damage off premises :
Annual average fire incidents : 387	Annual average fire incidents : 288
Casualties : 1	Casualties: 0
Injuries : 8	Injuries: 3
Direct Property Damage : $5,540,000	Direct Property Damage: $948,000

Average fire data at stationary LP-gas fuel storage facilities from 1994 to 1998. Data[7] provided from the NFPA.

Total :	Damage off premises :
Annual average fire incidents : 49	Annual average fire incidents : 26
Casualties : 1	Casualties: 0
Injuries : 5	Injuries: 1
Direct Property Damage : $722.00	Direct Property Damage: $117,000

The data presented supports the reason behind the development of the ASD under the regulation 24 CFR Part 51 Subpart C, which is to avoid injuring people or destroying property by properly assessing the distance between project sites and facilities that store, handle or process flammable or combustible chemicals.

This edition of the *Guidebook* incorporates the results of the 1981 Rolf Jensen and Associates study. Later experiments at the National Institutes of Health (see footnote 10) confirm the Regulation standards of thermal radiation for people (450 BTU/ft^2-hr) and the effect of heat on exposed human skin.

[5] Urban Development Siting with Respect to Hazardous Commercial/Industrial Facilities
[6] Fires at Flammable or Combustible Liquid Tank Storage Facilities: Statistical Analysis
[7] Fires at LP-Gas Bulk Storage Plants: Statistical Analysis

A review of the Thermal Radiation Standard - Buildings

The standard for the determination of an Acceptable Separation Distance (ASD) for thermal radiation is based on heat flux. A report[8] from ABS consulting indicates that exposures of as little as 4,000 BTU/ft^2-hr can cause ignition of wooden structures. Referenced studies[9] show that the maximum thermal radiation exposure that combustible materials can tolerate for a long period of time, without being susceptible to pilot ignition, is 4,000 BTU/ft^2-hr. From 5,000 BTU/ft^2-hr to 9,000 BTU/ft^2-hr, the tolerance on combustible materials on the maximum thermal radiation exposure reduces gradually as the thermal heat flux increases.

According to the Department of Homeland Security, United States Fire Administration/National Fire Data Center, response times for structure fires are generally less than 5 minutes 50 percent of the time, regardless of region, season, or time of day. The nationwide 90^{th} percent response time to structural fires is generally less than 11 minutes.

<u>The maximum thermal radiation heat flux exposure to buildings is 10,000 BTU/ft^2-hr for a maximum duration of 15 minutes.</u>

This is based upon the assumption that there will be fire department response to protect exposed combustible buildings within 15 minutes and that the exposed combustible materials will not spontaneously ignite before the fire department responds.

Modern multi-occupant buildings and homes made from wood are more fire resistant than before. (Research and development of fire resistant wood started in 1985 and was fully implemented in the construction of buildings and residences by 1997). With updated developments on advanced additives incorporated into wood and the substitution of plastic wood in homes and multi-occupant buildings, it takes more than 15 minutes for exposed combustible materials to ignite spontaneously, which is well within fire department response times. For multi-occupant buildings constructed before 1985, the fire department response time is well within the time limits at which exposed combustible materials spontaneously ignite.**<u>Therefore, a parameter standard of 10,000 BTU/ft^2-hr is considered the acceptable level of thermal radiation for buildings</u>.**

A Review of the Thermal Radiation Standard - People

Human skin reacts to heat by perspiring and increasing blood flow to the affected area. Pain is felt when skin temperature rises to just above 44° C or 111° F over a depth of 0.1mm (Normal is 37° C or 98.4° F). 44° C is an approximate value due to various skin depths, body fat, etc.

The National Library of Medicine and the National Institutes of Health and in collaboration with the Food and Drug Administration, performed an oximeter study[10] to

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[8] ABS consulting, Risk consulting Division, table 2.9, page 34, various Thermal Radiation Limits for Structure from Lees (1996).

[9] Loss Prevention in the Process Industries

[10] "Temperature Threshold for burn Injury, an Oximeter Safety Study", National Library of Medicine and the National Institutes of Heath report, 2004., Greenhalgh, G.H., Lawless, B.B. Chew, W.A. Crone, M.E. Fein, T.L. Palmieri.

determine the temperature threshold for burn injury. Pulse oximeters, essential devices for evaluating and monitoring patient oxygenation, emit a small amount of heat into the skin then detect a signal.

The standard for thermal radiation flux level for open spaces such as parks and playgrounds where people of all ages congregate is based on the time it would take to react and find protection from a fire hazard.

At 41° C or 106° F, the thermal heat flux is 175.3 BTU/ft^2-hr. At this heat flux level, people in open spaces will experience some degree of "redness" on their skin depending on their distance from the hazard, exposure time and atmospheric conditions such as wind temperature and speed, etc. This set parameter of thermal heat flux (175.3 BTU/ft^2-hr) is the normal standard for protection of people in outside environments.

At 55° C or 228° F, the thermal heat flux is 450 BTU/ft^2-hr. At 55° C or 228° F, people in open spaces will experience a much greater degree of "redness" on the skin, depending on the distance from the hazard, exposure time and atmospheric conditions such as wind temperature and speed, etc. This set parameter of thermal heat flux (450 BTU/ft^2-hr) is the maximum limit standard for protection of people in open spaces.

Therefore, the maximum set level parameter of 450 BTU/ft^2-hr is considered the acceptable level of thermal radiation for people in open spaces where people congregate, such as parks and playgrounds, etc.

A Review of the Blast-Overpressure Standard - Buildings

The criteria for determining Acceptable Separation Distances (ASD's) for blast-overpressure is based on the pressure wave exerted by detonation of a set mass quantity of TNT.

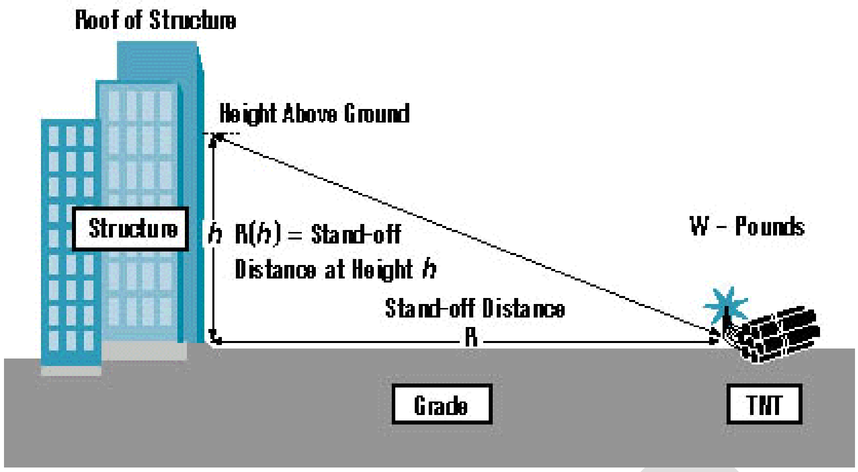
The method of comparison, also known as the "TNT Equivalent," is used because the blast-overpressure produced by 1 pound of TNT is known. This is the TNT equivalent weight of the actual explosive.

The TNT equivalent weight is defined by W (in pounds) = mass of the explosive in question times its relative strength.

For reference purposes, virtually all explosives have TNT equivalent weights within a factor of 1.4 of their physical weight.

Therefore, the mathematical formula to calculate the scaled distance (Z) is $Z = R/W^{1/3}$, where
W = pounds of TNT equivalent weight at a distance R (the stand off distance) from the vertical exterior wall of a building (example).

Below is a visual representation of a hazard (TNT equivalent weight – W) and the standoff distance (R) between the explosive hazard and a structure.



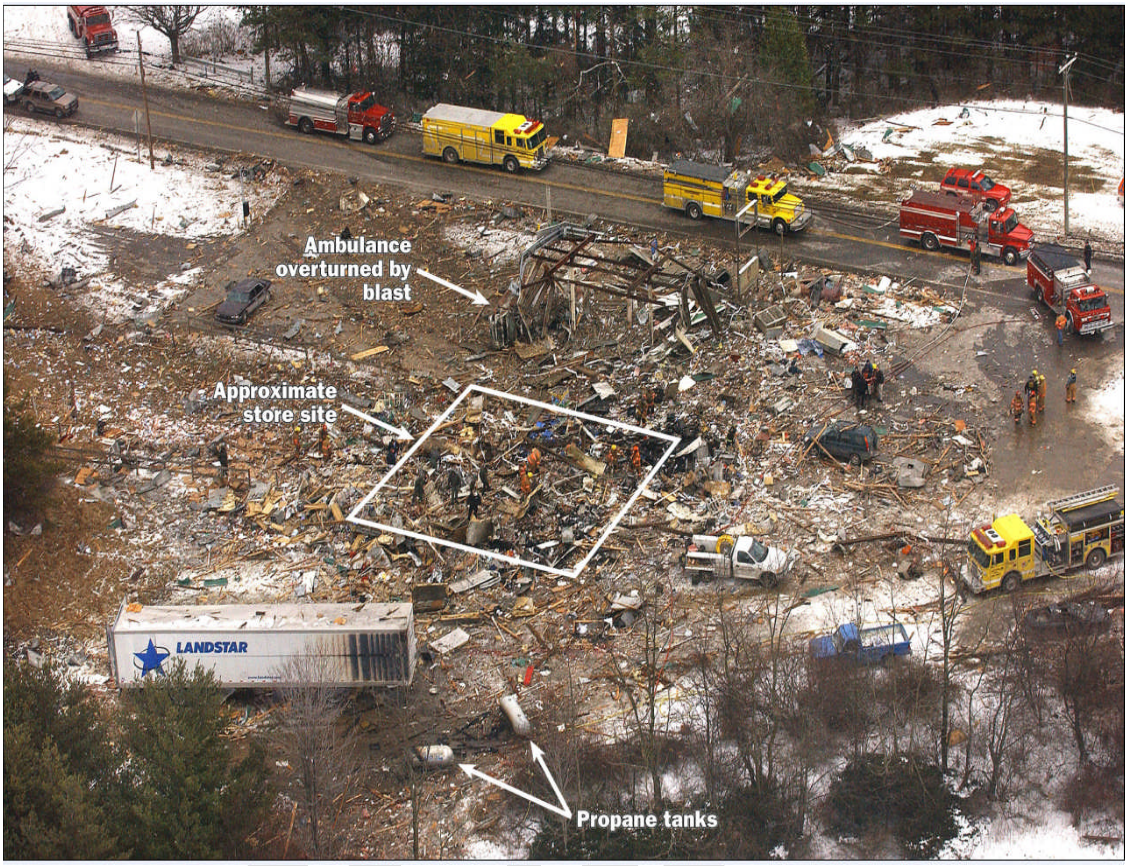
The following table illustrates several test results developed by a Department of Defense and Sandia National Laboratories study[11] of explosives detonation and the blast-overpressure effects on different materials. The amount and type of explosive used and the distance between the explosives and the structural element were not released as part of the results of the subject study.

