

# The Transition of the Hazardous Materials Codes and the Emergence of the Threshold Quantity System to NFPA 1 UFC

*Final Report*

**Prepared by:**

**Fluer, Inc.**



THE  
FIRE PROTECTION  
RESEARCH FOUNDATION

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## FOREWORD

In the 1980's, the Uniform Fire Code developed a system for classifying hazardous materials and setting threshold amounts of these materials that could be used or stored in a fire control area. If these thresholds were exceeded, the occupancy would change to a Hazardous Occupancy, requiring a defined set of additional fire protection measures to be implemented. These requirements appeared in Article 80 of the Uniform Fire Code. This system of classification of materials by hazard class with allowable threshold amounts was transferred into the International Fire Code, NFPA 5000 and NFPA 1, although the required protection measures differ. It has become THE national hazardous material classification system and is also being implemented in the new NFPA 400 Hazardous Materials Code. However, the basis for this system, particularly the threshold amounts of classes of hazardous materials allowed in a fire control area, is not well documented.

This report is intended to provide information to NFPA Technical Committees on the background of the current national hazardous material classification system, focusing on threshold limits, and its technical basis.

The Research Foundation expresses gratitude to Fluer, Inc. for authorship of the report, to the Project Technical Panel listed on the following page, and to Principal Sponsor NFPA.

The content, opinions and conclusions contained in this report are solely those of the author.

**The Transition of the Hazardous Materials Codes and  
the Emergence of the Threshold Quantity System to  
NFPA 1 UFC  
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# THE TRANSITION OF THE HAZARDOUS MATERIALS CODES AND THE EMERGENCE OF THE THRESHOLD QUANTITY SYSTEM TO NFPA 1 UFC

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ANALYSIS • REVIEW • RECOMMENDATIONS

Prepared for:

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## Glossary of Terms

<b>AIA</b>	<b>American Insurance Association</b>
<b>BOCA</b>	Building Officials and Code Administrators, International
<b>CAA</b>	Clean Air Act
<b>CAS</b>	Chemical Abstracts Service Reference Number
<b>CEPP</b>	Chemical Emergency Preparedness Plan
<b>CERCLA</b>	Comprehensive Environmental Responsibility, Compensation and Liability Act (Superfund)
<b>Control Area</b>	An area within which hazardous materials are allowed to be stored or used in quantities not exceeding the maximum allowable quantities (MAQ)
<b>CPSC</b>	Consumer Product Safety Commission
<b>DOT</b>	US Department of Transportation
<b>EHS</b>	Extremely Hazardous Substances
<b>EPA</b>	US Environmental Protection Agency
<b>EPCRA</b>	Emergency Planning and Community Right-to-Know Act
<b>Exempt Amount</b>	The maximum allowable quantity of hazardous materials in a control area before protection level controls are required or the occupancy reverts to a hazardous occupancy
<b>FWPCA</b>	Federal Water Pollution Control Act
<b>HCS</b>	OSHA's Hazard Communication Standard
<b>IBC</b>	International Building Code
<b>ICBO</b>	International Conference of Building Officials
<b>ICC</b>	International Code Council
<b>I-Codes</b>	International codes published by the International Code Council
<b>IFC</b>	International Fire Code
<b>MAQ</b>	Maximum Allowable Quantity per Control Area before protection level controls are required or the occupancy reverts to a hazardous occupancy
<b>MSDS</b>	Material Safety Data Sheet(s)
<b>NBFU</b>	National Board of Fire Underwriters
<b>NFPA</b>	National Fire Protection Association
<b>NRC</b>	National Response Center
<b>OSHA</b>	US Occupational Safety and Health Administration
<b>Protection Level</b>	A term used to describe a tier of building safety that exceeds the construction requirements for control areas to accommodate quantities o

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	hazardous materials in excess of those permitted using the control area concept.
<b>RQ</b>	Reportable Quantity
<b>SARA</b>	Superfund Amendments and Reauthorization Act
<b>SBCCI</b>	Southern Building Code Congress, International
<b>SIC</b>	Standard Industrial Classification
<b>Tabular Limit</b>	A quantity or value listed in a table (tabular)
<b>TPQ</b>	Threshold Planning Quantity
<b>TSCA</b>	Toxic Substances Control Act
<b>UBC</b>	Uniform Building Code
<b>UBCS</b>	Uniform Building Code Standards
<b>UFC</b>	Uniform Fire Code
<b>UFCS</b>	Uniform Fire Code Standards
<b>WFCA</b>	Western Fire Chiefs Association

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## Notes to Reader

This project report was prepared with the intent of examining the historical progress of hazardous materials control using limited quantities identified as Maximum Allowable Quantities per Control Area (MAQ) within the context of Table 60.2.2.1(a) of the 2003 Edition of NFPA 1 UFC before declaring the occupancy hazardous. This project report does not review the historical progress of threshold MAQs allowed in outdoor areas embodied in Table 60.2.2.1(b) or Mercantile and Storage Occupancies as included in Table 60.2.3.3.1.1.

The recommendations and findings are not finite. There is a need to evaluate the findings and to develop a plan to address the anomalies, gaps and inconsistencies that have been identified.

The author expresses appreciation to the Project Technical Panel for their guidance and comments on the project. Special recognition is extended to Mr. Samuel Vanover of the Jefferson Parrish LA Fire Department for lending the author several original National Board of Fire Underwriters (NBFU) publications including the 1938 *Suggested Fire Prevention Ordinance* and 1956 and 1965 Editions of the NBFU model *Fire Prevention Codes* from his personal library, and to Ms. Susan Marsh at the NFPA Morgan Technical Library for her assistance in obtaining key documents that served to facilitate the historical review.

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# THE TRANSITION OF THE HAZARDOUS MATERIALS CODES

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## 1 INTRODUCTION

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- 1.0 Purpose.** To develop an historic analysis and review of the basis for hazardous materials classification and its use within a threshold quantity system that has been integrated into Table 60.2.2.1(a) of the 2003 Edition of NFPA 1 – *Uniform Fire Code*. The basis and evolutionary progression will be discussed and documented to provide greater understanding of the regulatory approach based on classification and tabular limits as they have been incorporated into NFPA 1 *Uniform Fire Code* and NFPA 5000 *Building and Construction Safety Code*.
- 1.1 Scope.** A report will be provided that addresses the method of hazardous materials control utilized in precedent codes which created the concept of using quantity of hazardous materials as a means to trigger requirements for hazardous occupancies beginning with the requirements of the International Conference of Building Officials (ICBO) and Western Fire Chiefs Association (WFCA) as published in the pre-1988 editions of the Uniform Building Code (UBC) and Uniform Fire Code (UFC) during the period of 1971 to 1985. The period of transition which established the method of classification and threshold limits in the three regional model building and fire prevention codes in the period between 1988 and 1997 will be addressed. The subsequent evolution of the classification concepts and utilization of Maximum Allowable Quantities (MAQs) into the International Codes published by the International Code Council and the eventual transition to the NFPA *Building and Construction Safety Code* and NFPA 1 *Uniform Fire Code* will be discussed.
- 1.1.1 Definitional Basis.** The basis for the definitions, classifications, and threshold amounts Maximum Allowable Quantities (MAQ) in a *control area* for hazardous materials found in Table 60.2.2.1(a) of the 2003 Edition NFPA 1 – UFC will be included. The significance of the progress made will be substantiated through code development documents, research review and technical documentation.



**1.1.2 Inconsistencies, Anomalies and Gaps.** Inconsistencies, anomalies, and gaps in the classification system will be identified. A roadmap to enhancement of the hazardous materials classification system will be suggested based on the review of the existing classification scheme.

**1.2 The Social Need.** The 1960's were a critical period for the United States with national interests and concerns demanding resolution. These concerns ranged from the free speech movement to civil rights, women's rights, the Vietnam War and environmental damage all of which demanded the attention of the government by one group or another. The U.S. Department of Labor reports that concurrently, occupational injuries and illnesses were increasing in both number and severity. Disabling injuries increased 20 percent during the decade, and 14,000 workers were dying on the job each year.<sup>1</sup> Senator Harrison A. Williams Jr. of the United States Senate said,

*"The knowledge that the industrial accident situation is deteriorating, rather than improving, underscores the need for action now."*<sup>2</sup>

Emphasis was given to the need to protect workers from hazards such as noise, cotton dust, and asbestos. In the House of Representatives, Congressman William A. Steiger who worked for the passage of a bill stated:

*"In the last 25 years, more than 400,000 Americans were killed by work-related accidents and disease, and close to 50 million more suffered disabling injuries on the job."* During the debate he pointed out that ...

*"Not only has this resulted in incalculable pain and suffering for workers and their families, but such injuries have cost billions of dollars in lost wages and production."*<sup>3</sup>

Social awareness of the dangers of the workplace and of the hazardous materials used or produced within the workplace was raised as the national workforce began to react to this new emphasis placed on safety. Throughout the 1970's and into the early to mid 1980's there were major changes in the society that focused on technological change and the benefit that technology could bring to the individual in terms of a working and living environment.

With the advent of the 1970's it was predicted that technology would bring more leisure time. The integration of technology into the industrial and home environment would provide new ways of working and new ways to recreate. The rising social awareness recognized that an industrial

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<sup>1</sup> OSHA's 30<sup>th</sup> Anniversary, U.S. Department of Labor [<http://www.osha.gov/as/opa/osa-at-30.html>], visited July 9, 2008.

<sup>2</sup> Ibid.

<sup>3</sup> Ibid.

society had certain benefits. Even with all of the technological advances the close proximity of hazardous materials to the human environment was not without risk. Threats or perceived dangers from the industrial community included potential birth defects, environmental damage, hazardous waste handling, and catastrophic events all of which became part of the social consciousness of the American public. A growing social awareness to the dangers of hazardous materials coalesced in a large segment of the population which was driven in part by the realization that a longer life could be realized if the dangers of the workplace could be reduced. There was an expectation that the living environment could be maintained in an unpolluted and more natural state.

**1.3 The Political Need.** The political need to address regulations affecting the storage and use of hazardous materials can be traced to major legislation enacted at the Federal level affecting health, safety and the environment during the period between 1970 and 1986. This legislation raised the awareness of code officials throughout the country to the concerns of the public. Although the thrust of the legislation was not focused on building construction or occupancy of buildings or premises, the information produced was directly related to materials that were being produced, or otherwise stored, handled or used within facilities throughout the country. The reporting systems which in some cases required notification of local authorities including the fire department increased the level of awareness to the local community thus raising questions regarding the suitability of facilities in some cases. The following historic legislative actions served as the means to raise the national level of awareness of the hazards of hazardous materials in terms of both quantity and type.

**1.3.1 OSHA.** The Occupational Safety and Health Act of 1970, known as the Williams-Steiger Act, named in honor of the legislators that worked for its passage, was signed into law by President Richard M. Nixon on December 29, 1970. This legislation was a watershed event as it established what is known today as the OSHA administration which was empowered to set and enforce workplace standards, the National Institute for Occupational Safety and Health (NIOSH) which was empowered to conduct research on occupational safety and health, and the Occupational Safety and Health Review Commission (OSHRC) an agency empowered to adjudicate enforcement actions challenged by employers. In the beginning OSHA covered 56 million workers at 3.5 million workplaces. When the 30th anniversary of

OSHA was celebrated in 2000 it was noted that 105 million private-sector workers and 6.9 million workplaces were covered.<sup>4</sup>

**1.3.1.1 Hazard Communication Standard.** OSHA's Hazard Communications Standard (HCS) was initiated in 1974 requiring Material Safety Data Sheets (MSDS) in a limited number of circumstances; however, by 1983 MSDS were required under OSHA's Hazard Communication program for all employees in manufacturing. The rule was expanded in 1987 to require all industries where employees are exposed to dangerous chemicals. It was subsequently delayed by various court and administrative actions; however, it became fully effective in January of 1989.<sup>5</sup> As will be discussed in Section 5 of this report the establishment of the rule for manufacturing industries and definitions integral to 29 CFR 1910.1200 was a critical consideration in the development of the classification system used by the International Conference of Building Officials and Western Fire Chiefs Association in the publication of the 1988 Edition of the Uniform Codes.

**1.3.2 Environmental Protection Agency (EPA) Established.** Concurrent with the development of workplace standards for worker protection, efforts were underway to establish protection for the environment occupied by the general population. The environmental movement can trace its roots back to the mid 1800's with benchmark legislation passed by Congress to establish the national parks making Yellowstone the world's first official National Park in 1872.<sup>6</sup> Yosemite, Sequoia and General Grant National Parks were established in the early 1890's.<sup>7</sup> In 1970 the National Environmental Policy Act was passed, and the Environmental Protection Agency (EPA) was established on May 2, 1971.<sup>8</sup> In establishing the EPA Congress declared the following:

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<sup>4</sup> Ibid.

<sup>5</sup> Hazard Communication, U.S. Department of Labor, Occupational Safety and Health Administration, Federal Registers 59:6126-6184, [[http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=FEDERAL\\_REGISTER&p\\_id=13349](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=13349)] visited July 14, 2008.

<sup>6</sup> Environmental Movement Timeline, A History of the American Environmental Movement, [<http://www.ecotopia.org/ehof/timeline.html>], visited July 9, 2008.

<sup>7</sup> Ibid.

<sup>8</sup> History of the Clean Air Act, U.S. Environmental Protection Agency (EPA) [[http://www.epa.gov/air/caa/caa\\_history.html](http://www.epa.gov/air/caa/caa_history.html)], visited July 14, 2008.

*The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.<sup>9</sup>*

**1.3.3 Clean Air Act of 1970.** The Clean Air Act (CAA) of 1970 resulted in a major shift in the federal government's role in air pollution control.<sup>10</sup> The adoption of this legislation occurred at approximately the same time as that which established the Environmental Protection Agency. The act authorized the establishment of national ambient air quality standards. The adoption of the CAA was the culmination of a national effort to address air pollution which began in 1955. Significant amendments to the CAA occurred in 1977 and 1990 with the amendments of 1990 resulting in a program to control the emission of 189 toxic pollutants.<sup>11</sup>

**1.3.4 Toxic Substances Control Act (TSCA).** The toxic substances control act of 1976 was established to give EPA the ability to track 75,000 industrial chemical currently produced or imported into the U.S. TSCA supplements other Federal statutes including the Clean Air Act and the Toxic Release Inventory under the Emergency Planning and Community Right-to-Know Act (see below).<sup>12</sup>

**1.3.5 Comprehensive Environmental Responsibility, Compensation and Liability Act (CERCLA) aka Superfund.** CERCLA was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal

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<sup>9</sup> The National Environmental Policy Act Of 1969, as amended (Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, § 4(b), Sept. 13, 1982), § 101, 42 USC § 4331(a). [<http://ceq.hss.doe.gov/Nepa/regs/nepa/nepaeqia.htm>], visited July 9, 2008.

<sup>10</sup> History of the Clean Air Act, [[http://www.epa.gov/air/caa/caa\\_history.html](http://www.epa.gov/air/caa/caa_history.html)], visited July 14, 2008.

<sup>11</sup> Ibid.

<sup>12</sup> *Summary of the Toxic Substances Control Act*, 15 U.S.C. §2601 et seq.(1976), [<http://www.epa.gov/lawsregs/laws/tsca.html>], visited July 14, 2008.

authority to respond to releases or threatened releases of hazardous substances that may endanger public health or the environment.<sup>13</sup> The collected tax was transferred to a trust fund to be utilized to pay for cleaning up abandoned or uncontrolled hazardous waste sites.

**1.3.5.1 Reporting Releases.** Releases of CERCLA hazardous substances in quantities equal to or greater than their reportable quantity (RQ) are subject to reporting to the National Response Center under CERCLA. Such releases are also subject to state and local reporting under section 304 of EPCRA. The RQ for listed items ranges from 1 to 5,000 lbs.<sup>14</sup>

**1.3.6 Emergency Planning and Community Right-to-Know Act (EPCRA).** EPCRA (pronounced EP-kra), also known as Title III of the Superfund Amendments and Reauthorization Act (SARA) was enacted into legislation under 42 U.S.C. §11001 et seq. in 1986. The law was designed to help local communities protect public health, safety, and the environment from chemical hazards. Under the law Congress requires each state to appoint a State Emergency Response Commission (SERC). The SERCs are required to divide their states into Emergency Planning Districts and to name a Local Emergency Planning Committee (LEPC) for each district. Broad representation by fire firefighters, health officials, government and media representatives, community groups, industrial facilities, and emergency manager are to ensure that all necessary elements of the planning process are represented.<sup>15</sup> EPCRA has been cited as the first major law intended specifically to address the problem of chemical accidents in the United States.<sup>16</sup>

**1.3.6.1 Threshold Planning Quantity (TPQ).** Materials subject to reporting requirements are limited to extremely hazardous substances (EHS) as specified on a published list. The EHSs and their threshold planning quantities (TPQ) are listed in 40 CFR Part

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<sup>13</sup> CERCLA Overview, Environmental Protection Agency (EPA), [<http://www.epa.gov/superfund/policy/cercla.htm>], visited July 14, 2008.

<sup>14</sup> List of Lists, *Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112® of the Clean Air Act*, US Environmental Protection Agency (EPA), Office of Solid Waste and Emergency Response, EPA 550-B-01-003, October 2001, pp. i-iii.

<sup>15</sup> Summary of the Emergency Planning and Community Right-to-Know Act, Laws, Regulations, Guidance and Dockets, Environmental Protection Agency (EPA), Last updated on Monday, June 9, 2008 [<http://www.epa.gov/lawsregs/laws/epcra.html>], visited July 14, 2008.

<sup>16</sup> Belke, James C., *Chemical Accident Risks In U.S. Industry – A Preliminary Analysis Of Accident Risk Data From U.S. Hazardous Chemical Facilities*, U. S. Environmental Protection Agency, Chemical Emergency Preparedness and Prevention Office, Ariel Rios Building, 1200 Pennsylvania Ave. N.W., Washington, D.C., 20460, September 25, 2000, p. 2.

355, Appendices A and B. For certain chemicals the LEPC must develop emergency response plans and facilities must notify the SERC and LEPC if they receive or produce the substance on site at or above the TPQ. The presence of an EHS may require a variety of actions depending on, 1) the quantity determined or 2) on the form of the material, e.g., solids, powders, molten form, etc. with quantity ranging from a low of 10 pounds to a high of 10,000 pounds.<sup>17</sup>

**1.3.6.2 Reporting Quantity (RQ).** The release of regulated materials in quantities requiring reporting to outside agencies is defined as the reporting quantity (RQ). The RQ can vary from 1 to 10,000 lbs. depending on the material.<sup>18</sup>

**1.3.7 Superfund Amendments and Reauthorization Act (SARA).** SARA amended CERCLA on October 17, 1986. The legislation reflected EPA's experience in administering the Superfund program during its first six years, and made several important changes and additions to the program including: recognition of the importance of permanent remedies and innovative treatment technologies to cleaning up hazardous waste sites, required Superfund actions to consider the standards and requirements found in other State and Federal environmental laws and regulations, provided new enforcement authorities, increased state involvement, increased the focus on human health problems posed by hazardous waste sites, encouraged greater citizen participation in making decisions on how sites should be cleaned up increased the size of the trust fund established under CERCLA from \$1.6 billion to \$8.5 billion dollars.<sup>19</sup>

**1.3.8 National Response Center.** In August of 1973, President Richard M. Nixon delegated the authority and responsibility of establishing a National Contingency Plan to provide for efficient, coordinated and effective action to minimize damage from oil and the discharge of hazardous substances including containment, dispersal and removal of oil and hazardous substances. The National Response Center (NRC) became operational in August of 1974 at US Coast Guard Headquarters in Washington, D.C. for the reporting and coordination of response to pollution by oil and hazardous substances.<sup>20</sup> Under the plan, the NRC was

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<sup>17</sup> List of Lists, pp.1-38.

<sup>18</sup> Ibid.

<sup>19</sup> SARA Overview, Environmental Protection Agency (EPA), [<http://www.epa.gov/superfund/policy/sara.htm>], visited July 14, 2008.

<sup>20</sup> National Response Center, Legislative Requirements [<http://www.nrc.uscg.mil/nrclegal.html>], visited July 9, 2008.

charged with receiving reports of discharges of oil and hazardous substances in accordance with the Federal Water Pollution Control Act (FWPCA). Over time it was recognized that a more comprehensive approach was necessary, and Congress enacted the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) which includes those materials formally regulated by the FWPCA, the Toxic Substance Control Act, and the Resource Conservation and Recovery Act. The NRC was given the responsibility of receiving the reports required. The responsibility of receiving reports has grown over the years where today the NRC has been given the responsibility of receiving reports of incidents involving hazardous materials transportation under the Hazardous Materials Transportation Act and reportable under the requirements of 49 CFR.<sup>21</sup>

The incidents required to be reported to the NRC are limited to those materials and/or quantities regulated by the aforementioned specific acts. In addition reports are received from others, including required reports by the Nuclear Regulatory Commission, the Department of the Interior Trans-Alaskan Pipeline Oil, Department of Defense (DOD) munitions, the Centers for Disease Control, the Federal Railroad Administration and others. As a result statistical information is made available to the American public on the types and numbers of incidents that occur across a spectrum of fourteen (14) different types. Incidents occurring in the period 1991 – 1999 are shown in Table No. 1.<sup>22</sup>

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<sup>21</sup> Ibid.

<sup>22</sup> National Response Center, Statistics 1991 through 1999, [<http://www.nrc.uscg.mil/incident91-96.html>], visited July 14, 2008.

TABLE 1  
**Hazardous Materials Incidents National Response Center  
 1991 to 1999**

Incident Type	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fixed	11,404	12,636	13,656	14,656	15,080	12,067	10,386	10,961	11,320
Unknown Sheen(on water)	3,794	3,784	4,416	5,087	5,147	4,433	4,228	4,809	4,802
Vessel	2,914	2,680	2,886	3,598	3,967	4,091	3,778	3,886	3,877
Mobile	1,832	1,850	2,782	3,456	3,133	2,511	2,490	2,718	2,836
Pipeline	1,794	2,030	1,918	1,945	1,630	1,737	1,740	1,657	1,404
Platform	2,331	2,166	1,617	1,671	1,770	2,106	1,943	1,570	1,465
Storage Tank	0	0	0	0	0	0	0	0	0
Railroad (non-release)	248	441	502	493	455	446	586	823	1,049
Railroad	965	1,162	1,425	1,530	1,578	1,645	1,883	2,266	2,252
Continuous	333	323	476	215	183	177	170	304	376
Aircraft	138	203	264	265	225	173	207	181	241
Drill/Exercise	0	0	88	188	228	349	349	503	532
Unknown	0	0	6	21	8	46	14	3	52
Terrorist non-release	0	0	0	0	0	0	0	18	61
<b>Total Incidents</b>	<b>25,754</b>	<b>27,186</b>	<b>29,936</b>	<b>33,125</b>	<b>33,304</b>	<b>29,781</b>	<b>27,776</b>	<b>29,699</b>	<b>30,166</b>

Similar data available for the period of 2000 through 2007 show a slight increase.<sup>23</sup> See Table 2 below:

<sup>23</sup> Ibid.



TABLE 2  
**Hazardous Materials Incidents National Response Center  
 2000 to 2007**

Incident Type	2000	2001	2002	2003	2004	2005	2006	2007
Fixed	11,813	12,441	11,917	11,975	12,975	13,017	13,621	11,913
Unknown Sheen (on water)	4,016	4,147	3,426	3,733	3,411	3,934	3,797	4,199
Vessel	3,945	4,378	3,919	3,962	4,385	4,611	4,767	4,931
Mobile	3,597	3,216	2,942	2,947	3,192	3,215	3,267	3,297
Pipeline	1,618	1,841	1,621	1,643	1,574	1,898	1,839	1,580
Platform	1,428	1,355	1,233	1,344	1,198	1,395	1,606	1,407
Storage Tank	1,379	3,140	3,044	2,808	2,838	2,687	2,577	2,519
Railroad (non- release)	1,335	1,235	1,124	1,173	1,476	1,685	1,868	1,913
Railroad	1,332	1,241	1,200	1,074	1,276	1,532	1,451	1,390
Continuous	938	238	393	462	112	189	150	284
Aircraft	248	297	278	262	277	211	217	214
Drill/Exercise	669	789	908	743	1,073	1,223	1,578	1,584
Unknown	84	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Terrorist non- release	33	42	180	105	126	119	117	43
<b>Total Incidents</b>	<b>32,435</b>	<b>34,360</b>	<b>32,185</b>	<b>32,231</b>	<b>33,912</b>	<b>35,714</b>	<b>36,855</b>	<b>35,274</b>

**1.4 Economic Interests Affected.** Details on major industrial accidents that caused a large number of deaths or injuries were becoming more available to the public as the information age began to develop. Many of the major industrial accidents brought to the attention of the public by the media involve the transportation of dangerous goods; but there are a significant number of events that occur in fixed facilities on an annual basis.

Major events involving evacuation, loss of life, property damage, damage to the environment continued to capture public attention. Several of those that received major media attention in fixed facilities in the period 1970 - 1988 included the following:

- July 10, 1976, Seveso, Italy: An uncontrolled exothermic reaction in a reactor at a Hoffman-La Roche Givaudan chemical plant caused a major explosion. The subsequent release of 10-22 lbs of tetrachlorodibenzo-p-dioxin contaminated soil and vegetation over 4,450 acres of land and killed over 100,000 grazing animals. Although there were no immediate injuries or loss of human life, over 1,000 residents were forced to flee and many children developed a disfiguring rash called chloracne.<sup>24</sup> The accident led to the adoption of legislation aimed at the prevention and control of such accidents. Initially called the Seveso Directive by the European Union, the legislation utilizes a quantity threshold approach which requires the establishment of safety reports, and emergency plans. In light of recent industrial accidents in Europe and studies on carcinogens and substances dangerous to the environment the Seveso II Directive (broadened the scope of the original directive, in particular to include the storage of dangerous substances) was extended and the scope expanded to cover risks arising from storage and processing activities in mining, from pyrotechnic and explosive substances and from the storage of ammonium nitrate and ammonium nitrate based fertilizers.<sup>25</sup>
- April 10, 1982, Belle, West Virginia: A pipeline carrying chlorine gas burst, releasing 29 tons of the chemical.<sup>26</sup> No one was killed, but 11 people were reported as injured and 1,700 others evacuated.<sup>27</sup>
- December 3, 1984, Bhopal, India: A toxic cloud of methyl isocyanate leaked from a Union Carbide pesticide production plant in the city of Bhopal killing thousands of people. Investigators determined that 4 tons of MIC vaporized and enveloped half of Bhopal, at the time a city of 800,000. Attendees of a conference on December 1-3 at the Indian Institute of Technology in Kanpur, India note that there is no reliable count of the people killed. Doctors in Bhopal insist that the number of dead is at least 10,000. The exact number of people injured, which conference attendees conservatively estimated in the tens of thousands, is another mystery due to an inability to differentiate between those afflicted by a respiratory ailment known as Bhopal syndrome and those with respiratory disease from other sources.<sup>28</sup>

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<sup>24</sup> Weir, David, *The Bhopal Syndrome*, Sierra Club Books, San Francisco, 1987, p. 190.

<sup>25</sup> *Chemical Accidents, (Seveso II) – Prevention, Preparedness and Response*, European Commission, European Civil Protection, [<http://ec.europa.eu/environment/seveso/index.htm>], visited July 16, 2008.

<sup>26</sup> Weir, *The Bhopal Syndrome*, p. 192.

<sup>27</sup> *Chlorine Leak Forces Evacuation of a Town*, The New York Times, April 11, 1982, [<http://query.nytimes.com/gst/fullpage.html?res=9C03E5D91339F932A25757COA964948260>], visited July 16, 1982.

<sup>28</sup> Tremblay, Jean-Francois, and Reisch, Marc, *Twenty Years After Bhopal – Compensation still sought for victims as investigation of accident continues*, Chemical & Engineering News, American Chemical Society, December 6, 2004, Vol. 82, Number 49, p.8.

- August 12, 1985, Institute, West Virginia: A 300 meter long cloud of toxic gases involving methyl isocyanate leaked from a Union Carbide pesticide production facility that had been redesigned, with the installation of a \$5 million safety system, in the wake of the Bhopal tragedy.<sup>29</sup> There was no loss of life, however, more than 100 residents were sent to the hospital. The event was a key event related to the establishment of OSHA's Risk Management Program Rule.<sup>30</sup>
- November, 1986, Basel, Switzerland: Firemen attempting to put out a fire at Schweizerhalle, Switzerland, near Basel, in a warehouse that stored some 1,200 tons of agricultural chemicals accidentally washed some of the chemicals into the river where they soon formed a 35-mile-long trail that moved downstream at 2 m.p.h. Before long, all four countries that share the river – Switzerland, France, West Germany and the Netherlands were affected by the spreading plume. The incident affected thousands of Europeans who depended on the Rhine for drinking water.<sup>31</sup>
- June 17, 1988, Springfield, Massachusetts: Swimming Pool Chemical Plant Fire. Rain leakage wetted chemicals that released chlorine along with sufficient heat to cause ignition of ordinary combustibles. In the course of the incident, large amounts of chlorine gas were released, triggering several levels of evacuation involving more than 6,000 people.<sup>32</sup>
- 1987 Pampa, Texas: Chemical company plant fire cited by NFPA as one of the top 25 of all time for property loss.<sup>33</sup> Two explosions caused blasts that ripped apart the chemical plant, blowing out windows six miles away and touching off a huge fire and killing three people.<sup>34</sup>

Recent incidents and events present a more current picture. In a report issued by NFPA in May of 2007 it was noted that processing or manufacturing areas were the most frequent areas of origin (15%) for fires reported in industrial or manufacturing properties; and fires beginning with flammable or combustible liquids or gases, filters, or piping were responsible for a disproportionate share of the casualties. While only 10% of the structure fires reported in these occupancies began

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<sup>29</sup> Weir, *The Bhopal Syndrome*, p. 195.

<sup>30</sup> *Chemical Safety in Your Community, EPA's New Risk Management Program*, EPA 550-B-99-010, May 1999, p.3.

<sup>31</sup> Hull, Jennifer, B., *Environment a Proud River Runs Red*, Time, Inc., Time Magazine, New York, Monday November 24, 1986, [<http://www.time.com/time/printout/0,8816,962910,00.html>], visited July 15, 2008.

<sup>32</sup> *Swimming Pool Chemical Plant Fire Springfield, MA*, June 17, 1988, United States Fire Administration, Technical Report Series, Federal Emergency Management Agency, US Fire Administration National Fire Data Center, Report 027 of the Major Fires Investigation Project conducted by TriData Corporation, [<http://ncsp.tamu.edu/reports/USFA/springfield.pdf>], visited July 15, 2008.

<sup>33</sup> Flynn, Jennifer, *U.S. Structure Fires In Industrial And Manufacturing Properties*, Fire Analysis and Research Division, National Fire Protection Association, Quincy, MA, May 2007, p. 5.

<sup>34</sup> *Inquiry is Begun on Blasts in Texas*, The New York Times, Wednesday July 16, 2008, [<http://query.nytimes.com/gst/fullpage.html?res=9B0DE5DE1631F935A25752C1A961948260>], visited July 16, 2008.

with the ignition of a flammable or combustible liquid or gas, filter or piping; 28% of the civilian fire deaths and 38% of the civilian fire injuries resulted from these incidents.<sup>35</sup> The total fire loss in structural fires in industrial and manufacturing properties in the 2000-2004 periods was \$747 million with spontaneous combustion or chemical reaction representing 2% of the total fires, and 2% of the damage, but 9% of the civilian deaths and 1% of the civilian injuries.<sup>36</sup>

In 2007 the U.S. Department of Transportation reported a total of 19,146 hazardous materials incidents.<sup>37</sup> Approximately 92% of the incidents in transportation involved spillage, 2.3% resulted in a release of vapor (gas), and approximately 1% resulted in fire, explosion or environmental damage. The loss in dollars was approximately \$148.5 million with spillage accounting for 42.8% of the total dollar loss followed by fire at 21.2%, environmental damage at 12.5%, vapor (gas) release at 6.1%, and explosion at 5.2%. Losses from all other causes were 11.2% of the total.

One of the first comprehensive studies of hazardous materials incidents conducted in California for incidents occurring in 1989 reflected incidents in fixed facilities as well as those in transportation.<sup>38</sup> The study showed that incidents on roads, freeways and railroads accounted for 37% of the hazardous materials incidents reports, while 48% of all incidents occur at fixed facilities. In a report to determine the mechanisms of and facility types involved in hazardous materials incidents. An analysis of data recorded in response by Massachusetts' six district hazmat teams from their inception through May of 1996 Kales and Polyhronopoulos, et al. determined that the majority of hazardous materials incidents were caused by spills, leaks, or escapes of hazardous materials (76%), and that 80% occurred at fixed facilities while transportation related accidents accounted for just 20% of the incidents.<sup>39</sup>

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<sup>35</sup> Flynn, *U.S. Structure Fires In Industrial And Manufacturing Properties*, p. 4.

<sup>36</sup> *Ibid*, p. 9.

<sup>37</sup> Hazardous Materials Information System, U.S. Department of Transportation. Data as of 6/12/2008 DOT, US. *Department of Transportation Hazardous Materials Incidents 2007*. Washington D.C.: US Printing Office , 2008 [http://hazmat.dot.gov/pubs/inc/data/1994/1994frm.htm], visited 7/9/08.

<sup>38</sup> *Hazardous Materials Incidents – California January – December 1989*, California OES 1989 CHMIRS Report, California Office of Emergency Services, Hazardous Materials Division, February 1991, p. 1

<sup>39</sup> Kales, Stephen N., Polyhronopoulos, Gerry N., Castro, Michael J., Goldman, Rose H., and Christiani, David C., *Mechanisms of and Facility Types Involved in Hazardous Materials Incidents*, Environmental Health Perspectives, Vol. 105, Number 9, September 1997, pp. 998-1000.

As reported by the NRC, there was an average of 12,431 incidents/year that occurred in fixed facilities in the period from 1991 to 1999.<sup>40</sup> The average number of incidents/year reported in the period from 2000 to 2007 remained essentially constant with an average of 12,459 incidents/year throughout the period.<sup>41</sup> The NRC statistical data is limited in some cases to only include those incidents that require reporting to the NRC where the reportable quantity (RQ) threshold limit has been exceeded. For example, the reportable quantity for CERCLA and EPCRA chemicals are limited based on materials and quantities specifically listed.

As reported by Fewtrell and Atkins in a review of major chemical accidents, the cost of industrial accidents is normally made available to the public through press releases or investigative reports published by the media.<sup>42</sup> The public generally sees a composite cost of the incident without regard to the cost of the individual elements. The overall economic losses can include losses to production and capital, personnel, civil costs, public relations, cost to neighboring facilities, and if the loss is great – national implications.

The obvious costs include those of reconstruction, lost production, court costs and fines; however, ancillary loss can be expected do to any number of elements including but not limited to the following:

- Business interruption, repair of equipment, equipment replacement, rental of temporary equipment, building repairs.
- Repair of offsite damage and property. Cost to neighboring plants that may be affected by temporary events including road closures, evacuation, etc. Evacuation of the public.
- Increased insurance premiums.
- Reallocation of production to other sites, storage and or rerouting of process materials.
- Loss of market share, loss of share value.
- Transportation costs

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<sup>40</sup> National Response Center, Statistics, Incident Type, 1991-1999, [<http://www.nrc.uscg.mil/incident91-96.html>], visited 7/9/08

<sup>41</sup> National Response Center, Statistics, Incident Type, 2000-2007, [<http://www.nrc.uscg.mil/incident97-02.html>], visited 7/9/08

<sup>42</sup> P. Fewtrell, W.S. Atkins Consultants Ltd., Cheshire, UK and I.L. Hirst, Health and Safety Executive, Chemical and Hazardous Installations Division, Bootle, Merseyside, UK, *A Review of High-cost Chemical/Petrochemical Accidents since Flixborough 1974*, IchemE Loss Prevention bulletin, April 1998 No. 140, [<http://www.hse.gov.uk/comah/lossprev.pdf>], visited July 16, 2008.

- Sick pay, temporary staff replacements, lost time of non-productive staff members due to plant shut down, additional training, etc.
- Fire department costs, ambulance service, hospital costs, health support and long term health care, police protection, other emergency services.
- Legal costs, court costs, investigations, inspections, specialist research, public inquiries, toxicological studies, environmental cleanup, decontamination, fines.
- Public relations, information to local residents and media.
- Safety reviews, improved safety procedures.

Although minor incidents may result in losses lesser in scale, the above considerations enter into the overall cost to facility owners/operators with the loss generally shared not only by the business entity, but by the community in one form or another.

**1.5 Summary.** The time period from 1970 to 1986 represented a new era where social issues including free speech, civil rights, women’s rights, and the Vietnam War all became actionable and lasting contributions to the social fabric of the country. Recognition by the general population that a healthier working and living environment could result in a longer and healthier life resulted in a shift in Federal regulations designed to address worker safety and the environment. The potential for catastrophic loss of life, injuries and property loss due to accidents or incidents involving hazardous materials or other causes in the industrial environment served as the basis for political action which was translated into landmark Federal legislation. Hence, the economic impact of the new rule set and acceptable risk was to become an arguing point as was the funding available to deal with the risks identified.

Tighter control of hazardous materials, especially those which could have a major effect on a large number of the population resulted in greater public safety. Requirements for hazard communication and recognition of hazards integral to the OSHA regulations addressed hazards posed, not only to the workers by hazardous materials, but to emergency responders and the general public.