Structural element	**Overpressure effects on structural element**	**Approximate peak positive incident pressure recorded on structural element (psi)**
Glass windows, large and small	Shattering usually, occasional frame failure	0.5- 1
Corrugated asbestos siding	Shattering	1.0- 2.0
Corrugated steel or aluminum paneling	Connection failure following by buckling	1.0-2.0
Brick wall panel, 8in, or 12 in thick (not reinforced)	Shearing and flexure failures	3.0-10.00
Wood siding panels, standard house construction	Usually failure occurs at the main connections allowing a whole panel to be blown in	1.0- 2.0
Concrete or cinder-block wall panels, 8 in, or 12 in thick (not reinforced)	Shattering of the wall	1.5- 5.5

[11] "Effects of Nuclear Weapons, Conditions of failure of overpressure-sensitive elements", Table 5.145, page 221, 1997., Glasstone, S., and P.J. Dolan

The most current standard developed from testing on window systems, as used on GSA buildings and Department of State embassies (Applied Research Associates, Inc.), reflects a standard for glass overpressure of 0.5 psi.

Therefore, the parameter standard of 0.5 psi is the maximum allowable pressure that can be measured at a distance from an explosive hazard when selecting a site for HUD- assisted housing and occupants.



3. The aftermath of the January 30, 2007 propane blast at the Little General Store in Ghent, West Virginia. Enhancements note the approximate location of the store, the propane tanks and the ambulance overturned in the explosion.

Chapter 3 - Compliance Process

HUD-assisted projects (as defined in 24 CFR 51.201) shall be in compliance with 24 CFR Part 51 Subpart C. The implementation of the Regulation is the responsibility of the HUD approving official (certifying officer) or responsible entity.

The Regulation addresses protection of buildings and people when siting HUD-assisted projects near hazardous operations that handle conventional fuels or chemicals of an explosive, combustible or flammable nature.

For a HUD-assisted project to be in compliance with the regulation 24 CFR Part 51 Subpart C, the project location must be within the Acceptable Separation Distance (ASD) established by HUD from facilities that store, handle or process explosive or fire prone substances.

The key steps to complying with the regulation 24 CFR Part 51 Subpart C are as follows:

Step 1: Identify hazardous operations/facilities with stationary, aboveground storage tanks in proximity of the proposed HUD-assisted project site.

Step 2: Calculate the ASD between the proposed HUD-assisted project site and the hazardous facility using thermal radiation and blast overpressure standards.

Step 3: Determine whether the project site meets the standard.

Step 4: If the project meets the standard, no further action is required. However, if the project does not meet the standard, mitigation (covered in detail in Chapter 5) may be required.

The ASD is prescribed from the standards set out in the regulation 24 CFR Part 51 Subpart C, as follows:

- Thermal Radiation, 10,000 BTU/ft^2 - hr
  - Applicable to buildings
- Thermal Radiation, 450 BTU/ft^2 – hr
  - Applicable to people
- Blast-Overpressure, 0.5 psi
  - Applicable to buildings, building occupants and outdoor unprotected facilities

To protect buildings and housing units from thermal radiation, HUD established the thermal radiation standard of 10,000 BTU/ft^2 – hr.

To protect people in outside areas, such as patios or common areas, or in places where communities congregate, like parks or recreation areas, HUD established the thermal radiation standard of 450 BTU/ft^2-hr. If no mitigation exists or is implemented, it is required to build HUD-assisted projects to the ASD at which the thermal radiation flux will not exceed 450 BTU/ft^2-hr.

Blast overpressure can harm people or destroy buildings if this pressure is higher than 0.5 psi. For proposed HUD-assisted project sites where there are stored hazards that can cause blast overpressures and no mitigation, it is required to build to the ASD at which this pressure is no higher than 0.5 psi.

HUD will not approve applications for assistance unless 1) the proposed project meets the required ASD from the facility assessed as hazardous; or and 2) appropriate mitigation measures or plans for appropriate mitigation are implemented.

Appropriate mitigation measures are classified as either natural or man-made structures that shield or serve as an abatement to the HUD-assisted project site from the blast overpressure and/or thermal radiation effects from the hazard. Whether natural or man-made, mitigation measures shall be stationary, of adequate size and strength, and located between the hazard and the proposed HUD-assisted project site, and shall shield all points of the project from the line of sight exposure of the hazard. (Chapter 5 of this *Guidebook* covers mitigation measures in detail.)

If the HUD-assisted project is a facility that will process, manufacture or store hazardous substances, HUD will not approve applications for assistance unless the proposed project is located at the required ASD from housing developments and from facilities or areas where people congregate or engage in outdoor activities.

In the case for all applications for HUD-assisted projects, the Department shall evaluate projected development plans for the installation or existence of hazardous operations near the location of the proposed HUD-assisted project. If such hazardous facility exists, or there are plans for the development of such facility, the project must comply with the standards of the Regulation, or adequate mitigation measures must exist, or the Department must obtain satisfactory assurances that adequate mitigation measures will be taken where the hazardous operation is installed before the Department approves the applications for development of such projects.

4. Fire and smoke caused by the explosion of a propane tank at a maintenance facility for Como Oil, located at Duluth, Minnesota.

Chapter 4 – Evaluations and Findings

To determine if the proposed HUD-assisted project meets the established standards for blast-overpressure or thermal radiation, HUD or the responsible entity is required to calculate the Acceptable Separation Distance (ASD) between the proposed project and the hazardous facility.

The following steps are intended to help the user of this *Guidebook* understand the required process necessary for evaluating a HUD-assisted project that is located in close proximity to a potentially hazardous site.

Step 1: Obtain a map, site plan or photos of the proposed HUD-assisted project site and surrounding areas.

- Maps
  - Scaled maps with site contours (topographic maps) are highly recommended for the analysis of proposed HUD-assisted project sites. These maps make it easier to determine the existence of natural or man- made barriers and to perform an analysis of these barriers with reference to the location of the facility storing hazardous or explosive hazards.
  - Topographic maps or site maps can be obtained from the United States Geological Survey (USGS), City or County engineer's or planning office related to the proposed HUD-assisted project.
  - Digitized topographic maps (free of cost) can be obtained from the World Wide Web (WWW) for general public use from the following sources. (HUD does not endorse any of the referenced electronic sources of information.)
    - Yahoo Maps, http://developer.yahoo.com/maps/
    - Google Earth, http://earth.google.com/
  - Site maps provide geographic site information for recognizance and analysis of the various facilities near proposed HUD-assisted project sites.

- Site plans
  - Site plans provide detailed existing land-use information for proper identification and analysis of the areas comprising the proposed HUD-assisted project site. Site plans may be obtained from the engineer's, planning or developer's office working on the HUD-assisted project.

- Photos
  - Aerial photographs may be available from the developer of the HUD-assisted project, local commercial survey firms or planning departments.
  - Site photographs provide actual images of the facilities near proposed HUD-assisted project sites and nearby land uses when current. Site photographs provide valuable information for site evaluation. This information can be gathered (camera required by the person gathering the information) by scheduling a visit to the hazardous facility (making

sure that photographs are allowed) to be assessed and contacting the facility site manager.

Step 2: Use the maps, photos and plans of the proposed HUD-assisted project site, identify the following:

- HUD-assisted project site boundaries – to determine the area where facilities that store, manufacture or process hazardous substances are located, plot a mile-radius perimeter from the center of the proposed HUD-assisted project site.

  - Consider all the stationary, above-ground containers containing hazardous substances that can pose a hazard to the buildings or open areas where people congregate, play, etc., associated with the HUD-assisted project.

  - Collect the following information for each container to be considered:
    - Container's capacity (in gallons).
    - Container's product chemical name (not the trade name).
    - Container's product phase of state (gases or liquids).
    - If the container is unpressurized (containing liquids), find out if the container is diked or undiked. If it is diked, determine the dike area (**Length** times the **Width** - in square feet units).

  - Measure the distance between the proposed HUD-assisted project site and the container(s) being assessed.

    When plotting the actual distances from the hazards in stationary, above ground storage containers, always measure the distance from the center of the containers to the perimeter of the proposed HUD-assisted project site.

    Actual distances from the hazards to the buildings or open areas where people congregate should be plotted in "feet" units. This distance must be measured from the center of the above-ground storage container(s) to the perimeter of the proposed HUD-assisted project site.

  - Determine which container(s) to use in making ASD calculations.

    How do you evaluate your containers for each facility?

    Guidelines on container evaluation (applies to pressurized and non-pressurized containers) for ASD calculations
    - When there is a facility with stationary above-ground storage containers and diked areas of the same size, the ASD needs to be calculated for the container or diked area closest to the proposed HUD-assisted project site.
    - When there is a facility with stationary above-ground containers and diked areas of different sizes, the ASD needs to be calculated for the container or diked area of largest capacity closest to the proposed HUD-assisted project site.
    - When there is a facility with the same type of stationary above-ground containers of different capacity and the smaller capacity container is the one closest to the proposed HUD-assisted project site, the ASD must be calculated for the container that is closest

How do you evaluate your containers for each facility?

to the proposed HUD-assisted project site, as well as the largest capacity container.

- Calculate the ASD for the stationary container of largest capacity (whether pressurized or unpressurized) closest to the proposed HUD-assisted project. Always calculate the ASD for the pressurized container, regardless of its location. Consider only aboveground storage tanks.

Information on containers:

Within the regulation 24 CFR Part 51 Subpart C, there are 5 types of above-ground stationary containers, as follow:

This *Guidebook*, Regulation 24 CFR Part 51 Subpart C, and the ASD assessment tool **all apply** to these types of containers.

1. Pressurized containers (gases) designed to store a liquid-gas mixture substance under pressure. If the substance contained is a hazardous substance, the ASD for this container must be calculated for blast-overpressure (explosion) and thermal radiation (fire). If the substance contained is not of a flammable or combustible nature, the container does not need to be considered for the ASD analysis.

2. Pressurized containers (gases) holding cryogenic hazardous substances kept in a liquid state by temperature control, consider ASD calculations for fire. For hazardous cryogenic gases kept in gas phase, consider ASD calculations for fire and explosion. Hazardous cryogenic gases are kept in their liquid state at very low temperatures by refrigeration, insulation, etc. Hazardous cryogenic gases (e.g., Liquefied Natural Gas and Hydrogen) are listed under the “Hazardous Gases” list located in Appendix I of Subpart C and at Appendix C of this *Guidebook*.

3. Unpressurized containers designed to store a substance in a liquid phase of state (for liquids), calculate the ASD for thermal radiation (fire) only if the substance is of a hazardous nature. Since the substance contained is not under pressure, there is no need to calculate the ASD for blast-overpressure (explosion). If the liquid substance contained is not of a hazardous nature, the container does not need to be considered for the ASD analysis.

This *Guidebook*, Regulation 24 CFR Part 51 Subpart C and the ASD assessment tool **do not apply** to these types of containers.

4. Underground storage containers (liquids or gases) that are designed to store liquids or gases that are placed under the ground do not apply under this *Guidebook*, the regulation 24 CFR Part 51 Subpart C, or the ASD assessment tool.