The advent of federal legislation that focused on hazardous materials in the workplace and the potential for release or adverse reaction affecting the environment heightened the awareness of local code officials charged with building construction, maintenance and emergency response. This increased sense of awareness was ultimately translated to an examination of requirements affecting building safety and the operation of facilities and premises for the storage, manufacture, processing or use hazardous materials. The need for a comprehensive approach to classification

and evaluation of hazards in the industrial environment led code officials to examine the building and fire prevention codes with respect to the overall control strategy applied to facilities in which hazardous materials were stored or used.

## 2 MODEL BUILDING CODES AS A PRECURSOR TO HAZARDOUS MATERIALS CONTROL.

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**2.0 The Origin And Function Of Model Building Codes.** Although in today's code environment the concept of the model codes is accepted, it is only in the recent past that model codes have become the accepted norm for use by local government. In a Bureau of Economics Staff Report to the Federal Trade Commission it was reported that in 1964 only 47 percent of jurisdictions were covered by model codes. This proportion increased to about 90 percent in 1970 and 94 percent by 1976.<sup>43</sup> As further discussed in the report:*During the 1960's, the Federal government required cities to adopt a model code in order to qualify for urban renewal funds. Courts also began to overturn highly restrictive local building codes.*<sup>44</sup>

These actions were on the cusp of regulatory changes affecting hazardous materials which were incorporated into the three major regional building codes and their companion fire prevention codes in use throughout the country.

**2.1 The Need.** In the late 1800's and early 1900's concerns with safety in buildings became the focus of special interest groups including the insurance industry as fire related losses to life and property mounted. The early construction laws that had developed were becoming more complex as the cities grew and experienced the consequences of disease, fire and structural collapse.<sup>45</sup> The lack of uniformity in existing codes established by the major cities and states presented a concern for those involved in construction as well as those involved in the operation and occupancy of buildings. The solution which evolved was to develop a model code or codes that could be offered to the states or cities for their voluntary use and enactment.

As expressed by Duke, the Federal government and private lawsuits have been important factors behind the increase in the use of model codes. The Federal government has promoted adoption through the providing of funds for localities to modernize their building codes, and through the Urban Renewal Program by specifying that in order to be eligible to receive urban renewal

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<sup>43</sup> Duke, Richard, *Local Building Codes and the Use of Cost-Saving Methods*, A Staff Report of the Bureau of Economics to the Federal Trade Commission, December, 1988, p. iv.

<sup>44</sup> Ibid.

<sup>45</sup> *Accessibility Workbook*. The International Code Council (ICC), in partnership with the US Spinal Association, and in cooperation with the National Association of Homebuilders (NAHB) was awarded a grant by the US Department of Housing and Urban Development (HUD) in a national effort to encourage states and local jurisdictions to adopt one of the Codes or regulations that HUD considers to be "Safe Harbor" (for accessibility purposes), [[http://www.iccsafe.org/safety/fairhousing/Legislative\\_Workshop\\_2-13-06.pdf](http://www.iccsafe.org/safety/fairhousing/Legislative_Workshop_2-13-06.pdf)], visited July 16, 2008, p. 26.



assistance the locality must adopt a building code based on a national building code.<sup>46</sup> The courts through the decision process have moved building code regulation toward a greater responsiveness to new construction methods and materials as well as a more uniform approach to administration of the codes.

Building codes are normally *enforced* at the lowest level of government, i.e., the city or town (the municipality). Once enacted into law, the model code becomes a legal document in the same manner as traffic laws and the multitude of other laws adopted at the local or state level. In some cases, the building code and related codes are *adopted* by the state legislature and required to be enforced by the local government. In cases where the legislative power for adoption has been delegated by the state, the codes may be adopted by a local entity such as a county or a city. The forms of local government vary throughout the country, and each of these variations, e.g., state, county, municipality (city, town, borough, village, etc.), charter city may have a bearing on the immunity of the legislative body which establishes the codes that are to be enforced.

A *model code* is a complete document that can be adopted into law, by reference, without the jurisdiction having to write it. The term “by reference” means that the law or ordinance enacted by the legislative body need only refer to the name and edition of the code and need not print the code in its entirety.<sup>47</sup>

**2.1.1 National Board of Fire Underwriters.** The first model code, the National Building Code, was published by the National Board of Fire Underwriters (NBFU) in 1905. The NBFU later became known as the American Insurance Association (AIA). The code was intended to be a guide to local governments in able to enact their own regulations. The appeal was that legislative authorities could access a source of comprehensive, contemporary and respected technical requirements without the expense of investigation, research, and drafting and promulgation attendant to locally developed codes. A new edition of the code was to be issued at approximately ten (10) year intervals thereby allowing local governments to reflect current construction technology and keep their building codes up to date.<sup>48</sup>

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<sup>46</sup> Duke, Richard, *Local Building Codes and the Use of Cost-Saving Methods*, p.13.

<sup>47</sup> Goldberg, A., and Fluer, L., *H-6 Design Guide to the Uniform Codes for High Tech Facilities*, Codes and Standards Information Company & GRDA Publications, Mill Valley, CA, First Edition, December 1986, p. 1-1

<sup>48</sup> *Accessibility Workbook*, p. 26.

Beginning in 1915, code enforcement officials charged with the enforcement of building code laws began regular regional and national meetings to discuss their common problems and concerns. From these meetings there were three regional organizations formed including the International Conference of Building Officials (ICBO), Building Officials and Code Administrators (BOCA) International, Inc., and Southern Building Code Congress international, Inc. (SBCCI).<sup>49</sup> The last edition of the *National Building Code* was published in 1976 and it has not been revised since because the American Insurance Association believed that the objectives of the code were being accomplished by the three model code organizations.

**2.1.2 International Conference of Building Officials (Uniform Codes).** ICBO as an organization was formed in 1922 with the group citing knowledge and the lack of uniformity existing in city and state buildings codes as one of the reasons for the formation. The first edition of the *Uniform Building Code* was published in 1927. Buildings were classified based on use of the character of the occupancy to allow the application of appropriate safety features and construction according to the hazard inherent in a particular use or occupancy.<sup>50</sup> The UBC was used predominantly in the western region of the country.

**2.1.3 Building Officials and Code Administrators International (BOCA National Codes).** Building Officials and Code Administrators International (BOCA) published the *Basic Building Code* in 1950.<sup>51</sup> The code was used primarily in the northeastern and Midwestern part of the country. With changes in title and content, the *Basic Building Code* had evolved into the *BOCA National Building Code* by the time of the last publication of the code in 1999.

**2.1.4 Southern Building Code Congress International (SBCCI Standard Codes).** The codes published by SBCCI were known as the Standard Codes. The first edition of the *Standard*

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<sup>49</sup> Ibid.

<sup>50</sup> *Uniform Building Code*, 1927 Edition, Prepared by the International Conference of Building Officials, Long Beach, CA, and Copyrighted in 1928 and 1987 and issued January 1928, p. un-numbered preface.

<sup>51</sup> *Legal Aspects of Code Administration*, Building Officials and Code Administrators International, Inc., Country Club Hills, Illinois; International Conference of Building Officials, Whittier, California; and Southern Building code Congress International, Birmingham, Alabama, 1984 Edition, p. 10.

*Building Code* was published by SBCCI in 1945.<sup>52</sup> The code was used primarily in the southeastern part of the country.

**2.1.5 International Code Council (ICC).** The structure of all three model codes published by ICBO, BOCA and SBCCI was similar, as was the code development process used by these organizations. All three organizations published a new edition of the code every three years. In 1994 these three code publishers established the International Code Council (ICC) as a joint venture to publish a single set of comprehensive construction codes for use nationally. The first edition of the *International Building Code* (IBC) was published in 2000. There are a number of companion codes including codes that address: Energy Conservation; Fuel Gas; Mechanical; Plumbing; Private Sewage Disposal; Zoning; Existing Buildings; Residential; Fire; and Urban-Wildland Interface. The merger of the three regional model code organizations on February 1, 2003 into the ICC resulted in the dissolution of ICBO, BOCA and SBCCI with the ICC being recognized as the membership organization. The past codes published by the three former organizations are now referenced as the *legacy codes*.

**2.1.6 National Fire Protection Association (NFPA).** The National Fire Protection Association (NFPA) grew out of efforts which began in 1895 by individuals representing sprinkler and fire insurance interests to address inconsistencies in the requirements surrounding the design and construction of fire sprinkler systems. The First Annual Meeting of the NFPA was held in May of 1897. The initial focus of the organization involved the development of general principles governing fire protection so that a set of uniform rules and conditions could be presented to the public. The majority of the twenty original members of the NFPA were involved with the insurance industry either as underwriters or as insurance associations.<sup>53</sup>

The *Life Safety Code* evolved out of early efforts to develop standards for the construction of stairways, fire escapes, and other egress routes for fire drills in various occupancies, and for the construction and arrangement of exit facilities for factories, schools and other occupancies. The first edition of the *Building Exits Code* was published in 1927. As time

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<sup>52</sup> Ibid.

<sup>53</sup> *The Men Who Made the NFPA*, *NFPA Journal*, May/June 1995, National Fire Protection Association, Quincy, MA, p. 97.

progressed the scope of the code was broadened to address fire matters in all occupancies, and the name of the document transitioned to the *Life Safety Code*.<sup>54</sup>

In March of 2000, the NFPA Standards Council established a Building Code Project to commence the development of NFPA's Building Code, NFPA 5000 *Building Construction and Safety Code*. The *Life Safety Code* was the fundamental starting point for the development of NFPA 5000. The first edition of NFPA 5000 was published in 2003. The code covers a range of subjects, including allowable building heights and areas based on occupancy and construction; protection schemes for vertical openings; means of egress and the rehabilitation of existing buildings. Specific requirements were provided for individual occupancies. In addition, specific requirements were provided for hazardous contents including hazardous materials formerly referred to as "high hazard contents."

**2.2 The Origin and Function of Model Fire Prevention Codes.** The first model fire prevention code was developed by the National Board of Fire Underwriters in 1930.<sup>55</sup> The fire prevention department in many jurisdictions is charged with the investigation of fires and explosions. Review of fire protection system plans typically fell to the fire prevention bureau, even though fire protection systems were frequently required by the building code. The review of fire access roads and other fire protection features required by model building codes also became the purview of the fire prevention bureau.

Today's fire prevention codes have been published as documents covering all aspects of fire protection and prevention. The presumption of any building code is that all elements of construction including the elements of fire protection are built in when the building is constructed. It was recognized by code officials that in order to ensure that the safeguards for life safety and against fire needed to be addressed through a program of periodic inspections. The responsibility to ensure that buildings are maintained as expected has generally been given to the bureau of fire prevention or the fire department.

Early editions of the fire prevention codes were written as a maintenance and operations code. The fire prevention code, similar to the building code, may be adopted locally or on a statewide basis. The fundamental premise of the fire prevention code is that buildings and premises including the land surrounding buildings constructed on site were to be maintained and operated in a manner so

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<sup>54</sup> *NFPA 101 Life Safety Code*, 2006 Edition, National Fire Protection Association, Quincy, MA, p. 101-1-101-2.

<sup>55</sup> Diamantes, David, *Principles of Fire Prevention*, CENGAGE Delmar Learning, Clifton Park, NY, 9/2/2004, Chapter 2, p. 20

as not subject the building's occupants, the premises or the general public to undue hazards from fires or explosions. Over time, the concern with fire and explosion has been broadened to include conditions hazardous to life, property or public welfare in the occupancy of structures or premises with recognition that the term "premises" includes operations that may occur on the building site outside of buildings that are under the purview of the local building code.

The fire prevention codes use a permit system to control the presence of hazardous materials on the premises. Permits range from those regulating the types or quantities of materials stored, used or handled to those required for a specific activity to occur e.g., spray painting. The permit constitutes the permission to utilize the material or conduct the specific operation designated.

The intent of the permit process is to require that there be a physical inspection, by the designated code responsible, i.e., the fire prevention bureau or fire department, of the area in which the activity may occur, or in which the hazardous material may be stored or used. The purpose of the inspection is to assure that the building or premises is proper for the use intended, and that the proper controls are in place.

Other elements of the codes may include matters related to the construction or alteration of fire protection and alarm systems as well as fire hazards in the structure or on the premises due to either occupancy or operation.

**2.2.1 National Board of Fire Underwriters (AIA).** The NBFU published the first edition of the *National Fire Prevention Code* in 1930 as a companion to the *National Building Code*. One of the early editions of the code stated the purpose of the code as follows:

*It is the intent of this code to prescribe regulations consistent with nationally recognized good practice for the safeguarding to a reasonable degree of life and property from the hazards of fire and explosion arising from the storage, handling and use of hazardous substances, materials and devices, and from conditions hazardous to life or property in the use or occupancy of buildings or premises. Compliance with standards of the National Board of Fire Underwriters or other approved nationally recognized safety standards shall be deemed to be prima facie evidence of compliance with this intent.*<sup>56</sup>

It is of interest to note that the purpose of the fire prevention codes have remained relatively consistent over the span of the last fifty (50) years. The 2006 Edition of NFPA 1 UFC contains the following text:

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<sup>56</sup> *Fire Prevention Code*, 1956 Edition, National Board of Fire Underwriters, 85 John St. New York, NY, p. 5.

*The purpose of this Code is to prescribe minimum requirements necessary to establish a reasonable level of fire and life safety and property protection from the hazards created by fire, explosion, and dangerous conditions.<sup>57</sup>*

And...

*Where no applicable codes, standards, or requirements are set forth in this Code or contained within other laws, codes, regulations, ordinances, or bylaws adopted by the authority having jurisdiction (AHJ), compliance with applicable codes and standards of NFPA or other nationally recognized standards as are approved shall be deemed as prima facie evidence of compliance with the intent of this Code.<sup>58</sup>*

**2.2.2 Western Fire Chiefs Association (WFCA).** The *Uniform Fire Code* (UFC) was initially developed by the California Fire Chiefs Association and the first edition of the UFC was published by ICBO and the Western Fire Chiefs Association (WFCA) in 1971.<sup>59</sup>

**2.2.3 NFPA.** Work to develop NFPA's Fire Code, NFPA 1, was initiated by a directive of NFPA's Board of Directors in 1971. The original code was written around a format that served as a guide for the development of a local fire prevention code. In the late 1980's, the Fire Marshals Association of North America added administrative sections and extracted technical content from other NFPA codes and standards. A special task group on hazardous materials examined technological changes in the handling, storage and use of flammable and combustible materials and a greater emphasis on protection of life and property from chemical products made and used in the environment was considered. Subsequent revisions of the code updated text extracted from other NFPA codes and standards adding requirements for compliance with the codes and standards referenced.<sup>60</sup>

In 2003 NFPA 1 was completely revised to incorporate provision from the WFCA UFC under a partnership between NFPA and WFCA and the code was renamed as NFPA 1, *Uniform Fire Code*.<sup>61</sup>

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<sup>57</sup> *NFPA 1 Uniform Fire Code*, 2006 Edition, National Fire Protection Association, Quincy, MA, § 1.2, p. 1-11.

<sup>58</sup> *Ibid.*, § 1.3.2.2, p. 1-11.

<sup>59</sup> *Uniform Fire Code*, 1988 Edition, International Conference of Building Officials and Western Fire Chiefs Association, Whittier, CA, May, 1988, p. iii.

<sup>60</sup> *NFPA 1, Uniform Fire Code*, National Fire Protection Association, Quincy MA, 2003 Edition, p. 1-1.

<sup>61</sup> *Ibid.*.

The scope of the code includes, but is not limited to, the following. Hazardous materials are included as a special area of interest under items (3), (11) and (12) below [underlining added for emphasis]:<sup>62</sup>

- (1) Inspection of permanent and temporary buildings, processes, equipment, systems, and other fire and related life safety situations
- (2) Investigation of fires, explosions, hazardous materials incidents, and other related emergency incidents
- (3) Review of design and construction plans, drawings, and specifications for life safety systems, fire protection systems, access, water supplies, processes, and hazardous materials and other fire and life safety issues
- (4) Fire and life safety education of fire brigades, employees, responsible parties, and the general public
- (5) Existing occupancies and conditions, the design and construction of new buildings, remodeling of existing buildings, and additions to existing buildings
- (6) Design, alteration, modification, construction, maintenance, and testing of fire protection systems and equipment
- (7) Access requirements for fire department operations
- (8) Hazards from outside fires in vegetation, trash, building debris, and other materials
- (9) Regulation and control of special events including, but not limited to, assemblage of people, exhibits, trade shows, amusement parks, haunted houses, outdoor events, and other similar special temporary and permanent occupancies
- (10) Interior finish, decorations, furnishings, and other combustibles that contribute to fire spread, fire load, and smoke production
- (11) Storage, use, processing, handling, and on-site transportation of flammable and combustible gases, liquids, and solids
- (12) Storage, use, processing, handling, and on-site transportation of hazardous materials
- (13) Control of emergency operations and scenes
- (14) Conditions affecting fire fighter safety

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<sup>62</sup> Ibid, § 1.1, p. 1-11.

## 3 HAZARDOUS MATERIALS – CONTROL STRATEGY

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3.0 **Occupancy Classification – Domain of the Building Code.** Historically, *occupancy* has been defined as the purpose for which a building is used or intended to be used.<sup>63</sup> The concept of use of occupancy appears to have evolved from action to collect and develop actuarial data involving fire loss. When the gathering of statistical data was undertaken by the National Board of Fire Underwriters in 1915, the Actuarial Bureau established a standard classification system of occupancy hazards that listed 584 different occupancy classes for the purpose of classification of fire and property damage. The number of classes was reduced to 26 different classes by 1932 and finally revised upward to 115 classes by 1947. The occupancy classes were sorted into five broad categories designated I through V to include Residential, Mercantile, Non-Manufacturing, Manufacturing and Sprinklered Risks. The categories were then further subdivided into groups within each of the categories which mirror some of the “group classifications” used by today’s building codes, e.g., warehouses, grain elevators, dairy products, educational institutions, hotels, hospitals, churches, penal institutions, etc.<sup>64</sup>

**3.0.1 Use based occupancy classification.** The division of occupancy into groups is practiced into today’s codes with the following list of groups being prominent, e.g., Group A – Assembly; Group B – Business; Group E – Education, Group F – Factory, etc. As explained by the commentary to the *International Building Code*, the use of occupancy groups is to...

*...provide rational criteria for the classification of various occupancies into groups based on their relative fire hazard and life safety properties. This is necessary because the code utilizes group classification as a fundamental principle for differentiating requirements in other parts of the code related to fire and life safety protection.*<sup>65</sup>

In relating occupancy to methods of construction the concept of equivalent risk is explained...

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<sup>63</sup> *Uniform Building Code*, 1970 Edition, Volume I, International Conference of Building Officials, Whittier, CA, p. 39.

<sup>64</sup> Finnegan, J.H., *Statistics of the National Board of Fire Underwriters*, Proceedings of the Casualty Actuarial Society Casualty Actuarial Society - Arlington, Virginia 1956: XLIII, pp. 32-89, [<http://www.casact.org/pubs/proceed/proceed56/56082.pdf>], visited July 24, 2008, p. 84

<sup>65</sup> *International Building Code Commentary*, 2006 Edition, Volume I, International Code Council, Country Club Hills, IL, p. 3-2.



*In the early years of building code development, the essence of regulatory safeguards from fire was to provide a reasonable level of protection to property. The idea was that if property was adequately protected from fire, then the building occupants would also be protected.*

*From this outlook on fire safety, the concept of equivalent risk has evolved in the code. This concept maintains that, in part, an acceptable level of risk against the damages of fire respective to a particular occupancy type (group) can be achieved by limiting the height and area of buildings containing such occupancies according to the building's construction type (i.e., its relative fire endurance). The concept of equivalent risk involves three interdependent considerations: (1) the level of fire hazard associated with the specific occupancy of the facility; (2) the reduction of fire hazard by limiting the floor area(s) and the height of the building based on the fuel load (combustible contents and burnable building components) and (3) the level of overall fire resistance provided by the type of construction used for the building.<sup>66</sup>*

The IBC establishes ten (10) occupancy groups based on use.<sup>67</sup> The groups include: Group A – Assembly; Group B – Business; Group E – Educational; Group F – Factory and Industrial; Group H – High Hazard; Group I – Institutional; Group M – Mercantile; Group R – Residential; Group S – Storage; and Group U – Utility and Miscellaneous. The groups may be further subdivided based on the character of the occupancy with each subdivision including a list of activities or uses, not unlike those established by the NBFU for actuarial purposes. For example the Assembly group is subdivided into five subgroups including Group A-1 through A-5. The list of activities varies. The A-1 occupancy includes: motion picture theaters, symphony and concert halls, television and radio studios admitting an audience and theaters. The A-2 occupancies (or uses) include: banquet halls, night clubs, restaurants, taverns and bars, etc. It is important to note that by including specific uses on a list within each of the groups the code has determined that these uses are of equivalent risk.

NFPA's Building Code, NFPA 5000 establishes occupancies which are somewhat in parallel those used in *the Life Safety Code*, NFPA 101 the primary differences between the IBC and NFPA codes relate to health care occupancies and institutional uses. With respect to hazardous materials the IBC establishes *high hazard* occupancies which prescribe controls when certain quantity thresholds are crossed. By comparison, NFPA 5000 establishes requirements for *protection level controls* when the quantity thresholds are crossed. The required controls are comparable; however, NFPA uses *high hazard contents* to describe the materials present rather than the occupancy as such.

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<sup>66</sup> Ibid, p. 3-1.

<sup>67</sup> *International Building Code*, 2006 Edition, International Code Council, Country Club Hills, IL, p. 23.

TABLE 3

**Designation of Occupancies**

<b>Occupancy</b>	<b>IBC</b>	<b>NFPA 101</b>	<b>NFPA 5000</b>
<b>Assembly</b>	Yes	Yes	Yes
<b>Ambulatory Health Care</b>	Note 1	Yes	Note 11
<b>Business</b>	Yes	Yes	Yes
<b>Day Care</b>	Note 2	Yes	Yes
<b>Detention/Correction</b>	Note 3	Yes	Yes
<b>Educational</b>	Yes	Yes	Yes
<b>Factory and Industrial</b>	Yes	Note 7	Note 7
<b>Health Care</b>	Note 4	Yes	Yes
<b>High Hazard</b>	Yes	Note 8	Note 8
<b>Industrial</b>	Note 5	Yes	Yes
<b>Institutional</b>	Yes	Note 9	Note 9
<b>Mercantile</b>	Yes	Yes	Yes
<b>Residential</b>	Yes	Yes	Note 10
<b>Residential Board and Care</b>	Note 6	Yes	Yes
<b>Storage</b>	Yes	Yes	Yes
<b>Utility and Misc.</b>	Yes	Note 10	Yes

## Notes:

1. Could be included in Group B or I uses. Clinics and outpatient care facilities are included in Group B uses.
2. Day care can be established in any group; however, the number of persons included influences the occupancy. It could be in Groups E, I or R.
3. Included in Group I as an institutional use.
4. Included in the Group I uses. Clinics and outpatient care facilities are included in Group B uses.
5. Included with the Group F (factory and industrial) uses.
6. Included in the Group R uses when the number of occupants is less than 5. For resident loads greater than 5 the use reverts to Group I.
7. Factory and industrial uses are equated. The term used in NFPA codes is "industrial."
8. NFPA does not have a high hazard category. The concept of control is embodied in "Protection Level" controls which in effect equate to occupancies of high hazard without using the term occupancy.
9. No comparable occupancy. Institutional uses could include health care, detention and correction, etc.
10. No comparable occupancy.
11. Included as Health Care occupancies.

From a use perspective, if the building or area in the building is employed to one of the uses designated or listed under the occupancy group designation, e.g., in the IBC Group S-1 (moderate hazard storage): baskets, books and paper in rolls or packs, boots and shoes, furniture, furs, leather, lumber, etc. the description on the list is sufficient as a means to classify the occupancy. Alternatively, the use may be determined by the application of a defined term used in the code, e.g., the use of the definition for detention and correctional occupancy under NFPA 5000 is sufficient to cause the occupancy to be classified accordingly.

In the 1970 Edition of the UBC the use of a building or building area for various activities (uses) without respect to quantity was sufficient as a means to designate the occupancy as

hazardous. The General occupancy designation was assigned to Group E (hazardous not educational) and further subdivided into five (5) divisions including the following.<sup>68</sup> Divisions 2, 3, 4 and 5 classifications are based on the nature of use. For example, specific activities or uses are sufficient to trigger the classification, e.g., paint stores with bulk handling; paint shops, spray painting rooms and shops; woodworking establishments, box factories, etc.

TABLE 4  
**Subdivision of Occupancies within Group E (hazardous)**  
**1970 UBC**

Division	Description
<b>Division 1</b>	Storage and handling of hazardous and highly flammable or explosive materials other than flammable liquids
<b>Division 2</b>	Storage and handling of Class I, II, and III flammable liquids, as set forth in U.B.C. Standard No. 9-1; dry cleaning plants using flammable liquids, paint stores with bulk handling; paint shops and spray painting rooms and shops. (See note).
<b>Division 3</b>	Woodworking establishments, planing mills and box factories; shops, factories where loose, combustible fibers or dust [sic] are manufactured, processed or generated; warehouses where highly combustible material is stored
<b>Division 4</b>	Repair garages
<b>Division 5</b>	Aircraft repair hangars

Note: An exception was provided to address flammable liquids as follows: *Highly flammable liquids shall be deemed to be those with a flash point below 190° F. as determined by the closed cup tester, provided that liquids with a flash point above 138.5° F. shall not be deemed to be highly flammable when used in a closed safety cleaning system meeting the requirements of U.B.C. Standard No. 10-1 for a Class III rating.*

**3.0.2 Contents Based Occupancy Classification.** While the activity or uses of a building or area may be used to determine the major occupancy group, the hazards of the contents within the occupancy may be used to further refine the level of equivalent risk presented. The 1970 UBC identified hazardous contents through the use of a list of materials that was incorporated into the various Divisions of the Group E occupancy. The presence of the following materials in any quantity was sufficient to require the use of a Group E occupancy classification.

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<sup>68</sup> *Uniform Building Code*, 1970 Edition, p. 68.

TABLE 5

**1970 UBC List Of Hazardous Contents That Establish  
A Group E (Hazardous) Occupancy**

<b>Hazardous and highly flammable materials other than flammable liquids</b>
<b>Explosive materials</b>
<b>Class I, II and III flammable liquids (see note)</b>
<b>Combustible fibers (loose)</b>
<b>Combustible dust</b>
<b>Highly combustible material</b>

Note: An exception was provided to address highly flammable liquids as follows: *Highly flammable liquids shall be deemed to be those with a flash point below 190° F. as determined by the closed cup tester, provided that liquids with a flash point above 138.5° F. shall not be deemed to be highly flammable when used in a closed safety cleaning system meeting the requirements of U.B.C. Standard No. 10-1 for a Class III rating.*

Hazardous materials, specifically flammable liquids, were limited in other occupancies by exclusion. For example, in the 1970 UBC Group F occupancies were further subdivided into three divisions noted in Section 1101 as shown in Table 6.

TABLE 6

**Subdivision of Occupancies Within Group F  
1970 UBC**

<b>Division</b>	<b>Description</b>
<b>Division 1</b>	Gasoline service stations, storage garages where no repair work is done except exchange of parts and maintenance requiring no open flame, welding, or the use of highly flammable liquids.
<b>Division 2</b>	Wholesale and retail stores, office buildings, drinking and dining establishments having an occupant load of less than 100, printing plants, municipal police and fire stations, factories and workshops using materials not highly flammable or combustible, storage and sales rooms for combustible goods, paint stores without bulk handling. (See Section 402, for definition of Assembly Buildings.)
	Buildings or portions of buildings having rooms used for educational purposes, beyond the 12 <sup>th</sup> grade with less than 50 occupants in any room.
<b>Division 3</b>	Aircraft hangars where no repair work is done except exchange of parts and maintenance requiring no open flame, welding, or the use of highly flammable liquids. Open parking garages. Heliports.

At that point in time it was not uncommon for any number of occupancies including offices and factories and printing plants (otherwise classified in Division 2) to store or use flammable solvents. For example, it was common for printing plants to use flammable solvents in the various inks that were employed. In addition, the use of solvent based adhesives was integral to these businesses. Even offices used alcohol as a solvent in the

cleaning of typewriters, and solvent based glues and adhesives were found in any office in varying quantities. While the quantity in any single office may have been small, in the aggregate the quantities grew, especially in multistoried office buildings. The storage of flammable liquids in wholesale and retail stores was also common as were aerosols, paints, and adhesives which incorporated flammable liquids as a major component. The use of flammable or combustible materials in factories and workshops, even in limited amounts was and continues to be a common practice as flammable organic solvents are ubiquitous to the industrial environment.

Section 1108, for Group F Occupancies provided a mechanism that allowed the use (but not storage) of certain flammable liquids when the liquids were handled in accordance with U.B.C. Standard 9-1 as follows:

*No storage of volatile flammable liquids shall be allowed in Group F Occupancies and the handling and use of gasoline, fuel oil and other flammable liquids shall not be permitted in any Group F Occupancy unless such use and handling comply [sic] with U.B.C. Standard No. 9-1.<sup>69</sup>*

The *U.B.C. Standard No. 9-1 Storage and Handling of Flammable and Combustible Liquids* extracted a limited number of provisions from NFPA 30. Once extracted, the provisions were open to amendment. UBC Standard 9-1 contained selected definitions from NFPA 30, a section on tank storage, and limited provisions for construction of buildings used for liquid storage and use. The modification and partial extraction of requirements from NFPA 30 resulted in what was described as a change of intent of the NFPA standard and the UBC modifications to produce a UBC Standard to be used for the regulation of flammable liquids ended with the publication of the 1979 Edition of Standard 9-1.

The picture for code users in Group F occupancies lacked clarity with the apparent contradiction between Sections 1101 and 1108. It was clear from Section 1108, however, that Class IA liquids (highly volatile) could not be used in any Group F occupancy, and literally applied flammable liquids could be used and handled, but not stored unless such handling or use complied with the extracted and modified requirements from NFPA 30.

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<sup>69</sup> *Uniform Building Code*, 1970 Edition, p. 74.

**3.0.3 Quantity and Contents Based Occupancy Classification.** The use of quantity of as a threshold for certain hazardous materials first emerged in the 1973 Edition of *Uniform Building Code*. The requirements for Group E Occupancies (Chapter 10) were revised in a manner that resulted in a major shift in the Uniform Codes in the manner of regulating buildings containing hazardous materials. In 1973 ICBO's UBC Fire and Life Safety Code Development Committee enacted changes in Chapter 10 regulating Group E Occupancies to use a quantity threshold as the means to determine occupancy. Table No. 10-A established a quantity threshold for certain hazardous materials which became the precedent for the use of "maximum quantities" that were occupancy specific.

Group E, Division 1 occupancies included:

*Storage and handling of hazardous and highly flammable or explosive materials other than flammable liquids.*

By default the *exempt amount* was zero. In other words, any quantity of highly flammable or explosive materials other than flammable liquids that were not further identified in Division 2 was sufficient to trigger the use of the Division 1 occupancy.

Group E, Division 2 included:

*Storage and handling of Class I, II, and III-A liquids, as set forth in U.B.C. Standard No. 10-1 (modified extraction from NFPA 30); dry cleaning plants using flammable liquids, paint stores with bulk handling; paint shops and spray painting rooms and shops. Table No. 10-A was established to address the storage or sale of hazardous materials or chemicals or Class I, II and III-A liquids in amounts that do not exceed those set forth in Table No. 10-A is permitted in buildings or portions thereof without classifying such buildings as a Group E Occupancy, provided such chemicals, hazardous materials or liquids are stored and handled in compliance with the provisions of the Fire Code.*

Table 10-A was titled "Exempt Amounts Of Hazardous Materials, Liquids And Chemicals."<sup>70</sup> The applicability of the table was limited to those materials and quantities shown in Table 7 below. The staff analysis of revisions to the code by way of explanation of a new Table 10-A explained the table as follows:

*A new Table No. 10-A has been introduced to the Chapter which establishes exempt amounts of hazardous materials, chemicals and liquids, thus permitting the use of these materials in the exempt quantities without classifying the building or portion*

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<sup>70</sup> *Uniform Building Code*, 1973 Edition, International Conference of Building Officials, Whittier, CA, p. 74.

*thereof housing the use as a Group E Occupancy. The handling and processing of these materials must be in accordance with the provisions of the Fire Code.<sup>71</sup>*

It was also noted that there were also correlating revisions in Chapter 10 related to hazardous materials including the deletion of a reference in Occupancies of Group H, Division 3 to “highly combustible material” in view of the lack of a definition.

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<sup>71</sup> 1973 Analysis of Revisions of the Uniform Building Code, U.B.C. Standards, Uniform Mechanical Code, Uniform Housing Code, Uniform Sign Code, Uniform Fire Code, International Conference of Building Officials, Whittier, CA, p. 10.

TABLE 7  
**1973 UBC Table No. 10-A**  
**Exempt Amounts of Hazardous Materials, Liquids and Chemicals**

Category	Exempt Amount
<b>Flammable Liquids</b>	
IA	60 gal
IB	120 gal
IC	180 gal
Combination IA, IB,IC <sup>1</sup>	240 gal
<b>Combustible Liquids<sup>2</sup></b>	
Class II	240 gal
Class IIIA	500 gal
Flammable gases	3000 cf
Liquefied flammable gases	60 gal
Flammable fibers (loose)	100 cf
Flammable fibers (baled)	1000 cf
Flammable solids	500 lbs
Unstable Materials	No exemptions
Corrosive Liquids	55 gal
Oxidizing material (gases)	6000 cf
Oxidizing material (liquids)	50 gal
Oxidizing material (solids)	500 lbs
Organic peroxides	10 lbs
Nitromethane (Unstable Materials )	No exemptions
Ammonium nitrate	1000 lbs
Ammonium nitrate compound mixtures >60% nitrate by weight	1000 lbs
Highly toxic material and poisonous gas	No exemptions

<sup>1</sup>Containing not more than the exempt amounts of Class I-A, I-B, or I-C flammable liquids.



<sup>2</sup> Combustible liquids Class II were listed under Flammable Liquids group. They have been reordered in this table for clarity.

The basis for the majority of the materials and quantities listed in the table to establish quantity as a means to determine a threshold used to determine occupancy was derived in part from the 1970 Edition of the National Board of Fire Underwriters *Fire Prevention Code* (FPC) which used quantity as a means to establish a permit amount.<sup>72</sup> There were modifications made by ICBO's Fire and Life Safety Committee to address categories which were not clear, e.g., unstable reactives, or where further clarification was felt to be needed. The introduction of a table establishing "exempt amounts" resolved the problem embodied in previous editions of the code where the presence of certain materials, e.g., flammable liquids, in any quantity caused the occupancy to be classified as highly hazardous. Broadening the list of materials in the table also brought a closer correlation between the building code and the fire prevention code with the overall concept of *hazardous chemicals* designated by the fire prevention codes which described hazardous materials in terms of flammable or combustible liquids, unstable (reactive) materials, flammable solids, corrosive liquids, radioactive materials, oxidizing materials, potentially explosive chemicals, highly toxic materials, poisonous gases, and others.

The 1971 Edition of the WFCAs *Uniform Fire Code* in Article 19 (Hazardous Chemicals) established similar provisions as those developed in the NBFU FPC with permits required for...

*...the storage, transportation or handling of more than 55 gallons of corrosive liquids; or more than 500 pounds of oxidizing materials; or more than 10 pounds of organic peroxides; or more than 500 pounds of nitromethane; or 1000 pounds or more of ammonium nitrate, ammonium nitrate fertilizers and fertilizer mixtures covered in Section 19.106(d); or any amount of highly toxic materials, pyrophoric materials, hypergolic materials, cryogenic materials or poisonous gases.*

And...

*A permit shall be required for the storage or handling at any installation of more than one microcurie of radium not contained in a sealed source; or more than one millicurie of radium or other radioactive material in a sealed source or sources, or any amount of radioactive material for which a specific license from the United States Atomic Energy Commission is required.*<sup>73</sup>

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<sup>72</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, 85 John St., New York, NY., § 1.9, pp. 4-5.

<sup>73</sup> *Uniform Fire Code*, 1971 Edition, Western Fire Chiefs Association and International Conference of Building Officials, Whittier, CA, §19.102 (a) and (b), p. 151.

Section 1.9 of the NBFU FPC establishing requirements for permits included the following statements:

- a. A permit shall constitute permission to maintain, store or handle materials, or to conduct processes, which produce conditions hazardous to life or property, or to install equipment used in connection with such activities. Such permit does not take the place of any license required by law. It shall not be transferable, and any change in use or occupancy of premises shall require a new permit.
- b. Before a permit may be issued, the Chief of the bureau of Fire Prevention, or his assistants, shall inspect and approve the receptacles, vehicles, buildings or storage places to be used. In cases where laws or regulations enforceable by departments other than the Bureau of Fire Prevention are applicable, joint approval shall be obtained from all departments concerned.
- c. All applications for a permit required by this code shall be made to the Bureau of Fire Prevention in such form and detail as it shall prescribe. Applications for permits shall be accompanied by such plans as required by the Bureau of Fire Prevention.
- d. Permits shall at all times be kept on the premises designated therein, and shall at all times be subject to inspection by any officer of the fire or police departments.
- e. One permit only shall be required by establishments dealing in, or using, two or more flammable, combustible or explosive materials to be kept in the establishment at any one time, but each of the materials shall be listed in the permit.

Individual permits were required for various hazardous materials including:

Cellulose nitrate plastics (pyroxylin) – Article 6  
Combustible fibers – Article 7  
Compressed gases – Article 8  
Flammable and combustible liquids – Article 16  
Hazardous Chemicals – Article 20

The term *hazardous chemical* was a defined term and included materials not otherwise covered in the code which....

*...are highly flammable, or which may react to cause fires or explosion, or which by their presence create or augment a fire or explosion hazard, or which because of their toxicity, flammability, or liability to explosion render fire fighting abnormally dangerous or difficult; also to materials and formulations which are chemically unstable and which may spontaneously form explosive compounds, or undergo spontaneous or exothermic reactions of explosive violence or with sufficient evolution of heat to be a fire hazard. Hazardous chemicals shall include such materials as corrosive liquids, flammable solids, highly toxic materials, oxidizing materials,*

*poisonous gases, radioactive materials, and unstable chemicals, as defined in Section 20.2.<sup>74</sup>*

Definitions are provided for each of the hazard categories identified, e.g., corrosive liquid, flammable solid, highly toxic material, etc. A comparison between the tabular limits of 1973 UBC Table No. 10-A and the permit quantities listed in the 1970 Edition of the NBFU *Fire Prevention Code* is shown in Table 8 below:

**TABLE 8**  
**Comparison Between 1973 UBC Table No. 10-A and Permit Limits Established In The 1970 Edition of the NBFU Fire Prevention Code**

Category	UBC Table No. 10-A Exempt Amounts	AIA Permit Limits	AIA Notes (comments)
<b>Highly flammable or explosive materials other than flammable liquids</b>	None listed as these materials required the use of Group E, Division 1	Any amount (see AIA notes)	There is no specific permit category for highly flammable materials (other than flammable liquids); however, §1.9 requires a permit to store or handle materials, etc. which produce conditions hazardous to life or property.
<b>Explosive materials</b>	None listed as these materials required the use of Group E, Division 1	Any amount	Permit to mfg., possess, store, sell, use explosives, blasting agents, small arms ammunition [§12.3]
<b>Flammable Liquids</b>			
<b>IA</b>	60	1 gal (in dwellings) 6 gal storage, handling or use in other occupancies (some exemptions for painting, maintenance, etc.)	Any quantity in manufacturing, processing, blending or refining or storage in stationary tanks [§16.13].
<b>IB</b>	120	1 gal (in dwellings) 6 gal storage, handling or use in other occupancies (some exemptions for painting, maintenance, etc.)	Any quantity in manufacturing, processing, blending or refining or storage in stationary tanks [§16.13].
<b>IC</b>	180	Some exemptions.	Any quantity in manufacturing, processing, blending or refining or

<sup>74</sup> Ibid, p. 155.

Category	UBC Table No. 10-A Exempt Amounts	AIA Permit Limits	AIA Notes (comments)
			storage in stationary tanks [§16.13].
<b>Combination IA, IB,IC<sup>1</sup></b>	240	Not listed	
<b>Combustible Liquids</b>			
<b>Class II</b>	240	25 gal in storage, handling or use.	Any quantity in manufacturing, processing, blending or refining or storage in stationary tanks [§16.13].
<b>Class IIIA</b>	500	25 gal in storage, handling or use.	Any quantity in manufacturing, processing, blending or refining or storage in stationary tanks. Combustible liquids excluded IIIB liquids [§16.13].
<b>Flammable gases</b>	3000 cf	2000 cf	Permit for “compressed” flammable gases [§8.3]
<b>Liquefied flammable gases</b>	60 gal	Aggregate connected containers of >2,000 gal water capacity	Permit required for each permanent installation, irrespective of size of containers when used at buildings in which people congregate for civic, political, educational, etc.
<b>Flammable fibers (loose)</b>	100 cf	>100 cf	Permit quantity applied to storage and handling without differentiating between loose or baled fibers [§7.2].
<b>Flammable fibers (baled)</b>	1000 cf	>100 cf	Permit quantity applied to storage and handling without differentiating between loose or baled fibers [§7.2].
<b>Flammable solids</b>	500 lbs	Not specifically listed	Flammable solids are within the scope of the code; however, a permit quantity was not listed.
<b>Unstable Materials<sup>2</sup></b>	No exemptions	Not specifically listed	There is no specific permit quantity listed for unstable materials; however, §1.9 requires a permit to store or handle materials, etc. which produce conditions hazardous to life or property.
<b>Corrosive Liquids</b>	55 gal	55 gal	Permit for storage or handling [§20.3].

Category	UBC Table No. 10-A Exempt Amounts	AIA Permit Limits	AIA Notes (comments)
Oxidizing gases	6000 cf	6000 cf	Permit for nonflammable compressed gas [§8.3].
Oxidizing liquids	50 gal	50 lbs	Permit for storage or handling [§20.3].
Oxidizing solids	500 lbs	50 lbs	Permit for storage or handling [§20.3].
Organic peroxides	10 lbs	10 lbs	Permit for storage or handling [§20.3].
Nitromethane (Unstable Materials )	No exemptions	500 lbs	Permit for storage or handling nitromethane [§20.3].
Ammonium nitrate (AN)	1000 lbs	1000 lbs	Permit for storage or handling [§20.3]. Could be interpreted to be the aggregate of AN plus AN fertilizers and mixtures.
Ammonium nitrate compound mixtures >60% nitrate by weight	1000 lbs	1000 lbs	Permit for storage or handling [§20.3]. Could be interpreted to be the aggregate of AN plus AN fertilizers and mixtures.
Highly toxic material	No exemptions	Any amount	Permit for storage or handling [§20.3].
Poisonous gas	No exemptions	Any amount	Permit for storage or handling [§20.3].
Radioactive material	Not listed	> microcurie of radium or other radioactive material not contained in a sealed source; or more than one millicurie of radium or other ,etc. in a sealed source, or any quantity for which a U.S. AEC license is required.	Permit for storage or handling at any installation [§20.3].

<sup>1</sup>Containing not more than the exempt amounts of Class I-A, I-B, or I-C flammable liquids.

<sup>2</sup> Defined as... any substance, other than one classified as an explosive or blasting agent, which will vigorously and energetically react, is potentially explosive, will polymerize, decompose instantaneously, undergo uncontrollable auto-reaction or can be exploded by heat, shock, pressure or combinations thereof. Examples are: organic peroxides, nitromethane, and ammonium nitrate. [§20.2k.]

**3.1 Influence Of OSHA And EPA Requirements For Hazardous Materials On Local Codes And Regulations.** There is a lag time between the publication of any regulation and adoption. The time between publication of a code such as the building or fire prevention code varies from location to location. There are many factors which are considered in the adoption process by the legislative entity including the cost of adoption, the public process, the code impact on builders and building owners, and other considerations. In the interim period between publication of the 1973 Edition of the UBC and its adoption by jurisdictions using the legislative process throughout the 1970's, the awareness of the presence of hazardous materials in the workplace grew as the requirements of OSHA and EPA regulations were implemented.

OSHA's hazard communication program placed an emphasis on the development of Material Safety Data Sheets (MSDS) and the providing of information that identified the hazards of chemicals through the use of a set of definitions, many of which had been used by the early fire prevention codes. The terms toxic and highly toxic were now defined, as were other terms that had been used in the fire prevention and building codes, in a manner which brought closer correlation between information produced by chemical manufacturers and suppliers and those used by the codes. The initial requirements for MSDS applied to limited segments of industry i.e., shipbuilding when the concept was first introduced in the OSHA regulations. Suppliers of hazardous materials began reacting to the concept of hazard communication, and MSDS were furnished to users outside of the presently regulated industry.

The EPA requirements for handling of hazardous waste resulted in the classification of hazardous waste for a category of materials that previously had been viewed simply as industrial waste. Industry was subject to reporting requirements that required knowledge of the hazards of waste and non-waste materials. The reporting requirements of the EPA under SARA and CERCLA regulations placed further attention on the presence of hazardous materials in the workplace. In addition, requirements that established State and Local Emergency Planning Commissions resulted in an exchange of information with local fire departments that may not have otherwise been aware of the presence of materials classified by EPA as *extremely hazardous substances (EHS)*. See also Section 1.4.6.

**3.2 Recognition of Hazardous Materials in the Code Arena Broadens as the High Tech Industries Grow.** The advent of the semiconductor in the early 1950's led to the development of commercially produced integrated circuits in the 1960's. In the 1970's and into the early 1980's the high tech industries expanded from what had been R&D scaled operations into factory operations producing electronic devices based on semiconductor technology.

By 1980 the U.S. Electronics Industry was characterized as a large and varied industry engaged in manufacturing electronic components and accessories. In 1976 it was estimated that 27% of the total production workers in Standard Industrial Classification (SIC) Group No. 367 which included radio and television receiving electron tubes, cathode ray tubes, transmitting purpose electron tubes, semiconductors and related devices, electronic capacitors and others, were employed in the semiconductor and related devices category. In a study of the Semiconductor Industry conducted by California State OSHA in 1981 it was estimated that U.S. semiconductor companies employed 225,000 workers worldwide with employment growing in excess of 50% from 1975 to 1979.<sup>75</sup>

The California study was a definitive study which was conducted in response to heightened concerns about potential health hazards within the electronics industry. It was recognized that the “microelectronics” industry, which utilized semiconductor technology, was a revolutionary industry that had grown to a point where it had become of major economic and technological importance to the world in a very short period of time. The advent of a commercially viable integrated circuit and related components led to the information age and the development of the personal computer. As heavy manufacturing in the country declined, states throughout the country sought to attract the new and “clean industries” to bolster their industrial base.

The industry was not a traditional “smoke stack” industry; however, the industry was not without its hazards. The manufacture of semiconductors and integrated circuits involves the use of hazardous materials including solids, liquids and gases. In the 1970’s and 1980’s the manufacture of semiconductor devices involved a combination of many processes, some of which were truly new while others were practiced long before the transistor was developed.<sup>76</sup> Many of the processes used involved chemical reactions. The quantities of hazardous materials employed were small compared with those involved in the chemical industry, however, the hazards of the materials employed ranged across the spectrum of many of the hazard categories identified in Table No. 10-A of the 1973 Edition of the UBC.

In the industry’s infancy research and development was conducted in a laboratory environment. As the industry grew, factory scale operations evolved and the operations conducted were carried out

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<sup>75</sup> Wade, Richard, Williams, M. and Wong, J., *Semiconductor Industry Study*, California Department of Industrial Relations, Division of Occupational Safety and Health, Taskforce on the Electronics Industry, 1981, San Francisco, CA, p. 3.

<sup>76</sup> Rohm, T., Scarpace, L. and Fluer, L., *The Chemical Nature of the Microelectronics Industry*, The Microelectronics Industry, Occupational Medicine, Joseph LaDou, Editor, Volume 1/Number 1, January-March 1986, Hanley & Belfus, Inc., Philadelphia, PA, p. 13.

in “clean rooms” in which temperature, humidity and particulates were tightly controlled. The required floor area of the buildings in which manufacturing was conducted quickly expanded from one where several thousand square feet may have been needed to one where the clean room alone could exceed 40,000 square feet. The area in which the devices were produced was called a fabrication area (or fab) which was an outgrowth of the early term “fab lab” which had been used to describe the R&D environment in which early semiconductor devices were produced; and it was not uncommon for a building to have multiple fabrication areas each with their own unique set of hazardous materials. The transition from laboratory to factory environments in the 1970’s was explosive as the industry evolved out of the R&D phase and the transition was made to volume production.

The chemicals used involved a number of materials that were exotic compared with those typically encountered in general industrial applications. A number of the manufacturing steps involve the use of gaseous atmospheres and the hazards of the gases include those that are pyrophoric, flammable, oxidizing, nonflammable, corrosive, toxic or highly toxic and others. Corrosive and oxidizing liquids and flammable solvents were also required to be used in quantities exceeding the tabular limits of 1970 UBC Table No. 10-A. With a reorganization of the UBC in 1979 Table No. 10-A became Table No. 9-A. In the time period 1979-1980 code officials in UBC jurisdictions where the semiconductor industry was principally located became aware that factory operations had been permitted to be constructed as business (Group B) uses even though the quantities of hazardous materials had exceeded the quantity thresholds otherwise requiring classification as a hazardous occupancy under the requirements of the UBC.

From a building code perspective, the height and area limits imposed on hazardous occupancies compared with factory or business occupancies represent a significant reduction in allowable area. For example, using the 1979 Edition of the UBC and considering a single story building of non-fire-rated, non-combustible construction (Type IIB) with 60 foot clear side yards, the maximum allowable area is reduced from what could be unlimited area of construction to an area of 7,400 square feet.<sup>77</sup> Even with the most rigorous type of construction (Type I FR), the maximum area allowed for a building in an H-1 or H-2 occupancy was 30,000 square feet,<sup>78</sup> and the industry was envisioning clean rooms, not counting the requirements for support space that would grow from 45,000 to 100,000 square feet. In 1980 construction in California for this rapidly growing industry

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<sup>77</sup> *Uniform Building Code*, 1979 Edition, International Conference of Building Officials, Whittier, CA, §505(a), p. 50.

<sup>78</sup> *Ibid*, §506(b) and Table 5-C, pp. 52-59.



was either delayed or suspended as code officials and industry representatives sought to address the limitations imposed by the code relative to occupancy, area limitations and other restrictions.

After a collaborative effort of several years between the semiconductor industry, code professionals and regulatory officials a set of requirements that embodied construction features and engineering controls was developed and adopted into the 1984 Supplement to the UBC and UFC as the Group H-6 Occupancy.<sup>79</sup> The H-6 concept and the spread of the high tech industries throughout the country quickly raised the awareness of code officials to the problems inherent in codes that were either overly restrictive with respect to quantity or type of materials, or which did not recognize the wide array of hazard categories which were defined by the fire prevention codes or under the hazard communication standards of OSHA.

**3.3 Need for Comprehensive Controls Recognized.** The task of revising the *Uniform Fire Code* that established the 1971 Edition spanned a period from August 1970 to the fall of 1971. Correlation between the building and fire code was a major goal of the Fire and building Code Correlating Committee that performed the task. Due to timing the committee came to the realization that although the UFC could be completed, that the time needed for making companion changes to the UBC was not available. In the introduction to the 1971 *Uniform Fire Code*, the Correlating Committee in considering the need for broader and more detailed requirements, especially regarding structures that housed unusual materials or processes opined...

*It is also the hope of the committee that a future edition of the Uniform Building Code will answer the need for broader and more detailed requirements for structures housing in part unusual materials or processes which probably would be classified as an "E" (hazardous) use. This would alleviate the need for some of the regulations now remaining in the Uniform Fire Code. Examples are requirements for: Cellulose Nitrate Motion Picture Film Vaults; Flammable Liquid Inside Storage and Handling Rooms; Storage Rooms for Organic Peroxides; and Tents and Air Supported Structures.<sup>80</sup>*

The semiconductor industry efforts to achieve parity in the codes published by ICBO, BOCA and SBCCI occurred over the period from 1980 to 1987. The establishment of the H-6 occupancy in the UBC included a comprehensive set of controls to address hazardous materials used by the high-tech industries. In 1984 BOCA adopted the concept of exempt amounts for hazardous materials, liquids

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<sup>79</sup> 1984 *Accumulative Supplement to the Uniform Building code, U.B.C. Standards, Uniform Mechanical Code, Uniform Administrative Code, Uniform Housing Code, Uniform Building Security Code, Uniform Fire Code*, International Conference of Building Officials, Whittier, CA, UBC pp. 7-10 and UFC pp. 142-155.

<sup>80</sup> *Uniform Fire Code*, 1971 Edition, Introduction (p. un-numbered).

and chemicals into Table 306.2.1 of the BOCA Basic/National Code in 1984.<sup>81</sup> In 1987 BOCA adopted provisions for HPM Use (hazardous production material) facilities comparable to those established in the UBC for semiconductor manufacturing facilities with provisions adopted into the building and fire prevention codes.<sup>82</sup> The Standard Building and Fire Prevention Codes published by SBCCI adopted provisions for *Hazardous Production Material Facilities* into the 1988 publication of the Standard Codes.<sup>83</sup>

During the period 1980 – 1987 a series of changes occurred within the regional model codes involving hazardous materials that began in the Western region with codes published by ICBO and WFCA with changes carried progressively from west to east to BOCA and then south to SBCCI. The primary change began with the creation of the H-6 Occupancy in the Uniform Codes which activated a movement to address hazardous materials in general storage and use in a comprehensive manner. The formation of the H-6 Occupancy and legislation at the Federal level served to raise the awareness of the regulatory community and industry professionals to a point where hazardous materials received national attention in the model codes. This was reinforced by continued pressure in the workplace exercised by the workplace controls and hazards communication program of OSHA, the hazardous waste regulations of the EPA, and allied regulation associated with Community Right-To-Know regulations and the Chemical Emergency Preparedness Plan requirements (CEPP).

### **3.4 Proactive Approach By Industry To Hazardous Materials Control Leads To Harmonization.**

As the interest group broadened to the three regional model codes the industry's effort turned to correlation between the model codes. Harmonization became of interest as large industries had facilities in more than one code region and input into the development of provisions affecting the storage and use of hazardous materials regulated by the regional building and fire prevention codes intensified throughout the 1980's and 1990's. In 1984 activity began within the California Fire Chiefs Association to substantially revise and update the Uniform Fire Code approach to hazardous materials control. Simultaneously, ICBO initiated a committee to rewrite Chapter 9 of the UBC addressing requirements for hazardous occupancies, earlier classified as Group E and which were had been defined as Group H Occupancies with the 1976 revisions to the Uniform Building Code.

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<sup>81</sup> *The BOCA Basic/National Building Code*, 1984 Edition, Building Officials and Code Administrators International, Inc., Table 306.2.1, p. 51.

<sup>82</sup> *The BOCA National Building Code*, 1987 Edition, Building Officials and Code Administrators International, Inc., pp. 85-90.

<sup>83</sup> *Standard Building Code*, 1988 Edition, Southern Building Code Congress International, Inc., Birmingham, AL, pp. 93-99.

The groups identified the need for revision based on a number of factors including the fact that:

- Existing provisions were very broad in scope.
- Hazardous materials regulations were limited and addressed only several of the many categories of hazard now recognized.
- Little specific guidance was offered from the provisions in the existing code.
- Lack of specific requirements resulted in non-uniform enforcement and application of the code.
- The provisions in the fire prevention codes and the building codes were not well correlated.
- UBC Table No. 9-A did not provide sufficient flexibility to address the wide array of industrial uses of hazardous materials. As demonstrated in the development of the provisions for H-6 Occupancies, a specific set of user controls could be of benefit to all parties.

Goals of the groups working to revise the UBC and UFC included, but were not limited to the following:

- Providing reasonable minimum safeguards.
- Protecting building occupants and the public from untoward events involving hazardous materials.
- Minimizing the impact of events on the public. Toxic and highly toxic gases were identified as an important issue based on the potential impact on areas off site.
- Protecting emergency responders.
- Providing guidance for users and inspectors.
- Promotion of uniformity of approach and control of comparable hazards in keeping with the concept of equivalent risk.

Revisions in response to the identified needs and goals would ultimately be adopted into the 1988 Edition of the Uniform Codes.

**3.5 Evolution Continues (1988 – 1993).** The revisions produced in the 1988 Edition of the Uniform Codes continued to evolve as various stakeholders brought concerns into the code development process and work continued from 1988 to the mid 1990's with changes being adopted by BOCA and SBCCI that recognized the pattern established in the IBC. There were modifications made to address regional differences as the provisions worked their way through the regional groups; but the essential concepts of hazardous materials control established in the UBC/UFC remained intact. The general, and now expanded concept of "exempt amounts" to include the use of a table that included conditions of storage, closed and open use as well as the related use of control areas was

adopted into the Standard Codes in 1991<sup>84</sup>, and in the BOCA codes in 1993.<sup>85</sup> The use of exempt amounts and control areas will be discussed in Section 4 of this report.

**3.6 Regional Codes Coalesce and the ICC Emerges.** The International Code Council (ICC) was established in 1994 (See discussion in Section 2.1.6), and public participation was invited. The *first draft* of the *International Fire Code*<sup>®</sup> (IFC) was published in October of 1997<sup>86</sup> and the *first draft* of the *International Building Code*<sup>®</sup> (IBC) was published in November of 1997.<sup>87</sup>

NFPA was party to the development of the First Draft of the IFC; however, by the time the first round of changes was proposed to the draft in 1998 NFPA and the ICC had agreed to pursue different interests and the cooperative effort to jointly publish the IFC was terminated. The First Editions of the IFC and IBC were published in March of 2000. The concept of hazardous materials control and hazardous occupancies established in the three regional codes, now known as the *legacy codes* was incorporated into the I-Codes. After entering a partnership with the Western Fire Chiefs Association, NFPA went on to publish the 2003 Edition of NFPA's Fire Prevention Code as NFPA 1 *Uniform Fire Code*. NFPA 1 contains a Chapter on hazardous materials which incorporated many of the concepts that had been embodied in the 1997 and 2000 Editions of the *Uniform Fire Code* published by WFCA.<sup>88</sup>

Although there were revisions that occurred in each of the legacy codes in the period between 1988 and 1996 the pattern established by ICBO and WFCA's UFC was used as a template for provisions regulating hazardous materials including the concept of exempt amounts and control areas.

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<sup>84</sup> *Standard Building Code*, 1991 Edition, Southern Building Code Congress International, Birmingham, AL, §408, pp. 74-101.

<sup>85</sup> *The BOCA National Building Code/1993*, Building Officials & Code Administrators International, Inc., Country Club Hills, IL, §307, pp. 17 – 23.

<sup>86</sup> *International Fire Code, First Draft*, International Code Council, Inc., Building Officials and Code administrators International, Inc., Country Club Hills, IL, International Conference of Building Officials, Whittier, CA, Southern Building Code Congress International, Inc., Birmingham, AL and National Fire Protection Association, Quincy, MA, October 1997.

<sup>87</sup> *International Building Code, First Draft*, International Code Council, Inc., Building Officials and Code administrators International, Inc., Country Club Hills, IL, International Conference of Building Officials, Whittier, CA, Southern Building Code Congress International, Inc., Birmingham, AL, November 1997.

<sup>88</sup> *NFPA 1 Uniform Fire Code*, 2003 Edition, p. 1-1.

## 4 UNIFORM BUILDING CODE ESTABLISHES TEMPLATE FOR THE REGULATION OF HAZARDOUS MATERIALS THROUGH THE USE OF QUANTITY LIMITS

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**4.0 Quantity Based Controls Broadened To Address Physical and Health Hazard Materials (1985 – 1988).** There were two independent committees that worked to further update and develop the control concepts embodied in Chapter 9 of the UBC for Hazardous Occupancies (Group H) and of UFC Article 80 for Hazardous Materials. The committee working on the UBC was appointed by ICBO’s Board of Directors. The committee working on revisions to the UFC was an ad hoc committee formed under the auspices of the California Fire Chiefs Association and managed by the Southern California Fire Prevention Officers Association. The ICBO committee operated under rules established for a governmental consensus process with voting membership on the committee limited to governmental officials. Industry participation was invited, but overall industry participation was narrow. The voting membership on the ad hoc committee working on the UFC included regulatory or governmental officials as well as representatives from stakeholder industries. As in the case of the building code, industry participation on the ad hoc committee was narrow although the committee actively tried to broaden the input.

The quantities of hazardous materials listed in UBC Table No. 9-A were designated as “exempt amounts.” They were not exempt from regulation, as misinterpreted by some, rather when the quantities were not exceeded; the exemption was that the occupancy in which the materials were located did not revert to Group H. Table No. 9-A included materials that are recognized as *physical hazards* and others that are recognized as *health hazards* under definitions promulgated by OSHA.

A physical hazard material is a material that had the potential for fire, explosion or physical events that can damage physical structures. A health hazard material is one that can have a deleterious effect on living beings. The concept of physical hazard and health hazard is not unlike those embodied in the terms “fire and life safety” with the exception that life could also be imperiled by events other than a fire or explosion e.g., inhalation of toxics, bodily contact with corrosives, etc.

With the publication of the 1988 Edition of the UBC the 1973 version of Table No. 9-A, as it had evolved to the 1985 Edition was revised to create a new table and limited to physical hazard materials, and a new Table No. 9-B was created for health hazard materials. In addition, a new Table No. 9-E was created to establish quantity limits above which a detached building would be

required. The new tables combined both quantity and *condition* as a means to recognize that materials in use represented a different level of risk to building occupants. There were four *conditions* that were identified and integrated into the UBC and UFC. The conditions included:

Storage

Use Open

Use Closed

Handling (on site transport)

Other elements of the tables that were either new or relatively new to the code included the use of “multipliers” or “credits” in the form of footnotes where credit was given for added protection features such as sprinklers, storage cabinets, safety cans and *control areas*.<sup>89</sup> UBC Table No. 9-A and Table No. 9-B are shown as Tables 9 and 10 below. Detached building threshold limits are briefly discussed in Section 4.2 of this report. Table No. 9-E from the 1988 Edition of the UBC is included as Table 14. Unlike the threshold limits imposed by Table Nos. 9-A and 9-B, the detached building threshold limit is an aggregate and no distinction is made as to *condition*, i.e., storage, use or handling.

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<sup>89</sup> *Uniform Building Code*, 1988 Edition, International Conference of Building Officials, Whittier, CA, Tables No. 9-A and 9-B, pp. 78-81.

TABLE 9

**1988 UBC Table No. 9-A Exempt Amounts Of Hazardous Materials, Liquids  
And Chemicals Presenting A Physical Hazard  
Basic Quantities Per Control Area<sup>1</sup>**

**When two units are given, values within parentheses are in cubic feet (Cu. Ft.) or pounds (Lbs.)**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
1.1 Combustible liquid <sup>3</sup>	II	-	120 <sup>45</sup>	-	-	120 <sup>4</sup>	-	-	30 <sup>4</sup>	-
	III-A	-	330 <sup>45</sup>	-	-	330 <sup>4</sup>	-	-	80 <sup>4</sup>	-
	III-B	-	13,200 <sup>56</sup>	-	-	13,200 <sup>6</sup>	-	-	3,300 <sup>6</sup>	-
1.2 Combustible dust lbs./1000 cu. ft.		1 <sup>7</sup>	-	-	1 <sup>7</sup>	-	-	1 <sup>7</sup>	-	-
1.3 Combustible fiber	(loose) (baled)	(100) (1,000)	-	-	(100) (1,000)	-	-	(20) (200)	-	-
1.4 Cryogenic, flammable or oxidizing		-	45	-	-	45	-	-	10	-
2.1 Explosives		1 <sup>589</sup>	(1) <sup>589</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-
3.1 Flammable solid		125 <sup>45</sup>	-	-	25 <sup>4</sup>	-	-	25 <sup>4</sup>	-	-
3.2 Flammable gas	Gaseous	-	-	750 <sup>45</sup>	-	-	750 <sup>45</sup>	-	-	-
	Liquefied	-	15 <sup>45</sup>	-	-	15 <sup>45</sup>	-	-	-	-
3.3 Flammable liquid <sup>3</sup>	I-A	-	30 <sup>45</sup>	-	-	30 <sup>4</sup>	-	-	10 <sup>4</sup>	-
	I-B	-	60 <sup>45</sup>	-	-	60 <sup>4</sup>	-	-	15 <sup>4</sup>	-
	I-C	-	90 <sup>45</sup>	-	-	90 <sup>4</sup>	-	-	20 <sup>4</sup>	-
Combination I-A, I-B, I-C		-	120 <sup>4510</sup>	-	-	120 <sup>410</sup>	-	-	30 <sup>410</sup>	-
4.1 Organic peroxide unclassified detonable		1 <sup>58</sup>	(1) <sup>58</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-
4.2 Organic peroxide	I	5 <sup>45</sup>	(5) <sup>45</sup>	-	1 <sup>4</sup>	(1) <sup>4</sup>	-	1 <sup>4</sup>	(1) <sup>4</sup>	-
	II	50 <sup>45</sup>	(50) <sup>45</sup>	-	50 <sup>4</sup>	(50) <sup>4</sup>	-	10 <sup>4</sup>	(10) <sup>4</sup>	-
	III	125 <sup>45</sup>	(125) <sup>45</sup>	-	125 <sup>4</sup>	(125) <sup>4</sup>	-	25 <sup>4</sup>	(25) <sup>4</sup>	-
	IV	500	(500)	-	500 <sup>4</sup>	(500)	-	100	(100)	-
	V	N.L.	N.L.	-	N.L.	N.L.	-	N.L.	N.L.	-
4.3 Oxidizer	4	1 <sup>58</sup>	(1) <sup>58</sup>	-	¼ <sup>8</sup>	(¼) <sup>8</sup>	-	¼ <sup>8</sup>	(¼) <sup>8</sup>	-
	3	10 <sup>45</sup>	(10) <sup>45</sup>	-	2 <sup>4</sup>	(2) <sup>4</sup>	-	2 <sup>4</sup>	(2) <sup>4</sup>	-
	2	250 <sup>45</sup>	(250) <sup>45</sup>	-	250 <sup>4</sup>	(250) <sup>4</sup>	-	50 <sup>4</sup>	(50) <sup>4</sup>	-
	1	1,000 <sup>45</sup>	(1,000) <sup>45</sup>	-	1,000 <sup>4</sup>	(1,000) <sup>4</sup>	-	200 <sup>4</sup>	(200) <sup>4</sup>	-
4.4 Oxidizer gas	Gaseous	-	-	1,500 <sup>45</sup>	-	-	1,500 <sup>45</sup>	-	-	-

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
	Liquefied	-	15 <sup>4.5</sup>	-	-	15 <sup>4.5</sup>	-	-	-	-
5.1 Pyrophoric		4 <sup>5.8</sup>	(4) <sup>5.8</sup>	50 <sup>5.8</sup>	1 <sup>8</sup>	(1) <sup>8</sup>	10 <sup>5.8</sup>	0	0	0
6.1 Unstable (reactive)	4	1 <sup>5.8</sup>	(1) <sup>5.8</sup>	10 <sup>5.8</sup>	¼ <sup>8</sup>	(¼) <sup>8</sup>	2 <sup>5.8</sup>	¼ <sup>8</sup>	(¼) <sup>8</sup>	0
	3	5 <sup>4.5</sup>	(5) <sup>4.5</sup>	50 <sup>4.5</sup>	1 <sup>4</sup>	(1) <sup>4</sup>	10 <sup>4.5</sup>	1 <sup>4</sup>	(1) <sup>4</sup>	0
	2	50 <sup>4.5</sup>	(50) <sup>4.5</sup>	250 <sup>4.5</sup>	50 <sup>4</sup>	(50) <sup>4</sup>	250 <sup>4.5</sup>	10 <sup>4</sup>	(10) <sup>4</sup>	0
	1	125 <sup>4.5</sup>	(125) <sup>4.5</sup>	750 <sup>4.5</sup>	125 <sup>4</sup>	(125) <sup>4</sup>	750 <sup>4.5</sup>	25 <sup>4</sup>	(25) <sup>4</sup>	0
7.1 Water (reactive)	3	5 <sup>4.5</sup>	(5) <sup>4.5</sup>	-	5 <sup>4</sup>	(5) <sup>4</sup>	-	1 <sup>4</sup>	(1) <sup>4</sup>	-
	2	50 <sup>4.5</sup>	(50) <sup>4.5</sup>	-	50 <sup>4</sup>	(50) <sup>4</sup>	-	10 <sup>4</sup>	(10) <sup>4</sup>	-
	1	125 <sup>5.6</sup>	(125) <sup>5.6</sup>	-	125 <sup>6</sup>	(125) <sup>5.6</sup>	-	25 <sup>6</sup>	(25) <sup>6</sup>	-

N.L. = Not Limited.

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>3</sup>The quantities of alcoholic beverages in retail sales uses are unlimited provided the liquids are packaged in individual containers not exceeding four liters. The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>6</sup>The quantities permitted in a sprinklered building are not limited.

<sup>7</sup>A dust explosion potential is considered to exist if 1 pound or more of combustible dust per 1,000 cubic feet of volume is normally in suspension or could be put into suspension in all or a portion of an enclosure or inside pieces of equipment. This also includes combustible dust which accumulates on horizontal surfaces inside buildings or equipment and which could be put into suspension by an accident, sudden force or small explosion.

<sup>8</sup>Permitted in sprinklered buildings only. None is allowed in unsprinklered buildings.

<sup>9</sup>One pound of black sporting powder and 20 pounds of smokeless powder are permitted in sprinklered or unsprinklered buildings.

<sup>10</sup>Containing not more than the exempt amounts of Class I-A, Class I-B or Class I-C flammable liquids.



TABLE 10

**1988 UBC Table No. 9-B**  
**Exempt Amounts Of Hazardous Materials, Liquids**  
**And Chemicals Presenting A Health Hazard**  
**Maximum Quantities Per Control Area<sup>1,2</sup>**  
**When two units are given, values within parentheses are in pounds (Lbs.)**

Material <sup>4</sup>	STORAGE <sup>3</sup>			USE <sup>3</sup> - CLOSED SYSTEMS			USE <sup>3</sup> - OPEN SYSTEMS		
	Solid Lbs. <sup>5,6</sup>	Liquid Gallons <sup>5,6</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons <sup>5</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons <sup>5</sup> (Lbs.) <sup>5</sup>	Gas Cu.Ft.
1. Corrosives	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-
2. Highly Toxics <sup>8</sup>	1	(1)	20 <sup>7</sup>	1	(1)	20 <sup>7</sup>	1/4	(1/4)	-
3. Irritants	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-
4. Sensitizers	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-
5. Other Health Hazards	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup> The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>3</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>For carcinogenic and radioactive materials, see the Fire Code.

<sup>5</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 6 also applies, the increase for both footnotes may be applied.

<sup>6</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>7</sup>Permitted only when stored in approved exhausted gas cabinets, exhausted enclosures or fume hoods.

<sup>8</sup>For special provisions, see the Fire Code

**4.0.1 Quantity Limits Established.** The 1973 UBC Edition of Table No. 9-A evolved with minor changes throughout the time period between its initial adoption into the 1973 UBC until the publication of the 1985 Edition which became the starting point for the major revisions that resulted in the inclusion of Table Nos. 9-A and 9-B in the 1988 Edition of the Uniform Building Code. The refinements that occurred in the table between 1973 and 1985 were limited primarily to footnotes that addressed the following:

- Quantities of alcoholic beverages in retail sales or storage uses were unlimited providing that the liquids were packaged in individual containers not exceeding 4 liters.<sup>90</sup>
- Quantities of medicines, foodstuffs and cosmetics in retail sales or storage occupancies were unlimited providing that these products contained less than 50 percent by volume water-miscible combustible or flammable liquids with the remainder of the solution not being flammable.<sup>91</sup>

In addition, two line items were added to the table to address quantities of smokeless and black sporting powder when stored in accordance with the requirements of the Uniform Fire Code, e.g., magazines, etc. The exempt quantities for smokeless and black powder were added to address the storage of these materials as found in the typical sporting goods store.<sup>92</sup>

The determination of the quantity levels included in the 1988 Edition of the UBC will be discussed on a category by category basis in Section 5 of this report.

**4.0.2 Hazard Categories Established.** In developing the hazard categories for the new tables to be included in the 1988 Edition of the codes the committees working on the issue considered the following:

- There was precedent in the UBC to address hazardous materials in terms of generic hazard categories, e.g., flammable liquids, oxidizing material, flammable solids, etc.

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<sup>90</sup> *1982 Analysis of Revisions to the Uniform Codes*, International Conference of Building Officials, Whittier, CA, 1982, p. 6.

<sup>91</sup> Ibid.

<sup>92</sup> Ibid.

- OSHA’s Hazard Communication Standard categorized hazardous materials into two broad categories including materials characterized as *physical hazards* and materials designated as *health hazards*. The list of materials embodied in the 1985 Edition of the UBC did not include all of the hazard categories now designated as hazardous within the context of the workplace standards. For example, the categories of pyrophoric, water reactive, cryogenic fluids, corrosives, toxics, and others were not included.
- With the exception of flammable and combustible liquids which had been classified based on hazard designations promulgated by NFPA, i.e., Class I, II and III liquids, there was no other material hazard category that used hazard class as a means to show or differentiate between materials that may represent a different level of hazard within a given hazard category. On the other hand, NFPA had developed a classification system for solid and liquid oxidizers, unstable reactives, water reactives, organic peroxides and others.
- The definitions used for the hazard categories identified in the existing UBC tables were not consistent with the definitions used by OSHA, NFPA, or DOT which provided a cause for confusion when code users attempted to classify the various hazardous materials to be stored or used.
- With the exception of flammable and combustible liquids, there was no apparent equity or comparability established across the spectrum of hazards that may be present within a given group. For example, unstable materials were limited to “none” regardless of the degree of instability and the comparability of hazard between materials such as corrosive liquids (55 gallons) and oxidizing liquids (50 gallons) was not able to be identified.
- In some cases specific materials, rather than generic hazard categories, were listed, e.g., ammonium nitrate [CAS 6484-52-2], nitromethane [CAS 75-52-5], ammonium nitrate compound mixtures, black powder, etc.

One of the first steps was to correlate the hazard categories to the list of hazards identified by OSHA as physical or health hazards. These categories became the basis for Table Nos. 9-A and 9-B. The categories were chosen as they were the categories

that would be identified by Material Safety Data Sheets (MSDS) required to be provided by the suppliers, producers and importers.<sup>93</sup> Also, it was these same MSDS that were provided to code officials and users when requested as a means to evaluate the hazards of a material to be permitted on site. The following considerations were also measured:

- There was consideration given to the fact that the DOT classification system was somewhat different from the hazard classification system used by OSHA, and it was recognized that the NFPA ranking system that was used to recognize a gradation of hazards for a spectrum of materials such as flammable and combustible liquids, oxidizers, organic peroxides, water reactives and unstable materials was established.
- Specific materials such as black powder, ammonium nitrate and others could be eliminated as these materials would be classified within one or more of the generic hazard categories, e.g., explosives, oxidizers, etc.