5. Retrofitted mobile containers (tank trucks, barges, railroad tank cars containing liquids or gases) that have the capacity to store common liquid industrial fuels or hazardous gases as listed in Appendix I do not apply under this *Guidebook*, the regulation 24 CFR Part 51 Subpart C, and the ASD assessment tool.

Recommended guideline on calculating the ASD for pressurized and non-pressurized containers:

This is an ASD calculation guideline for pressurized containers. The diked area is never used for calculation of the ASD in pressurized containers.

1. The ASD calculation will not be affected by the diked area on pressurized containers (hazardous or non-hazardous substances) because gases occupy the volume of a container. If a leak occurs, the gas escapes to the atmosphere while the liquid boils and turns into vapor. Therefore, the diked area is not considered in the analysis.

ASD calculation facts on unpressurized containers:

These are ASD calculation facts for non-pressurized containers. Undiked , unpressurized containers have a larger ASD numerical value than diked because the dike defines the fire width as a controlled fire.

1. If the container is diked: the ASD will be of a smaller numerical value for diked containers vs. undiked containers storing hazardous liquids because the diked area defines the fire width, limiting the flames, heat dispersion and extension.

2. If the container is undiked: the ASD will be of a larger numerical value for undiked containers storing hazardous liquids. Without the dike area, the fire has no boundary or controlled perimeter.

Step 3: Calculate the ASD for the proposed HUD-assisted project:

The ASD can be calculated between a proposed HUD-assisted project and a facility that stores, handles or processes hazardous substances for:

- Thermal radiation (fire)
- Blast-Overpressure (explosion)
- Or both

Steps 1 and 2 of this Chapter, provide the user of this *Guidebook* with the steps required to gather the data necessary for calculating the ASD between a proposed HUD-assisted project and a facility that stores, handles or processes hazardous substances.

Flowcharts illustrating procedural calculation of the ASD for Thermal radiation, blast-overpressure or both can be found in Appendix A.

The ASD can be calculated using one of the following methods:

Manual Calculation (Nomographs)

Using the Nomographs located in Appendix B, calculate the ASD by plotting the required information (represented by the x- axis) to the respective graph (graphs are represented by a logarithmic line, as in worksheets #1 through #4, Appendix B) and then plotting the intersection point (between the x-axis and the graph) to the y- axis. The y-axis represents (depending on the worksheet) an interim calculation result required in the procedure to obtain the ASD or the ASD.

Electronic based calculation (The ASD Assessment Tool)

The web-based tool for calculation of the ASD offers an electronic application of the manual approach to calculation requirements contained in regulation 24 CFR Part 51 Subpart C and this *Guidebook*. Mathematical equations were derived from the Nomographs located in the Regulation and applied to the component parts of the assessment to determine the ASD between a proposed HUD-assisted project site and facilities that store, handle or process hazardous substances. This tool is accessible through the following URL:http://www.hud.gov/offices/cpd/environment/asdcalculator.cfm

Acceptable Separation Distance Principles

Most of these principles have been cited through the previous chapters of this *Guidebook*. However, because of their significance in the Regulation, they are all reiterated here:

1. There are two standards from which ASD calculations are produced:

    - Thermal Radiation (fire)
        - Buildings – 10,000 BTU/ft^2 – hr
        - People – 450 BTU/ft^2 – hr
    - Blast-Overpressure (explosion)
        - Buildings, building occupants and outdoor unprotected facilities– 0.5 psi

2. When measuring the ASD between a proposed HUD-assisted project and a facility that stores, handles or processes hazardous substances, always measure from the center of the stationary container containing the hazardous substance to the perimeter of the proposed project site. The perimeter is defined as the path or boundary that surrounds an area. In the case of proposed HUD-assisted projects, this area is the site where the project will be developed.

3. ASD calculations must be made between a proposed HUD-assisted project and a facility that stores, handles or processes hazardous substances. When calculating the ASD for thermal radiation for people, outdoor areas where people congregate must be assessed, such as:

    - Playgrounds
    - Outdoor recreation areas (parks, yards, planned open space)
    - Balconies
    - Residential parking lots (only parking lots associated to residential projects are considered applicable to the Regulation, since they are open spaces for congregation)

4. For stationary, above-ground **pressurized** containers that hold hazardous substances, the ASD calculations are generally required for blast-over pressure and thermal radiation.

5. For stationary, above-ground **unpressurized** containers that hold hazardous substances, the ASD calculations are generally required only for thermal radiation.

6. The diked area (in square feet) has an effect only on ASD calculations involving stationary, above-ground **unpressurized** containers that store hazardous substances. The diked area does not have an effect on ASD calculations involving stationary, above-ground **pressurized** containers that hold hazardous substances.

7. The information contained in this *Guidebook* and the ASD assessment tool do not apply in the following situations, which are excluded from Part 51 Subpart C (see page 4 for details):

    - Underground storage containers

- o Stationary containers of 100 gallons or less capacity containing common liquid industrial fuels
- o Natural gas holders with floating tops
- o Mobile conveyances (tank trucks, barges, railroad tank cars). Mobile conveyances, while performing fuel operations (loading or unloading fuel, etc.) into a gas station, fuel transfer or storing facility, are not to be considered as part of the ASD analysis for the proposed HUD-assisted project if the proposed project is the fuel transfer or storing facility, since in the fuel operation process (mobile conveyance being stationary), there is the release of fumes from the fueling operation procedure, therefore, moving conveyances do not apply to the Regulation.
- o Pipelines, such as high pressure natural gas transmission pipelines or liquid petroleum pipelines.
- o Release of toxic gases or liquids, distribution piping associated with a container or process vessel

8. If a proposed HUD-assisted project has more than one ASD, the ASD which assures the greatest separation distance will be applied to the proposed project.

9. If the actual separation distance between the hazardous facility-tank and the proposed HUD-assisted project is greater than the ASD, then the actual separation distance is acceptable for the proposal.

10. If the actual separation distance between the hazardous facility-tank and the proposed HUD-assisted project is less than the ASD, then the site is unacceptable unless natural or man-made mitigation measures already exist or are implemented between the above-ground stationary hazard and the proposed project site.

11. Consider the ASD for thermal radiation (fire) only for gases kept in a liquid phase of state by a low temperature setting (known as hazardous cryogenic gases). Hazardous cryogenic gases (e.g., Liquefied Natural Gas and Hydrogen) are listed under the "Hazardous Gases" list located in the Appendix I of Subpart C and in Appendix C. For hazardous cryogenic gases kept in gas phase, consider ASD calculations for fire and explosion.

12. Regulation 24 CFR Part 51 Subpart C, this *Guidebook*, and the ASD assessment tool apply to HUD-assisted projects located near hazardous operations which store, handle or process hazardous substances. No provision was made for waiver of the Regulation or for waivers of the ASD standard.

13. Barriers for blast-overpressure should be constructed as close to the hazard source as possible. The barrier design, location and construction must be site specific.

14. Gasoline service stations usually do not fall within the purview of 24 CFR Part 51, Subpart C. In most gasoline service stations, the containers where the fuel is stored are underground, and underground storage containers do not apply to the Regulation. However, if a gasoline service station does have above-ground stationary containers of capacities of greater than 100 gallons that store common liquid industrial fuels (such as gasoline, fuel oil, kerosene and crude oil), then those containers would be considered under the Regulation.

15. If the ASD cannot be achieved between a hazard involving thermal radiation effects and a proposed HUD-assisted project, please refer to Chapter 5 – Mitigation Options of this *Guidebook*. If difficulties are found calculating the ASD or performing a mitigation analysis for the proposed HUD-assisted project site, contact the respective HUD Field or Regional Environmental Officer. The thermal heat flux effects on the proposal need to be calculated by a licensed professional engineer on a case by case basis, and depending on the results of the analysis, if a fire mitigation wall is required, it may not be feasible for the developer due to the size requirements to mitigate the fire ball produced by the hazard.

16. If the ASD cannot be achieved on a hazard involving blast-overpressure effects on a proposed HUD-assisted project, please refer to Chapter 5 – Mitigation Options of this *Guidebook.* If difficulties are found calculating the ASD or performing a mitigation analysis for the proposed HUD-assisted project site, contact the HUD Field or Regional Environmental Officer. Blast barriers should be designed and implemented based on the calculation of the peak positive incident pressure (blast-overpressure) produced by the hazard. The blast barrier should be implemented as close as possible to the hazard producing the blast-overpressure. Only licensed professional engineers (civil or structural) should design and implement blast barriers. Design and implementation of blast barriers is site specific.

17. The Regulation does not apply to safety requirements of employees at facilities that store, handle or process flammable or explosive substances. Such standards and guidance or safety requirements would fall within the purview of the National Fire Protection Association (NFPA), local fire codes, and permitting requirements, and the Occupational Safety and Health Administration.

Important Questions and Answers Regarding 24 CFR Part 51 Subpart C:

The following questions are often asked of HUD-Headquarters personnel regarding the regulation 24 CFR Part 51 Subpart C:

1. Are above-ground, stationary tanks that contain flammable or explosive petrochemical fuels and are ancillary to the operation of a building (e.g., comfort heating, cooking, water heating) **that is not** a 1-4 family - FHA insured property subject to the Regulation?

   Answer : Yes, unless the tanks have a capacity of 100 gallons or less and contain common liquid industrial fuels, the ASD must be calculated for above-ground, stationary tanks containing flammable or explosive petrochemical fuels ancillary to the operation of a building if is not a 1-4 family - FHA insured property.

2. Does the Regulation consider tank designs (e.g., double wall, fire resistant, protected) on the ASD calculation procedures for a proposed HUD-assisted project site?

   Answer: No, the Regulation does not consider tank designs on the ASD calculation procedures for a proposed HUD-assisted project.

3. Does the Regulation consider fire suppression systems (e.g., water, high expansion foam, Halon gas, Aqueous Film Forming Foam) as a substitute for the ASD or mitigation?

Answer: No, the Regulation does not consider fire suppression systems as a substitute for mitigation or the ASD.

4. When should above-ground, stationary tanks containing hazardous substances be moved from a proposed HUD-assisted project in order for the project to be in compliance with the Regulation?

Answer: The tanks must be moved before the HUD-assisted building or site is occupied or used.

5. Does the Regulation provide standards for the location of above-ground stationary storage tanks for the protection of construction workers?

Answer: No, the Regulation does not regulate or provide standards for the location of storage tanks for the safety requirements of construction workers. Such standards and guidance or safety requirements would fall within the purview of the National Fire Protection Association (NFPA), local fire codes and permitting requirements, and the Occupational Safety and Health Administration, respectively.

6. Does the Regulation apply to protecting HUD-assisted hazardous facilities from the facility's own tanks?

Answer: No, the Regulation does not apply to the protection of the proposed HUD-assisted industrial facility from the facility's own tanks. For a proposed HUD-assisted project involving the installation of a hazardous facility, the Department shall ensure that such hazardous facility is located at an acceptable distance from residences and from any other facility or area where people may congregate.