**Exemptions.** There was a recognized need to exempt (except) from the requirements for hazardous materials certain materials where it was not intended that the code apply. In the initial drafting of UFC Article 80 (Hazardous Materials) there were only two exceptions which included 1) an exception for the off-site transportation of hazardous materials when in conformance with DOT regulations, and 2) an exemption for alcoholic beverages, medicines, foodstuffs and cosmetics containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, in retail sales occupancies when packaged in individual containers not exceeding 4 liters.<sup>94</sup> It is important to note that by including the exemption for alcoholic beverages, medicines, foodstuffs and cosmetics as an exception to UFC Article 80 the application was broadened from

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<sup>93</sup> *Occupational Safety and Health Standards*, 29 CFR Part 1910.1200, Changes through change 47 dated 7/17/87 affecting definitions was noted. Change No. 48 dated 6/3/88 may have affected certain definitions in § 1910.1200 no substantial differences were noted that had an impact on the direction established by the revisions occurring in the tables to the Uniform Codes during the period of concern.

<sup>94</sup> *Uniform Fire Code*, 1988 Edition, International Conference of Building Officials and Western Fire Chiefs Association, Whittier, CA, §80.101, p. 318.

limiting it to liquids that were either combustible or flammable to liquids in other hazard categories.

As the code evolved and transitioned into the 2000 Edition of the *International Fire Code* the number of exceptions had grown to nine and included the following:<sup>95</sup>

1. The quantities of alcoholic beverages, medicines, foodstuffs, cosmetics, and consumer or industrial products containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, in retail or wholesale sales occupancies, are unlimited when packaged in individual containers not exceeding 1.3 gallons (5L).
2. Application and release of pesticide and agricultural products and materials intended for use in weed abatement, erosion control, soil amendment or similar applications when applied in accordance with the manufacturer's instructions and label directions.
3. The off-site transportation of hazardous materials when in accordance with DOT regulations.
4. Building materials not otherwise regulated by this code.
5. Refrigeration systems.
6. Stationary lead-acid batteries regulated by Section 608.
7. The display, storage, sale or use of fireworks and explosives in accordance with Chapter 33 (explosives).
8. Corrosives utilized in personal and household products in the manufacturer's original consumer packaging in Group M occupancies.
9. The storage of distilled spirits and wines in wooden barrels and casks.

The initial list of exemptions had been refined to recognize certain building related services such as refrigeration systems, backup battery systems, fuel gas systems, etc. A limited number of exemptions were provided, primarily for common materials found in retail sales, and the list has grown over time as various interests seek exemption.

**4.0.3 Condition as a Means of Control.** The *condition* of a material refers to the circumstance in which it is found. The code establishes three fundamental conditions including that of *storage*, *use* and *handling*. Specific definitions for each

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<sup>95</sup> *International Fire Code*, 2000 Edition, International Fire Code Council, Country Club Hills, IL, §2701.1, p. 217.

of these conditions will be discussed in Section 5, however, a brief description of each at this juncture is appropriate:

***Storage*** is an inanimate state or condition where the material is essentially at rest. This is easily pictured for containers such as drums, bottles, bags, cylinders and other similar containers where it is obvious to the observer that the containers are capped, plugged or otherwise closed. The picture becomes more complex as the size of a container grows such as where the container may be a bulk tank that has connected piping systems. Such systems may be arranged solely to act as a source of material where the container is not refilled on site, or the system may be arranged so that material is added to a portion of the system where it remains until it is needed at which point it is transferred out of the “storage” component.

***Use*** involves placing the material into a condition where it is consumed, reacted in a process, mixed, blended or similar operations. In general large storage vessels, tanks, tubes, trailers, etc. located outside of a building or structure are viewed as being a portion of the storage system. On the other hand, when piping is used to convey the material from one point to another, or when the material is being dispensed it is considered to be in a condition of use. The storage system is typically viewed to terminate at a shut off such as a gate, a valve, or similar component immediately downstream of the storage vessel. An example that will assist the user is to visualize a large storage tank of the type typically used for storage of the public supply of natural gas. The gas could either be in the gaseous or cryogenic state. The container(s) that hold the gas are *storage* containers. The storage terminates at the shut off control at the public utility. The material in the pipeline is transmitted through a closed piping system to the user where the material is consumed or otherwise utilized.

***Handling*** within the context of the codes (1988 forward) is the transportation of material between a point of storage and a point of use. It is the deliberate movement of material. Off site transportation that is regulated by DOT or similar outside agencies is not within the scope of the model codes. Therefore, the natural gas used in the example above to describe use is not within the scope of the code until it arrives on site and becomes regulated by the Fuel Gas Code. The typical *handling* conditions include on site movement by hand carts and hand trucks, powered trucks, and other mobile equipment. Interconnecting piping is typically viewed as material that is in use. In application this distinction may involve some

judgment as piping systems which move materials from a point of production to a point of storage can be extensive. If the piping system is under the purview of an outside agency such as DOT, it is not regulated by the code.

A specific rationale for the tabular limits by hazard category and class will be provided in Section 5 of this report. However, it is helpful at this juncture to understand that the following concepts and considerations were built into the tables as they were constructed for inclusion in the 1988 Edition of the UBC.

- Materials that are open to the atmosphere present a higher risk than materials that are located within closed systems. This is due to the fact that fumes, mists or vapors may be liberated to the atmosphere, and that there may be either physical or health hazards associated with the liberation of the materials. The conditions of *use, open* and *use, closed* are specifically defined.
- The form of the material is limited to the three common states of matter, i.e., *solid, liquid* and *gas*. Each state has a specific definition. Other states of material may in fact exist such as semi-solid; however, the classic states are used for regulatory purposes.
- The hierarchy of hazards from low to high is ranked based on the state of material with solids having the lower degree of hazard and gases having the higher degree of hazard.
- Materials stored with a layer of physical protection present less of a risk than materials stored without protection. For example, the use of hazardous materials storage cabinets, gas cabinets, exhausted enclosures, safety cans, were viewed as providing isolation or similar protective barriers.<sup>96</sup>

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<sup>96</sup> The use of safety cans, although primarily employed for flammable and/or combustible liquids was viewed as an enhancement which had been recognized as a means of control for small quantities of material. As a precedent it was considered that NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals*, recognized storage cabinets and safety cans as a means to exclude flammable and combustible liquids from certain tabular limits when assigning a classification to laboratories. *NFPA 45 Fire Protection for Laboratories Using Chemicals*, 1986 Edition, National Fire Protection Association, Quincy, MA, Table 2-2.

- Sprinklered buildings presented a reduced level of risk to unsprinklered buildings. The use of sprinklers to allow a doubling of the quantity of flammable and combustible liquids in storage and use in all occupancies was integral to Table No. 9-A of the 1985 Edition of the UBC.<sup>97</sup> The same allowance for flammable and combustible liquids was also provided by NFPA 45 *Fire Protection for Laboratories Using Chemicals*.<sup>98</sup>
- The retail sales of limited quantities and types of hazardous materials should be exempted from the tabular limits. The types were limited to alcoholic beverages, medicines, foodstuffs and cosmetics when packaged in individual packages up to 4 liters in volume. The exemption for alcoholic beverages was without regard to alcohol content while the exemption for medicines, foodstuffs and cosmetics was limited to materials comprised of water miscible liquids in a quantity not more than 50% by volume with the remainder of the material not being flammable. The exemption had been included in the 1985 Edition of the UBC limited to liquids that were combustible or flammable.<sup>99</sup> The exemption for alcoholic beverages, medicines, foodstuffs and cosmetics was broadened to include water-miscible liquids in any hazard category to recognize the expansion of the code into the emerging area of health hazard materials.
- Physical hazard materials that were subject to unpiloted autoignition (pyrophoric materials), or which presented a high potential for explosion upon exposure to fire were required to be in stored or used in sprinklered buildings, e.g., explosives, oxidizer Class 4, unstable reactive Class 4, and unclassified detonable organic peroxides.

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<sup>97</sup> *Uniform Building Code*, 1985 Edition, International Conference of Building Officials, Whittier, CA, Table No. 9-A, footnote 2, p. 66.

<sup>98</sup> *NFPA 45 Fire Protection for Laboratories Using Chemicals*, 1986 Edition, National Fire Protection Association, Quincy, MA, Table 2-2.

<sup>99</sup> *Uniform Building Code*, 1985 Edition, Table No. 9-A, footnote 1, p. 66.



- Certain physical hazard materials could be present in unlimited amounts without classifying the building or area as a hazardous occupancy when sprinklers were provided, e.g., combustible liquids, Class III-B.

**4.1 Control Areas and Their Evolution.** In explaining the nature of risk Roland and Moriarty explain consequences as the immediate results of the occurrence of the initiating event. Consequences are variable. For example, when a train derailed, the number of cars that leave the track, overturn, and burst open varies with the event. Consequences therefore describe the nature of the events up to the point of describing losses. On the other hand losses describe the results of consequences. Losses describe mortality, injury, morbidity and property damage to include damage to the environment. Risk can be defined in terms of probability or it can be described in terms of potential loss.<sup>100</sup>

As the tables of exempt amounts were developed, it was recognized that the historical approach to limit the various quantities of hazardous materials by hazard class to an absolute building limit was one way to reduce risk, but it was also recognized that doing so imposed a penalty on large buildings as well as multistoried buildings which were being constructed and being used within the built environment. In other words, under the 1973 tabular limits the quantities of hazardous materials was the same for very small buildings as it was for very large buildings.

One of the key elements of control integral to the newly developed H-6 Occupancy involved the consideration of density which limited the quantity of the various hazard classes to a workstation. Under the H-6 concept a workstation was defined as a designated space or independent piece of equipment using hazardous production materials where a specific function, procedure or research activity was conducted. Each workstation had assigned quantity limits, and in turn a maximum quantity of hazardous materials was established for each fabrication area. Fabrication areas, based on size represented a finite limit for the number of workstations that could be present, and the quantities per work station were limited by hazard class. The result was tabulated into a maximum quantity on a density

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<sup>100</sup> Roland, Harold E., and Moriarty, Brian, *System Safety Engineering and Management*, John Wiley and Sons, New York, 1983, pp. 282-284.

basis.<sup>101</sup> It stood to reason that limiting the quantity in any single location had an effect of limiting the consequences of an initiating event.

The concept of control area was developed as a means to allow quantities of hazardous materials to increase without declaring the occupancy to be a high hazard (Group H under the terminology of the Uniform Codes), providing construction features were added to compartmentalize the materials. The building owner or occupant had the ability to designate the entire building as a single control area, or to subdivide the building using fire-resistive construction for those partitions or floors within the building which were used to bound the control area. The following elements were integral to the control area concept:<sup>102</sup>

- The limited quantities of hazardous materials in storage and use within a control area that is separated from other elements of the building by one-hour construction does not substantially increase the risk to the occupants of a building, or change the character of the occupancy to a hazardous occupancy.
- A control area could be an entire building or only a portion of a building.
- Control areas were to be bounded by any combination of exterior walls, roofs, foundations or one-hour fire-resistive occupancy separations.
- The requirements for separation substantially reduce the risk of simultaneous emergencies occurring in more than one control area.
- Limiting the quantity of hazardous materials and then limiting the number of control areas is the means used to establish the maximum quantity of hazardous materials in a building that is classified as other than a hazardous occupancy.
- At some point, one-hour fire-resistive occupancy separations alone were deemed to be insufficient as a means to keep the overall character of the building from becoming a hazardous occupancy. As a result the number of control areas in the building was limited to four except for mercantile (retail and wholesale) occupancies in which the number of control areas was reduced to two. The reduction from four to two was intended to recognize the people sensitive nature of mercantile occupancies, and to encourage the use of “back of house” storage rooms for large quantities of hazardous materials.
- A control area by definition was not a hazardous occupancy.

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<sup>101</sup> *Uniform Fire Code*, 1988 Edition, Table No. 51.105-B, p. 155.

<sup>102</sup> *Hazardous Materials Requirements In The Uniform Building Code and The Uniform Fire Code*, International Conference of Building Officials and International Fire Code Institute, Whittier, CA, 1991, pp. IV-33 to IV-38.

The concept of fire-resistive separation or compartmentation has been a long standing and traditional means to limit the potential exposure between various areas or uses within a building. When the quantity of materials is increased, the requirements for fire-resistant separation increase. If the quantity is great enough, (Table No. 9A or 9B limits exceeded) the occupancy of the area is designated as being highly hazardous (Group H within the context of the UBC), and when the appropriate controls are applied, a hazardous occupancy can be collocated in a building with multiple or mixed occupancies. There are exceptions to the rule for explosives and materials with detonation hazards which are restricted to buildings other than those containing mixed occupancies or uses.

**4.1.1 Influence of Other Regional Codes on Control Area Concept.** As the concept of control areas was introduced to the BOCA and SBCCI code regions the limitations on the number of control areas, and in some cases their construction, varied. Under the ICBO concept the number of control areas was limited to four in an individual or separate building. Buildings that were separated by use of fire walls (area separation walls within the context of the Uniform Codes) could gain additional control areas, and by using multiple fire walls, there was effectively no limit to the number of buildings that could be created.

When the control area concept was initially proposed in the ICBO process the number of control areas was limited only by the area of the building and the number of compartments created. However, as the concept was new to the code the number of control areas was limited based on subjective judgment of those involved in the development process. Given the fact that one could have up to the “exempt amount” of each material on the table in an individual control area there was some concern that large storage buildings could be created and the requirements of the code for hazardous occupancies would be circumvented.

The SBCCI regional adoption of the concept increased the number of control areas from four to ten in single story buildings. Multistory buildings were limited to four. Requirements for construction was increased from one to two hours when the control areas were on different floors of the building, but adjacent to one another.

The basis for the increase in single story buildings was primarily perceived risk and subjective judgment was used to increase the number to ten.<sup>103</sup>

The increased density of building construction in the BOCA region was a consideration that focused the concept of control areas when located in multistoried buildings. Controls were developed to limit the number of control areas and the quantity of materials per floor that could be “exempt” without designating the occupancy as high hazard. The controls result in a pyramiding effect where the number of control areas per floor and the density of the materials are reduced as the number of floors in the building increase. Table 11 below as published in *The BOCA National Building Code* illustrates the concept:<sup>104</sup>

TABLE 11  
1996 BOCA National Permitted Number of Control Areas <sup>a,b</sup>

Floor Level	% of allowable exempt quantities per control area	Control areas per floor	Vertical fire separation walls (hours)
1	100	4	1
2	75	3	1
3	50	2	1
4	12.5	2	2
5	12.5	2	2
6	12.5	2	2
7-9	5	2	2
<b>Higher than 9</b>	5	1	2

**Note a.** The number of floor levels below grade shall not exceed two. The first floor level below grade shall be limited to 75 percent of the maximum allowable exempt quantity per control area with a maximum of three control

<sup>103</sup> *Standard Building Code*, 1991 Edition, Southern Building Code Congress, International, Inc., Birmingham, AL, §408.1.2.1, p. 75.

<sup>104</sup> *The BOCA National Building Code/1993*, Building Officials and Code Administrators International, Inc., Country Club Hills, IL, Table 417.2, p. 43

areas. The second floor level below grade shall be limited to 50 percent of the maximum allowable exempt quantity per control area with a maximum of two control areas.

**Note b.** In mercantile occupancies, a maximum of two control areas per floor shall be permitted in retail sales rooms.

The philosophy was built to encourage designers and owners to minimize the quantities of hazardous materials that could be located in general areas in higher reaches of the building, and with recognition that multistoried buildings containing laboratory operations were common. It was envisioned that storage rooms could be constructed on upper floors where the occupancy of the storage room would be a high hazard occupancy. This type of design encourages the minimization of hazardous materials to be placed on floors above the ground floor, while providing a means to allow these materials to be stored and used on the upper floors. In considering the quantities the fire service expressed concern with allowing quantities to increase on higher floors due to the difficulty in response should an incident occur. There are other limitations in the building codes which limit the character of the occupancy allowed in upper stories of a multistoried building that may be imposed depending on the type of construction and nature of the occupancy. However, as a general rule buildings of Type I construction allow for occupancies other than those containing detonable materials, e.g., explosives, unstable reactive Class 4 materials, etc. to be located on floors above the third floor.<sup>105</sup> Therefore, the BOCA approach was recognized as a way to provide a reasonable level of control which met the needs of the fire service and industry for a number of buildings that would otherwise have been severely limited using the initial concept developed by ICBO which limited the number of control areas to four without regard to building height.

The BOCA concept transitioned into the 2000 IBC as Table 414.2.2 as follows:

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<sup>105</sup> *Building Construction and Safety Code, NFPA 5000*, 2006 Edition, National Fire Protection Association, Quincy, MA, Table 7.3.5.5, p. 5000-96.

TABLE 12

**2000 IBC Table 414.2.2 Design and Number of Control Areas**

Floor Level		Percentage of the Maximum Allowable Quantity per Control Area <sup>a</sup>	Number of Control Areas Per Floor <sup>b</sup>	Fire Resistance Rating for Fire Barriers in Hours <sup>c</sup>
Above Grade	Higher than 9	5	1	2
	7-9	5	2	2
	6	12.5	2	2
	5	12.5	2	2
	4	12.5	2	2
	3	50	2	1
	2	75	3	1
	1	100	4	1
	1	75	3	1
Below Grade	2	50	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

- Percentages shall be of the maximum allowable quantity per control area shown in Tables 307.7(1) and 307.7(2), with all increases allowed in the footnotes of those tables.
- There shall be a maximum of two control areas per floor in Group M occupancies and in buildings or portions of buildings having Group S occupancies with storage conditions and quantities in accordance with Section 414.2.4.
- Fire barriers shall include walls and floors as necessary to provide separation from other portions of the building.

As the concept transitioned to Table 34.2.4.2 of the 2003 Edition of NFPA 5000 the requirements of the table were consistent with the IFC approach. The table in NFPA 5000 was simplified by condensing some of the rows, however rather than prohibiting the use of control areas below the second floor of below grade locations, the table reflects that control

areas are not applicable (now indicated as NA) in levels lower than the second level. The difference is subtle, but it may carry different meanings for different users. The question is raised as to what might be applicable, rather than seeing that the use of control areas below the second level is not allowed.

TABLE 13  
2003 NFPA 5000 Table 34.2.4.2 Design and Number of Control Areas

Floor Level		Maximum Allowable Quantity per Control Area (%) <sup>1</sup>	Number of Control Areas Per Floor	Fire Resistance Rating for Fire Barriers <sup>2</sup> (hr)
Above Grade	> 9	5	1	2
	7-9	5	2	2
	4-6	12.5	2	2
	3	50	2	1
	2	75	3	1
	1	100	4	1
Below Grade	1	75	3	1
	2	50	2	1
	Lower than 2	NA	NA	NA

NA = Not applicable.

1 Percentages represent the maximum allowable quantities per control area shown in Table 34.1.3.1, with all of the increases permitted in the footnotes of that table.

2 Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas.

**4.2 Detached Building Threshold Limits.** The quantities of hazardous materials can again be increased in control areas and in occupancies classified as hazardous, however, for some materials a threshold limit is reached where a detached building is required. The establishment of a detached building threshold is somewhat analogous to limiting the number of control areas in a building. Once the threshold is reached the consequences of an

event are felt to be too great to allow the quantity to grow further without isolating the building by means of imposing greater restrictions on the building location so that the distance to property lines and adjoining structures is increased. The detached building threshold level established in the 1988 Uniform Codes represented an aggregate for the building where the aggregate quantity of materials contained in control areas, and areas where the exempt amount was exceeded was considered. UBC Table No. 9E was developed to establish the aggregate amount of hazardous materials deemed to warrant the use of a detached building.

In some cases, the quantity was not limited by the exempt amount, the only limitation being the space and storage or use arrangement in which the material was to be located. Table 14 below illustrates the quantity thresholds used in the 1988 Editions of the Uniform Codes that when exceeded required the use of a detached building.



TABLE 14  
**Detached Building Threshold**  
**Based on 1988 Edition of the Uniform Codes<sup>106</sup>**

Hazard Category	Detached Building Threshold Limit (aggregate in storage and use)
Explosives Blasting Agents Black Powder Fireworks Organic Peroxides detonable Oxidizers Class 4 Unstable Reactive Class 4 Unstable Reactive Class 3 (detonable)	Greater than exempt amount
Oxidizers (liquids and solids)	
• Class 3	25 tons
• Class 2	50 tons
Flammable cryogens	No limit
Flammable gases	No limit
Flammable or combustible liquids	Limited only by the quantity per liquid storage room. <sup>107</sup>
Flammable solids	No limit
Organic Peroxides	
• Class I	Greater than exempt amount
• Class II	25 tons
• Class III	50 tons
Organic Peroxides Class IV and V	No limit
Oxidizing cryogens	No limit
Pyrophoric gases	2,000 cubic feet
Pyrophoric solids and liquids	No limit
Unstable reactive	
• Class 4	2 pounds (solid/liquid); 20 cf (gas)
• Class 3	1 ton (solid/liquid); 2,000 cf (gas)
• Class 2	25 tons (solid/liquid); 10,000 cf (gas)
Unstable reactive Class 1	No limit
Water reactive Class 1	No limit
Water reactives	

<sup>106</sup> *Uniform Building Code*, 1988 Edition, Table No. 9-E, p. 85.

<sup>107</sup> *Uniform Fire Code*, 1988 Edition, Table Nos. 79.200-A and 79.200-B, pp. 228-229.

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Hazard Category	Detached Building Threshold Limit (aggregate in storage and use)
• Class 3 • Class 2	1 ton (solid/liquid); 2000 cf (gas) 25 tons (solid/liquid); 10,000 cf (gas)

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## 5 THE CATEGORIZATION OF HAZARDOUS MATERIALS AND THE USE OF MAXIMUM ALLOWABLE QUANTITIES PER CONTROL AREA AS A MEANS OF CONTROL

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**5.0 General.** The term “exempt amount” used in the 1988 Edition of the Uniform Codes caused some code users to incorrectly assume that the term *exempt* meant that the materials were exempt from all requirements of the code. When the control area concept was adopted into the codes published by the International Code Council (I-Codes) the term was revised to become the Maximum Allowable Quantity Per Control Area (MAQ). The acronym MAQ is used today by most code users to describe the control area limits. MAQ is a threshold level above which additional safeguards and controls are applied.

The expansion of the list of hazard classes necessitated the addition of definitions to the codes which related to condition of material, e.g., storage, use open, etc., as well as for each category of hazardous material to be regulated. Definitions in the Uniform Codes were under the purview of the UFC and established by the fire code officials. On the other hand the *exempt* quantities listed in the UBC tables were controlled by the building code officials. This organization was chosen as elements of the building code involving building construction were activated when the *exempt amounts* were exceeded. A similar level of control was exercised in both the BOCA and SBCCI regions. With the publication of the I-Codes, responsibility for establishing quantity limits and definitions transitioned to the fire code officials.

Part 5 of this report contains a discussion on definitions pertinent to the application of the exempt amounts as well as a discussion on the determination of what will be referred to as the Maximum Allowable Quantities per Control Area or MAQs as they were formulated in 1988 recognizing that MAQ was referred to as the *exempt amount* at the time when the tabular limits were established. For the purposes of this report the terms *exempt amount* and *MAQ* can be used interchangeably; however, the term MAQ is now the current term in use nationally.

When the UFC Article 80 drafting committee considered the development of definitions, there were several general considerations that were made as each of the definitions was developed. The considerations included the following:

- Existing definitions found in the 1985 Edition of the UFC.

- Definitions promulgated by OSHA in 29 CFR Part 1910.1200(c).<sup>108</sup> The OSHA definitions were given priority over other definitional bases as the OSHA definitions were 1) mandated for use by chemical manufacturers, suppliers and importers in the preparation of MSDS, and exposure to the chemicals by building occupants and first responders would likely be addressed by the information contained on MSDS than other sources.
- Definitions promulgated by NFPA when subcategories of hazard had been identified by precedent NFPA standards, e.g., Flammable Liquid Class IA, IB, IC, etc.
- Definitions promulgated by the US Department of Transportation (DOT). DOT definitions would be used lacking definitions found in the existing code, OSHA or NFPA due to the major inconsistencies encountered when attempting to use DOT definitions with the existing code.

In some cases definitions were a hybrid between one or more of the systems noted above.

## 5.1 Physical State

**5.1.1 Solid.** The term was not specifically defined in the 1988 Version of the UFC. The 1988 Edition of the UFC contained the following statement to address terms that were not specifically defined:

*When terms are not defined, they shall have their ordinary accepted meanings within the context with which they are used. Webster's Third New International dictionary of the English Language, Unabridged, copyright 1981, shall be considered as providing ordinarily accepted meanings.*<sup>109</sup>

The code continued without a specific definition until the 1997 Edition was published to include the following definition:

***Solid*** is a material which has a melting point or decomposes at a temperature greater than 68°F.<sup>110</sup>

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<sup>108</sup> *Hazard Communication; Final Rule, November 25, 1983*, Part IV, Department of Labor, Occupational Safety and Health Administration, Federal Register, Vol. 48, No. 228, Friday November 25, 1983, Rules and Regulations, §1910.1200, pp. 53340-53348.

<sup>109</sup> *Uniform Fire Code*, 1988 Edition, § 9.102, p. 20.

<sup>110</sup> *Uniform Fire Code*, 1994 Edition, International Fire Code Institute, Austin, TX, § 220, p. 1-24.

The term “solid” was defined in 3.3.340.14 of NFPA 5000 in a manner consistent with that used in the 2000 UFC (consistent with the 1997 Edition). However, the definition has not been carried into either the 2003 or 2006 Editions of NFPA 1 UFC. The 2003 NFPA 1 UFC includes four sub definitions for the term solid under 3.3.216 as 1) combustible particulate solid, and 2) flammable solid; however, these terms do not relate to corrosive solid, unstable reactive solid, toxic solid, etc. within the context of Chapter 60. As a result gap has been created between NFPA 5000 and NFPA 1 UFC, and NFPA 1 UFC is not internally consistent.

**5.1.2 Liquid.** The term liquid was not revised from the definition included in the previous edition (1985) of the UFC. The term was defined in the 1988 Edition of the UFC as follows:

*Liquid is a material which has a fluidity greater than that of 300 penetration asphalt when tested in accordance with approved standards. See Section 2.303(b). When not otherwise identified, the term “liquid” is [sic] both flammable and combustible liquids.*

Section 2.303(b) contains a reference to ASTM D5-78 *Penetration of Bituminous Materials*. The definition for liquid in the 1985 UFC was taken from previous editions of NFPA 30. This definition remained in place until the publication of the 1997 Edition of the UFC which revised the definition to the following:

*Liquid is a material that has a melting point which is equal to or less than 68°F (20°C) and a boiling point which is greater than 68°F (20°C) at 14.7 psia (101.3 kPa). When not otherwise identified, the term “liquid” includes both flammable and combustible liquids.*

The term “liquid” was defined in 3.3.313 of NFPA 5000 in a manner consistent with that used in the 2000 UFC. However, the definition has not been carried into either the 2003 or 2006 Editions of NFPA 1 UFC. The 2003 NFPA 1 UFC includes four sub-definitions definitions for the term liquid under 3.3.148 as 1) combustible liquid, 2) flammable liquid, 3) highly volatile liquid, and 4) stable liquid; however, these terms do not necessarily relate to corrosive liquid, unstable reactive liquid, toxic liquid, etc. within the context of Chapter 60. As a result a gap has been created between NFPA 5000 and NFPA 1 UFC, and NFPA 1 UFC is not internally consistent.

**5.1.3 Gas.** The term gas is defined in terms of *compressed gas* with a new definition introduced into the 1988 Edition of the code.

**Compressed gas** is: (a) a gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F., or

(b) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F. regardless of the pressure at 70°F., or

(c) A liquid having a vapor pressure exceeding 40 psi at 100°F. as determined by UFC Standard No. 9-5.

The definition was revised with the publication of the 1994 Edition of the UFC to the following:

**COMPRESSED GAS.** A material, or mixture of materials which:

1. Is a gas at 68°F (20°C) or less at 14.7 psia (101.3 kPa) of pressure; and
2. Has a boiling point of 68°F (20°C) or less at 14.7 psia (101.3 kPa) which is either liquefied, nonliquefied or in solution, except those gases which have no other health- or physical-hazard properties are not considered to be compressed until the pressure in the packaging exceeds 41psia (28 kPa) at 68°F (20°C).

The states of a compressed gas are categorized as follows:

1. Nonliquefied compressed gases are gases, other than those in solution, which are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
2. Liquefied compressed gases are gases which, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C).
3. Compressed gases in solution are nonliquefied gases which are dissolved in a solvent.
4. Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

The definition of compressed gas found in 3.3.101.1 of NFPA 1 UFC has been extracted from NFPA 55. The NFPA 1 UFC definition has been split into two components with the states of a compressed gas listed in the Annex. The definition is essentially consistent with the 2000 UFC, NFPA 5000 and NFPA 55 which served as the source of the definition. In addition, each of the terms identified in the annex note have also been defined, i.e., nonliquefied compressed gas, liquefied compressed gas, compressed gas in solution and compressed gas mixtures.

**3.3.101.1 COMPRESSED GAS.** A material, or mixture of materials that (1) is a gas at 68°F (20°C) or less at 14.696 psia (101.325 kPa) and (2) that has a boiling point of 68°F (20°C) or less at 14.7 psia (101.325 kPa) and that is liquefied, nonliquefied or in

*solution, except those gases which have no other health or physical hazard properties are not considered to be compressed gases until the pressure in the packaging exceeds 40.6 psia (280 kPa) at 68°F (20°C).[55:3.3]*

**A.3.3.101 Gas.** *The states of a compressed gas are categorized as follows:*

*(1) Nonliquefied compressed gases are gases, other than those in solution, that are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).*

*(2) Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C).*

*(3) Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.*

*(4) Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.*

**5.2 Condition.** Condition refers to the circumstance or situation in which the material is found. From the perspective of the tables of *exempt amounts* or MAQ, the code listed materials under conditions of *storage, use-open, and use-closed*. It was recognized that materials found in use could be involved in dispensing, processing, mixing or blending, etc. The *1988 Analysis of Revisions*, in pertinent part, notes that a distinction was being introduced into the 1988 UBC between storage and use in closed systems, and use in open systems. The concept of the use-open condition recognized that the release of vapors and the potential exposure to ignition sources was a much more hazardous condition than that of the closed condition and that threshold quantities were reduced accordingly.<sup>111</sup>

**5.2.1 Storage.** The term storage was not specifically defined in the 1988 Version of the UFC. It remained undefined through the publication of the 1997 Edition of the code. Within the context of the code storage is viewed as an inanimate state where the material is at rest. Storage is commonly defined as the act of storing goods which is a supply reserved for future use.

The 2000 Edition of the IFC contains the following definition for *storage, hazardous materials*:

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<sup>111</sup> *1988 Analysis of Revisions to the Uniform Building Code and Uniform Building Code Standards, Uniform Mechanical Code, Uniform Housing Code, Uniform Code for the Abatement of Dangerous Buildings, Uniform Administrative Code, Uniform Fire Code, Uniform Fire Code Standards*, International Conference of Building Officials, Whittier, CA, First Printing, May 1988, p. 11.

***Storage, hazardous materials.*** *The keeping, retention or leaving of hazardous materials in closed containers, tanks, cylinders, or similar vessels; or vessels supplying operations through closed connections to the vessel.*

The definition appears to be problematical with respect to the concept of supplying operations through closed connections. For example, if a cylinder of compressed gas is connected to a closed piping system is the cylinder in storage even though gas is supplied to a system, or is the cylinder in use? What is a closed container? For example, is a stationary tank with an atmospheric vent a closed container?

Storage has been defined in 3.3.192 of the 2003 Edition of NFPA 1 UFC, however, it is subdivided into subcategories of 1) detached storage, 2) high-piled storage, 3) isolated storage, and 4) segregated storage. The definition in 3.3.225 of the 2006 Edition has been expanded to twelve different sub-definitions now including terms like 1) banded tire storage, 2) cartoned storage, etc. None of these definitions fit within the context of the term as it is used in Table 60.2.2.1(a), or Table 60.1.3.1 of the 2003 or 2006 Editions of NFPA 1 UFC respectively.

**5.2.2 Use.** The term *use* was introduced into the 1988 Edition of the UFC as follows:

***Use (material)*** *is the placing in action or making available for service by openings or connecting anything utilized for confinement of material whether a solid, liquid or gas.*

The term was created to recognize that “action” involved activity other than having the material in an inanimate state. In addition, it was intended to recognize that the connection of containers, such as compressed gas cylinders to regulator or control systems placed the container into service regardless of whether the primary shut off valve was open or closed. The definition raised questions regarding whether or not large storage tanks were to be considered to be in use, or in storage given the fact that a closed pipe system was used to connect the tank to a point of use.

Whether or not tanks located outside of a building should be considered to be in use within the building was the subject of an interpretation issued in the *1997 UFC Code Applications Manual*. In discussion on the application of the definition *use*, the *Applications Manual* contained the following<sup>112</sup>:

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<sup>112</sup> 1997 *Uniform Fire Code, Code Applications Manual*, International Fire Code Institute, Whittier, CA, pp. 9-10.



*Application of this definition to the case of material being piped from an exterior tank into a building requires a degree of judgment. In general, the quantity of material that should be considered to be in “use” is the quantity that would normally be involved in a process or that could reasonably be expected to be released or involved as a result of a process-related emergency. Considering the case of materials in an outside or underground tank being piped into a building, if an approved, reliable arrangement of a normally closed valve control system is provide between the supply and the point where the material is dispensed, the quantity on the supply side of such control system located outside of the building should not impact incidents occurring inside the building and therefore, should not affect the occupancy classification.*

*A reliable arrangement of the valve control system should be considered as an interruption of the connection between the confined material and the point where the material is placed into action or made available for service. The necessary control system design may vary on a case-by-case basis, depending on the particular operation or layout.*

*If one were to take the contrary position and consider quantities kept outside or underground to be in “use” within the building for purposes of occupancy classification, it would likely require the occupancy to be classified in the Group H category. This could result in a shift to placing tanks within the building because, from the owner’s perspective, once the building becomes a Group H Occupancy, there would no longer be an incentive to keep such tanks outside of the building. Generally, tanks located outside a building are considered the safer alternative.*

The term was included in 3.3.560.1 of the 2003 Edition of NFPA 5000; however, it was substantially revised as follows:

***3.3.560.1 Use (material).*** *Placing a solid, liquid, or gaseous material into action or keeping a solid or liquid material in an open vessel.*

The revised term appears to address the use of MAQ tables in NFPA 5000, however, as defined it raises a question as to the use of the term use-closed, and use-open systems. Perhaps the intent is to define the keeping of liquids or solids in closed vessels as storage; however, the intent is not clear. The term was not carried into the 2003 Edition of NFPA 1 UFC.

**5.2.3 Use, Closed System.** A definition was introduced in 1989 and intended to fill the void left by not having defined the term with the publication of the 1988 Edition of the code. The following definition was published in the 1990 Supplement to the UFC:

***Use, closed system*** *is use of a solid or liquid hazardous material in a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of compressed gases. Examples of closed systems for solids and liquids include product conveyed through a*

*pipng system into a closed vessel, system or piece of equipment; reaction process operations.*

The staff analysis published in the code change monograph contained the following comment in support of the proposed definition which was adopted<sup>113</sup>:

*The proposal would eliminate confusion regarding what constitutes “open” and “closed” uses. Of particular concern has been compressed gas systems which terminate at an opening to the atmosphere, such as torches and portable oxygen bottles. The revision would clarify that all compressed gas uses are considered to be closed systems for the purposes outlined in the Fire Code, since a truly “open” gas system would result in all gas being immediately dispersed into the atmosphere.*

The term remained unchanged through the 2000 UFC which served as the basis for the definition as it appeared in 3.3.207.1 of the 2003 Edition of NFPA 1 UFC. When the term was codified the informational statement was moved to the annex.

**5.2.4 Use, Open System.** A definition was introduced in 1989 and intended to fill the void left by not having defined the term with the publication of the 1988 Edition of the code. The following definition was published in the 1990 Supplement to the UFC:

*Use, open system is use of a solid or liquid hazardous material in a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for solids and liquids include dispensing form or into open beakers or containers, dip tank and plating tank operations.*

The term remained unchanged through the 2000 UFC which served as the basis for the definition as it appeared in 3.3.207.2 of the 2003 Edition of NFPA 1 UFC. When the term was codified the informational statement was moved to the annex.

**5.3 Hazard Categories Established.** There were two broad categories of hazard that were promulgated in the Uniform Codes. The categories of *physical* and *health hazards* were used as the basis for occupancy level controls established in the building code.

**5.3.1 Physical Hazards Defined.** The term *physical hazard* was derived from the OSHA definition.<sup>114</sup> Modifications were made to insert the term “cryogenic” as cryogenes were

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<sup>113</sup> *WFCA News Quarterly Supplement, September-October, 1989, Part III 1990 Submittals for Proposed Revisions to the Uniform Fire Code and Fire Code Standards and Provisions of the Uniform Building Code and UBC Standards Maintained by WFCA, International Conference of Building Officials and Western Fire Chiefs Association, Whittier, CA,, 1989, 80.102(b) 90-2, p. 59.*

<sup>114</sup> *Occupational Safety and Health Standards, 29 CFR Part 1910.1200, Change 48, June 3, 1988, p. 806.19.*

regulated as a separate category in the Uniform Codes, and to subdivide the general category of “flammable” as included in the OSHA definition into solids, liquids and gases. The definition in the 1988 Edition of the UFC follows:

***Physical Hazard*** is a classification of a chemical for which there is scientifically valid evidence that it is a combustible liquid, compressed gas, cryogenic [fluid], explosive, flammable gas, flammable liquid, flammable solid, organic peroxide, oxidizer, pyrophoric, unstable (reactive) or water-reactive material.

Physical hazard materials are recognized as those materials the hazards of which are likely to be involved with fires or explosions. The hazardous occupancies of the building code have been established to consider three general categories of hazard which include materials that are prone to:

- Detonation potential
- Deflagration potential or rapid or accelerated combustion
- High fire or physical hazards

The Uniform Codes classified occupancies containing physical hazard materials in excess of the *exempt amounts* into Group H, Division 1, 2 or 3 occupancies accordingly.<sup>115</sup>

The definition of *physical hazard material* was introduced into 3.3.340.12 of the 2003 Edition of NFPA 5000 from the 2000 UFC with modifications to add combustible fibers and to limit the term “cryogenic” to flammable or oxidizing cryogenes. The intent was to correlate the terms included with the hazard of contents for the purpose of determining protection level controls within the context of the code. It was extracted into NFPA 1 UFC as follows:

**3.3.130.7 Physical Hazard.** A chemical or substance classified as a combustible liquid combustible fiber, explosive, flammable cryogen, flammable gas, flammable solid, organic peroxide, oxidizer, oxidizing cryogen, pyrophoric, unstable (reactive) or water-reactive material.[5000:3.3]

**5.3.2 Health Hazards Defined.** The term *physical hazard* was derived from the OSHA definition.<sup>116</sup> The definition in the 1988 Edition of the UFC follows:

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<sup>115</sup> *Uniform Building Code*, 1988 Edition, § 901(a), pp. 66-67.

<sup>116</sup> *Occupational Safety and Health Standards*, 29 CFR Part 1910.1200, Change 48, June 3, 1988, p. 806.19.

**Health Hazard** is a classification of a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed persons. The term “health hazard” includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes or mucous membranes.

Health hazard materials are recognized as those materials the hazards of which are likely to produce deleterious health effects on humans. When the requirements were initially codified, the Group H, Division 7 Occupancy was established to consider this specific group of materials which could have an effect on the building occupants whether the exposure was acute or chronic.<sup>117</sup>

The definition of *health hazard material* was introduced into 3.3.340.7 of the 2003 Edition of NFPA 5000 from the 2000 UFC with modifications to limit the categories included to only toxic, highly toxic or corrosive materials. The intent was to correlate the terms included with the hazard of contents for the purpose of determining protection level controls within the context of the code. It was extracted into NFPA 1 UFC as follows:

**3.3.130.2\* Health Hazard Material.** *A chemical or substance classified as a toxic, highly toxic, or corrosive material in accordance with the definitions set forth in this code [5000:3.3]*

## 5.4 Physical Hazard Materials.

### 5.4.1 Combustible Liquids.

**5.4.1.1 Definition and Basis 1988 UFC.** The definition of *combustible liquid* established in the 1988 UFC was retained unchanged from the 1985 Edition. The definitions were consistent with those published in the 1979 Edition of the Uniform Fire Code. The Uniform Fire Code Standards referenced by the UFC included UBC Standard 9-1 which was based on the 1977 Edition of NFPA 30.<sup>118</sup>

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<sup>117</sup> *Uniform Building Code*, 1988 Edition, § 901(a), p. 67.

<sup>118</sup> *Uniform Fire Code Standards (UFCS)*, 1979 Edition, UBC Standard 9-1 referenced the 1977 Edition of NFPA’s *Flammable and Combustible Liquids Code*, NFPA 30. The definitions for combustible liquids were published in §9.105, of the 1979 Edition of the *Uniform Fire Code*, p. 48 and remained consistent through the 1985 Edition of the UFC.

**Combustible Liquid** is a liquid having a flash point at or above 100°F. Combustible liquids shall be subdivided as follows:

**Class II** liquids shall include those having flash points at or above 100°F. and below 140°F.

**Class III-A** liquids shall include those having flash points at or above 140°F. and below 200°F.

**Class III-B** liquids shall include those liquids having flash points at or above 200°F.

#### **5.4.1.2 Definition and Basis 2000 IFC.**

**Combustible Liquid** is a liquid having a flash point at or above 100°F (38°C). Combustible liquids shall be subdivided as follows:

**Class II** liquids shall include those having flash points at or above 100°F (38°C) and below 140°F (60°C).

**Class III-A** liquids shall include those having flash points at or above 140°F (60°C) and below 200°F (93°C).

**Class III-B** liquids shall include those liquids having flash points at or above 200°F (93°C).

The definitions are consistent with those published in the 1988 UFC with editorial changes to add SI units of measure.

#### **5.4.1.3 Definition and Basis 2003 NFPA 1 UFC.**

**Combustible Liquid.** A combustible liquid shall be defined as any liquid that has a closed-cup flash point at or above 100°F (38°C) as determined by the test procedures and apparatus set forth in 1.7.4 of NFPA 30. Combustible liquids shall be classified as Class II or Class III as follows: (1) Class II Liquid - any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C); (2) Class III-A - any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C); (3) Class III-B any liquid that has a flash point at or above 200°F (93°C) [30:1.7].

As shown, the NFPA 1 UFC definition was extracted from the 2003 Edition of NFPA 30.

#### **5.4.1.4 Threshold MAQ and Basis 1985 UBC.** The 1985 Edition of the UBC established the following exempt quantities for combustible liquids.

TABLE 15  
**Combustible Liquids - 1985 UBC Table No. 9-A**

Combustible liquids <sup>1</sup>	Maximum Quantities
Class II	120 gallons <sup>2</sup>
Class III-A	250 gallons <sup>2</sup>

<sup>1</sup>The quantities of alcoholic beverages in retail sales or storage uses are unlimited, provided the liquids are packaged in individual containers not exceeding 4 liters. The quantities of medicines, foodstuffs and cosmetics, containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solution not being flammable, in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding 4 liters.

<sup>2</sup>Quantities may be increased by 100 percent in areas which are not accessible to the public. In buildings where automatic fire-extinguishing systems are installed, the quantities may be increased 100 percent in areas accessible to the public.

Table No. 10-A of the 1973 Edition of the UBC established an exempt amount (MAQ threshold) of 500 gallons for Combustible Liquids Class III-A. No other categories were indicated. Revisions to the table that appeared in the 1976 Edition of the code reduced the exempt amount to 250 gallons, but allowed an increase back to the original 500 gallons in areas not accessible to the public. The increase was also allowed for sprinklered buildings in areas accessible to the public. With the inclusion of Class II, III-A and III-B definitions in the 1979 Edition of the UFC, the exempt amount in Table No. 9-A of the UBC was revised to include a quantity of 120 gallons of Class II liquids and the 250 gallons of Class III-A liquids was maintained. The exempt amounts for each liquid could be increased by a factor of two for areas not accessible to the public or in buildings where automatic fire-extinguishing systems were installed.

With the publication of the 1982 Edition of the UBC footnote 1 of Table No. 9-A, alcoholic beverages, medicines, foodstuffs, etc. was added to restore exceptions that had been promulgated in UBC Standard (UBCS) 9-1. UBCS 9-1 was ICBO's publication and reference to NFPA 30. The 1979 Edition of the Standard was based on the 1977 Edition of NFPA 30. ICBO discontinued the publication of UBC Standard 9-1 (based on NFPA 30) with the publication of the 1982 Edition of the UBC as the standard was no longer referenced by the UBC (or UFC).

**5.4.1.5 Threshold MAQ and Basis 1988 UBC.** Table No. 9-A of the 1988 UBC established the MAQ for combustible liquids as follows.

TABLE 16

**Combustible Liquids – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
1.1 Combustible liquid <sup>3</sup>	II	-	120 <sup>4 5</sup>	-	-	120 <sup>4</sup>	-	-	30 <sup>4</sup>	
	III-A	-	330 <sup>4 5</sup>	-	-	330 <sup>4</sup>	-	-	80 <sup>4</sup>	
	III-B	-	13,200 <sup>5 6</sup>	-	-	13,200 <sup>6</sup>	-	-	3,300 <sup>6</sup>	

N.L. = Not Limited.

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>3</sup>The quantities of alcoholic beverages in retail sales uses are unlimited provided the liquids are packaged in individual containers not exceeding four liters. The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>6</sup>The quantities permitted in a sprinklered building are not limited.

Class II combustible liquids had an established baseline of 120 gallons with a doubling allowed when located in sprinklered buildings or when the area was not accessible by the public. The increase allowed for lack of public access was interpreted as being compounded with the increase allowed for sprinklers. Under the requirements of the 1988 UBC 120 gallons basis was retained with a doubling allowed when located in sprinklered buildings. Access by the public was not considered within the context of the table in the 1988 UBC; however, a doubling of



quantities were provided for when storage was located in approved storage cabinets with that increase allowed to be compounded with the increase for sprinklers.

The tables were intended to allow a quantity of materials for each cell in the table. For example, one could have a quantity in storage, an additional quantity in use open and an additional quantity in a use closed condition across the spectrum of the table and the footnote multipliers. Footnote 2 was a caveat to restrict the quantity in storage and use to a quantity not exceeding the stored amount as a means to address an overall aggregate. In general across each of the hazard categories identified in the table, the quantities of materials in a use-closed condition equal the quantity in storage while the quantities of materials allowed in a use-open condition are about one fourth of the amount allowed in a use-closed condition.

Using the Class II combustible liquid as an example, one could have up to 480 gallons of Class II liquid in a single control area under the maximum set of conditions. The quantities of use-closed and use-open were restricted by the footnotes accordingly.

The 1979 Edition of the UFC allowed up to 500 gallons of Classes III-A and III-B liquids in rooms not accessible to the public. The 1981 Code Supplement noted that an increase from 500 gallons to 600 gallons had been allowed without the inclusion of Class III-B liquids. A doubling of the quantities of water miscible liquids in nonpublic areas was allowed; however, these quantity limits were not coordinated with the UBC Table No. 9-A.<sup>119</sup>

The 1985 UBC quantity of 250 gallons for Class III-A (maximum 500 gallons under the conditions of sprinklers or no access by the public) was revised upward to a base amount of 330 gallons with allowances for increase to a maximum of 1,320 gallons with the application of sprinklers and cabinets. In the 1985 UFC storage of Class III-A combustible liquids was limited to 660 gallons in retail and wholesale uses (mercantile occupancies) and in miscellaneous industrial buildings. This

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<sup>119</sup> *Uniform Fire Code*, 1979 Edition, §79.402(b) and 1981 *Accumulative Supplement to the Uniform Codes*, ICBO, Whittier, CA, p. 80.



quantity was allowed to be doubled in rooms not accessible to the public (retail and wholesale uses), and for water-miscible liquids the quantity was allowed to double when the “area” was protected with an extra hazard sprinkler system.<sup>120</sup> The quantity limits in the UFC were inconsistent with those established in the UBC; however, it was noted that under the system of increases proposed by the footnotes that reducing the base amount from 660 gallons to 330 gallons and then allowing a four-fold increase for sprinklers and cabinets the a maximum threshold quantity of 1,320 gallons brought closer coordination between the UBC and UFC.

Class III-B liquids had not been included in Table No. 9-A of the UBC, however, there had been a recent warehouse fire in California involving unsprinklered storage of motor oil and the fire service expressed concern regarding the need for a threshold level. Class III-B liquids were added to the table based on subjectively based on a number (20) of 660 gallon tanks. The *1988 Analysis of Revisions to the UBC* notes that Class III-B liquids were added to the table as large quantities of these liquids in unsprinklered buildings become similar to flammable liquids when a hot fire is established.<sup>121</sup> A footnote was added to allow the quantities to be unlimited when located in sprinklered buildings.

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<sup>120</sup> *Uniform Fire Code*, 1985 Edition, § 79.201(e), pp. 209-211.

<sup>121</sup> *1988 Analysis of Revisions to the Uniform Building Code and...(other Uniform Codes)*, International Conference of Building Officials, Whittier, CA, First Printing, May 1988, p. 12.

5.4.1.6 Threshold MAQ and Basis 2000 IBC.

TABLE 17

**Combustible Liquids – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Combustible liquid <sup>c, i</sup>	II	H-2 or H-3	N/A	120 <sup>d, e</sup>	N/A	N/A	120 <sup>d</sup>	N/A	N/A	30 <sup>d</sup>
	III-A			330 <sup>d, e</sup>			330 <sup>d</sup>			80 <sup>d</sup>
	III-B	H-2 or H-3		13,200 <sup>e, f</sup>			13,200 <sup>g</sup>			3,300 <sup>f</sup>

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>c</sup> The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable shall not be limited provided that such materials are packaged in individual containers not exceeding 1.3 gallons (5L).

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>f</sup> The permitted quantities shall not be limited in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>i</sup> Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system shall be 660 gallons provided such system conforms to the *International Fire Code*.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQ limits established in the 1988 Edition of the UFC have been maintained in the publication of the 2000 Edition of the IFC. However, the addition of footnote “i” established a control area limit for combustible liquids connected to a fuel oil piping system. The 660 gallon limit was included in the First Draft of the IBC as the code was being developed. The intent was to correlate the approach in

quantity with that established by NFPA 31 *Standard for the Installation of Oil-burning Equipment* which limited tanks to 660 gallons where the tank was not installed in a dedicated room or other fire-resistive enclosure. NFPA 31 provides the means to allow additional tanks and quantities of combustible fuels to be installed when tanks are isolated by 2-hour or 3-hour construction. As control areas are limited to one-hour construction a base limit of 660 gallons was established to coordinate the quantity with the minimum requirements of NFPA 31.<sup>122</sup>

#### 5.4.1.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 18

**Combustible Liquids – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Combustible liquid <sup>c</sup>	II	2 or 3	NA	120 <sup>e, f</sup>	NA	NA	120 <sup>f</sup>	NA	NA	30 <sup>f</sup>
	III-A	2 or 3		330 <sup>e, f</sup>			330 <sup>f</sup>		NA	80 <sup>f</sup>
	III-B	NA		13,200 <sup>f, g</sup>			13,200 <sup>g</sup>		NA	13,200 <sup>e, g</sup>

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>c</sup> Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system is permitted to be 660 gal, provided that such system conforms to NFPA 31.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>™</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>122</sup> *Standard for the Installation of Oil-Burning Equipment, NFPA 31*, 2001 Edition, National Fire Protection Association, Quincy, MA, electronic edition, §7.5.13.1.

<sup>g</sup> The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

The threshold MAQs for combustible liquids established by the 1988 UFC have generally been maintained, however, the quantity of Class III-B liquids in open use was increased from 3,300 to 13,200 gallons. As this was not part of the submittal from the drafting committee it is assumed to be an editorial error which was not caught during the publishing process. The ROP version shows the amount at 3,300 gallons and the quantity does not appear to have been changed during the ROC process. The application of footnote “e” to Class III-B liquids in open use also appears to be in error. It was not published in the ROP version of the document. Liquids in open use would not be stored in approved cabinets. In addition, the application of footnote “f” is in conflict with footnote “g.”

#### **5.4.1.8 Anomalies, Inconsistencies and Gaps.**

- (a) The quantity of Class III-B liquids in open use of 13,200 gallons appears to be in error. The use of a footnote to increase quantities in use when “stored” in an approved cabinet was corrected in the 2006 Edition of NFPA 1 UFC.
- (b) The use of footnote “f” to allow increases in the stored amount with the application of a sprinkler system is in conflict with footnote “g” which indicates that the quantity is unlimited in sprinklered buildings. The problem was continued with the publication of the 2006 Edition of NFPA 1 UFC.

#### **5.4.2 Combustible Dust.**

**5.4.2.1 Definition and Basis 1988 UFC.** Combustible dust was not defined as such in the 1988 UFC. However, the term *dust* was defined in the 1988 UFC as follows:

*Dust is pulverized particles which, if mixed with air in the proper proportions, become explosive and may be ignited by a flame or a spark or other source of ignition.*

The term *combustible dust* was defined in the 1997 Edition of the UFC as follows:

*Combustible Dust is finely divided solid material which is 420 microns or less in diameter and which, when dispersed in air in the proper proportions, could*

*be ignited by a flame, spark or other source of ignition. Combustible dust will pass through a U.S. No. 40 Standard sieve.*

#### **5.4.2.2 Definition and Basis 2000 IFC.**

**Combustible Dust.** *Finely divided solid material that is 420 microns or less in diameter and which, when dispersed in air in the proper proportions, could be ignited by a flame, spark or other source of ignition. Combustible dust will pass through a U.S. No. 40 Standard sieve.*

The definition in the IFC came from the 1997 Edition of the UFC. It was developed around definitions promulgated in NFPA 69 which established the diameter of 420 microns or less.<sup>123</sup> The definition was added to the 1997 Edition of the UFC under code change item 205-95-1.<sup>124</sup>

#### **5.4.2.3 Definition and Basis 2003 NFPA 1 UFC.**

**3.3.37\* Combustible Dust** *any finely divided solid material that is 420 microns or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air. [654:1.5]*

The definition of dust has been retained; however, dust is not regulated within the context of the MAQ tables. NFPA 1 UFC in Chapter 40 requires equipment, processes and operations that involve the manufacture, processing, blending, repackaging, or handling of combustible particulate solids or combustible dusts regardless of concentration or particle size to be installed and maintained in accordance with various NFPA Standards including NFPA 61 *Standard for the Prevention of Fires and dust Explosions in Agricultural and Food Processing Facilities*, NFPA 69, *Standard on Explosion Prevention Systems*, etc.

**5.4.2.4 Threshold MAQ and Basis 1985 UBC.** Combustible dust had not been included in Table No. 9-A of the 1985 Edition of the UBC. The UFC regulated combustible dust as a housekeeping item under the requirements of Article 76 *Prevention of Dust Explosions*.

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<sup>123</sup> *Standard on Explosion Prevention Systems, NFPA69, 1992 Edition, §1-9, p. 6.*

<sup>124</sup> *1995 Submittals for Proposed Revisions to the Uniform Fire Code and Provisions of the Uniform Building Code Maintained by IFCI, Part II, IFCI Fire Code Journal, Fall 1994, Item 6, 205-95-1, p. 2.*

### 5.4.2.5 Threshold MAQ and Basis 1988 UBC.

TABLE 19

**Combustible Dust – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
1.2 Combustible dust lbs./1000 cu. ft.		1 <sup>7</sup>	-	-	1 <sup>7</sup>	-	-	1 <sup>7</sup>	-	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>7</sup>A dust explosion potential is considered to exist if 1 pound or more of combustible dust per 1,000 cubic feet of volume is normally in suspension or could be put into suspension in all or a portion of an enclosure or inside pieces of equipment. This also includes combustible dust which accumulates on horizontal surfaces inside buildings or equipment and which could be put into suspension by an accident, sudden force or small explosion.

Factory Mutual Engineering Corporation’s Loss Prevention Data sheet 7-76 was used to develop the basis for limiting combustible dust.<sup>125</sup> FM’s data sheet in discussion of fire and explosion protection measures included the following statement which was considered as the tabular limits were developed.

*Equipment containing small amounts of dust in suspension or capable of being thrown into suspension may be located in a room or ordinary construction and vented within the room if the remainder of the room is free of other combustible dusts likely to be dispersed by an explosion within the equipment. “Small amounts” are defined as less than one pound of dust per 1,000 cu. ft. of volume. Regardless of the size of equipment, the total amount should not exceed 10 lb.*

The 1988 Analysis of Revisions to the UBC cited the fact that the quantity was based on Factory Mutual data. The one pound per 1,000 cubic feet of volume was based on the fact that many combustible dusts have a lower explosive limit of 0.04 ounces per cubic foot or

<sup>125</sup> *Combustible Dusts*, Loss Prevention Data, Factory Mutual Engineering, Norwood, MA, Data Sheet 7-76, 1976

higher. Using a safety factor of 2.5 ( $2.5 = 0.04 * 1000/x$ ) resulted in establishing 16 ounces or one pound per 1000 cubic feet as the threshold.<sup>126</sup>

The 1985 UBC classified woodworking establishments, planing mills, box factories, buffing rooms for tire-rebuilding plants and picking rooms; shops, factories or warehouses where loose combustible fibers of dust [sic] are manufactured, processed, generated or stored; and pin-refinishing rooms as Group H, division 3 Occupancies. ICBO had received a number of requests for interpretation involving the assignment of a hazardous occupancy to woodworking establishments. In responding to a question as to how much woodworking is necessary to classify a building as a hazardous occupancy ICBO responded in pertinent part as follows. The question included a list of typical uses including 1) large sawmill operations, 2) large door manufacturers that do some sawing and a little sanding, provided with a dust collection system, 3) cabinet shops, large and small operations that do various degrees of sawing, sanding and the like, provided with a dust collection system; 4) Countertop shops consisting of some sawing of particleboard for sizing, the remainder being assembly, provided with a dust collection system, 5) Antique and furniture repair and finishing consisting of minor sawing, some sanding and finishing operations, provided with a dust collection system,; and 6) building contractor's shop with table saw for minor wood operations. A dust collection system is sometimes provided. The answer in part is as follows:<sup>127</sup>

*All of the operations you outlined would be considered Group H, Division 3 Occupancies, except for the first on your list, the large sawmill operation. The sawmill would not be considered a Group H, Division 3 Occupancy unless it also had a planing mill in conjunction with the sawmill. There may also be an exception for the building contractor's shop if a table saw is use only during a small percentage of the time. The situation with the contractor's shop and table saw for minor wood operations impinges upon the first question regarding how much woodworking is necessary to classify a building as a hazardous occupancy. There is no answer to the question in the code and it is up to the judgment of the building official. Certainly, if the table saw in the contractor's shop is only used for 15 or 20 minutes each day, it would be reasonable to classify it as a Group B, Division 2 Occupancy. If, on the other hand, it is used for the majority of the time, it could be considered a group H, Division 3 Occupancy. Somewhere in between is the dividing line and this has to be a matter of*

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<sup>126</sup> 1988 *Analysis of Revisions to the Uniform Building Code, et al.*, p. 12.

<sup>127</sup> *Uniform Building Code, Application/Interpretation Manual*, International Conference of Building Officials, Whittier, CA, 1986, p. 48.

*judgment on the part of the building official and in most cases it would be advisable for him to call upon his fire marshal for assistance in making this decision.*

Clearly, ICBO was struggling in an effort to provide guidance to code users. The establishment of the one pound/1,000 cubic foot of room volume limit established a threshold, however, once applied there was a major impact on numerous wood working establishments that had been constructed as other than Group H, Division 3 occupancies over the years. The 1988 Edition of the code increased the level of hazard from Group 3 to Group 2 based on the dust explosion potential. The net effect was a reduction in the allowable floor area for woodworking establishments.

In 1994 woodworking operations were removed from Group H uses and included in the Group F, Division 1 Occupancy with the following explanation:<sup>128</sup>

*In the 1991 edition, woodworking establishments were classified as Group H, division 2 Occupancies with some seldom used exceptions which are no longer needed. Note that in the 1993 Accumulative Supplement, woodworking establishments were considered Group H, Division 3 Occupancies. Classifying cabinet shops, furniture manufacturing and millwork (sash and door) as Group F, Division 2 Occupancies eases some of the provision is limited by the Group H, Division 3 classification since the hazard of such occupancies usually do not warrant such restriction. However, the last paragraph of Section 306.8 does require automatic sprinkler systems for woodworking operations exceeding 2,500 square feet and dust-collection systems for equipment generating dust.*

The *exempt amount* of combustible dust was deleted from the table with a statement that its use was vague and difficult to enforce. It was further noted in removing the listed quantity that a technical report could be requested by the code official if evaluation was needed and difficulties including particle size, material density, humidity and oxygen concentration were elements that played a major role in the evaluation all of which were far too complex to be simply addressed.

**5.4.2.6 Threshold MAQ and Basis 2000 IBC.** Combustible dust is not included in the MAQ tables for the IBC.

**5.4.2.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.** Combustible dust is not included in the MAQ tables for NFPA 1 UFC.

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<sup>128</sup> *Analysis of Revisions to the 1994 Uniform Codes*, International Conference of Building Officials, Whittier, CA, 1994, p. 5.



**5.4.2.8 Anomalies, Inconsistencies and Gaps.** The material is not currently regulated as a hazardous material within the context of the MAQ approach.

### **5.4.3 Combustible Fibers.**

**5.4.3.1 Definition and Basis 1988 UFC.** The definition for combustible fibers as promulgated in the 1988 UFC remained as published in the 1985 Edition of the UFC. The definition has been tracked back as far as the 1956 Edition of the Fire Prevention Code published by the National Board of Fire Underwriters.

*Combustible Fibers are readily ignitable and free-burning fibers, such as cotton, sisal, henequen, ixtle, jute, hemp, tow, cocoa fiber, oakum, baled waste, baled wastepaper, kapok, hay, straw, excelsior, Spanish moss and other like materials.*

#### **5.4.3.2 Definition and Basis 2000 IFC.**

*Combustible Fibers. Readily ignitable and free-burning fibers, such cocoa fiber, cloth, cotton, excelsior, hay, hemp, henequen, istle [sic], jute, kapok, oakum, rags, sisal, Spanish moss, straw, tow, wastepaper or other like materials.*

The basis of the definition is consistent with the 1988 Edition of the UFC although the terms have been reordered, rags have been added, and unbaled wastepaper has been included.

#### **5.4.3.3 Definition and Basis 2003 NFPA 1 UFC**

*Combustible Fiber. Any material in a fibrous or shredded form that will readily ignite when heat sources are present.*

The definition is unique to NFPA 1 and it appeared in the 1992 Edition of the Code.

**5.4.3.4 Threshold MAQ and Basis 1985 UBC.** Combustible fibers (loose and baled) were included in Table No. 9-A of the 1985 Edition of the UBC. The UFC regulated combustible fibers under the requirements of Article 28 *Storage and Handling of Combustible Fibers*.

TABLE 20

**Combustible Fibers – 1985 UBC Table No. 9-A**

Combustible Fibers	Maximum Quantities
Loose	100 cubic feet
Baled	1,000 cubic feet

The 100 cubic foot limit was based on the permit amount required by the National Board of Fire Underwriters Fire Prevention Code. The permit included both loose and baled fibers.<sup>129</sup>

**5.4.3.5 Threshold MAQ and Basis 1988 UBC.**

TABLE 21

**Combustible Fibers – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
1.3 Combustible fiber	(loose) (baled)	(100) (1,000)	-	-	(100) (1,000)	-	-	(20) (200)	-	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

The threshold MAQ for stored material established in the 1985 Edition of the UBC has been maintained. However, as previously mentioned in this report there was a general reduction in the allowable quantities of any given material in use-open systems compared with those in use-closed conditions. The reduction varies, but

<sup>129</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, p. 19.

there are a number of materials with physical hazard that have quantities reduced to from 20 to 25% of the closed use or storage amount. The logic in part was based in part on application of the footnotes that allowed for a doubling in sprinklered buildings, and an additional doubling of the increased quantity when storage was in an approved cabinet that when compounded resulted in an increase of four times the base amount. A reduction to one fourth to one fifth of the base amount was subjective, but it was also recognized that increasing the base amount by a factor of four also had a certain amount of subjectivity applied.

In the case of combustible fibers there were no tabular increases allowed based on sprinklers or cabinets as other construction features were required (vaults) by Chapter 28 of the UFC. A reduction to 20% of the base amount was applied to the use-open condition.

**5.4.3.6 Threshold MAQ and Basis 2000 IBC.**

TABLE 22

**Combustible Fibers – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Combustible fiber	(loose) (baled )	H-3	(100) (1,000)	N/A	N/A	(100) (1,000)	N/A	N/A	(20) (200)	N/A

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs are consistent with those contained in the 1988 UBC.

### 5.4.3.6 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 23

**Combustible Fibers – NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Combustible fiber	Loose Baled	3	(100) (1,000)	NA	NA	(100) (1,000)	NA	-	(20) (200)	NA

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

The threshold MAQs are consistent with those contained in the 1988 UBC. The category was removed from regulation under the MAQ concepts with the publication of the 2006 Edition of NFPA 1 UFC.

**5.4.3.7 Anomalies, Inconsistencies and Gaps.** There are no definitions provided to distinguish between loose and baled fibers. A dictionary definition for *baled* may be sufficient as a means to distinguish between the two. Whether loose material that has been wrapped or bagged is considered to be baled or not is not clear.

#### 5.4.4 Cryogenic (fluids).

**5.4.4.1 Definition and Basis 1988 UFC.** The term *cryogenic fluid* was defined in the 1988 UFC as follows:

*Cryogenic fluid(s) are those fluids that have a normal boiling point below -150°F. (See Table No. 75.102-B)*

The definition was unchanged from the definition found in the 1985 Edition of the UFC. The definition was introduced into the UFC in 1979 using the then DOT definition as the basis.

**5.4.4.2 Definition and Basis 2000 IFC.**

*Cryogenic Fluid. A liquid having a boiling point lower than -150°F (-101 °C) at 14.7 pounds per square inch atmosphere (psia) (an absolute pressure of 101 kPa).*

The definition was revised in the 2006 Edition of the IFC to correlate with the then current version of the DOT definition as follows:<sup>130</sup>

***Cryogenic Fluid.*** *A fluid having a boiling point lower than -130°F (-89.9°C) at 14.7 pounds per square inch atmosphere (psia) (an absolute pressure of 101 kPa).*

Cryogenic fluids are said to be “refrigerated” liquids as they don’t remain in their super-cooled state without a means to maintain the reduced temperature. The containers usually have evacuated, high-efficiency insulation, and most of them dissipate heat absorbed by the contained cryogenic fluid by venting small amounts of vapor.

#### **5.4.4.3 Definition and Basis 2003 NFPA 1 UFC.**

***Cryogenic Fluid.*** *A fluid having a boiling point lower than -130°F (-90°C) at 14.7 psia (101.325 kPa). [55:3.3]*

The NFPA 1 UFC definition has been extracted from NFPA 55 and is consistent with the 2006 Edition of the IFC.

**5.4.4.4 Threshold MAQ and Basis 1985 UBC.** Flammable cryogenics were not identified as a category under the requirements of the 1985 UBC. Flammable gases were defined; however, whether this was to include flammable gases that might be in a cryogenic state is doubtful. A definition for *flammable cryogenic* fluid did appear in the 1979 Edition of the UFC, and cryogenic fluids were regulated under Article 75 of the UFC; however, the requirements for cryogenics were not coordinated with the UBC and the category of cryogenics was not regulated by Table No. 9-A.

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<sup>130</sup> 49 C.F.R., §173.115(g), October 1, 2005, [http://edocket.access.gpo.gov/cfr\\_2005/octqtr/pdf/49cfr173.115.pdf](http://edocket.access.gpo.gov/cfr_2005/octqtr/pdf/49cfr173.115.pdf) visited 12/23/08.

**5.4.4.5 Threshold MAQ and Basis 1988 UBC.** Flammable and oxidizing cryogens were added to the MAQ table in the 1988 Edition of the UBC.

TABLE 24

**Cryogens, Flammable and Oxidizing – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
1.4 Cryogenic, flammable or oxidizing		-	45	-	-	45	-	-	10	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

The quantity of 45 gallons was based on the content of a typical DOT 4L container called a dewar with a nominal content of 160 liters.<sup>131</sup> These containers are constructed as a double walled insulated container with the annular space held under a vacuum. The reduction in open use was based on an approximate 25% of the base amount and rounded off for ease of application. Credits for sprinkler systems, gas cabinets or exhausted enclosures were not included when the table was developed.

<sup>131</sup> 1988 Analysis of Revisions to the Uniform Building Code, et al., p. 12.

5.4.4.6 Threshold MAQ and Basis 2000 IBC.

TABLE 25

**Cryogenics, Flammable and Oxidizing – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Cryogenics, flammable		H-2	N/A	45 <sup>d</sup>	N/A	N/A	45 <sup>d</sup>	N/A	N/A	10 <sup>d</sup>
Cryogenics, oxidizing		H-3	N/A	45 <sup>d</sup>	N/A	N/A	45 <sup>d</sup>	N/A	N/A	10 <sup>d</sup>

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The First Draft of the IFC included the use of footnote “d” allowing the increase in base amounts for the addition of sprinkler systems. Comparability was established between flammable and oxidizing gases as whether the material is in the refrigerated state or under ambient conditions at high pressure the hazards are comparable from the standpoint of flammability or oxidizing potential. Additional increases were not allowed for the use of gas cabinets or exhausted enclosures as ventilation is required for use of these systems in open containers that might be encountered in operations where open containers may be used.

### 5.4.4.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 26

#### Cryogenics, Flammable and Oxidizing – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Cryogenic	flammable	2	NA	45 <sup>f</sup>	NA	NA	45 <sup>f</sup>	NA	NA	10 <sup>f</sup>
	oxidizing	3	NA	45 <sup>f</sup>	NA	NA	45 <sup>f</sup>	NA	NA	10 <sup>f</sup>

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

The threshold MAQs are consistent with the quantities established in the 1988 UBC as modified by the addition of a credit for sprinkler systems established with the evolution of the 2000 IBC.

**5.4.4.8 Anomalies, Inconsistencies and Gaps.** There have been no anomalies, inconsistencies or gaps identified in this category.

### 5.4.5 Explosives.

**5.4.5.1 Definition and Basis 1988 UFC.** The term *explosive* was defined in the 1988 UFC as follows. Part (a) of the definition was taken from OSHA:<sup>132</sup>

**Explosive** is (a) chemical that causes a sudden, almost instantaneous release of pressure, gas and heat when subjected to sudden shock, pressure, or high temperatures; or (b) a material or chemical, other than a blasting agent, that is commonly used or intended to be used for the purpose of producing an explosive effect and is regulated by Article 77 (*Explosives and Blasting Agents*).

<sup>132</sup> Hazard Communication; Final Rule, November 25, 1983, p. 53341.



#### 5.4.5.2 Definition and Basis 2000 IFC.

**Explosive.** *A chemical compound, mixture or device, the primary or common purpose of which is to function by explosion. The term includes, but is not limited to, dynamite, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, igniters and display fireworks, 1.3G (Class B, Special).*

*The term “explosive” includes any material determined to be within the scope of USC Title 18: Chapter 40 and also includes any material classified as an explosive other than consumer fireworks, 1.4G (Class C, Common) by the hazardous materials regulations of DOTn 49 CFR.*

The definition came from the BOCA Fire Prevention Code.<sup>133</sup> In addition, the IFC includes definitions for High explosive, Low explosive, UN/FOT Class 1 explosives to include the current terminology for explosives that are further subdivided into six subcategories including those materials in Division 1.1 through 1.6.

#### 5.4.5.3 Definition and Basis 2003 NFPA 1 UFC.

**3.3.78\* Explosive Material.** *Any chemical compound, mixture or device, the primary or common purpose of which is to function by explosion [5000:3.3].*

**A.3.3.78.** *The term explosive material includes, but is not limited to, dynamite, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, igniters and Display Fireworks, 1.3G (Class B, Special).*

*The term explosive includes any material determined to be within the scope of USC Title 18 United States Code: Chapter 40, and also includes any material classified as an explosive other than Consumer Fireworks, 1.4G (Class C, Common, ) by the Hazardous Materials Regulations of Title 49 Code of Federal Regulations. [5000:A.3.3]*

**5.4.5.4 Threshold MAQ and Basis 1985 UBC.** Explosives were not regulated as a category under Table No. 9-A of the UBC. However, smokeless powder and black sporting powder were regulated, both of which could be classified as explosives under part (b) of the definition.

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<sup>133</sup> *The BOCA National Fire Prevention Code/1996*, Building Officials and Code Administrators International, Inc., Country Club Hills, IL, p. 122.

TABLE 27

**Explosives – 1985 UBC Table No. 9-A**

Explosives	Maximum Quantities
Smokeless powder	20 pounds <sup>4</sup>
Black sporting powder	1 pound <sup>5</sup>

<sup>4</sup>Quantities of smokeless powder may be increased to a maximum of 100 pounds, providing these amounts exceeding 20 pounds are stored in an approved Class II magazine as specified in the Uniform Fire Code.

<sup>5</sup>Quantities of black sporting powder may be increased to a maximum of 5 pounds, providing said amount is stored in an approved Class II magazine as specified in the Uniform Fire Code.

The quantities of smokeless and black sporting powder were established to accommodate a quantity of these materials found in the typical sporting goods store. A Class II magazine is a portable magazine constructed of two inch nominal thickness lumber covered on the outside with No. 20 standard gage steel. There are alternate methods of construction; however, they include wood and metal or materials of equivalent strength and fire resistance. The magazine is required to be able to be easily removed in the event of a fire, and equipped with wheels or casters to accommodate movement.

**5.4.5.5 Threshold MAQ and Basis for 1988 UBC.**

TABLE 28

**Explosives – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
2.1 Explosives		1 <sup>5,8,9</sup>	(1) <sup>5,8,9</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>8</sup>Permitted in sprinklered buildings only. None is allowed in unsprinklered buildings.

<sup>9</sup>One pound of black sporting powder and 20 pounds of smokeless powder are permitted in sprinklered or unsprinklered buildings.