7. Does the Regulation apply to public facilities, such as sewer and water treatment plants that may have water tanks, underground sewer lines, and pumping facilities?

Answer: Public facilities like the ones described above are not subject to consideration under the Regulation as it applies to above-ground stationary storage containers that hold hazardous substances. The Regulation does not generally apply to public facilities unless there are above-ground stationary containers on site that would meet the criteria contained in the Regulation.

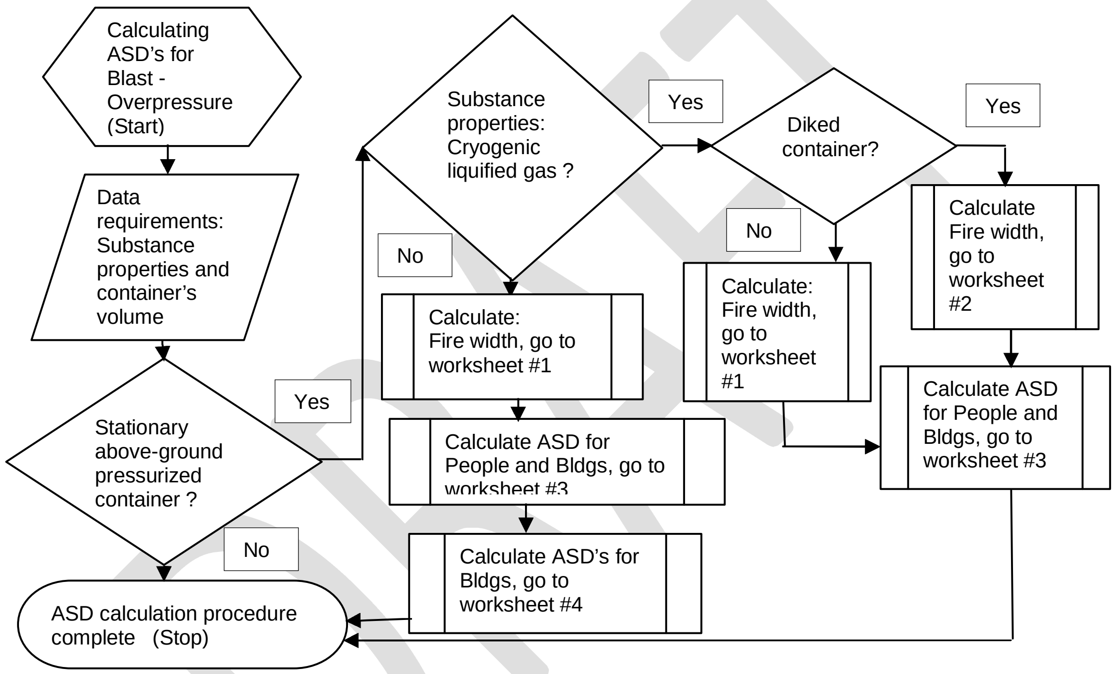
What are the steps to follow after the ASD of a proposed HUD-assisted project has been calculated?

- If the ASD meets the standard requirement, no further action is required.
- If the ASD does not meet the standard requirement, mitigation (explained in Chapter 5) may be required.
- If the ASD does not meet the standard requirement and mitigation is not possible, consult Chapter 5 (mitigation analysis #9).

Example 1: On the determination of the ASD for blast-overpressure (explosion) and thermal radiation (fire):

In this hypothetical case, a proposed HUD-assisted project is to be sited 850 feet from a stationary above-ground, 30,000 gallon liquid propane gas (LPG) container. The objective is to determine the Acceptable Separation Distance (ASD) from the proposed HUD-assisted project to the LPG container. Since LPG has flammable properties and it is under pressure (gases), the ASD must be evaluated for blast-overpressure and thermal radiation.

Follow the flowchart below for a flammable, non-cryogenic substance contained in a stationary above-ground container under pressure in order to determine the ASD for Thermal Radiation (fire) and Blast-Overpressure while knowing the substance properties and the volume of the container.



Proceed to calculate the fire width, using Worksheet 1. Use Worksheet 1 because the dike area on a pressurized container does not have any effect on the ASD calculations. Following with the procedure, the volume of the container (30,000 gallons) is plotted in the x-axis toward the line graph, making an intersection with the line graph. This intersection point is then plotted toward the y-axis, providing the fire width (see figure 1). The fire width was determined to be 350 feet.

Proceeding with ASD calculation procedures for people and buildings, use Worksheet 3. The fire width (x-axis) is plotted toward the first line graph (bottom graph), making an intersection with the graph. This intersection point is plotted toward the y-axis, providing the ASD for buildings (see figure 2). The ASD for buildings was determined to be 240 feet. Further on, the first intersection point (bottom graph), is (continued in page 33)

Figure 1: Fire Width calculation (Undiked Container)

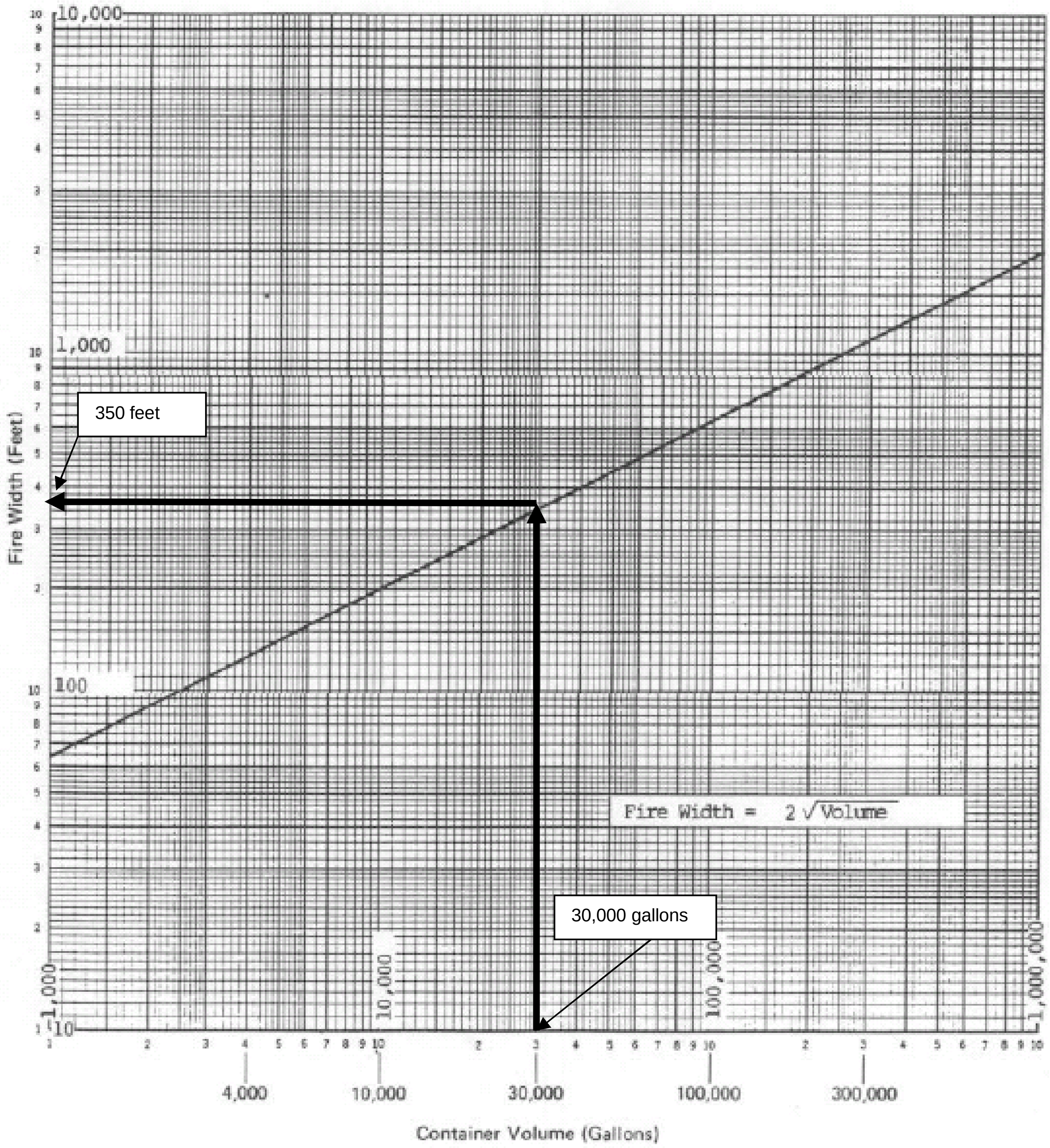
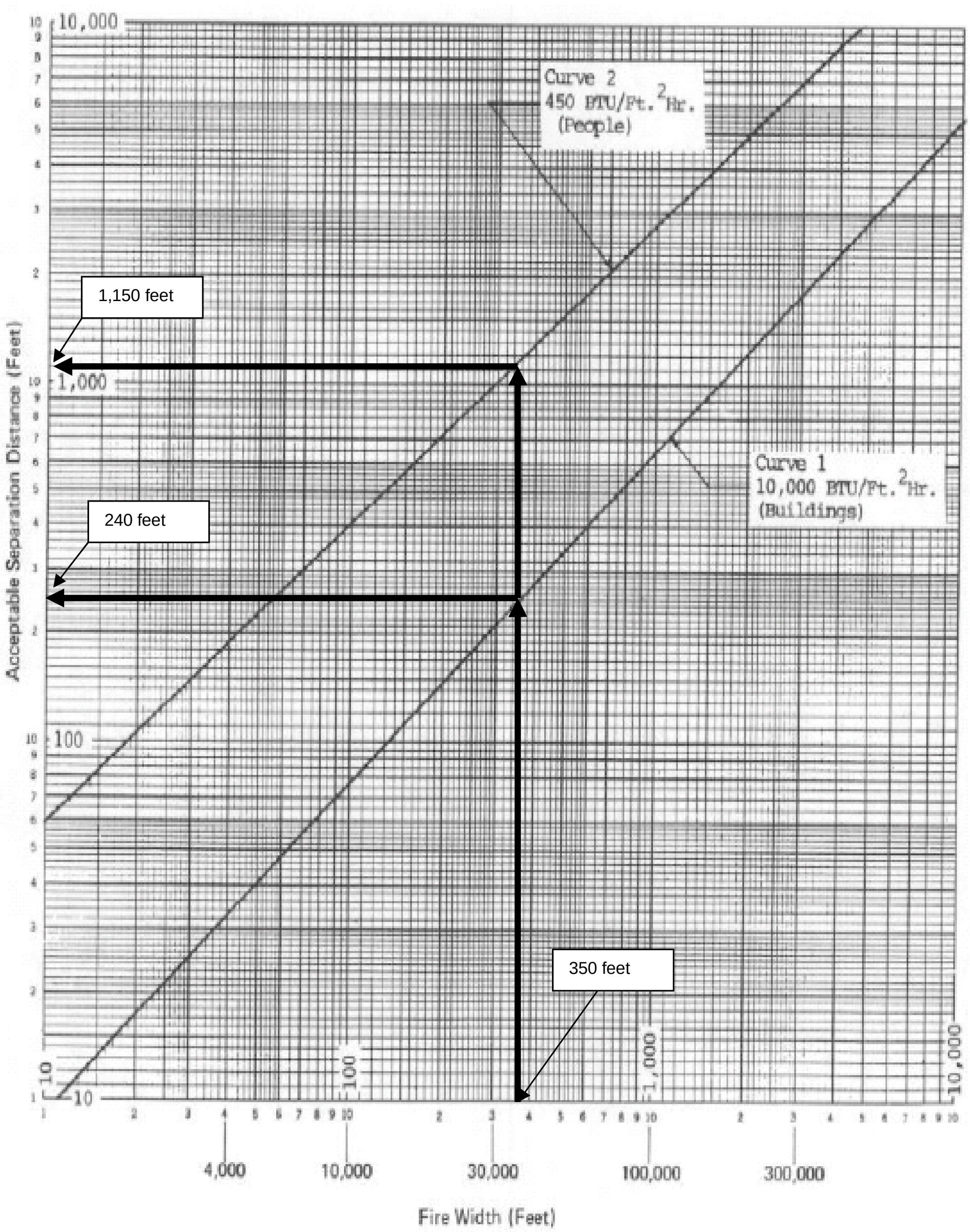