Explosives as a category were introduced into the 1988 UBC. Although it was recognized that there was more than one subcategory of explosives at that time, i.e., High Explosives, Low Explosives and Blasting Agents, there was no difference in the approach used to address the group as a whole and all materials were placed into the same hazard category from the code perspective. The *1988 Analysis to Revisions* indicates that the quantity set for explosives is the same as the allowable quantities for Class I organic peroxides.<sup>134</sup>

Footnote 9 was crafted to retain the established exemption for sporting goods stores; however, footnote 8 was added to require that the buildings in which these materials were stored or used be fully sprinklered. Sprinklers were used as a means to protect the area in which explosives were stored or used from exposure hazards. The potential exposure was other portions of the building in which a fire could occur.

#### 5.4.5.6 Threshold MAQ and Basis 2000 IBC.

TABLE 29

**Explosives – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Explosives			1 <sup>e, g</sup>	(1) <sup>e, g</sup>	N/A	¼ <sup>g</sup>	(1/4) <sup>g</sup>	N/A	¼ <sup>g</sup>	(1/4) <sup>g</sup>

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>134</sup> *1988 Analysis of Revisions to the Uniform Building Code, et al.*, p. 12.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>g</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The MAQ threshold established in the 2000 Edition of the IFC was consistent with the approach taken in the 1988 UBC. Changes made in the 2003 Edition of the IFC introduced threshold MAQ limits across the spectrum of UN/DOT Class 1 explosive materials i.e., materials classified as explosives in Divisions 1.1 through 1.6. These changes were integrated with major changes to IFC Chapter 33 for explosive materials. The MAQ as it now appears in the 2006 Edition of the IBC is as follows:

TABLE 30

**Explosives – 2006 IBC Table 307.1(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard.**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Explosives	Div 1.1	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	N/A	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	N/A	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Div 1.2	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	N/A	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	N/A	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Div 1.3	H-1 or H-2	5 <sup>e, g</sup>	(5) <sup>e, g</sup>	N/A	1 <sup>g</sup>	(1) <sup>g</sup>	N/A	1 <sup>g</sup>	(1) <sup>g</sup>
	Div 1.4	H-3	50 <sup>e, g</sup>	(50) <sup>e, g</sup>	N/A	50 <sup>g</sup>	(50) <sup>g</sup>	N/A	50 <sup>g</sup>	(50) <sup>g</sup>
	Div 1.4G	H-3	125 <sup>d, e, i</sup>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Div 1.5	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	N/A	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	N/A	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Div 1.6	H-1	1 <sup>d, e, g</sup>	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not Applicable

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>c</sup> The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable shall not be limited provided that such materials are packaged in individual containers not exceeding 1.3 gallons (5L).

<sup>d</sup> Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied accumulatively.

<sup>e</sup> Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, day boxes, gas cabinets, exhausted enclosures or safety cans. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>f</sup> The permitted quantities shall not be limited in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>g</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>h</sup> Containing not more than the maximum allowable quantity per control area of Class I-A, Class I-B or Class I-C flammable liquids.

<sup>i</sup> Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system shall be 660 gallons provided such system complies with the *International Fire Code*.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

<sup>l</sup> Net weight of the pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks including the packaging shall be used.

Division 1.4G was intended to focus on fireworks that have been addressed in the definition. The letter following a division indicates compatibility for storage and shipping purposes. Division 1.4 materials are “articles” compared with materials that may be in other divisions such as Division 1.1 which indicates materials with a mass explosion hazard. Footnotes were further revised to recognize the use of “day boxes” which are a type of portable magazine as being equivalent with approved cabinets.

### 5.4.5.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 31

**Explosives and Fireworks – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Explosives	NA	1	1 <sup>e, h, i, j</sup>	(1) <sup>e, h, j</sup>	NA	¼ <sup>h</sup>	(1/4) <sup>h</sup>	NA	¼ <sup>h</sup>	(1/4) <sup>h</sup>
Consumer fireworks	1.4G	3	125 <sup>c, k, d</sup>	NA	NA	NA	NA	NA	NA	NA

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>c</sup> Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system is permitted to be 660 gal, provided that such system conforms to NFPA 31.

<sup>d</sup> Unless the actual weight of the pyrotechnic composition of the consumer fireworks, 1.4G, is known, 25 percent of the gross weight of the fireworks, including packaging, is permitted to be used to determine the weight of the fireworks for the purpose of this table.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>TM</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>h</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

<sup>i</sup> Maximum quantities of black powder, smokeless propellant, and small arms primers stored or displayed in mercantile occupancies or stored in one- or two-family dwellings shall be permitted to exceed the amount specified by this table when such storage complies with the requirements of NFPA 495, Chapter 13.

<sup>j</sup> In lieu of the maximum allowable quantity limit per control area, the maximum aggregate quantity per building of special explosive devices in industrial, mercantile, and storage occupancies shall be 50 lb.

<sup>k</sup> A maximum quantity of 200 lb of solid or 20 gal of liquid Class 3 oxidizers is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

#### 5.4.5.8 Anomalies, Inconsistencies and Gaps.

- (a) The use of footnotes “c and k” applicable to fireworks was in error. The errors were corrected in the 2006 Edition of the code to reflect an increase for storage in cabinets and the calculation of weights as indicated in footnote “d.”
- (b) NFPA 495 is not fully coordinated with the NFPA 1 or NFPA 5000 approach with respect to the use of MAQ. Although Division 1.1 through 1.6 materials have been recognized in NFPA 495, there was little movement made to integrate the concept into the 2003 or 2006 Editions of NFPA 1 UFC or NFPA 5000. The NFPA codes are not in harmony with other nationally recognized codes regarding the storage and use of explosive materials in buildings where the use of explosives may be incidental to the overall purpose of the building which includes the *control area* concept.

#### 5.4.6 Flammable Solids.

**5.4.6.1 Definition and Basis 1988 UFC.** The term *flammable solid* was defined in the 1988 UFC as follows:

*Flammable Solid is a solid substance, other than one which is defined in this article as a blasting agent or explosive, that is liable to cause fire through friction or as a result of retained heat from manufacture, or which has an ignition temperature below 212°F., or which burns so vigorously or persistently when ignited so as to create a serious hazard. Finely divided solid materials which when dispersed in air as a cloud may be ignited and cause an explosion are flammable solids.*

The definition was a revision of the 1985 Edition of the code.

**5.4.6.2 Definition and Basis 2000 IFC.**

*Flammable Solid is a solid substance, other than one which is defined in this article as a blasting agent or explosive, that is liable to cause fire through friction or as a result of retained heat from manufacture, or which has an ignition temperature below 212°F., or which burns so vigorously or persistently when ignited so as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR; Part 1500.44, if it ignites and burns with a self-*

*sustained flame at a rate greater than 0.1 inches (2.5 mm) per second along its major axis.*

The basis for the definition was the BOCA Fire Prevention Code. The BOCA code had adopted the 1988 UBC definition and modified it to include a requirement for a specific test in accordance with requirements of the consumer product safety commission.<sup>135</sup>

#### 5.4.6.3 Definition and Basis 2003 NFPA 1 UFC.

**3.3.184.2\* Flammable Solid** is a solid substance, other than one which is defined in this article as a blasting agent or explosive, that is liable to cause fire through friction or as a result of retained heat from manufacture, or which has an ignition temperature below 212°F (110°C), or which burns so vigorously or persistently when ignited that it creates a serious hazard.

**A.3.3.184.2\* Flammable Solid.** Flammable solids include finely divided solid materials that when dispersed in air as a cloud could be ignited and cause an explosion.

The definition for flammable solid has been taken from the 2000 UFC. It has been modified to move the last sentence to an annex note.

**5.4.6.4 Threshold MAQ and Basis 1985 UBC.** Flammable solids were limited by Table No. 9-A of the 1985 UBC as follows. There were no increases allowed under footnotes included with the table:

TABLE 32

**Flammable Solids – 1985 UBC Table No. 9-A**

Material	Maximum Quantities
Flammable solids	500 pounds

Flammable solids were listed along with other hazardous materials in the 1970 Edition of the AIA Fire Prevention Code; however, a quantity trigger for this hazard category was not established.<sup>136</sup> The quantity limit of 500 pounds was established

<sup>135</sup> *The BOCA National Fire Prevention Code/1996*, p. 141.

<sup>136</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, New York, pp. 155-157.



initially with the promulgation of the 1973 Edition of the UBC. The available documentation provided for the establishment of the limitation notes only that a new table has been introduced which establishes exempt amounts of hazardous materials and no further supporting details are provided.<sup>137</sup> The AIA code permit quantity limit for oxidizing materials was 500 pounds which may have served as a comparable basis for limiting flammable solids to 500 pounds. There is no documentation available to further understand the rationale.

#### 5.4.6.5 Threshold MAQ and Basis 1988 UBC.

TABLE 33

**Flammable Solids – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
3.1 Flammable solid		125 <sup>4,5</sup>	-	-	25 <sup>4</sup>	-	-	25 <sup>4</sup>	-	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

The storage MAQ of 500 pounds established by the 1985 Edition of the UBC was reduced to 125 pounds recognizing that it could be increased to 500 pounds through the use of sprinklers and approved storage cabinets. A reduction of 20% was applied to the use-open condition. It is believed that the use-closed condition was to have been 125 pounds and that a publication error was made when the 1988 Edition was published.

<sup>137</sup> 1973 Analysis of Revisions of the Uniform Codes, International Conference of Building Officials, Whittier, CA, 1973, p. 12.

Table 3-D of the 1994 Edition of the UBC revised the tabular limits for use-closed and use-open conditions by deleting the MAQ and referring the code user to the definition for Group H-2 and H-3 Occupancies. The deletion of the MAQ appears to have been part of the coordination with changes that occurred to move woodworking from a Group H, Division 2 Occupancy to that of Group F, Division 1. In the *Analysis of Revisions to the 1994 Uniform Codes* there is substantial discussion in the reason regarding the change in occupancy about combustible dust and some mention of combustible fibers; however, there is no discussion regarding flammable solids or the reason for the deletion. However, in discussion regarding changes to the table of exempt amounts the following explanation is provided:<sup>138</sup>

*In item 3.1 [flammable solids], the deletion of the exempt amounts for flammable solids where in use-open or closed systems was a companion change to revisions made to the definitions for Divisions 2 and 3 Occupancies. "Division 3 Occupancy" is revised to address occupancies where flammable solids, other than combustible dust, are [sic] manufactured, used or generated. Item 7 to Division 3 Occupancy is revised to specifically address flammable solids in storage, but in Table 3-D the 125 pounds of exempt amounts in a control area is retained.*

Also:

*Footnote 14, previously Footnote 12 in the 1991 UBC, has been revised to reflect the change concerning the removal of combustible dust.*

Footnote 14 was a reference to the user to the definitions of Divisions 2 and 3. The footnote was placed in the cell of the table under flammable solid use-closed and use-open. At the same time *combustible dust* was removed from the table. These actions were reportedly made to address a problem with wood shops where combustible dust and not flammable solids was the problem. There was no explanation offered to explain why flammable solids such as nitrocellulose, potassium, sodium, zirconium powder and similar materials in use were not regulated by the MAQ table and an inconsistency was inadvertently built into the code to address perceived problems related to the classification of woodworking occupancies.

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<sup>138</sup> *Analysis of Revisions To The 1994 Uniform Codes*, International Conference of Building Officials, Whittier, CA, 1994, pp. 5-8.

### 5.4.6.6 Threshold MAQ and Basis 2000 IBC.

TABLE 34

**Flammable Solids – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>A, J</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable solid			125 <sup>d, e</sup>	N/A	N/A	25 <sup>d</sup>	N/A	N/A	25 <sup>d</sup>	N/A

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs are consistent with those used in the 1988 UBC.

### 5.4.6.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 35

**Flammable Solids – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable solid	NA	3	125 <sup>e, f</sup>	NA	NA	25 <sup>f</sup>	NA	NA	25 <sup>e, f</sup>	NA

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>™</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

The threshold MAQs are consistent with those published in the 1988 UBC/UFC.

#### 5.4.6.8 Anomalies, Inconsistencies and Gaps.

- (a) The annex note to A.3.3.184.2 appears to be an informational note that defines in part a combustible dust.

#### 5.4.7 Flammable Gases.

**5.4.7.1 Definition and Basis 1988 UFC.** The 1988 UFC defined *flammable gas* as follows:

***Flammable Gas*** is a gas which is flammable in [a] mixture of 13 percent or less (by volume) with air, or the flammable range with air is wider than 12 percent, regardless of the lower limit.

The definition was based on the DOT definition found in 49CFR §173.115.

**5.4.7.2 Definition and Basis 2000 IFC.**

***Flammable Gas.*** A material which is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure [a material that has a boiling point of 68° F (20° C) or less at 14.7 psia (101 kPa)] which:

1. Is ignitable at 14.7 psia (101kPa) when in a mixture of 13 percent or less by volume with air; or
2. Has a flammable range at 14.7 psia (101 kPa) with air of at least 12 percent, regardless of the lower limit.

**5.4.7.3 Definition and Basis 2003 NFPA 1 UFC.**

***3.3.101.3\* Flammable Gas.*** A material that is a gas at 68°F (20°C) or less at an absolute pressure of 14.7 psia (101.325 kPa), that is ignitable at an absolute pressure of 14.7 psia (101.325 kPa)] when in a mixture of 13 percent or less by volume with air, or that has a flammable range at 14.7 psia (101.325 kPa) with air of at least 12 percent, regardless of the lower limit [55:3.3].

***A.3.3.101.3 Flammable Gas.*** The degrees of hazard are ranked according to ease, rate, and quantity of energy release of the material in pure or commercial form detailed in Table A.3.3.101.3. [55:A.3.3]

[Table A.3.3.101.3 is an extract from NFPA 704 for instability hazards]

**5.4.7.4 Threshold MAQ and Basis 1985 UBC.**

TABLE 36

**Flammable Gas – 1985 UBC Table No. 9-A**

Material	Maximum Quantities
Flammable gases	3000 cubic feet at one atmosphere of pressure at 70°F
Liquefied flammable gases	60 gallons

The AIA Fire Prevention Code required a permit for more than 2,000 cubic feet of flammable compressed gas at normal temperature and pressure.<sup>139</sup> Fuel gas cylinders used for welding and cutting and located inside a building were limited to 300 pounds of liquefied petroleum gas or 3,000 cubic feet of other fuel gas. Additional quantities of gas could be located in the same room or area providing that the total quantity on a manifold did not exceed 3,000 cubic feet and each manifold was separated by fifty feet. If the capacity on a single manifold exceeded 3,000 cubic feet the manifold was required to be located outdoors or in a separate building or room requiring fire-resistive construction and protected openings. It is likely that the 3,000 cf limit for fuel gas was used as the basis for the MAQ at 3,000 cf.<sup>140</sup> The quantity limit of 300 pounds for LPG can be converted through the use of density to 60 gallons. Using the density for butane a weight of 300 pounds would yield a nominal volumetric quantity of 62 gallons which may have been rounded down to 60 gallons.

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<sup>139</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, New York, §8.3, p. 22.

<sup>140</sup> *Fire Prevention Code*, 1965 Edition, American Insurance Association, New York, §30.9, p. 210.

### 5.4.7.5 Threshold MAQ and Basis 1988 UBC.

TABLE 37

**Flammable Gas – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
3.2 Flammable gas	Gaseous	-	-	750 <sup>4 5</sup>	-	-	750 <sup>4 5</sup>	-	-	-
	Liquefied	-	15 <sup>4 5</sup>	-	-	15 <sup>4 5</sup>	-	-	-	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

The MAQ of 3,000 cf for nonliquefied flammable gas in storage and use-closed conditions was reduced to 750 cf in either storage or use-closed conditions which could be increased back to 3,000 by the use of approved cabinets and fully sprinklered buildings. The MAQ of 15 gallons in storage or use-closed conditions was based on a reduction of 60 gallons by a factor of four which could be increased back to 60 gallons through the use of approved cabinets and sprinklers.

The philosophy of reducing the 1985 quantities by a factor of four which is used in a number of hazard categories shown in Table No. 9-A also recognized that under the UBC concept the number of control areas allowed an increase in the maximum quantity by a factor of 4 as well. To earn the maximum per building increase, construction features or engineering controls such as cabinets, sprinklers and fire-resistive compartmentation was applied.

**5.4.7.5.1 Restrictions on MAQ.** There were no further restrictions on the MAQ for flammable gases in people sensitive occupancies in the 1988 UFC.

**5.4.7.6 Threshold MAQ and Basis 2000 IBC.**

TABLE 38

**Flammable Gas – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard<sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable gas	Gaseous Liquefied	H-2	N/A -	N/A 30 <sup>d, e</sup>	1000 <sup>d, e</sup> N/A	N/A	N/A 30 <sup>d, e</sup>	1000 <sup>d, e</sup> N/A	N/A -	N/A

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

As the first draft of the IFC was developed the quantity of flammable gases in storage was increased by the drafting committee from 750 to 1000 cubic feet (gaseous) and from 15 to 30 gallons (liquefied). The same increase was extended to flammable gases in use by a code change introduced into the public process for consistency in approach and application of the threshold limits integral to the table, i.e., storage and use-closed quantities were equivalent.<sup>141</sup>

<sup>141</sup> 1999 Proposed Changes to the Final Draft of the International Fire Code, International Code Council, Country Club Hills, IL, First Printing, January 1999, Item F666-99, p. F357.

### 5.4.7.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 39

**Flammable Gas – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable, gas	Gaseous Liquefied	2	NA	NA 30 <sup>e,f</sup>	1000 <sup>e,f</sup> NA	NA NA	NA 30 <sup>e,f</sup>	1000 <sup>e,f</sup> NA	NA NA	NA NA

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>TM</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

In 2006 a threshold MAQ for liquefied petroleum gas (LP) was introduced into the table.<sup>142</sup> A threshold MAQ of 300 pounds in storage and use-closed was established with additional quantities of 300 pounds to be separated by a minimum of 300 feet. The result is that the total quantity of LP gas to be included inside a building is only limited by the size of the building. The basis for the addition of the threshold limit was for correlation with NFPA 58. The 2008 Edition of NFPA 58 Table 8.3.1(b) establishes a base quantity limit of 300 pounds of LP as the MAQ threshold for storage in mercantile, industrial and storage occupancies. NFPA 1 UFC and NFPA 5000 have incorrectly listed a base threshold MAQ of 300 gallons. This error appears to be a publication error that was carried into the 2006 Edition of NFPA

<sup>142</sup> *Report on Proposals NFPA 5000 Annual 2005 Code Cycle*, <http://www.nfpa.org/assets/files/PDF/ROP/5000-A2005-ROPPart3.pdf>, visited 11/19/08, Item 5000-893 Log #CP1609, p. 5000-354.



5000. It is contrary to the committee proposal under which the change was made, and it has now been carried into the 2006 Edition of NFPA 1 UFC.

Using an average liquid density (average of propane and butane densities) of 4.5 lb/gal a quantity of 300 lb equates to approximately 67 gallons or nominally 2,278 cubic feet. On the other hand using 300 gallons as the base amount the quantity is increased to 20,100 cubic feet. Footnotes in NFPA 1 UFC Table 60.1.3.1 decrease the limit in mercantile occupancies to 200 pounds in nominal 1 lb LP-Gas containers.

#### **5.4.7.8 Anomalies, Inconsistencies and Gaps.**

- (a) The Annex notes regarding the degrees of instability hazards in NFPA 55 and NFPA 1 UFC for flammable gases were in error in the 2003 Editions of NFPA 55 and NFPA 1 UFC. Flammable gases are either flammable or not based on their ability to be ignited under the limitations established by the definition of flammable gas. A correction was made in the 2006 Edition of NFPA 1 UFC and the 2005 Edition of NFPA 55 accordingly.
  
- (b) The definition of flammable gas has been established by the Department of Transportation (DOT) for shipping purposes. The current codes do not apply a strategy to address gases that are highly flammable from those that are moderately flammable. Subdivisions of flammability for gases similar to those established for flammable liquids have been defined to a certain degree by NFPA 497 in Table 4.4.2 establishes the classification of various materials. For example, gases are Class I materials that are further subdivided into Groups A, B, C, or D for the purposes of designating electrical classification. The table has been developed in part based on intrinsic properties of materials including autoignition temperatures and minimum ignition energies. Historically, the model codes have regulated “flammable gases” as a single category which has raised a number of questions for a gas like ammonia which falls outside of the definition which would place it into a flammable hazard class. On the other hand ammonia is classified as flammable in Europe, and it has been documented as having been involved in fires and explosions when leakage occurred and the ammonia was

released into confined spaces.<sup>143 144</sup> It could be that gases like ammonia could be classified as “moderately flammable” with no change to the level of regulation required. A similar approach is taken with toxic materials where the code regulates materials that are defined as either highly toxic or toxic and materials that are moderately toxic, or which have degrees of toxicity below the defined toxic threshold are not treated with special regulations. An alternative would be to define those gases under the current definition to be *highly flammable gases* which would allow a continuation of the current regulatory approach.

The American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) has developed a system of classification of hazards of refrigerants that recognizes the moderate flammability of a number of common refrigerants, and has grouped these materials in accordance with a hierarchy to identify their propensity toward ignition.<sup>145</sup> The requirements of ASHRAE are typically referenced in the model mechanical codes; however, there has been no movement to harmonize the apparent differences in terminology, and code users continue to be confused with materials like ammonia.

- (c) The threshold MAQ in NFPA 1 UFC and NFPA 5000 of 300 gallons is not consistent with NFPA 58. The quantity for the units of measure listed in NFPA 5000 and NFPA 1 UFC (2006 Editions) results in a tenfold increase in the quantity of LP gas being stored and used in buildings without instituting suitable protection level controls.

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<sup>143</sup> Bretherick, Leslie, *Bretherick's Handbook of Reactive Chemical Hazards*, Butterworth's, Boston, Fourth Edition, 1990, pp. 1228 – 1230.

<sup>144</sup> *Mechanical Refrigeration, FM Global Property Loss Prevention Data Sheet 7-13*, Factory Mutual Engineering, Norwood, MA, May 2007, Table 3, p. 10.

<sup>145</sup> *Designation and Safety Classification of Refrigerants, ASHRAE 34 2001*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc, Atlanta, GA.

## 5.4.8 Flammable Liquids.

**5.4.8.1 Definition and Basis 1988 UFC.** The definition for flammable liquids in the 1988 UFC was unchanged from the definition promulgated in the 1985 Edition of the Code

***Flammable Liquid** is any liquid having a flash point below 100°F. and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100°F. Class I liquids shall include those having flash points below 100°F. and may be subdivided as follows:*

***Class I-A** shall include those having flash points below 73°F. and having a boiling point below 100°F.*

***Class I-B** shall include those having flash points below 73°F and having a boiling point at or above 100°F.*

***Class I-C** shall include those having flash points at or above 73°F and below 100°F.*

The definitions have been long standing definitions and they are in concert with those used in the AIA Fire Prevention Code.<sup>146</sup>

The limitations included in the definition for vapor pressure of 40 psia presented a problem with some materials, like ethylene oxide, which meet the definitions for a compressed gas and which is packaged and shipped as a compressed gas under DOT requirements promulgated in 49 CFR.

## 5.4.8.2 Definition and Basis 2000 IFC.

***Flammable Liquid.** A liquid having a closed cup flash point below 100°F (38° C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:*

***Class I-A.** Liquids having a flash point below 73°F (23°C) and having a boiling point below 100°F (38°C).*

***Class I-B.** Liquids having a flash point below 73°F (23°C) and having a boiling point at or above 100°F (38°C).*

***Class I-C.** Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C).*

The definition in the 1988 UFC was modified in the 1997 Edition of the UFC to delete the reference to vapor pressure as had been included in previous editions of

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<sup>146</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, §16.12, pp. 81-82.

the code. The deletion resolved conflicts with compressed gases caused by the definition.

**5.4.8.3 Definition and Basis 2003 NFPA 1 UFC.**

**3.3.125.3 Flammable Liquid.** Any liquid that has a closed cup flash point below 100°F (38°C), as determined by the test procedures and apparatus set forth in 1.7.4 of NFPA 30. Flammable liquids are classified as Class I as follows: (a) Class I Liquid – any liquid that has a closed-cup flash point below 100°F (38°C) and a Reid vapor pressure not exceeding 40 psia (2068.6 mm Hg) at 100°F (38°C), as determined by ASTM D323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*. Class I liquids are further classified as follows: (1) Class IA liquids – those liquids that have flash points below 73°F (23°C) and boiling points below 100; (2) Class IB liquids shall include those liquids that have flash points below 73°F (23°C) and boiling points at or above 100°F (38°C); (3) Class IC liquids shall include those liquids – flash points at or above 73°F (23°C), but below 100°F (38°C). [30:1.7].

The definition has been extracted from NFPA 30; however, by including criteria for pressure, i.e., pressures not exceeding 40 psia at 100°F (38°C) a number of flammable gases are included and a conflict is created.

**5.4.8.4 Threshold MAQ and Basis 1985 UBC.** Flammable liquids were included in Table No. 9-A of the 1985 Edition of the code with the following MAQ limits:

TABLE 40

**Flammable Liquids – 1985 UBC Table No. 9-A**

Material	Maximum Quantities
<b>Flammable liquids<sup>1</sup></b>	
Class I-A	30 gal <sup>2</sup>
Class I-B	60 gal <sup>2</sup>
Class I-C	90 gal <sup>2</sup>
<b>Combination flammable liquids<sup>3</sup></b>	120 gal <sup>2</sup>

<sup>1</sup>The quantities of alcoholic beverages in retail sales or storage uses are unlimited, provided the liquids are packaged in individual containers not exceeding 4 liters. The quantities of medicines, foodstuffs and cosmetics, containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solution not being flammable, in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding 4 liters.

<sup>2</sup>Quantities may be increased by 100 percent in areas which are not accessible to the public. In buildings where automatic fire-extinguishing systems are installed, the quantities may be increased 100 percent in areas accessible to the public.

<sup>3</sup>Containing not more than the exempt amounts of Class I-A, I-B or I-C flammable liquids.

The basis for the 30, 60, 90 gallon limits appears to be an evolution from the 1973 UBC which established the threshold for Class IA, IB and IC liquids at 60, 120 and 180 gallons respectively. In 1976 the 1973 thresholds were reduced from 60, 120 and 180 by a factor of two with an increase by a factor of two allowed in buildings that either were protected with automatic fire-extinguishing systems or which were not accessible to the public. This concept was retained through the publication of the 1985 Edition of the UBC. A similar approach was taken with combination flammable liquids (combination of Class IA, IB and IC) with the original threshold level of 240 gallons being reduced by a factor of two being able to be increased by the application of footnote 2 accordingly.

#### 5.4.8.5 Threshold MAQ and Basis 1988 UBC.

TABLE 41

**Flammable Liquids – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
3.3 Flammable liquid <sup>3</sup>	I-A	-	30 <sup>4,5</sup>	-	-	30 <sup>4</sup>	-	-	10 <sup>4</sup>	-
	I-B	-	60 <sup>4,5</sup>	-	-	60 <sup>4</sup>	-	-	15 <sup>4</sup>	-
	I-C	-	90 <sup>4,5</sup>	-	-	90 <sup>4</sup>	-	-	20 <sup>4</sup>	-
Combination I-A, I-B, I-C		-	120 <sup>4,5,10</sup>	-	-	120 <sup>4,10</sup>	-	-	30 <sup>4,10</sup>	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>3</sup>The quantities of alcoholic beverages in retail sales uses are unlimited provided the liquids are packaged in individual containers not exceeding four liters. The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>10</sup>Containing not more than the exempt amounts of Class I-A, Class I-B or Class I-C flammable liquids.

The base quantity established by Table No. 9-A was maintained consistent with the 1985 UBC. Modifications to footnotes were applied to recognize the use of control areas, and to apply a reduction for materials found in open-use. The storage and use of flammable liquids is encountered in numerous buildings. The use of sprinklers and no access by the public was replaced by sprinklers and approved cabinets under the revisions promulgated in the 1988 Edition of the code. A reduction in the base quantity by a factor of four would have proven to be problematical to a large number of buildings, and increases by a factor of four were in line with the general approach that had been used for some period of time. A reduction was applied for use-open conditions using one fourth of the storage amount and rounding of the value to the nearest five gallons (rounding 7.5 up to 10 in the case of Class I-A, and down from 22.5 to 20 in the case of Class I-C).

#### 5.4.8.6 Threshold MAQ and Basis 2000 IBC.

TABLE 42  
**Flammable Liquids – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable liquid <sup>c</sup>	I-A	H-2 or H-3	N/A	30 <sup>d, e</sup>	N/A	N/A	30 <sup>d</sup>	N/A	N/A	10 <sup>d</sup>
	I-B			60 <sup>d, e</sup>			60 <sup>d</sup>			15 <sup>d</sup>
	I-C			90 <sup>d, e</sup>			90 <sup>d</sup>			20 <sup>d</sup>
Combination (I-A, I-B, I-C)		H-2 or H-3	N/A	120 <sup>d, e, h</sup>	N/A	N/A	120 <sup>d, h</sup>	N/A	N/A	30 <sup>d, h</sup>

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>c</sup> The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies

the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable shall not be limited provided that such materials are packaged in individual containers not exceeding 1.3 gallons (5L).

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>h</sup> Containing not more than the maximum allowable quantity per control area of Class I-A, Class I-B or Class I-C flammable liquids.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs are consistent with the approach established in the 1988 Edition of the UBC. A code change to increase the limit of Class IB liquids in storage and use by combining the threshold quantities for Class IB & IC liquids was accepted and published in the 2003 Edition of the IBC.<sup>147</sup> The justification was that the burning and fire exposure hazards between IB and IC liquids are very similar at the small quantity levels integral to the MAQ. An aggregate quantity of 120 gallons of Class IB and IC liquids in storage, and 120 gallons in use-closed, and 30 gallons in use-open replaced what might have been viewed as a larger volume had the classes been aggregated previously. For example if an aggregate had been assumed under the former MAQ thresholds a total of 150 gallons (60 gallons IB + 90 gallons IC) would have been the result. Under the aggregate concept an increase in the level of IB liquids comes with a reduction in the level of IC liquids and vice versa.

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<sup>147</sup> 2002 Code Development Cycle, Proposed Changes to the 2000 Editions of the International Codes, International Code Council, Country Club Hills, IL, First Printing, February 2002, Item F190-02, pp. F97-98.

### 5.4.8.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 43

**Flammable Liquids – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable liquid <sup>c</sup>	I-A I-B & I-C Combination I-A, I-B, I-C	2 or 3	NA	30 <sup>e, f</sup> 120 <sup>e, f</sup> 120 <sup>e, f</sup>	NA	NA	30 <sup>f</sup> 120 <sup>e, f</sup> 120 <sup>f, l</sup>	NA	NA	10 <sup>f</sup> 30 <sup>e, f</sup> 30 <sup>f, l</sup>

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>c</sup> Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system is permitted to be 660 gal, provided that such system conforms to NFPA 31.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>™</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>l</sup> Containing not more than the maximum allowable quantity per control area of Class I-A, Class I-B, or Class I-C flammable liquids.

The threshold MAQs are consistent with the 1988 Edition of the UFC with the exception of Class IB & IC liquids which have been combined in accordance with changes made in the 2003 IBC. The change was intended to increase the quantity of Class IB liquids with a commensurate reduction in Class IC liquids as the totals represent an independent aggregate under the combined categories under either the conditions of storage or use.



#### 5.4.8.8 Anomalies, Inconsistencies and Gaps.

(a) The definition for flammable liquids has been extracted from NFPA 30. By including criteria for pressure, i.e., pressures not exceeding 40 psia at 100°F (38°C) a number of flammable gases are inadvertently included. The vapor pressure qualifier as noted in the definition is designed for petroleum products. Not all materials may be petroleum products. Ethylene oxide [CAS 75-21-8] is a flammable liquefied compressed gas has a vapor pressure of 38 psi absolute at 100 degrees F. A few other examples of compressed gases that do not exceed the 40 psi pressure include: ethyl acetylene [CAS 107-00-6] (38 psi); ethyl chloride [CAS 75-00-3] (36 psi); 2, 2-dimethylpropane [CAS 463-82-1] (36 psi); methyl butane [CAS 78-78-4] (26 psi); and monoethylamine [CAS 75-04-7] (~32 psi). These materials are shipped in “pressure vessels” and as compressed gases under requirements of DOT. They have been regulated as compressed gases for many years. These materials are packaged and shipped as compressed gases either in steel cylinders typical of those used for other compressed gases, or in drums (ethylene oxide) constructed for containment of fluids under pressure.

#### 5.4.9 Organic peroxides.

**5.4.9.1 Definition and Basis.** The definition for organic peroxides in the 1988 UFC was new, and although the materials were regulated by previous editions of the code there was no defined term. The 1988 UFC base definition (underlined text) was taken from 29CFR §1910.1200 with modification to indicate a general level of hazard as follows:

*Organic Peroxide is an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical.*<sup>148</sup> *Organic peroxides may present an explosion hazard (detonation or deflagration) or they may be shock sensitive. They may also decompose into various unstable compounds over an extended period of time.*

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<sup>148</sup> Hazard Communication; Final Rule, November 25, 1983, p. 53342.

The subdivision of the peroxide category was contained in Appendix VI-A with an explanation and examples of materials that fit into each of the subdivisions identified. The Appendix was used in concert with the requirements of the code in application. The descriptive, not including the examples are listed below.

***Unclassified (detonable):*** Peroxides which are capable of detonation. These peroxides present an extremely high explosion hazard through rapid explosive decomposition and are regulated in accordance with the provisions of Article 77 for Class A explosives.

*[Note: the parenthetical term “detonable” was not included in the UFC Appendix, but it was used in Table No. 9-A of the UBC in the establishment of exempt amounts.*

***Class I:*** Class I peroxides are capable of deflagration, but not detonation. These peroxides present a high explosion hazard through rapid decomposition.

***Class II:*** Class II peroxides burn very rapidly and present a severe reactivity hazard.

***Class III:*** Class III peroxides burn rapidly and present a moderate reactivity hazard.

***Class IV:*** Class IV peroxides burn in the same manner as ordinary combustibles and present a minimum reactivity hazard.

***Class V:*** Class V peroxides do not burn or present a decomposition hazard.

Factory Mutual Engineering published a data sheet 7-80 for organic peroxides which included materials subdivided into Class I through Class V.<sup>149</sup> The first edition of NFPA 43B (which transitioned to NFPA 432) was adopted at the 1985 NFPA Fall Meeting and published as the 1986 Edition of the code. The definitions for Class I through V were developed by the UFC Article 80 Ad hoc code committee from definitions found in FM 7-80 with recognition of classifications included in the Appendix of NFPA 43B.<sup>150</sup> The definition of *unclassified* was developed with recognition that the classification system was only applicable to organic peroxides in their normal shipping containers.

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<sup>149</sup> *Organic Peroxides*, Loss Prevention Data, Factory Mutual Engineering, Norwood, MA, Data Sheet 7-80, March 1972.

<sup>150</sup> *Code for the Storage of Organic Peroxide Formulations*, NFPA 43B, National Fire Protection Association, Quincy, MA, 1986.

#### 5.4.9.2 Definition and Basis 2000 IFC.

**Organic Peroxide** is an organic compound that contains the bivalent –O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical. Organic peroxides can present an explosion hazard (detonation or deflagration) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.<sup>151</sup>

**Unclassified detonable.** Organic peroxides that are capable of detonation. These peroxides present an extremely high explosion hazard through rapid explosive decomposition.<sup>152</sup>

**Class I.** Those formulations that are capable of deflagration, but not detonation.<sup>153</sup>

**Class II.** Those formulations that burn very rapidly and present a severe reactivity hazard.

**Class III.** Those formulations that burn rapidly and present a moderate reactivity hazard.

**Class IV.** Those formulations that burn in the same manner as ordinary combustibles and present a minimum reactivity hazard.

**Class V.** Those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.

The definitions for Class I through Class V are based on the 1997 Edition of NFPA 32. The base definition and the definition for unclassified detonable organic peroxides evolved from the 1988 UFC.

#### 5.4.9.3 Definition and Basis 2003 NFPA 1 UFC.

**3.3.144 Organic Peroxide.** Any organic compound having a double oxygen or peroxy (-O-O-) group in its chemical structure. [432:1.5]

**3.3.144.1\* Organic Peroxide Formulation.** A pure organic peroxide or a mixture of one or more organic peroxides with one or more other materials in various combinations and concentrations. [432:1.5]

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<sup>151</sup> *Uniform Fire Code*, 1997 Edition, p. 1-21.

<sup>152</sup> *Ibid*, Appendix VI-A with editorial modification to remove an internal reference to Article 77, p. 1-316

<sup>153</sup> *Code for the Storage of Organic Peroxide Formulations, NFPA 432*, 1997 Edition, National Fire Protection Association, Quincy, MA, Electronic version May 2001 Meeting Edition, October 2001.

**A.3.3.144.1 Organic Peroxide Formulation.** *Terms such as accelerator, catalyst, initiator, and so forth, are sometimes used to describe organic peroxide formulations. These terms are misleading because they can also refer to materials that are not or do not contain organic peroxides, some of which might present increased hazard when mixed with organic peroxides. [432:A.1.5]*

Annex B of the 2003 Edition of NFPA 1 UFC contains a list of typical organic peroxide formulations. The annex is an informative annex and not part of the code. There are descriptions included for typical Class I through V formulations which are similar to the Class I through V definitions found in the 2000 IFC. However, the terms are not otherwise defined in the code.

**5.4.9.4 Threshold MAQ and Basis 1985 UBC.** Organic peroxides as a general category (without subdivisions) were limited by Table No. 9-A of the 1985 UBC as follows. There were no increases allowed under footnotes included with the table:

TABLE 44

**Organic Peroxides – 1985 UBC Table No. 9-A**

Material	Maximum Quantities
Organic Peroxides	10 pounds

Organic peroxides were listed along with other hazardous materials in the 1970 Edition of the AIA Fire Prevention Code; a quantity of 10 pounds was used as the permit limit.<sup>154</sup> The quantity limit of 10 pounds was established initially with the promulgation of the 1973 Edition of the UBC; however, the available documentation provided for the establishment of the limitation notes only that a new table has been introduced which establishes exempt amounts of hazardous materials and no further supporting details are provided.

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<sup>154</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, New York, §20.3, p. 156.

### 5.4.9.5 Threshold MAQ and Basis 1988 UBC.

TABLE 45

**Organic Peroxides – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
4.1 Organic peroxide unclassified detonable		1 <sup>5 8</sup>	(1) <sup>5 8</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-	¼ <sup>8</sup>	(1/4) <sup>8</sup>	-
4.2 Organic peroxide	I	5 <sup>4 5</sup>	(5) <sup>4 5</sup>	-	1 <sup>4</sup>	(1) <sup>4</sup>	-	1 <sup>4</sup>	(1) <sup>4</sup>	-
	II	50 <sup>4 5</sup>	(50) <sup>4 5</sup>	-	50 <sup>4</sup>	(50) <sup>4</sup>	-	10 <sup>4</sup>	(10) <sup>4</sup>	-
	III	125 <sup>4 5</sup>	(125) <sup>4 5</sup>	-	125 <sup>4</sup>	(125) <sup>4</sup>	-	25 <sup>4</sup>	(25) <sup>4</sup>	-
	IV	500	(500)	-	500 <sup>4</sup>	(500)	-	100	(100)	-
	V	N.L.	N.L.	-	N.L.	N.L.	-	N.L.	N.L.	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>8</sup>Permitted in sprinklered buildings only. None is allowed in unsprinklered buildings.

The exempt amount quantity for Unclassified organic peroxides of one pound (1 lb) was based on the limitation for black powder which was established in the UBC with revisions produced in 1982.<sup>155</sup> Undocumented testing with black powder in buildings of ordinary construction had been performed by representatives of the California Fire Chiefs Association and it was reported that five pounds of black powder would produce significant damage in a room, but that 50 pounds would demolish ordinary buildings.

<sup>155</sup> 1982 Analysis of Revisions to the Uniform Codes, International Conference of Building Officials, Whittier, CA, 1982, p. 6.

A five pound (5 lb) limit for Class I organic peroxides was established with the recognition of the deflagration potential embodied in the definition, and experience which was common knowledge at the time through those in the Northern California Fire Prevention Officers Association that had participated as observers in the testing.<sup>156</sup>

The fifty pound (50 lb) limit for Class II organic peroxides was subjectively based on a tenfold increase or five gallon container of liquid assuming a density of 10 pounds per gallon with the recognition of the burning potential and assumed risk. See discussion on FM 7-80 limitations below.

The one hundred twenty-five pound (125 lb) limit for Class III organic peroxides was based on a two and a half fold increase over the Class II quantity. See discussion on FM 7-80 limitations below.

The five hundred pound (500 lb) limit for Class IV organic peroxides was based on an increase in quantity to 50 gallons with recognition that there was rapid burning with moderate reactivity being reported. Comparisons were made with the limitations imposed by FM 7-80.

The unlimited quantity established for Class V organic peroxides was based on the definition and recognition that this category did not appear to materially alter the typical combustible loading in most any occupancy.

FM 7-80 established a table of maximum quantities in various areas including process areas; cutoff or attached areas; detached areas and laboratories. The laboratory storage quantities per 5,000 square foot of floor space were:

Class I – 2 pounds

Class II – 20 pounds

Class III- 200 pounds

Class IV – 500 pounds

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<sup>156</sup> Personal conversations between the author and members of the Northern California Fire Prevention Officers Association when the author served as a pro bono member of the Uniform Fire Code Committee of the Nor Cal FPO, circa 1980-1986.

Class V – 500 pounds

Areas that were “cutoff or detached” were other than ordinary occupancies as they would parallel the Group H occupancy within the context of the UBC. Process areas under the FM guidance document were limited to quantities of:

Class I – Immediate needs

Class II – Immediate needs

Class III – Shift supply

Class IV – Day’s supply

Class V – unlimited with some consideration as to the value of the area, combustibility of packing materials, housekeeping, exposure to and from other storage and occupancy, etc.

Overall judgment in the determination of quantity was tempered by the fact that the classification system encompassed in the FM Engineering documents and NFPA 43B was less than exact, and with the recognition that the exempt quantity established for unstable materials in the 1985 UBC had been “none.” In other words, any quantity of unstable material would trigger the use of a Group H Occupancy. In addition, it was recognized that many of these materials were flammable or mixed with flammable liquids and that the instability hazard exhibited was in addition to that of the flammable hazard. In addition, terms like “immediate needs, shift supply, or day’s supply” were deemed to be unenforceable for the purposes of occupancy determination.

A comparability was established between solid and liquid materials based on a unit of measure of weight and the exempt amounts were included in Table No. 9-A on a weight basis. The quantities allowed in use closed and use open conditions were scaled down accordingly and footnotes applied that recognized the value of sprinklered buildings and the use of approved storage cabinets. The laboratory quantities appeared to be more in keeping with general application while recognizing that the overall quantity for what had now become five or more subcategories of material that had been limited to an aggregate quantity of 10 pounds since the publication of the 1973 Edition of the UBC.

**5.4.9.5.1 Restrictions on MAQ.** A concern with allowing the use of exempt amounts in what were designated as “people sensitive” uses was addressed by the use of footnotes to the exempt amount tables as they appeared in the 1988 Edition of the UFC. Exempt amounts for *unclassified detonable* or Class I organic peroxides were reduced to “none” in Group R Occupancies or in offices or retail sales portions of Group B Occupancies. No exempt amounts of *unclassified detonable* or Class I organic peroxides were permitted in Groups A, E, I or M Occupancies or in classrooms of Group B Occupancies unless storage was within a hazardous materials storage cabinet containing no other storage.



### 5.4.9.6 Threshold MAQ and Basis 2000 IBC.

TABLE 46

**Organic Peroxides – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Organic peroxide	UD	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	N/A	(1/4) <sup>g</sup>	(1/4) <sup>g</sup>	N/A	(1/4) <sup>g</sup>	(1/4) <sup>g</sup>
	I	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	N/A	1 <sup>d</sup>	(1) <sup>d</sup>	N/A	1 <sup>d</sup>	(1) <sup>d</sup>
	II	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	N/A	50 <sup>d</sup>	(50) <sup>d</sup>	N/A	10 <sup>d</sup>	(10) <sup>d</sup>
	III	H-3	125 <sup>d, e</sup>	(125) <sup>d, e</sup>	N/A	125 <sup>d</sup>	(125) <sup>d</sup>	N/A	25 <sup>d</sup>	(25) <sup>d</sup>
	IV		NL	NL	N/A	500 <sup>d</sup>	(500)	N/A	100	NL
	V		NL	NL	N/A	NL	NL	N/A	NL	NL

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>g</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs are consistent with the 1988 UFC except that Class IV organic peroxides have been increased to an unlimited amount. The substantiation for increasing the quantity to NL (not limited) was based on the fact that there was no hazardous occupancy associated with the MAQ, and therefore, there was no need to limit the quantity accordingly.<sup>157</sup> The fact that there was no occupancy indicated was interpreted that these materials could be located in occupancies other than Group H.

<sup>157</sup> 1999 Proposed Changes to the Final Draft of the International Fire Code, International Code Council, Country Club Hills, IL, January 1999, item F670-99, pp. F360-F361.

### 5.4.9.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 47

**Organic Peroxides – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Organic peroxide	UD	1	1 <sup>e, h</sup>	(1) <sup>e, h</sup>	NA	¼ <sup>h</sup>	(1/4) <sup>h</sup>	NA	¼ <sup>h</sup>	(1/4) <sup>h</sup>
	I	1	5 <sup>e, f</sup>	(5) <sup>e, f</sup>	NA	1 <sup>f</sup>	(1) <sup>f</sup>	NA	1 <sup>f</sup>	(1) <sup>f</sup>
	II	2	50 <sup>e, f</sup>	(50) <sup>e, f</sup>	NA	50 <sup>f</sup>	(50) <sup>f</sup>	NA	10 <sup>f</sup>	(10) <sup>f</sup>
	II [sic]	3	125 <sup>e, f</sup>	(125) <sup>e, f</sup>	NA	125 <sup>f</sup>	(125) <sup>f</sup>	NA	25 <sup>f</sup>	(25) <sup>f</sup>
	IV	NA	NL	NL	NA	NL	NL	NA	NL	NL
	V	NA	NL	NL	NA	NL	NL	NA	NL	NL

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>™</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>h</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

The threshold MAQs are consistent with the 1988 UBC. There is a conflict that has been created between the concept of occupancy in the UBC and its successor code, the IBC and NFPA 1 UFC for the protection level requirements to be used with Class I, II and III organic peroxides. The problem appears to have been an editorial error in the tables shown in the 2003 Edition of NFPA 5000 which carried over into the publication of the 2003 Edition of NFPA 1 UFC. In the list of materials for the 2003 Edition of NFPA 1 UFC Class III materials were inadvertently shown as Class II. This error has been corrected in the 2006 Edition of NFPA 1 UFC; however, the

required protection levels are not consistent with the requirements of section 3.3.128.1.2 in that Class I organic peroxides are classified as High Hazard level 2 contents, while Class II and III organic peroxides are to be classified as being high hazard Level 3 contents under the definitions provided in 3.3.128.1.3. The same error has occurred in NFPA 5000 and there is a conflict between Table 34.1.3.1 and Sections 6.3.2.4.3 and 6.3.2.4.4.

#### **5.4.9.8 Anomalies, inconsistencies and gaps.**

- (a) The classification system for organic peroxides is package dependent. That is, it is based on a size and in some cases the construction of the container provided for transportation purposes. This method of classification does not address hazards of these materials to the user when the packages are either opened, combined or otherwise placed in a condition outside of the transportation system.
- (b) A category of “unclassified detonable” organic peroxide (OP) was created to recognize that organic peroxides could be in an unpackaged state and subject to detonation. For example, when these materials are being manufactured and either prior to packaging or after they have been removed from the packaging.
- (c) The classification system used in the MAQ tables requires classification for materials in use as well as in storage where they are likely to be found in the original shipping container. There is a need to determine the appropriate hazard classification of organic peroxides in process operations and when they are being utilized by the end user. A similar problem was encountered with explosive materials and requirements established based on physical testing to determine the in-process classification accordingly. Logic indicates that the “configuration” of mass for these materials have critical dimensions above which the hazard of the material may be elevated or below which the level of hazard is decreased. For example, explosive solids have a “critical diameter” which is used to describe the mass of material in terms of height and width (or radius). The existing classification system

creates a major hole in the code for users and code officials alike as once out of the package the behavior of the material is subject to change.

- (d) The category of unclassified detonable is likely not the only unclassified category to be considered. For example, any of the peroxides removed from their container become “unclassified” as there is no guidance from which a decision can be made. Not having a definition of unclassified detonable in NFPA 1 gives the impression that there is no need for such a category; yet limitations on the category are placed into the MAQ tables. The absence of a general category for unclassified organic peroxides would appear to be needed unless a methodology can be determined for the classification of materials in use.
- (e) There is an anomaly that has been created with the application of protection levels for Class I and II organic peroxides as shown in the MAQ tables for these materials. The anomaly was carried forward from the original submittal by the NFPA 5000 drafting committee in the production of the table. There was no intent to change the protection level for these materials as evidenced by the protection level descriptions found within the definitions. The error causes a major inconsistency in the code.

#### 5.4.10 Oxidizers

**5.4.10.1 Definition and Basis 1988 UFC.** The definition for oxidizers in the 1988 UFC was new. The 1988 UFC definition was taken from 29CFR §1910.1200.<sup>158</sup> The definition was as follows:

***Oxidizer** is a chemical other than a blasting agent or explosive as defined in this article that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.*

Oxidizers were further subdivided into classes based on definitional statements that were included in Appendix VI-A. The primary basis for the definitional statements

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<sup>158</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53342.

was NFPA 43A *Storage of Liquid and Solid Oxidizing Materials*.<sup>159</sup> With the publication of the 1988 UFC definition there was a modification to the NFPA 43A definition of Class 3 oxidizers (shown below in legislative format) that deleted a clause “or which will undergo vigorous self-sustained decomposition when catalyzed or exposed to heat.” This deletion may have occurred as the statement regarding decomposition is indicative of materials that are unstable reactive rather than those that are oxidizing.

***Class 4*** – An oxidizing material that can undergo an explosive reaction when catalyzed or exposed to heat, shock or friction.

***Class 3*** – An oxidizing material that will cause a severe increase in the burning rate of combustible material with which it comes in contact ~~or which will undergo vigorous self-sustained decomposition when catalyzed or exposed to heat.~~

***Class 2*** – An oxidizing material that will moderately increase the burning rate or which may cause spontaneous ignition of combustible material with which it comes in contact.

***Class 1*** – An oxidizing material whose primary hazard is that it may increase the burning rate of combustible material with which it comes in contact.

Appendix VI-A contained a list of solid and liquid oxidizing materials as examples for each class that were taken from the Annex of NFPA 43A referencing NFPA 43-A as the basis for the examples. Oxidizing gases was an undefined term in the 1988 Edition of the UFC, however, a list of example oxidizing gases was provided in Appendix VI-A.

#### **5.4.10.2 Definition and Basis 2000 IFC.**

***Oxidizer.*** A material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials. Examples of other oxidizing gases include bromine, chlorine and fluorine.

***Class 4.*** An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock. In addition, the oxidizer will enhance the burning rate and ~~may~~ can cause spontaneous ignition of combustibles.

***Class 3.*** An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact or that will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.

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<sup>159</sup> *Storage of Liquid and Solid Oxidizing Materials*, 1980 Edition, National Fire Protection Association, Quincy, MA, p. 7

**Class 2.** *An oxidizer that will cause a moderate increase in the burning rate or that ~~may~~ causes spontaneous ignition of combustible materials with which it comes in contact.*

**Class 1.** *An oxidizer whose primary hazard is that it slightly increases the burning rate but which does not cause spontaneous ignition when it comes in contact with combustible materials.*

The basis for the definition was the 1990 Edition of NFPA 43A.<sup>160</sup> There were changes made to delete the term “may” in the definitions for Class 4 and Class 2.

#### 5.4.10.3 Definition and Basis 2003 NFPA 1 UFC.

**3.3.146 Oxidizer.** *Any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials. [430:1.5]*

**3.3.146.1 Classification of Oxidizers.** *For the purpose of this Code, oxidizers are classified according to the system listed in (a) through (d) of Section 1.6 of NFPA 430 shown in 70.2.1. The classification is based on the technical committee’s evaluation of available scientific and technical data, actual experience, and its considered opinion. Classification refers to the pure oxidizer. Gross contamination can cause oxidizers of all classes to undergo exothermic or explosive reaction, particularly if they are also subjected to confinement and heating.*

**Class 4.** *An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock. In addition, the oxidizer will cause a severe increase in the burning rate of combustible materials with which it comes into contact.*

**Class 3.** *An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes into contact or that will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.*

**Class 2.** *An oxidizer that will cause a moderate increase in the burning rate of combustible materials with which it comes into contact.*

**Class 1.** *An oxidizer that does not moderately increase the burning rate of combustible materials with which it comes into contact.*

As stated in the “classification of oxidizers” statement found in § 3.3.146.1, the definitions have been extracted from NFPA 430, 2000 Edition.

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<sup>160</sup> *Code for the Storage of Liquid and solid Oxidizers*, 1990 Edition, NFPA 43A, National Fire Protection Association, Quincy, MA, p. 6.

**5.4.10.4 Threshold MAQ and Basis 1985 UBC.** Oxidizing materials (solids/liquids) as a general category (without subdivisions due to hazard class) was limited by Table No. 9-A of the 1985 UBC as follows. There were no increases allowed under footnotes included with the table:

TABLE 48  
**Oxidizers – 1985 UBC Table No. 9-A**

Material	Maximum Quantities
Oxidizing material – liquids	50 gallons
Oxidizing material – solids	500 pounds

The 1965 Edition of the AIA Code established the permit limit at 500 pounds.<sup>161</sup> The 1970 Edition of the AIA Fire Prevention Code established a permit limit for oxidizing materials of 50 pounds.<sup>162</sup>

The correlation between 500 pounds of solids and 50 gallons of liquid was recognized as the entrée for using a conversion for density of liquids to be 10 pounds per gallon that was developed with the introduction of the 1988 Edition of the code.

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<sup>161</sup> *Fire Prevention Code*, 1965 Edition, American Insurance Association, p. 154.

<sup>162</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, p. 156.

**5.4.10.5 Threshold MAQ and Basis 1988 UBC.**

TABLE 49

**Oxidizers – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
4.3 Oxidizer	4	1 <sup>5,8</sup>	(1) <sup>5,8</sup>		¼ <sup>8</sup>	(¼) <sup>8</sup>		¼ <sup>8</sup>	(¼) <sup>8</sup>	-
	3	10 <sup>4,5</sup>	(10) <sup>4,5</sup>		2 <sup>4</sup>	(2) <sup>4</sup>		2 <sup>4</sup>	(2) <sup>4</sup>	-
	2	250 <sup>4,5</sup>	(250) <sup>4,5</sup>		250 <sup>4</sup>	(250) <sup>4</sup>		50 <sup>4</sup>	(50) <sup>4</sup>	-
	1	1,000 <sup>4,5</sup>	(1,000) <sup>4,5</sup>		1,000 <sup>4</sup>	(1,000) <sup>4</sup>		200 <sup>4</sup>	(200) <sup>4</sup>	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>8</sup>Permitted in sprinklered buildings only. None is allowed in unsprinklered buildings.

The historical basis for limiting solids to 500 pounds and liquids to 50 gallons in occupancies other than those of Group H was established in 1973. This limit was an aggregate of all oxidizing solids and/or liquids regardless of Class, as Class had not been an integral consideration within the context of the AIA Fire Prevention Code or its successor in the form of Table No. 9-A of the 1973 Edition of the UBC. The philosophy of allowing a doubling of the base quantities for sprinklers to be compounded with another doubling in quantity for storage in cabinets was also a consideration. In addition, the concept of control areas raised the quantity to a point where the base quantity could be increased by sixteen fold if all of the controls were applied.

**Class 4 MAQ**

The exempt amount quantity for Class 4 oxidizer solids and liquids of one pound (1 lb) in storage was based on a comparability of explosive materials under the



limitation for black powder which was established in the 1982 UBC.<sup>163</sup> Undocumented testing with black powder in buildings of ordinary construction had been performed by representatives of the California Fire Chiefs Association and it was reported that five pounds of black powder would produce significant damage in a room, but that 50 pounds would demolish ordinary buildings. The 1980 Edition of NFPA 43A established hazard class specific rules for Class 4 materials when the quantity in storage exceeded 10 pounds, in ordinary buildings, or 50 pounds when stored in magazines. The one pound limit for materials with explosive characteristics was a point of consistency established for materials that were capable of explosive decomposition and the 10 pound limit was reduced accordingly.

### **Class 3 MAQ**

The exempt amount quantity for Class 3 oxidizer (solids and liquids) of ten pounds (10 lb) in storage was established based on hazards integral to the definition, i.e., in pertinent part, "...or which will undergo vigorous self sustained decomposition when catalyzed or exposed to heat." NFPA 43A established hazard class specific controls for Class 3 materials when the quantities in storage exceeded 200 pounds,<sup>164</sup> however, the base threshold level was decreased to 10 pounds recognizing that it could be increased to 40 pounds maximum through the use of sprinklers and storage in approved cabinets.

An allowance was added to increase the MAQ for Class 3 solid or liquid oxidizers and the base quantity for Class 1 materials was increased from 1,000 to 4,000 pounds. Footnote 2 was added to Table No. 80.306-A of the 1991 Edition of the UFC and coordinated with the UBC to address the use of Class 3 oxidizing materials used for maintenance purposes or operation of equipment, including the treatment of

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<sup>163</sup> *1982 Analysis of Revisions to the Uniform Codes*, International Conference of Building Officials, Whittier, CA, 1982, p. 6.

<sup>164</sup> *Storage of Liquid and Solid Oxidizing Materials, NFPA 43A*, 1980 Edition, National Fire Protection Association, Quincy, MA, § 5-1, p. 19.

indoor swimming pools and work areas such as restaurant kitchens, etc. The footnote was worded as follows:

*A maximum quantity of 200 pounds of solid or 20 gallons of liquid Class 3 oxidizers is allowed in Groups I, M and R Occupancies when such materials are necessary for maintenance purposes or operation of equipment. The oxidizers shall be stored in approved containers and in a manner approved by the chief.*

The 200 pound limit coincided with a quantity above which required additional controls under the concepts promulgated in NFPA 43A.<sup>165</sup> The footnote application was limited to I, M and R Occupancies. Approval of the containers and storage arrangement was included as a required control to ensure that the storage was protected or managed in a way so as not to create a hazardous condition. Without the exception, the quantity would have been reduced to 10 pounds unless stored in a Group H occupancy.

The limit of 500 pounds established in the 1973 Edition of the code did not recognize the gradation of hazards associated with this category of materials and the 200 pound exemption was recognized as a reasonable quantity given the restrictions otherwise placed on Class 3 materials in other occupancies or uses. The footnote was broadened in the 1997 Edition of the UFC to be applicable to all occupancies and the use of Class 3 oxidizers as a disinfectant for overall sanitation as well as for maintenance and operation of equipment was recognized.<sup>166</sup>

### **Class 2 MAQ**

The exempt amount quantity for Class 2 Oxidizers of two hundred and fifty pounds (250 lb) in storage was established based on requirements in NFPA 43A that established hazard class specific controls for Class 2 oxidizers, over and above those established as general provisions, when stored in quantities in excess of 1,000

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<sup>165</sup> *Storage of Liquid and Solid Oxidizing Materials, NFPA 43A*, National Fire Protection Association, Quincy, MA, 1980 Edition, §5-1 p. 19. Although there were later editions of NFPA 43 A the quantity thresholds for the application of special controls at a 200 pound threshold was retained. The 1980 Edition had been used as the basis for development of the 1988 Edition of the UFC.

<sup>166</sup> *1996 Submittals for Proposed Revisions to the Uniform Fire Code and Provisions of the Uniform Building Code Maintained by IFCI, IFCI Fire Code Journal*, International Fire Code Institute, Whittier, CA, Part II, Fall 1995, Item 84, p. 81.

pounds.<sup>167</sup> The 250 pound limit could be increased by a factor of two through the use of sprinklers and by a factor of four if sprinklers and approved cabinets were used. The four-fold increase would raise the threshold level to 1,000 pounds for individual control areas, and the number of control areas would allow an additional increase to a building maximum of 4,000 pounds.

### **Class 1 MAQ**

The exempt amount quantity for Class 1 Oxidizers of one thousand pounds (1000 lb) in storage was based on requirements in NFPA 43A that established hazard class specific controls for Class 1 oxidizers, over and above those established as general provisions, when stored in quantities in excess of 4,000 lb.<sup>168</sup>

Under the UBC control area concept a one thousand pound limit was established. The base limit of 1,000 lbs could be increased to 4,000 lbs. when sprinklers and cabinets were used. Assuming the creation of four control areas, the base limit of 1,000 lbs could be increased to sixteen thousand pounds (16,000 lbs) in any building classified as other than Group H including occupancies designated as being people sensitive occupancies such as business, assembly, institutional or educational uses. The increase within a single control area to 4,000 lbs based on the use of sprinklers and cabinets equated to the maximum pile size in the most conservative occupancy under the NFPA 43A concept. It also exceeded the five hundred pound (500 lb) limit that had been in use for a period of fifteen years (15 yrs) by a factor of eight.

The base threshold MAQ for Class 1 solid and liquid oxidizers was increased to 4,000 pounds in the 1991 UBC based on a recognition that the quantity above which special provisions were required by NFPA 43A for Class I materials was 4,000 pounds. The special provisions included segregated, cutoff or detached storage when the 4,000 pound limit was exceeded. Corresponding changes were made to

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<sup>167</sup> *Storage of Liquid and Solid Oxidizing Materials, NFPA 43A*, 1980 Edition, National Fire Protection Association, Quincy, MA, § 4-1, p. 16.

<sup>168</sup> *Storage of Liquid and Solid Oxidizing Materials, NFPA 43A*, 1980 Edition, National Fire Protection Association, Quincy, MA, § 3-1, p. 14.

increase the amounts in use to 4,000 pounds in use-closed systems and 1,000 pounds in use-open systems.<sup>169</sup>

**5.4.10.5.1 Reductions to MAQ for Use.** The threshold quantities for oxidizer solids and liquids in a Use-closed condition for the Class 3 and 4 hazard classes were reduced to one fifth (1/5<sup>th</sup>) of the quantities in storage. A reduction was applied in recognition of the increased level of hazard when these materials were manipulated. In the case of Class 4 solid and liquid materials rounding up to the nearest quarter pound resulted in a reduction to one quarter (1/4<sup>th</sup>) of the stored amount. The quantity of solids and liquids in a Use-open condition for Class 3 and 4 hazard classes were aligned with that of the Use, closed condition.

The threshold quantities for oxidizer solids and liquids in the Class 1 and 2 hazard class in a Use-closed condition were retained at the same level as those in storage as there was no apparent increase in the level of hazard perceived in the Use-closed condition based on the reduced hazard level. The threshold quantities for oxidizer solids and liquids in a Use-open condition for the Class 1 and 2 hazard classes was reduced to one fifth (1/5<sup>th</sup>) of the quantities in storage.

**5.4.10.5.2 Restrictions on MAQ.** A concern with allowing the use of exempt amounts in what were designated as “people sensitive” uses was addressed by the use of footnotes to the exempt amount tables as they appeared in the 1988 Edition of the UFC. Exempt amounts for Class 3 and Class 4 oxidizers were reduced to “none” in Group R Occupancies or in offices or retail sales portions of Group B Occupancies. No exempt amounts of Class 3 or 4 oxidizers were permitted in Groups A, E, I or M Occupancies or in classrooms of Group B Occupancies unless storage was within a hazardous materials storage cabinet containing no other storage. The exception provided for Class 3 oxidizers used for maintenance, operation or

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<sup>169</sup> *Agenda For The Code Change Session To Be Held At The 1990 Annual Meeting Of The Western Fire Chiefs Association, WFCAs News Quarterly Supplement, May-June, 1990, Part III, Item 112, pp. 33-34.*

sanitation allowed the storage and use of Class 3 oxidizers in quantities up to 200 pounds under the conditions imposed by the footnote.

**5.4.10.6 Threshold MAQ and Basis 2000 IBC.**

TABLE 50

**Oxidizers – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Oxidizer	4	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>		¼ <sup>g</sup>	(¼) <sup>g</sup>		¼ <sup>g</sup>	(1/4) <sup>g</sup>
	3 <sup>k</sup>	H-2	10 <sup>d, e</sup>	(10) <sup>d, e</sup>		2 <sup>d</sup>	(2) <sup>d</sup>		2 <sup>d</sup>	(2) <sup>d</sup>
	2	H-3	250 <sup>d, e</sup>	(250) <sup>d, e</sup>		250 <sup>d</sup>	(250) <sup>d</sup>		50 <sup>d</sup>	(50) <sup>d</sup>
	1	H-3	4,000 <sup>d, e</sup>	(4,000) <sup>d, e</sup>		4,000 <sup>d</sup>	(4,000) <sup>d</sup>		1,000 <sup>d</sup>	(1,000) <sup>d</sup>

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>f</sup> The permitted quantities shall not be limited in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>g</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

<sup>k</sup> a maximum quantity of 200 pounds of solid or 20 gallons of liquid Class 3 oxidizers is allowed when such materials are necessary for maintenance purposes, operation or sanitation of equipment. Storage containers and the manner of storage shall be approved.

The threshold MAQs were consistent with the 1988 UFC except that The increase in the base amount of Class 1 oxidizers was based on a recognition that the quantity above which special provisions were required by NFPA 430 for Class I materials was 4,000 pounds. The special provisions included segregated, cutoff or detached

storage when the 4,000 pound limit was exceeded.<sup>170</sup> The code was revised in the 2003 Edition to allow an unlimited quantity of Class 1 oxidizers in sprinklered buildings under the application of footnote “f.” The reason for the change was to provide parity with Class IV organic peroxides and unstable (reactive) Class 1 materials which were deemed to be of a similar nature from a hazards perspective.<sup>171</sup>

**5.4.10.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.**

TABLE 51

**Oxidizers – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Oxidizer	4	1	1 <sup>e, h</sup>	(1) <sup>e, h</sup>	NA	¼ <sup>h</sup>	(¼) <sup>h</sup>	NA	¼ <sup>h</sup>	(¼) <sup>h</sup>
	3 <sup>k</sup>	2 or 3	10 <sup>e, f</sup>	(10) <sup>e, f</sup>	NA	2 <sup>f</sup>	(2) <sup>f</sup>	NA	2 <sup>f</sup>	(2) <sup>f</sup>
	2	3	250 <sup>e, f</sup>	(250) <sup>e, f</sup>	NA	250 <sup>f</sup>	(250) <sup>f</sup>	NA	50 <sup>f</sup>	(50) <sup>f</sup>
	1	NA	4,000 <sup>e, g</sup>	(4,000) <sup>e, g</sup>	NA	4,000 <sup>g</sup>	(4,000) <sup>g</sup>	NA	1,000 <sup>g</sup>	(1,000) <sup>g</sup>

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>TM</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>g</sup> The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

<sup>170</sup> *Code for the Storage of Liquid and Solid Oxidizers, NFPA 430*, National Fire Protection Association, Quincy, MA, 2000 Edition, §3-1, Electronic version, May 2001 Meeting Edition, October 2001.

<sup>171</sup> *2000 Report of the Public Hearing on the International Codes*, International Code Council, Country Club Hills, IL, First Printing, May, 2000, Item F8-00, p. 8.

<sup>h</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

<sup>k</sup> A maximum quantity of 200 lb of solid or 20 gal of liquid Class 3 oxidizers is permitted where such materials are necessary for maintenance purposes, operation, or sanitation of equipment. Storage containers and the manner of storage are required to be approved.

The threshold MAQs are consistent with those published in the 1997 UBC and as they had evolved to the 2003 IBC with the changes noted to provide for unlimited quantities of Class 1 oxidizing solids and liquids in sprinklered buildings.

**5.4.10.8 Anomalies, Inconsistencies and Gaps.** The classification system as to degree of hazard (Class) is highly subjective, and based in part on examples found in an Annex.

#### **5.4.11 Oxidizing Gas**

**5.4.11.1 Definition and Basis 1988 UFC.** The term “oxidizing gas” was not defined in the 1988 Edition of the code. The definition for oxidizer could have been used. The term was specifically defined until a new definition was published in the 2007 Supplement to the International Fire Code.

**5.4.11.2 Definition and Basis 2000 IFC.** The term “oxidizing gas” was not defined in the 1988 Edition of the code. The definition for oxidizer could have been used. The term was not specifically defined until a new definition was published in the 2007 Supplement to the International Fire Code as follows:<sup>172</sup>

***OXIDIZING GAS.*** *A gas that can support and accelerate combustion of other materials more than air does.*

**5.4.11.3 Definition and Basis 2003 NFPA 1 UFC.**

***Oxidizing Gas.*** *A gas that can support and accelerate combustion of other materials. [55:3.3]*

The definition was extracted from the 2003 Edition of NFPA 55. The NFPA 55 definition has since been revised to correlate with the IFC definition pending the publication of the 2009 Edition of NFPA 55.

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<sup>172</sup> Excerpt From The 2007 Supplement International Fire Code, International Code Council, Inc., Country Club Hills, IL, First Printing, July 2007, p. 73.

**5.4.11.4 Threshold MAQ and Basis 1985 UBC.**

TABLE 52

**Oxidizing Gases – 1985 UBC Table No. 9-A**

Material	Maximum Quantities
Oxidizing material – gases	6,000 cubic feet

Oxidizing gases were regulated in the AIA Code under the term “nonflammable compressed gas.” Oxygen is labeled as a “nonflammable gas” under the requirements of the Department of Transportation (DOT) in 49 CFR. A permit limit of 6,000 cubic feet of nonflammable compressed gas was established in the 1970 Edition of the Code.<sup>173</sup>

**5.4.11.5 Threshold MAQ and Basis 1988 UBC.**

TABLE 53

**Oxidizing Gases – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
4.4 Oxidizer gas	Gaseous	-	-	1,500 <sup>45</sup>	-	-	1,500 <sup>45</sup>	-	-	-
	Liquefied	-	15 <sup>45</sup>	-	-	15 <sup>45</sup>	-	-	-	

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>173</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, p. 22.



The 1500 cubic foot amount could be increased to a control area limit of 6,000 cubic feet through the use of sprinklered buildings and gas cabinets. A fifteen gallon limit for liquefied oxidizing gases was likely based on an equivalent weight of oxygen in gaseous form using a specific volume of 12.1 cubic feet per pound (approximately 124 pounds).

The MAQ for use-closed was equated to that of storage as the hazards were deemed to be comparable given the fact that closed systems are involved.

**5.4.11.5.1 Restrictions on MAQ.** There were no further restrictions placed on the MAQ for oxidizing gases in people sensitive occupancies in the 1988 UFC.

**5.4.11.6 Threshold MAQ and Basis 2000 IBC.**

TABLE 54

**Oxidizing Gases – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Oxidizing gas	Gaseous Liquefied	H-3	N/A N/A	N/A 15 <sup>d, e</sup>	1,500 <sup>d, e</sup> N/A	N/A N/A	N/A 15 <sup>d, e</sup>	1,500 <sup>d, e</sup> N/A	N/A N/A	N/A N/A

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs are consistent with those published in the 1988 UBC.

**5.4.11.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.**

TABLE 55

**Oxidizing Gases – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Oxidizing gas	Gaseous	3	NA	NA	1,500 <sup>e,†</sup>	NA	NA	1,500 <sup>e,†</sup>	NA	NA
	Liquefied	3	NA	15 <sup>e,f</sup>	NA	NA	15 <sup>e,f</sup>	NA	NA	NA

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>™</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

The threshold MAQs are consistent with the 1988 UBC and the 2000 IBC.

**5.4.11.8 Anomalies, Inconsistencies and Gaps.** There is no empirical test that has been specified to determine what is meant by “accelerated burning.”

#### 5.4.12 Pyrophoric (materials)

**5.4.12.1 Definition and Basis 1988 UFC.** The definition for pyrophoric (materials) in the 1988 UFC was new. The definition was taken from 29CFR §1910.1200.<sup>174</sup> The definition is as follows:

*Pyrophoric is a chemical that will spontaneously ignite in air at or below a temperature of 130° F. (54.4°C.)*

Pyrophoric materials as a hazard category include solids, liquids and gases. Examples of pyrophoric materials were included in Appendix VI-A.

<sup>174</sup> Hazard Communication: Final Rule, p. 53342.

**5.4.12.2 Definition and Basis 2000 IFC.**

***Pyrophoric.*** A chemical with an autoignition temperature in air at or below a temperature of 130° F. (54°C.)

The definition was editorially revised. The intent is consistent with the 1988 UFC.

**5.4.12.3 Definition and Basis 2003 NFPA 1 UFC.**

***3.3.164 Pyrophoric.*** A chemical that spontaneously ignites in air at or below a temperature of 130°F (54.5°C).

The definition was extracted from the 2000 UFC.

***3.3.101.14 Pyrophoric gas.*** A gas with an autoignition temperature in air at or below 1300°F (704°C).

The autoignition temperatures shown for pyrophoric gases in the 2003 Edition of the Code were in error. The correct temperatures of 130°F (54.5°C) were included with the publication of the 2006 Edition of NFPA 1 UFC.

**5.4.12.4 Threshold MAQ and Basis 1985 UBC.** Pyrophoric materials were not included in Table No. 9-A of the 1985 UBC. In the most restrictive sense, it could be interpreted that such materials were “highly flammable” within the context of Section 901(a) and that the exempt quantity was NONE as they were not excepted from the requirements under the quantity limits of Table No. 9-A. The concept of including “highly flammable” materials was not new as the term was used in the AIA *Fire Prevention Code* to describe a general category of hazardous materials that were included.

The list of hazards included those materials subject to fire, explosion, toxicity or other properties that could render fire fighting abnormally dangerous or difficult including those materials which were chemically unstable or which were capable of spontaneous or exothermic reactions with sufficient evolution of heat to be a fire hazard.<sup>175</sup> The 1985 UBC classified the occupancy for materials that were “highly flammable or explosive, other than Class I, II or III-A liquids into Group H, Division 1 occupancies with the following statement:

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<sup>175</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, p. 155.

**§901(a) General.** Group H occupancies shall be:

**Division 1.** Storage, handling, use or sale of hazardous and highly flammable or explosive materials other than Class I, II or III-A liquids.

**Exception:** The storage, handling, use or sale of hazardous materials or chemicals that do not exceed the quantities listed in Table No. 9-A are permitted in other occupancies, provided the storage, handling, use or sale of such hazardous materials or chemicals is in compliance with the Fire Code.

**5.4.12.5 Threshold MAQ and Basis for 1988 UBC.**

TABLE 56

**Pyrophoric Materials – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
5.1 Pyrophoric		4 <sup>58</sup>	(4) <sup>58</sup>	50 <sup>58</sup>	1 <sup>8</sup>	(1) <sup>8</sup>	10 <sup>58</sup>	0	0	0

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>8</sup>Permitted in sprinklered buildings only. None is allowed in unsprinklered buildings.