Figure 2: Acceptable Separation Distance Calculation for Buildings and People (Thermal Radiation)

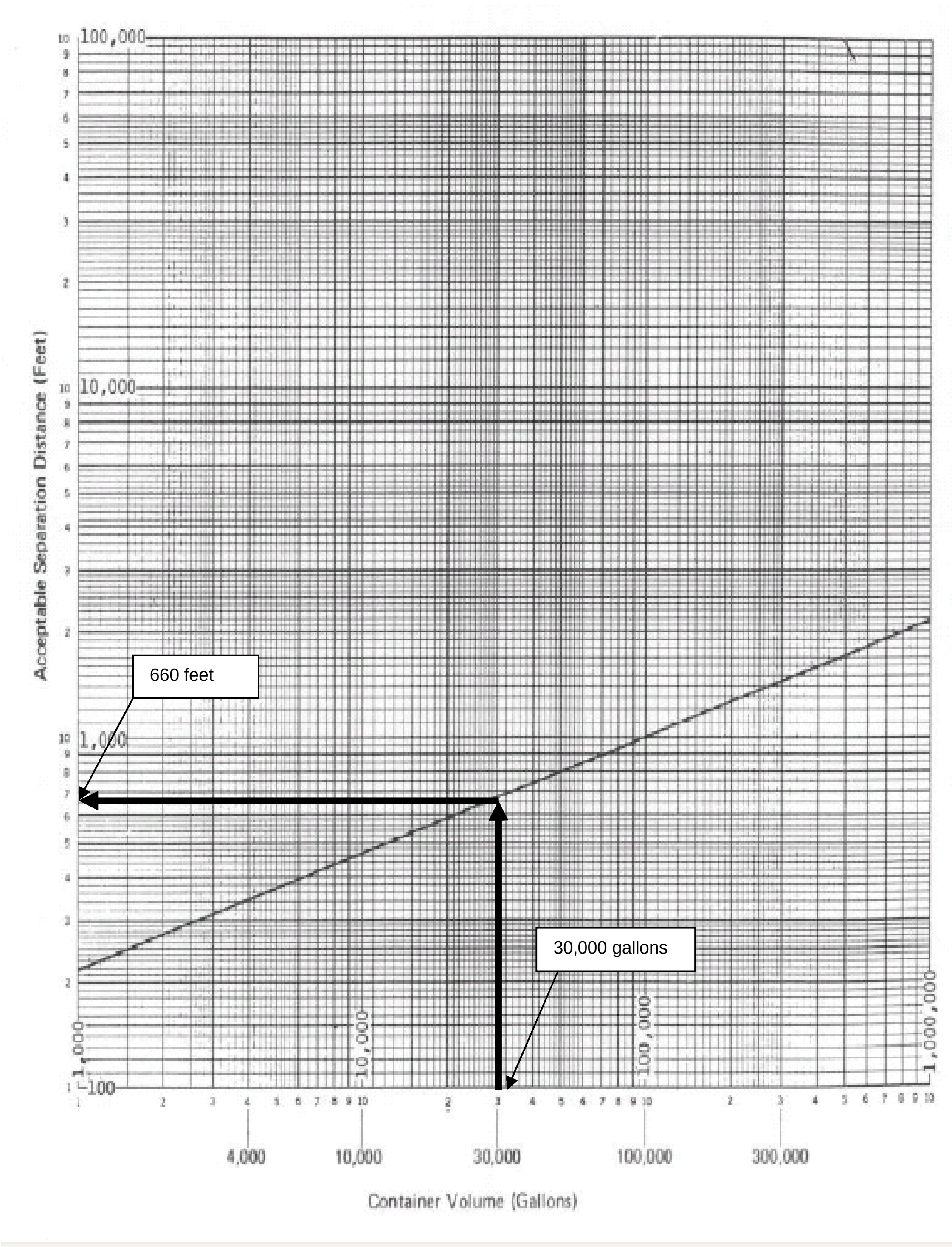


plotted toward the second line graph (top graph), making an intersection with the graph. This intersection is plotted toward the y-axis, providing the ASD for people (see figure 2). The ASD for people was determined to be 1,150 feet.

In this case, the actual distance from the center of the LPG container to the perimeter of the proposed HUD-assisted project is 850 feet. The proposed HUD-assisted project complies with the thermal radiation standard for buildings, but not for people. Since the project cannot achieve the ASD for thermal radiation for people (the ASD is 1,150, which is not within the actual distance of the proposal, measuring from the center of the LPG container), a mitigation analysis (presented and explained in detail in Chapter 5) would be required.

Since the product is contained under pressure (gases) and does have flammable properties, the ASD for blast-overpressure must be calculated. Referring to the flowchart used in this example, and knowing the volume of the LPG container (in gallons), use Worksheet 4. Plot the volume of the container (x axis) toward the line graph and make an intersection with the graph. Further on, plot this intersection toward the y axis to determine the ASD for blast-overpressure. In this case this value is 660 feet (see figure 3). This proposed HUD-assisted project complies with the blast-overpressure standard for buildings (the ASD is 660 feet, which is within the actual distance of the proposal, measuring from the center of the LPG container).

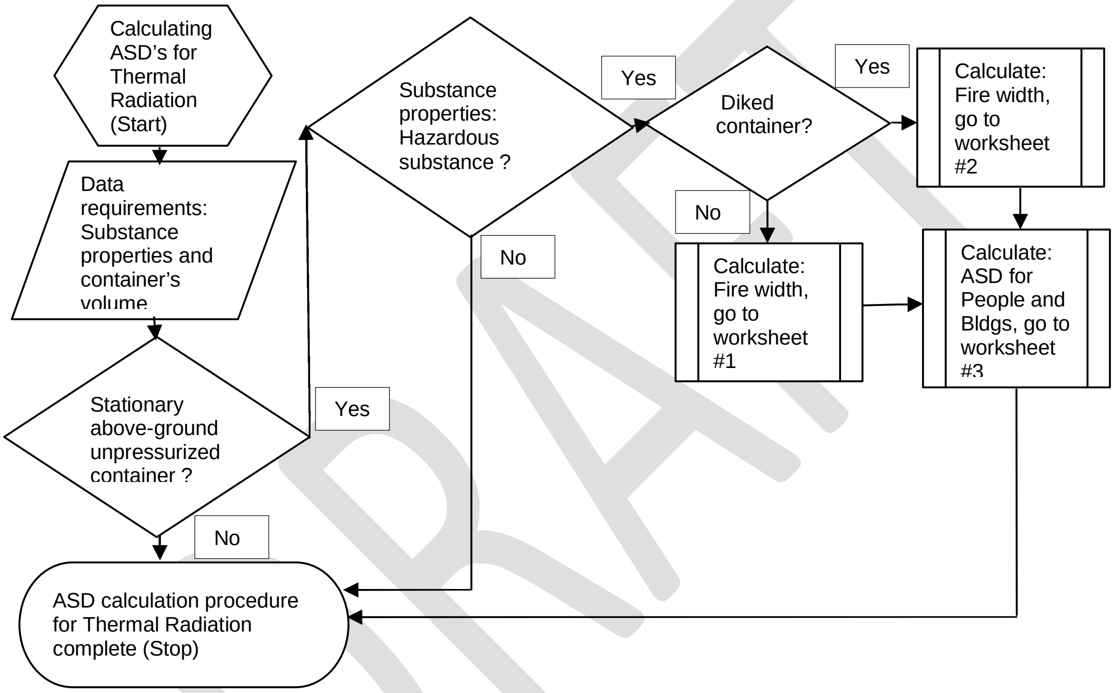
Figure 3: Acceptable Separation Distance calculation for Buildings (Blast-Overpressure) , Building Occupants and outdoor unprotected facilities



Example 2: On the determination of the ASD for thermal radiation (fire)

In this hypothetical case, a proposed HUD-assisted project is to be sited 850 feet from a diked, stationary, above-ground 30,000 gallon gasoline container. The objective is to determine the ASD from the proposed HUD-assisted project to the gasoline container. Since gasoline has flammable properties and is not under pressure (liquid), the ASD must be evaluated only for thermal radiation.

Follow the flowchart below for a hazardous substance contained in an above-ground stationary container not under pressure for the determination of the ASD for Thermal Radiation (fire), knowing the substance properties, diked area, and the volume of the container.



Knowing the diked area (**length** times the **width** in square feet) of 60,000 square feet (**200**ft times **300**ft), calculate the fire width using Worksheet 2. The diked area of the container (60,000 square feet) is plotted in the x-axis toward the line graph, making an intersection with the line graph. This intersection point is then plotted toward the y-axis, providing the fire width (see figure 4). The fire width was determined to be 235 feet.

Proceeding with calculation procedures for the ASD for people and buildings, use Worksheet 3. The fire width (x-axis) is plotted toward the first line graph (bottom graph), making an intersection with the graph. This intersection point is plotted toward the y-axis, providing the ASD for buildings (see figure 5). The ASD for buildings was determined to be 160 feet. Further on, the first intersection (bottom graph) is plotted toward the second line graph (top graph), making an intersection with the graph.

Figure 4: Fire Width calculation (Diked Container)

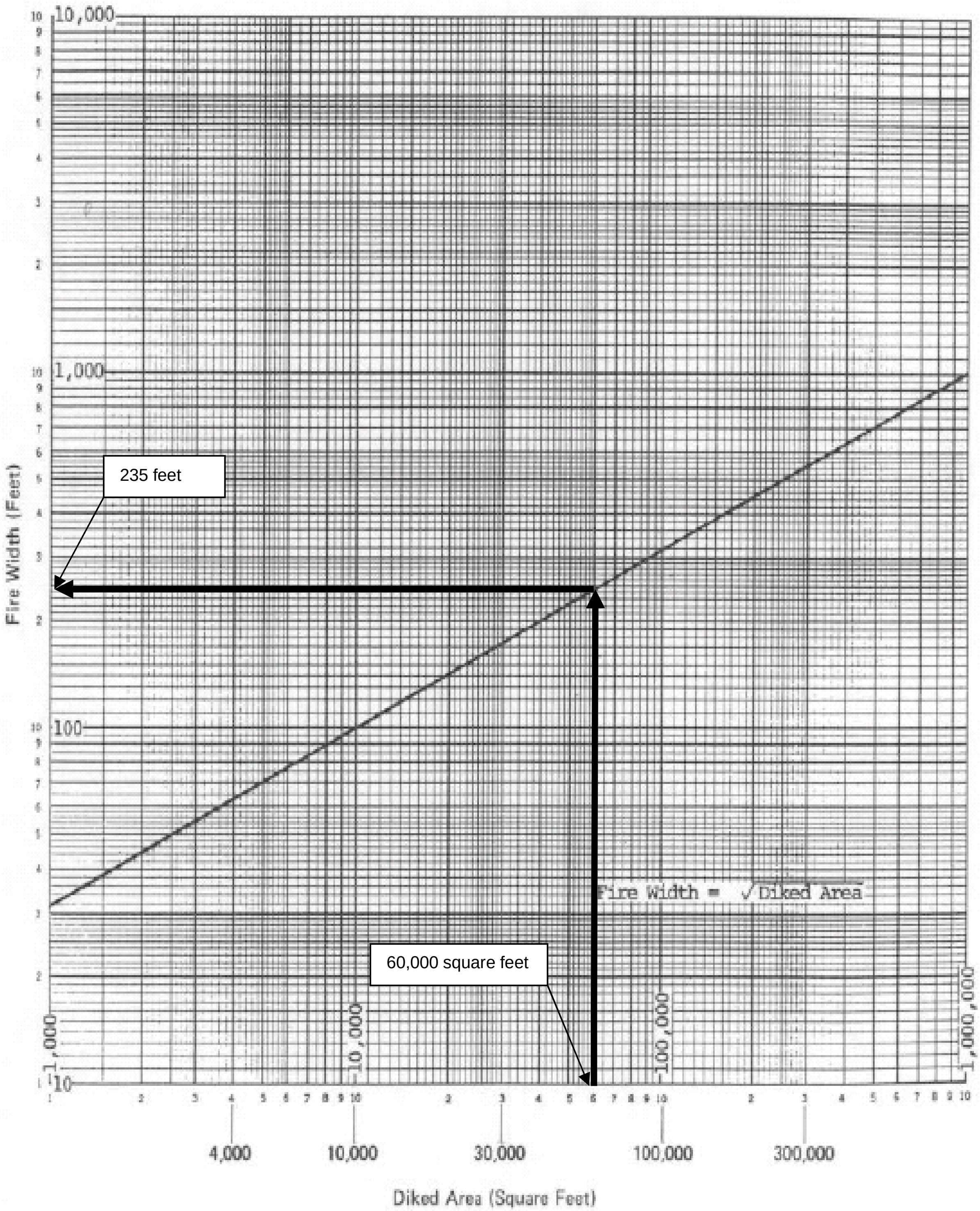
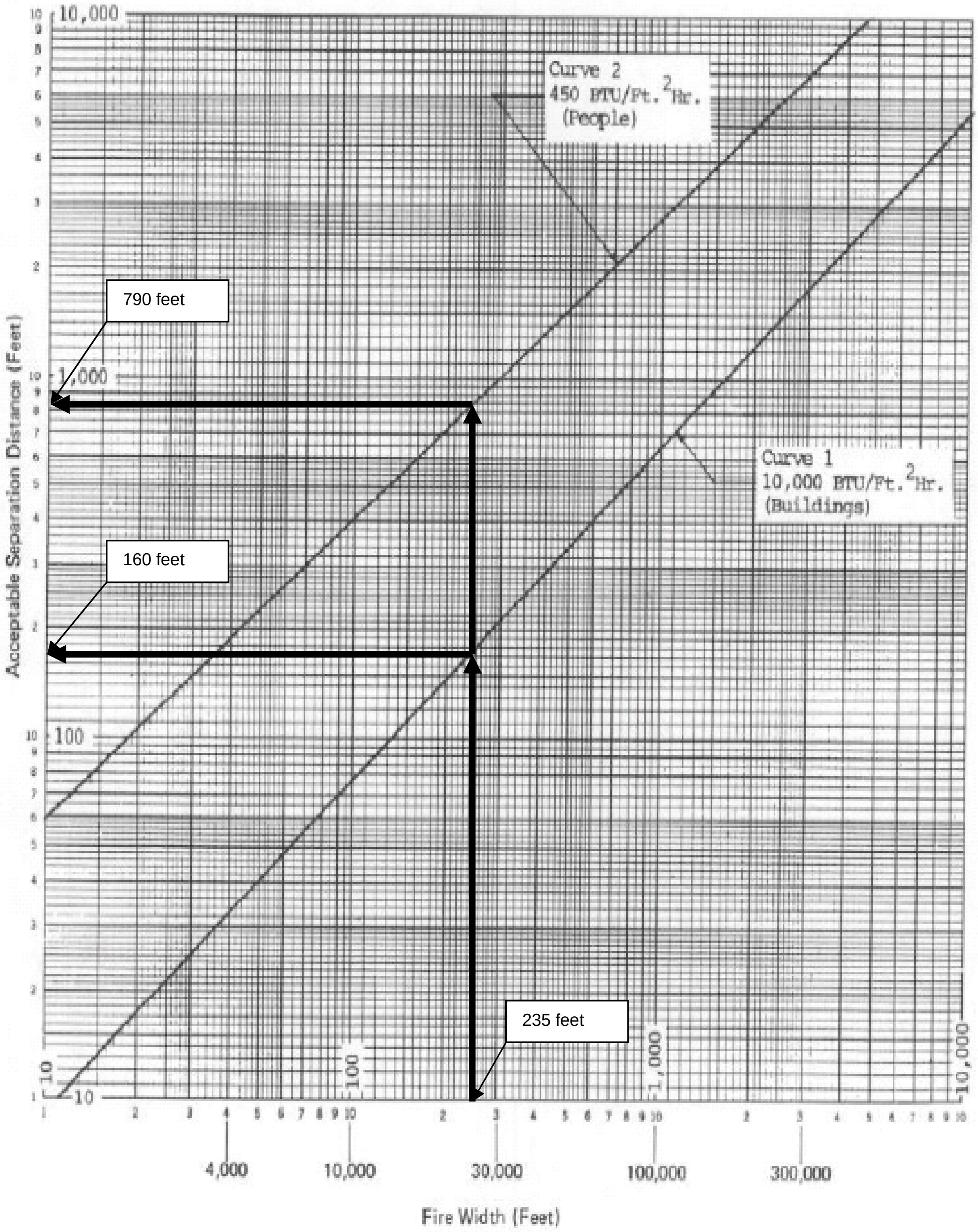


Figure 5: Acceptable Separation Distance Calculation for Buildings and People (Thermal Radiation)



This intersection is plotted toward the y-axis, providing the ASD for people (see figure 5). The ASD for people was determined to be 790 feet.

In this case, the actual distance from the center of the gasoline container to the perimeter of the proposed HUD-assisted project is 850 feet. The proposed HUD-assisted project complies with the thermal radiation standard for buildings and for people.

5. View of the aftermath of an explosion (caused by a chemical contained under pressure) at the Georgia Pacific Plant located in Ohio.

Chapter 5 – Mitigation Options

This chapter provides information about mitigation analysis and how to determine if mitigation is required on a proposed HUD-assisted project. This chapter identifies the data points and explains the analytic guidelines for a proposed HUD-assisted project, focusing on HUD standards for blast-overpressure and thermal radiation produced by stationary hazards covered under 24 CFR Part 51 Subpart C.

Mitigation is required to protect buildings and people when the ASD cannot be met between the specific stationary hazardous operation and the proposed project site. Mitigation applies only for HUD-assisted projects in proximity to stationary hazardous operations that have above-ground stationary storage containers of 1) more than 100 gallon capacity that contain common liquid industrial fuels (see Appendix I of the Regulation and Appendix C of this *Guidebook)*; and 2) of any capacity that contain hazardous liquids or gases that are not common liquid industrial fuels (see also the list of hazardous substances in Appendix C of this *Guidebook*).

<u>Mitigation analysis:</u>

The best mitigation is based on site analysis using the following 11 questions:

1. **Has the Acceptable Separation Distance (ASD) been calculated?**

   If the ASD has not been calculated, then calculate the ASD. The ASD is the first step of the mitigation analysis for HUD-assisted projects near hazardous operations that store, handle or process flammable or explosive substances.

   > If the ASD has been calculated, two results are possible: 1) The ASD is achievable using the proposed site and no further action required, or 2) The ASD is not achievable using the proposed site and so mitigation may be required.

2. **Where is the technical information for the ASD determination available?**

   Technical assistance is available from the following sources:

   - This guidebook,
   - Regulation 24 CFR Part 51 Subpart C, and
   - HUD field environmental staff (Regional Environmental Officers and Field Environmental Officers)

3. **What properties make the substances stored at the site hazardous?**

   Substances in general are classified as liquids, solids or gases. The physical state of matter of existent substances are in liquid, gas or solid form. Gases are stored under pressure, liquids cannot be compressed and take the form of the storage container in question. Solids are incompressible and have a solid structure.

   If the substances being assessed are hazardous and/or have blast-overpressure properties and are in stationary above-ground containers, a hazardous analysis is required for the proposed HUD-assisted project site. For ASD determination and mitigation hazard analysis of a proposed HUD-assisted project site, only hazardous liquids or gases and/or blast-overpressure properties are considered. Pressurized containers with hazardous substances, if ruptured, can cause steam gas explosions or gas explosions. For products (substances) stored under pressure, two results are possible:

- o Blast-overpressure or pressure wave
- o A fireball accompanied by a pressure wave (blast-overpressure)

4. **What differences are there between a diked and an undiked container?**

If containers are diked:

- o The ASD calculation will not be changed by the diked area on pressurized containers (hazardous substances); and
- o The ASD will be of a smaller numerical value for diked containers vs. undiked containers storing hazardous liquids.

If containers are undiked:

- o The ASD will be of a larger numerical value for undiked containers vs. diked containers storing hazardous liquids.

(Chapter 4 includes calculation guidelines and facts for pressurized and non-pressurized containers.)

5. **What role does topography have in influencing ASD calculations? Do natural or man-made barriers between the proposed HUD-assisted project and the hazard make a difference?**

Natural barriers are hills, mountains, earthen elevations, etc. Man made barriers are buildings, housing developments and other structures. Natural and man-made barriers may serve as abatement from thermal radiation or blast-overpressure effects that can have an impact on HUD-assisted projects and the people who live and work there.

If there are natural or man-made barriers between the proposed HUD-assisted project site and the hazard, the available barrier must serve to abate the effects of thermal radiation, blast-overpressure or both from the hazard.

The following points provide valuable information to evaluate the available barrier between the proposed HUD-assisted project and the hazard:

- Man-made or natural barriers may serve to abate the effects of thermal radiation or blast-overpressure on HUD-assisted projects and the people who live and work there.
    - o If the ASD is not achievable between the proposed HUD-assisted project site and the hazardous operation/facility, but there is no clear line of sight between the proposed HUD-assisted project and the hazard, mitigation may not be required. Under the regulation 24 CFR Part 51 Subpart C, if there is a natural or man-made abatement between the proposed HUD-assisted project

and the hazard that impedes a clear view, the abatement might serve as mitigation for the proposed HUD-assisted project.

  - If it has been determined that mitigation may not be required using the above mentioned analysis, the natural or man-made abatement must be further analyzed to ensure it will provide an acceptable level of mitigation for the proposed HUD-assisted project site. Only a licensed professional engineer should analyze and confirm the acceptability of preexisting barriers based on the hazard being analyzed.

- If the ASD is not achievable between the site to be developed and the hazard and there is a clear line of sight between the proposed HUD-assisted project and the hazard, mitigation is required.

If there are no natural or man-made barriers between the proposed HUD-assisted project site and the hazard and the ASD is not achievable, there are mitigation options described in this *Guidebook* to achieve abatement and compliance with HUD standards.

6. **Where can I get maps or other geographic information?**

- Sources of information:

  i. Maps and related site (topographic) information are available from the United States Geological Survey (USGS), City or County engineer's or planning office related to the proposed HUD-assisted project.

  ii. Although HUD does not endorse these sources, free digitized topographic maps and other relevant information can be found at

      a. Yahoo Maps, http://developer.yahoo.com/maps/
      b. Google Earth, http://earth.google.com/

- Types of information:

  i. Scaled maps with site contours (topographic maps) are highly recommended for the analysis of proposed HUD-assisted project sites.

  ii. Site maps similar in content to the scaled maps, but without site contours, are recommended as an initial type of geographic based information for analysis of proposed HUD-assisted project sites.

  iii. Site photos provide actual images of the facilities near proposed HUD-assisted project sites and are recommended for use with scaled and site maps for the analysis of proposed HUD-assisted project sites.

7. **What sources can I use if the facility storing these hazards will not release subject information?**

- Fire Department: the local fire department can provide information about facilities and operations

- Local Emergency Planning Committee Database: the governor of each state has designed a State Emergency Response Commission Contact (SERC) whose responsibility is to implement the Emergency Planning Community Right to Know Act (EPCRA) provisions within that State. The SERC supervises and coordinates the activities of the Local Emergency Planning Committee (LEPC) for each district, establishes procedures for receiving and processing public requests for information collected under EPCRA, and reviews local emergency response plans. The local LEPC database for public use can be found at

  http://YOSEMITE.EPA.GOV/OSWER/LEPCDB.NSF/SearchfORM?OpenForm

8. **Fire suppression systems, used along with sirens and fire alarms for protection of buildings and people, are designed to extinguish fires by automatically discharging fire suppressing media (e.g., water, high expansion foam, Halon gas) at areas that require fire protection.**

- Can fire suppression systems modify or change the analysis to obtain Acceptable Separation Distances (ASDs)?
  - No (not at this time).

- Can fire suppression systems modify or change the analysis as an alternative to ASDs?
  - Neither the Regulation, the *Guidebook* nor the ASD assessment tool consider the use of fire suppression systems as an alternative or modification to ASDs or as part of the ASD analysis.

9. **What are the options if you cannot achieve the ASD?**

In addition to a barrier, other options include:

- Burying the hazard, an alternative that is often less expensive than building a mitigation barrier.

- Modifying the building design to compensate for the ASD. The building design can be modified by using heat retardant and high tensile strength materials in the direction where the hazardous facility is located in order to compensate for the ASD. Buildings can also be re-arranged and their exterior shapes modified. A combination of these approaches may be used to provide an acceptable level of mitigation (e.g., a horseshoe-shaped building can be oriented with the convex curve facing the hazard and the structure augmented with heat retardant and tensile strength materials).

- Choosing a different site.

- Resorting to a barrier.

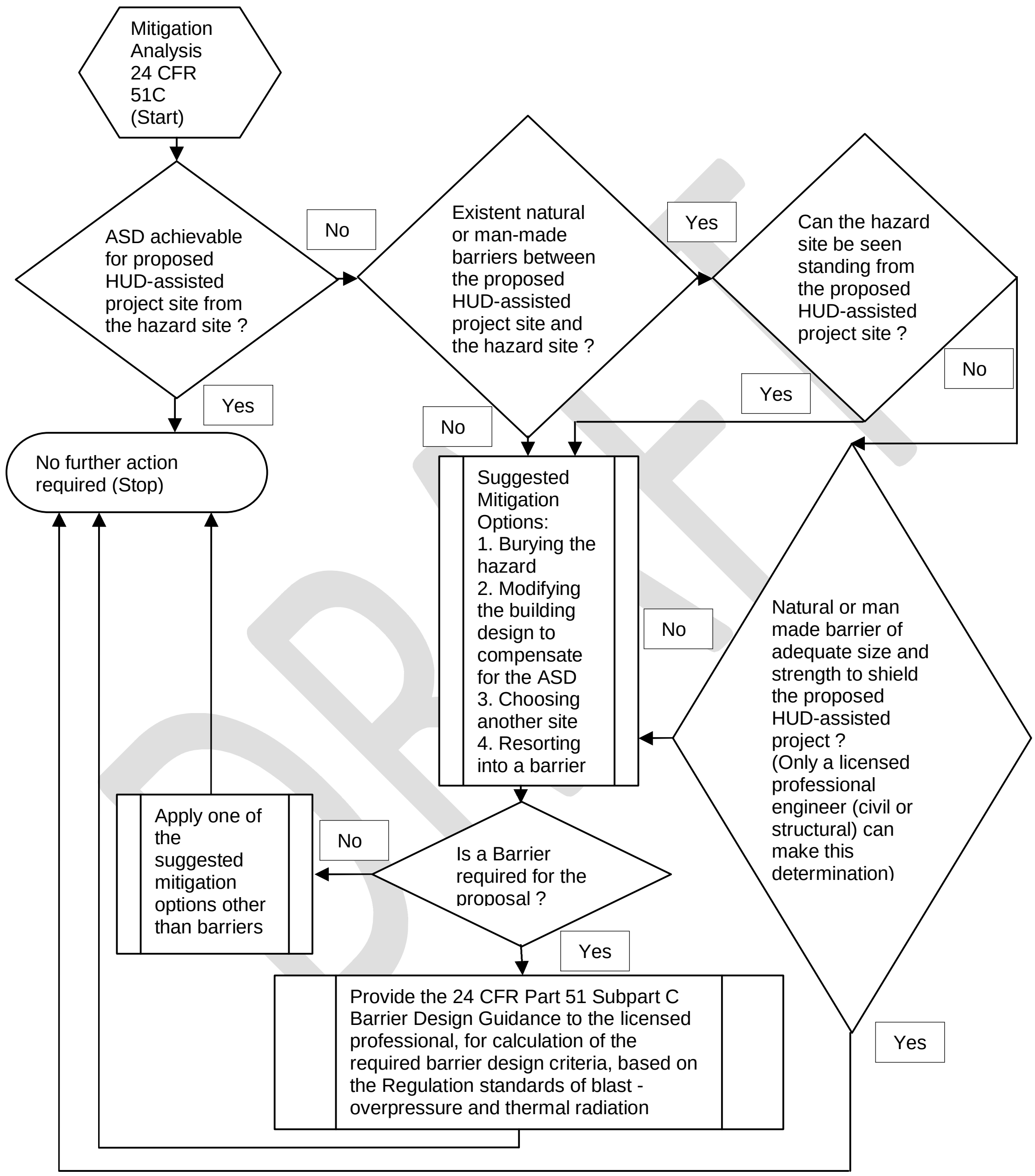
10. How does a barrier work?

- A barrier works as an abatement for thermal radiation and blast-overpressure and provides mitigation to HUD-assisted projects when the Acceptable Separation Distance (ASD) is not achievable.

11. Who should design a barrier?

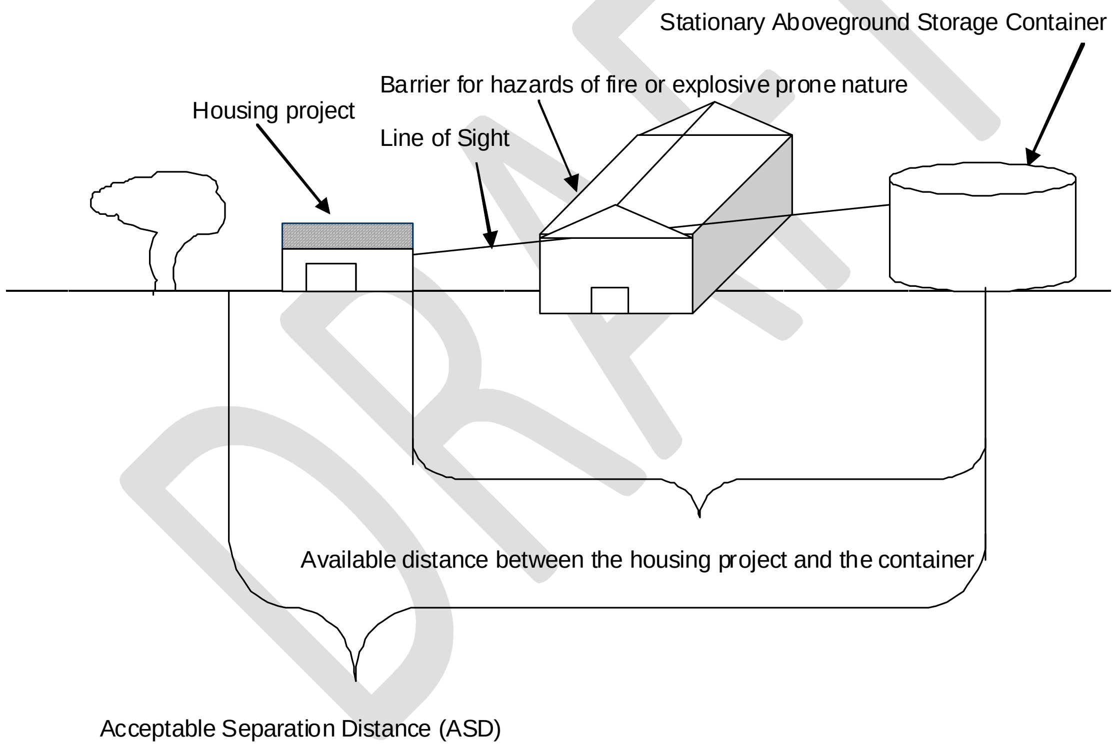
- Only a licensed professional engineer (civil or structural) should design and oversee the construction of mitigation barriers

Flowchart illustrating a mitigation analysis for a proposed HUD-assisted project site

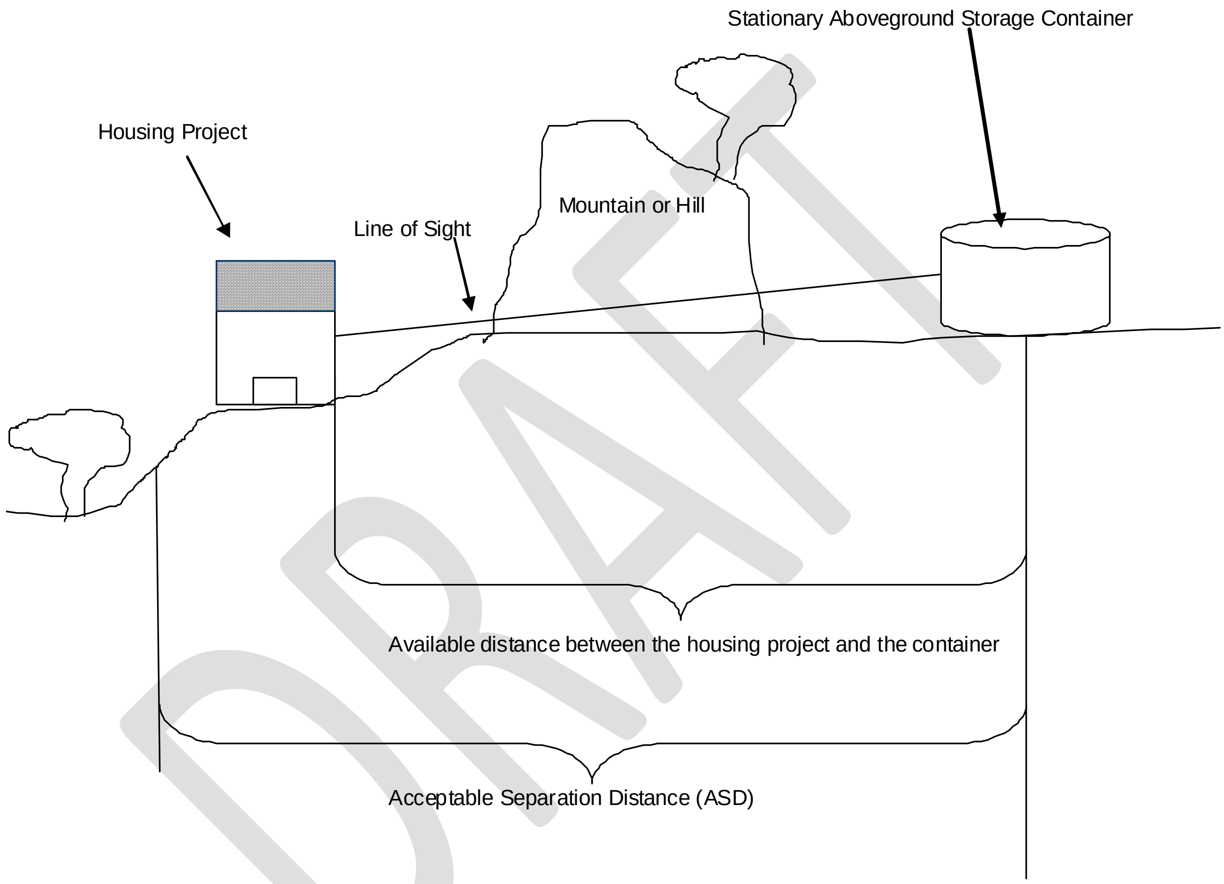


The following scenarios illustrate mitigation options involving natural and man-made barriers if the ASD cannot be achieved between the proposed HUD-assisted project and the hazard being assessed.

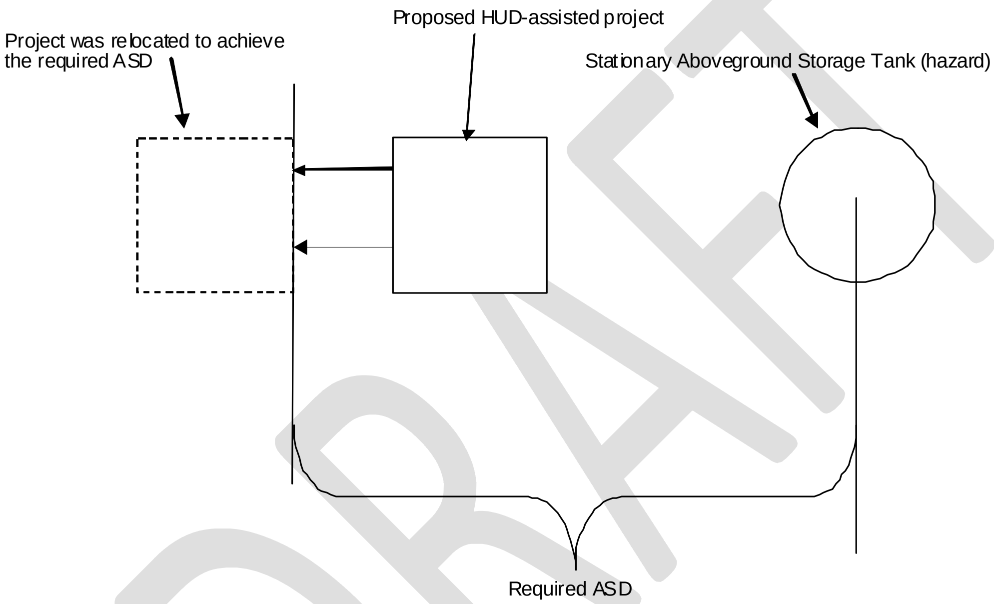
Scenario 1: A man-made barrier (warehouse) is located between a proposed housing project and a stationary above-ground storage tank as a mitigation measure, following the regulation 24 CFR Part 51 Subpart C.



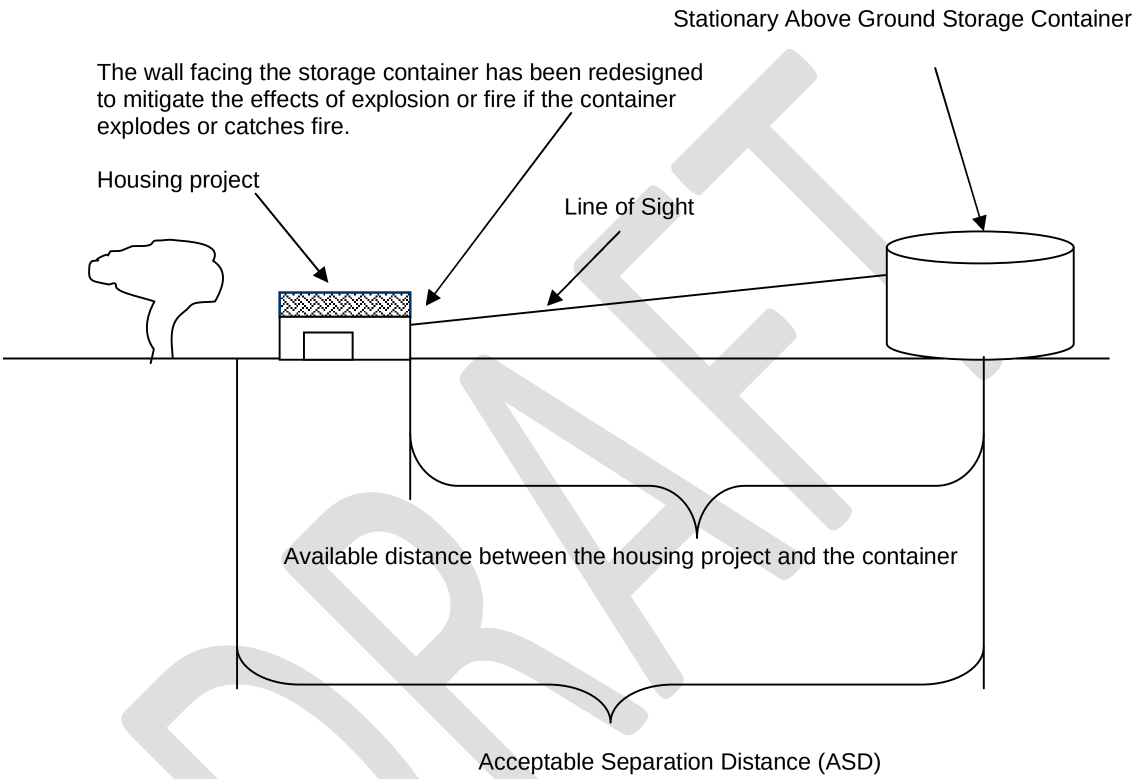
Scenario 2: A natural barrier (mountain or hill) is located between a proposed housing project and a stationary above-ground storage tank, providing mitigation to the housing project if the tank explodes or catches on fire.



Scenario 3: Reconfigure/relocate proposed HUD-assisted project to increase the available distance between the project and the hazard and achieve the required Acceptable Separation Distance (ASD) in accordance with the regulation 24 CFR Part 51 Subpart C.



Scenario 4: Modification of the building design to compensate for the ASD.



6. The aftermath of the January 10, 2008 propane blast near a unit townhouse complex in Brampton, California. More than a dozen propane containers had been stored near the townhouse complex.

Chapter 6 – Extraordinary Circumstances

This chapter identifies extraordinary circumstances which, due to a proposal's complexity, require consultation with HUD-Regional and Field Environmental Officers and additional information and procedures that are not provided in the regulation 24 CFR Part 51 Subpart C. Applicants for HUD funding assistance must comply with the standards and the Acceptable Separation Distance (ASD) stipulated under the Regulation between specific stationary hazardous facilities that store, handle, or process hazardous substances.

Standards under 24 CFR Part 51.203:

- Thermal Radiation, 10,000 BTU/ft^2 - hr
    - Applicable to buildings
- Thermal Radiation, 450 BTU/ft^2 – hr
    - Applicable to people
- Blast Overpressure, 0.5 psi
    - Applicable to buildings, building occupants and outdoor unprotected facilities

Extraordinary circumstances include:

- Analysis of containers that hold hazardous substances (liquids or gases) not listed in Appendix I of the Regulation or in Appendix C of this Guidebook in close proximity to proposed HUD-assisted projects.
- Analysis of existing natural or man-made barriers that may serve as mitigation for HUD-assisted projects from flammable or explosive hazards.
- Calculation of design specifications for barriers used to mitigate flammable and explosive hazards that are located near proposed HUD-assisted projects.

Every proposed HUD-assisted project is different. Therefore, each one should be analyzed according to site conditions such as container size and location, and proximity to residential structures, etc. Mitigation and/or safety measures may be required at some sites, but only suggested at others.

7. Firefighters extinguishing fires from jet fuels tanks that were burning out of control at Apra Harbor, Guam.

Appendices