Under the requirements of Table No. 9-A the exempt quantity in unsprinklered buildings was zero (none). See footnote 8 to Table No. 9-A. Sprinklers were the first level of control and the addition of the use of approved storage cabinets did not provide for an increase above the zero quantity threshold until sprinklers were provided.

A base threshold of four (4) pounds of solid or liquid and 50 cubic feet of gas was established for the stored amounts. The base threshold was reduced to 25% of the base amount for solids and liquids and 20% for gases. The apparent increase for solids and liquids (25% vs. 20%) was due to rounding, i.e., 0.8 lbs rounded up to 1

pound (the nearest whole pound). The four pound limit in storage was established in part on comparability with a limit of five pounds for Unstable Reactive Class 3, and five pounds of Organic Peroxide Class I, but with the recognition that piloted ignition was not necessary for fire to occur. The 50 cubic feet threshold for pyrophoric gases was also established for comparability to the 50 cubic feet established for Unstable Reactive Class 3 gases.

Comparability considerations included the following. When threshold amounts were exceeded for the following materials, a Group H, Division 2 Occupancy was required as the physical hazards were deemed to be comparable, i.e., “moderate explosion hazard or hazard from accelerated burning”:

- Class I Organic Peroxides
- Class 3 non-detonable unstable reactive materials
- Pyrophoric gases
- Flammable or oxidizing gases
- Class I, II or III-A flammable or combustible liquids which are used in normally open containers, or systems or in closed containers pressurized at more than 15 psig.
- Combustible dust in suspension or capable of being put into suspension in the atmosphere of the room or area.

The zero threshold for use-open systems was established with a belief that in the open pyrophoric materials would auto-ignite. It is possible to have open use of pyrophoric materials in systems that are blanketed with inert gas or where the ignition is otherwise inhibited by submersing the materials in a fluid. A zero quantity may be reasonable under these circumstances as the material is available to the area of use when removed from the inert environment.

### 5.4.12.6 Threshold MAQ and Basis 2000 IBC.

TABLE 57  
**Pyrophoric Materials - 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard <sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Pyrophoric		H-2	4 <sup>e, g</sup>	(4) <sup>e, g</sup>	50 <sup>e, g</sup>	1 <sup>g</sup>	(1) <sup>g</sup>	10 <sup>e, g</sup>	0	0

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>g</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs are consistent with the 1988 UBC.

### 5.4.12.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 58  
**Pyrophoric Materials - Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Pyrophoric		2	4 <sup>e, h</sup>	(4) <sup>e, h</sup>	50 <sup>e, h</sup>	1 <sup>h</sup>	(1) <sup>h</sup>	10 <sup>e, h</sup>	0	0

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>™</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>h</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

The threshold MAQs are consistent with the 1988 UBC.

**5.4.12.8 Anomalies, Inconsistencies and Gaps.** Other than the autoignition temperature there is no criteria to determine whether a material is pyrophoric. For example whether autoignition is dependent on time or quantity is not determined. Substances that are self heating in air may ignite only when in large quantities (kilograms) and after long periods of time (hours or days).<sup>176</sup>

### 5.4.13 Unstable Reactive Materials

**5.4.13.1 Definition and Basis 1988 UFC.** The category of Unstable Materials was included in the 1985 Edition of the UBC. The definition for Unstable Materials appeared in the 1985 Edition of the Uniform Fire Code as follows. It was carried to the 1988 Edition of the UFC in the same form. A definition for Unstable (reactive) chemical also appeared in the 1965 Edition of the *AIA Fire Prevention Code*:<sup>177</sup> The parenthetical term (reactive) was used in the UBC, but was not fully coordinated with the IFC. The term (reactive) was included in a definition promulgated by OSHA that was in sync with the 1985 definition as published in the UFC.<sup>178</sup>

*Unstable materials are those materials, other than explosives, which in the pure state or as commercially produced will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock,*

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<sup>176</sup> *Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, Second Revised Edition, United Nations, New York, 1995, p. 330.

<sup>177</sup> *Fire Prevention Code*, American Insurance Association, 1965 Edition, p. 154.

<sup>178</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53342.

*or in the absence of an inhibitor or in the presence of contaminants or in contact with noncompatible materials.*<sup>179</sup>

Unstable (reactive) materials were further subdivided into classes based on definitional statements that were included in Appendix VI-A. The term (reactive) was included as a heading in the Appendix along with the definitions for each specific hazard class. The basis for the definitional statements as used in the Appendix was Uniform Fire Code Standard No. 79-3 which was based on the 1980 Edition of NFPA 704.<sup>180</sup>

***Class 4*** – *Materials which in themselves are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. This class should include materials which are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.*

***Class 3*** – *Materials which in themselves are capable of detonation or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This degree should include materials which are sensitive to thermal or mechanical shock at elevated temperatures and pressures.*

***Class 2*** – *Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This degree should include materials which can undergo chemical change with rapid release of energy at normal temperatures and pressures and which can undergo violent chemical change at elevated temperatures and pressures.*

***Class 1*** – *Materials which in themselves are normally stable but which can become unstable at elevated temperatures and pressures.*

#### **5.4.13.2 Definition and Basis 2000 IFC.**

***Unstable materials*** are those materials, other than explosives, which in the pure state or as commercially produced will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor or in the presence of contaminants or in contact with incompatible materials. Unstable (reactive materials are subdivided as follows:

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<sup>179</sup> *Uniform Fire Code*, 1988 Edition, WFCB and ICBO, p. 44.

<sup>180</sup> *Uniform Fire Code Standards (UFCS 79-3)*, 1985 Edition, Western Fire Chiefs Association and the International Conference of Building Officials, Whittier, CA, pp. 554-575. UFCS 79-3, under an agreement with NFPA reproduced the 1980 Edition of NFPA 704 as Part II of the Standard. Part I of the Standard contained amendments to Part II. The amendments were of an administrative nature affecting applicability and evaluation of hazards by experienced, technically competent persons.



**Class 4** – Materials that in themselves are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

**Class 3** – Materials that in themselves are capable of detonation or of explosive decomposition or explosive reaction but that require a strong initiating source or that must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

**Class 2** – Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures and that can undergo violent chemical change at elevated temperatures and pressures.

**Class 1** – Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

The definitions with minor editorial changes were consistent with those in the 1988 UFC.

#### 5.4.13.3 Definition and Basis 2003 NFPA 1 UFC.

**3.3.130.9 Unstable (Reactive) material.** A material that in the pure state or as commercially produced vigorously polymerizes, decomposes, or condenses becomes self-reactive, or otherwise undergoes a violent chemical change under conditions of shock, pressure, or temperature.

**3.3.130.9.4\* Class 4 Unstable (Reactive) material.** A material that, in itself, is readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures.

**A.3.3.130.9.4 Class 4 Unstable (Reactive) material.** Class 4 materials include, among others, materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures.

**3.3.130.9.3\* Class 3 Unstable (Reactive) material.** A material that, in itself, is capable of detonation or of explosive decomposition or explosive reaction but requires a strong initiating source or that must be heated under confinement before initiation.

**A.3.3.130.9.3\* Class 3 Unstable (Reactive) material.** Class 3 materials include, among others, materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

**3.3.130.9.2\* Class 2 Unstable (Reactive) material.** A material that readily undergoes violent chemical change at elevated temperatures and pressures.

**A.3.3.130.9.2\* Class 2 Unstable (Reactive) material.** Class 2 materials include, among others, materials that exhibit an exotherm at temperatures less

than or equal to 302°F (150°C) when tested by differential scanning calorimetry.

**3.3.130.9.1\* Class 1 Unstable (Reactive) material.** A material that, in itself, is normally stable but can become unstable at elevated temperatures and pressures.

**A.3.3.130.9.1\* Class 1 Unstable (Reactive) material.** Class 1 materials include, among others, materials that change or decompose on exposure to air, light, or moisture and materials that exhibit an exotherm at temperatures greater than 302°F (150°C), but less than or equal to 572°F (300°C) when tested by differential scanning calorimetry.

The definitions are based on the 1990 Edition of NFPA 704 *Standard System for the Identification of the Fire Hazards of Materials*.<sup>181</sup>

**5.4.13.4 Threshold MAQ and Basis 1985 UBC.** Unstable materials as a general category, without subdivisions, were limited by Table No. 9-A of the 1985 UBC as follows. There were no increases allowed under footnotes included with the table:

TABLE 59

**Unstable Materials – 1985 UBC Table No. 9-A**

Unstable materials	Maximum Quantities
Unstable materials	No exemptions
Nitromethane (unstable materials)	No exemptions

Unstable chemicals as defined by Section 20.2 of the AIA Fire Prevention Code were included in the scope of Article 20 for Hazardous Chemicals. A general permit limit was not established. There was a permit limit for nitromethane [CAS 75-52-5] established at 500 lbs.<sup>182</sup> Nitromethane is an unstable material characterized by manufacturer’s MSDS as a material that is shock and heat sensitive, and thermally

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<sup>181</sup> *Standard System for the Identification of The Fire Hazards of Materials, NFPA 704*, National Fire Protection Association, 1990 Edition Quincy, MA, pp.

<sup>182</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, p. 156.

unstable. Mallinckrodt Baker, Inc. in their MSDS characterizes the material stability and reactivity as follows<sup>183</sup>:

*Shock and heat sensitive. Thermally unstable. Reacts violently with a broad range of materials. Contact with organic bases (amines), acids, and some metal oxides such as lead pigments, may markedly increase its sensitivity to detonation by shock. Heating of closed containers may cause detonation. Mixtures of nitromethane and known sensitizers are explosive and should be handled with extreme caution.*

Dow Chemical Company, a primary manufacturer of nitromethane, in its *Product Safety Assessment* describes the physical hazards of the material in pertinent part as follows<sup>184</sup>:

#### **Detonation**

*Nitromethane can be detonated when it is:*

- *Exposed to a very severe shock (when nitromethane is unconfined at room temperature)*
- *Experiencing severe and very rapid compression under adiabatic conditions*
- *Heated under confinement to near its critical temperature*

*Nitromethane is “sensitized” and more easily detonated when it is mixed with a few percent of certain compounds such as amines, acids and bases.*

*Raising the temperature of liquid nitromethane also increases the sensitivity of the material to detonation. It is therefore advisable to handle/store nitromethane at or below room temperature if possible. Shock sensitivity is controlled by selecting proper materials of construction and avoiding contact with incompatible materials. Because of this hazard, strict adherence to proper storage and handling equipment design and procedures is necessary.*

- *Do not heat liquid under confinement.*
- *Do not confine liquid in heavy-walled containers, such as in pipes between closed valves.*
- *Avoid contact with metals such as brass, copper, copper alloys, lead and its alloys.*
- *Avoid unintended contact with acids, bases, amines, aldehydes, alkenes, reducing agents and strong oxidizing agents.*
- *Avoid contact with absorbent materials such as clay-based absorbents and activated carbon.*

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<sup>183</sup> *Nitromethane*, MSDS No. N5740, Mallinckrodt Baker, Inc., Phillipsburg, NJ, 1/16/06, (§ 10), p. 3.

<sup>184</sup> *Product Safety Assessment, Nitromethane*, The Dow Chemical Company, Form No. 233-00287-MM-0207, February 9, 2007, p. 4. [http://www.dow.com/PublishedLiterature/dh\\_0060/0901b80380060a47.pdf?filepath=productsafety/pdfs/noreg/233-00287.pdf&fromPage=GetDoc](http://www.dow.com/PublishedLiterature/dh_0060/0901b80380060a47.pdf?filepath=productsafety/pdfs/noreg/233-00287.pdf&fromPage=GetDoc), visited 10/23/08.

The AIA permit limit of 500 pounds for a potentially detonable material was apparently rejected by the ICBO committee when Table No. 9-A and the exempt quantity was reduced to zero.

5.4.13.5 Threshold MAQ and Basis 1988 UBC.

TABLE 60

Unstable (reactive) Materials – 1988 UBC Table No. 9-A

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
6.1 Unstable (reactive)	4	1 <sup>58</sup>	(1) <sup>58</sup>	10 <sup>58</sup>	¼ <sup>8</sup>	(¼) <sup>8</sup>	2 <sup>58</sup>	¼ <sup>8</sup>	(¼) <sup>8</sup>	0
	3	5 <sup>45</sup>	(5) <sup>45</sup>	50 <sup>45</sup>	1 <sup>4</sup>	(1) <sup>4</sup>	10 <sup>45</sup>	1 <sup>4</sup>	(1) <sup>4</sup>	0
	2	50 <sup>45</sup>	(50) <sup>45</sup>	250 <sup>45</sup>	50 <sup>4</sup>	(50) <sup>4</sup>	250 <sup>45</sup>	10 <sup>4</sup>	(10) <sup>4</sup>	0
	1	125 <sup>45</sup>	(125) <sup>45</sup>	750 <sup>45</sup>	125 <sup>4</sup>	(125) <sup>4</sup>	750 <sup>45</sup>	25 <sup>4</sup>	(25) <sup>4</sup>	0

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>8</sup>Permitted in sprinklered buildings only. None is allowed in unsprinklered buildings.

The threshold MAQs for organic peroxides was used as the thresholds for unstable reactive materials were considered. The *1988 Analysis of Revisions* indicates that many of the unstable (reactive) materials could be organic peroxide and present a similar hazard and parity was established.<sup>185</sup> The historical basis for limiting Unstable (reactive) materials in occupancies other than those of Group H was established in 1973. This limit was an aggregate of all materials regardless of Class, as Class had not been an integral consideration within the context of the AIA Fire Prevention Code or its successor in the form of Table No. 9-A of the 1973 Edition of the UBC. The philosophy of allowing a doubling of the base quantities for sprinklers to be compounded with another doubling in quantity for storage in cabinets was also a consideration. In addition, the concept of control areas raised the quantity to

<sup>185</sup> *1988 Analysis of Revisions to the Uniform Building Code*, et al., p. 12.

a point where the base quantity could be increased by sixteen fold if all of the controls were applied.

#### **Class 4 MAQ.**

The exempt amount quantity for Class 4 Unstable (reactive) solids and liquids in storage of one pound (1 lb) was based on a comparable quantity of explosive materials under the limitation for black powder which was established in the 1982 UBC.<sup>186</sup> If the building was unsprinklered the exempt amount was zero (footnote 8).

The exempt amount quantity for Class 4 Unstable (reactive) gases in storage of 10 cubic feet corresponded to a gas with a nominal specific volume of 10 cubic feet per pound. There was no specific index gas used in the establishment of the MAQ.

#### **Class 3 MAQ.**

The exempt amount quantity of five (5) pounds for Class 3 Unstable (reactive) materials in storage was based on a level of hazard deemed to be comparable with that of Class I organic peroxides although in the case of organic peroxides the Class I materials were subject to deflagration not detonation. Undocumented testing with black powder in buildings of ordinary construction had been performed by representatives of the California Fire Chiefs Association and it was reported that five pounds of black powder would produce significant damage in a room, but that 50 pounds would demolish ordinary buildings.

There is some question within the explosives industry as to the nature of black powder when ignited in a confined state; however, black powder is shipped under the requirements of the DOT as a Class 1.1D material with Class 1.1 indicating a mass explosion hazard.<sup>187</sup>

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<sup>186</sup> *1982 Analysis of Revisions to the Uniform Codes*, International Conference of Building Officials, Whittier, CA, 1982, p. 6.

<sup>187</sup> Title 49, Code of Federal Regulations, Parts 100 to 185, Transportation, §172.101 Hazardous Materials Table, October 1, 2007, p. 154.

The exempt quantity of 50 cubic feet for gases in storage was scaled up from 10 cubic feet in parallel with the increase by a factor of five for solids and liquids from the limits established for Class 4 materials.

### **Class 2 MAQ.**

The exempt quantity for Class 2 Unstable (reactive) solids and liquids of 50 pounds in storage was established based on comparability with that of Class II organic peroxides which by definition included a severe reactivity hazard as an integral property.

The exempt quantity for Class 2 Unstable (reactive) gases in storage was based on a single 250 cubic foot (content at NTP) cylinder of acetylene which has been classified by primary manufacturers as a material with an instability rating of 2 under the NFPA 704 system when stabilized in solution dissolved in acetone [CAS 67-64-1] or dimethylformamide [CAS 68-12-2].<sup>188</sup>

### **Class 1 MAQ.**

The exempt quantity for Class 1 Unstable (reactive) solids and liquids of 125 lbs. in storage was based on comparability with Class III Organic Peroxides. The comparability was the moderate reactivity hazard for these two groups of materials. The exempt quantity for Class 1 Unstable (reactive) gases of 750 cubic feet was based on a scaling an increase based on the ration of 2.5 times the Class 2 amount and then rounding up to the nearest 250 cubic foot increment. The significance of 250 cubic feet is that it represents a typical volume for many permanent gases found in cylinders with a 9 inch diameter and a 52 inch height (most common industrial size across a spectrum of compressed gases).

The comparability concepts were rooted in descriptive integral to the definitions, which were also extended to that of occupancy. For example, Class I organic peroxides exceeding the MAQ limits were assigned to Group H, Division 2

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<sup>188</sup> *Acetylene*, MSDS, Air Products and Chemicals, Inc. MSDS No. 300000000002, 6/15/2007, <https://apdirect.airproducts.com/MSDS/DisplayPDF.aspx?docid=39122>, visited 10/23/08, p. 8.

occupancies as were Non-detonable Class 3 Unstable (reactive) materials. In turn Class II and III organic peroxides were assigned to Group H, Division 3 occupancies as were Class 2 or 1 Unstable (reactive) materials.

The threshold MAQ for solid and liquid Class 1 Unstable (reactive) materials was increased to an “unlimited” quantity in the 1990 Supplement to the Uniform Codes based on rationale provided that these materials do not pose a serious fire or explosion hazard in that they are normally stable materials becoming unstable only at elevated temperatures and pressures.<sup>189</sup>

**5.4.13.5.1 Reductions to MAQ for Use.** The threshold quantities for Unstable (reactive) materials in a Use-closed condition for the Class 3 and 4 hazard classes was reduced to one fifth (1/5<sup>th</sup>) of the quantities in storage. A reduction was applied in recognition of the increased level of hazard when these materials were manipulated. In the case of Class 4 solid and liquid materials rounding up to the nearest quarter pound resulted in a reduction to one quarter of the stored amount. The quantity of solids and liquids in a Use-open condition for Class 3 and 4 hazard classes were aligned with that of the Use, closed condition. All uses of compressed gas are considered closed use by definition, and a zero quantity was listed for a Use-open condition. The zero quantity was later changed to not applicable as the code evolved with the column in the table for Use-open for gases being deleted.

The threshold quantities for Unstable (reactive) solids and liquids in the Class 1 and 2 hazard class in a Use-closed condition were retained at the same level as those in storage as there was no apparent increase in the level of hazard perceived in the Use-closed condition based on the reduced hazard level. The threshold quantities for Unstable (reactive) solids and liquids in a Use-open

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<sup>189</sup> 1990 Submittals for Proposed Revisions to the Uniform Fire Code and Fire Code Standards and Provisions of the Uniform Building Code and UBC Standards Maintained by WFCA, Part III, International Conference of Building Officials, Whittier, CA, September-October, 1989, Item 80.309(a) 2-90-1, p. 62.



condition for the Class 1 and 2 hazard classes was reduced to one fifth (1/5<sup>th</sup>) of the quantities in storage.

The quantity of Unstable (reactive) compressed gases of 250 cubic feet was retained unchanged in a Use-closed condition as the quantity was that of a single cylinder with a dimension of nominally 9 x 52 inches as commonly found in industry. All uses of compressed gas are considered closed use by definition, and a zero quantity was listed. This zero quantity was changed as the code evolved with the column in the table for open use for gases being deleted. In 1991 the quantity threshold for solid and liquid Class 1 materials was increased to an unlimited amount. The increase was substantiated with a published statement from the code development committee that “Class 1 unstable (reactive) materials do not pose a serious fire or explosion hazard.”<sup>190</sup>

**5.4.13.5.2 Restrictions on MAQ.** A concern with allowing the use of exempt amounts in what were designated as “people sensitive” uses was addressed by the use of footnotes to the exempt amount tables as they appeared in the 1988 Edition of the UFC. Exempt amounts for Class 3 and Class 4 Unstable (reactive) materials were reduced to “none” in Group R Occupancies or in offices or retail sales portions of Group B Occupancies. No exempt amounts of Class 3 or 4 Unstable (reactive) materials were permitted in Groups A, E, I or M Occupancies or in classrooms of Group B Occupancies unless storage was within a hazardous materials storage cabinet containing no other storage.

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<sup>190</sup> *Building Standards, 1990 Annual Report of the Uniform Fire Code Committee of the Western Fire Chiefs Association, International Conference of Building Officials, Whittier, CA, Part III, March-April, 1990, Item 117, p. 50.*

5.4.13.6 Threshold MAQ and Basis 2000 IBC.

TABLE 61

**Unstable (reactive) Materials – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard<sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Unstable (reactive)	4	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	10 <sup>d, g</sup>	1/4 <sup>g</sup>	(1/4) <sup>g</sup>	2 <sup>e, g</sup>	1/4 <sup>g</sup>	(1/4) <sup>g</sup>
	3	H-1 or H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	50 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	10 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	250 <sup>d, e</sup>	50 <sup>d</sup>	(50) <sup>d</sup>	250 <sup>d, e</sup>	10 <sup>d</sup>	(10) <sup>d</sup>
	1	NL	NL	NL	NL	NL	NL	NL	NL	NL

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>g</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs are consistent with the 1997 Edition of the UBC with the exception of Class 1 Unstable (reactive) gases which was increased from a base of 750 cubic feet to unlimited for parity with the solids and liquids category during the evolution of the First Draft of the IFC.<sup>191</sup> The application of footnote “d” to Class 4 gases in storage appears to be in error, and it has been carried to the 2006 Edition of the IBC as well. Applying a credit for sprinklers to buildings that are required to be sprinklered is not in concert with the approach used by the code. The error has not been carried to NFPA 1 UFC.

<sup>191</sup> *International Fire Code, First Draft, International Code Council, International Code Council, Inc., Country Club Hills, IL, First Printing, October 1997, p. 28.19.*

### 5.4.13.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 62

**Unstable (reactive) Materials – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Unstable (reactive)	4	1	1 <sup>e, h</sup>	(1) <sup>e, h</sup>	10 <sup>e, h</sup>	¼ <sup>h</sup>	(¼) <sup>h</sup>	2 <sup>e, h</sup>	¼ <sup>h</sup>	(¼) <sup>h</sup>
	3	1 or 2	5 <sup>e, f</sup>	(5) <sup>e, f</sup>	50 <sup>e, f</sup>	1 <sup>f</sup>	(1) <sup>f</sup>	10 <sup>e, f</sup>	1 <sup>f</sup>	(1) <sup>f</sup>
	2	2	50 <sup>e, f</sup>	(50) <sup>e, f</sup>	250 <sup>e, f</sup>	50 <sup>f</sup>	(50) <sup>f</sup>	250 <sup>e, f</sup>	10 <sup>f</sup>	(10) <sup>f</sup>
	1	NA	NL	NL	NL	NL	NL	NL	NL	NL

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>™</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>g</sup> The permitted quantities are not limited in a building equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

<sup>h</sup> Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

The threshold MAQs are consistent with the approach used in the 1988 UFC as it evolved into the 2003 IBC with changes to increase the quantity of Class 1 materials accordingly.

### 5.4.13.8 Anomalies, inconsistencies and gaps.

(a) The use of the 1990 Edition of NFPA 704 to define the hazard classes was questionable due to its timeliness as the intent was to correlate the definitions in NFPA 1 UFC with NFPA 5000. The correlation occurred in the 2006 Edition of NFPA 1 UFC. The 2006 Edition of NFPA 5000 is in

error with respect to the exotherm temperatures referred to in the explanatory text for Class 1 and 2 materials found in A.3.3.388.19. The errors occurred due to typographical errors in the submittal at the drafting committee level in the preparation of the 2003 Edition of NFPA 5000. The submittal was to have been an extraction from the 2000 IFC and the temperatures were incorrectly typed into the submittal document and not discovered. The use of the temperatures indicated for Class 2 materials for the exotherm to be less than or equal to 30°F (-1°C) and for Class 1 materials to be for temperatures of greater than 30°F (-1°C), but less than 57°F (14°C) results in a major misclassification of materials. The correct temperatures using the 1990 Edition of NFPA 704 would have been for the exotherm to be less than or equal to 302°F (150°C) for Class 2 materials and for temperatures greater than 302°F (150°C) but less than or equal to 572°F (300°C).

- (b) The methodology may not be appropriate to determine the hazard classification for gases. The International Standards Organization (ISO) has been working to develop test criteria applicable to unstable compressed gases for the past several years. Initial work has been focused on the test used for determination of stability with discussions surrounding the test that may be applicable to determine the stability of nitrous oxide. The work is ongoing test procedures using the protocol established by ISO 10156 are being investigated.<sup>192</sup>

#### **5.4.14 Water Reactive Materials.**

**5.4.14.1 Definition and Basis 1988 UFC.** The definition for water reactive materials in the 1988 UFC was new.

***Water-Reactive Materials** are materials which explode, violently react, produce flammable, toxic or other hazardous gases, or evolve enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture.*

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<sup>192</sup> *Gas cylinders-Gases and gas mixtures, Part 2: Determination of oxidizing ability of toxic and corrosive gases and gas mixtures*, International Standards Organization (ISO), ISO 10156-2:2005(E), Geneva, Switzerland.

Water reactive materials were further subdivided into classes based on definitional statements that were included in Appendix VI-A. The term was included as a heading in the Appendix along with the definitions for each specific hazard class. The basis for the definitional statements as used in the Appendix was Uniform Fire Code Standard No. 79-3 which was based on the 1980 Edition of NFPA 704.<sup>193</sup>

***Water-Reactive Materials.*** *A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:*

***Class 3:*** *Materials which react explosively with water without requiring heat or confinement.*

***Class 2:*** *Materials which may form potentially explosive mixtures with water.*

***Class 1:*** *Materials which may react with water with some release of energy but not violently.*

#### **5.4.14.2 Definition and Basis 2000 IFC.**

***Water-Reactive Material.*** *A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:*

***Class 3:*** *Materials that react explosively with water without requiring heat or confinement.*

***Class 2:*** *Materials that may form potentially explosive mixtures with water.*

***Class 1:*** *Materials that may react with water with some release of energy, but not violently.*

The definitions are consistent with those published in the 1988 UFC.

#### **5.4.14.3 Definition and Basis 2003 NFPA 1 UFC.**

***3.3.130.10 Water-Reactive Material.*** *A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases;*

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<sup>193</sup> *Uniform Fire Code Standards (UFCS)*, 1985 Edition, Western Fire Chiefs Association and the International Conference of Building Officials, Whittier, CA, pp. 554-575.

or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided into Class 1, Class 2, and Class 3.

**3.3.130.10.3 Class 3 Water-Reactive Material.** Materials that react explosively with water without requiring heat or confinement.

**3.3.130.10.2 Class 2 Water-Reactive Material.** Materials that can form potentially explosive mixtures with water.

**3.3.130.10.1 Class 1 Water-Reactive Material.** Materials that can react with water with some release of energy, but not violently.

The definitions are consistent with the 1988 UFC, and were based on definitions published in the 2000 UFC.

**5.4.14.4 Threshold MAQ and Basis for 1985 UBC.** The category of water reactive materials was not included in the 1985 UBC. A category of water reactive was included in the list of hazard categories integral to OSHA's *Hazard Communication; Final Rule* issued in 1983.<sup>194</sup>

**5.4.14.5 Threshold MAQ and Basis 1988 UBC.**

TABLE 63

**Water Reactive Materials – 1988 UBC Table No. 9-A**

MATERIAL	CLASS	STORAGE <sup>2</sup>			USE <sup>2</sup> -CLOSED SYSTEMS			USE <sup>2</sup> -OPEN SYSTEMS		
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas
7.1 Water (reactive)	3	5 <sup>4,5</sup>	(5) <sup>4,5</sup>	-	5 <sup>4</sup>	(5) <sup>4</sup>	-	1 <sup>4</sup>	(1) <sup>4</sup>	-
	2	50 <sup>4,5</sup>	(50) <sup>4,5</sup>	-	50 <sup>4</sup>	(50) <sup>4</sup>	-	10 <sup>4</sup>	(10) <sup>4</sup>	-
	1	125 <sup>5,6</sup>	(125) <sup>5,6</sup>	-	125 <sup>5,6</sup>	(125) <sup>5,6</sup>	-	25 <sup>6</sup>	(25) <sup>6</sup>	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>194</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53342.

<sup>5</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 4 also applies, the increase for both footnotes may be applied.

<sup>6</sup>The quantities permitted in a sprinklered building are not limited.

The inclusion of water reactives as a category was principally based on their potentially explosive nature as well as their ability to display the hazard characteristics further illustrated in the NFPA 704 hazard class designations. Parity was declared between the threshold quantities for water reactive materials and unstable reactive materials.<sup>195</sup>

The category of water reactive materials had long been recognized by the Fire Prevention Codes as reason to restrict such materials from being stored in the same room with flammable or combustible liquids.<sup>196 197</sup> There has been a latent concern on the part of industry with providing sprinklers in areas where water-reactive materials are stored or used. The UFC and UBC addressed the concern through the use of exceptions that allowed the use of alternate fire protection systems where the use of sprinklers is determined to create a hazard.<sup>198 199</sup> Water reactive gases as a category were excluded from regulation in the water reactive category based on the nature of the robust packaging required for their containment, e.g., pressure vessels and the use of closed pipe systems. This is not to say that gases do not have the potential to react with water. Reactions with water are not considered to be problematic in quantities typical of the threshold MAQs.

**Class 4** – There is no class listed for Class 4 water reactive materials in NFPA 704. The highest degree of hazard is that of Class 3, therefore, there was no MAQ established.

**Class 3** – The MAQ for Class 3 water reactive materials was modeled after Class 3 Unstable (reactive) materials. There was an anomaly built into the tabular limit for

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<sup>195</sup> *1988 Analysis of Revisions to the Uniform Building Code, et al.*, p. 12.

<sup>196</sup> *Fire Prevention Code*, 1965 Edition, American Insurance Association, p. 114.

<sup>197</sup> *Uniform Fire Code*, 1988 Edition, §79.201(b), p. 222.

<sup>198</sup> *Uniform Fire Code*, 1988 Edition, §10.308, items 1, 2 and 5, p. 55.

<sup>199</sup> *Uniform Building Code*, 1988 Edition, §3804, pp. 683-684.

solids and liquids in that there was a reduction in the use-closed amount for unstable reactives to 20% of the stored amount that is not reflected for water reactive materials in a use-closed condition in the Class 3 MAQ.

**Class 2** - The MAQ for Class 2 water reactive materials was modeled after Class 2 Unstable (reactive) Class 2 materials.

**Class 1** - The MAQ for Class 1 water reactive materials was modeled with respect to the base limit after Unstable (reactive) Class 1 materials; however, there was a credit applied to allow an unlimited quantity of Class 1 materials when sprinklered buildings were provided. A revision made in the 1998 Supplement to the UFC to increase the quantity of Class 1 Water Reactive materials to unlimited based on a parity with Class 1 Unstable Reactive materials.<sup>200</sup>

**5.4.14.5.1 Restrictions on MAQ.** There were no further restrictions placed on water reactive materials in people sensitive occupancies in the 1988 UFC.

**5.4.14.6 Threshold MAQ and Basis 2000 IBC.**

TABLE 64

**Water Reactive Materials – 2000 IBC Table No. 307.7(1) Maximum Allowable Quantity Per Control Area Of Hazardous Materials Posing A Physical Hazard<sup>a, j</sup>**

MATERIAL	CLASS	Group When the MAQ is Exceeded	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Water (reactive)	3	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	N/A	5 <sup>d</sup>	(5) <sup>d</sup>	N/A	1 <sup>d</sup>	(1) <sup>d</sup>
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	N/A	50 <sup>d</sup>	(50) <sup>d</sup>	N/A	10 <sup>d</sup>	(10) <sup>d</sup>
	1		NL	NL	N/A	NL	NL	N/A	NL	NL

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>200</sup> *IFCI Fire Code Journal, 1997 Submittals for Proposed Revisions to the Uniform Fire Code and the Urban-Wildland Interface Code*, International Fire Code Institute, Whittier, CA, Part II, September-October 1996, Item 39, p. 28.



<sup>d</sup> Maximum quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>e</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>j</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQs were consistent with the 1988 UBC as it had evolved through the publication of the 1998 Supplement to the UFC. The last edition of the UBC published was the 1997 Edition.

#### 5.4.14.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 65

**Water Reactive Materials – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Water (reactive)	3	2	5 <sup>e,f</sup>	(5) <sup>e,f</sup>	NA	5 <sup>f</sup>	(5) <sup>f</sup>	NA	1 <sup>f</sup>	(1) <sup>f</sup>
	2	3	50 <sup>e,f</sup>	(50) <sup>e,f</sup>	NA	50 <sup>f</sup>	(50) <sup>f</sup>	NA	10 <sup>f</sup>	(10) <sup>f</sup>
	1	NA	NL	NL	NA	NL	NL	NA	NL	NL

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code*<sup>TM</sup>. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

The threshold MAQs are consistent with the 1988 UBC to include changes made to increase the MAQ for Class 1 water reactive materials to unlimited amounts with the 1998 Edition of the UFC.

**5.4.14.8 Anomalies, Inconsistencies and Gaps.** The ranking by hazard class is established in NFPA 704. Classification of the degree of water reactivity contains quantitative test procedures; but the system is admittedly qualitative especially when solid materials are involved as the heat of mixing is determined by physical characteristics of the solid and the degree to which the material has dissolved.<sup>201</sup>

**5.4.15 Comparability of Hazards – Physical Hazard Materials.** The development of MAQs for inclusion in the 1988 Edition of the UBC applied the rationale listed above as to state (solid, liquid, gas), and condition (storage, closed or open use) and protection through the use of footnotes and multipliers. At the same time there was a level of comparability developed between some of the hazard groups that was tempered in part by a recognition that there was a historical basis for quantity limits established in the past. Section 5.0 of this report includes discussion on each of the hazard materials categories and hazard classes where appropriate. Inherent in the tables of MAQs developed for inclusion in the 1988 UBC there is a level of comparability that has been considered. It is represented in Table 65 below where  $x$  is a *factor* that represents a unit of measure for solids and/or liquids, and  $y$  is a factor that represents a unit of measure for gases. The value of  $x$  and/or  $y$  varies by hazard class. For example, by referring to the column 6.1 for *unstable (reactive)* materials, and looking at the values for solids/liquids it can be seen that the quantity in term of  $x$  for Class 4, 3, 2, 1 varies as  $0.2x$ ,  $x$ ,  $10x$  and  $25x$  respectively where  $x$  is 5 pounds. This can then be compared with column 4.1, 4.2 for comparability with the category of *organic peroxide* where comparability in terms of  $x$  for Class unclassified detonable (UD), I, II, III, IV and V is  $0.2x$ ,  $x$ ,  $10x$ ,  $25x$ ,  $100x$  and NL (not limited) respectively. Those materials with the more closely aligned comparable quantities where parity has been established include organic peroxides, oxidizers, unstable reactives and water reactives.

Materials such as flammable liquids Class IA, IB, IC reflect an increase in quantity with a reduction in hazard class. There has not been a comparability established from column to column, in all cases. The tabular “base” amounts ( $x$  or  $y$ ) do not reflect changes in the ratios when footnotes to the tables are applied. These tables are useful for understanding the

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<sup>201</sup> *Standard System for the Identification of Hazardous Materials for Emergency Response*, NFPA 704, 2007 Edition, National Fire Protection Association, Quincy, MA, Annex F, Electronic Version 2007 Fall Revision Cycle Edition, April 2008.

philosophy applied to each of the hazard categories in each of the listed conditions e.g., storage, use closed, use open.

TABLE 66

**A Comparison Of Quantity Factors Used To Establish Comparable Storage Threshold Limits By Hazard Category And Class**

1.1 Combustible liquids		1.2 Combustible dust		1.3 Combustible Fiber		1.4 Cryogenic flammable or oxidizing		2.1 Explosives		3.1 Flammable solid		3.2 Flammable gas		3.3 Flammable liquid	
liquids x=120		solids x=1		solids x=100		liquids x=45		solids liquids x=1		solids x=125		gases y = 250 y'=15		liquids x=30	
II	x	x	Loose	x	flammable	x	x	x	x	gaseous	3y	IA	x		
IIIA	2.75 x		Baled	10 x	oxidizing	x				liquefied	y'	IB	2x		
IIIB	110x											IC	3x		
												Comb	4x		

TABLE 66 Continued

4.1, 4.2 Organic Peroxides		4.3 Oxidizer Solids/liquids		4.4 Oxidizing Gas		2.75 Pyrophoric		6.1 Unstable (reactive)		7.1 Water Reactive	
solids/liquids x=5		solids/liquids x=10		gases y= 15		solids/liquids x=4 gases y=50		solids/liquids x=5 gases y = 250		solids/liquids x=5	
UD	0.2x	Class 4	0.1x	Gaseous	100y	Solids liquids	0.25x	Class 4	0.2x	Class 4	n/a
Class I	x	Class 3	x	Liquefied	y	Gases	y	Class 3	x	Class 3	x
Class II	10x	Class 2	25x					Class 2	10x	Class 2	10x
Class III	25x	Class 1	100x					Class 1	25x	Class 1	25x
Class IV	100x							Gas Class 4	0.04y		
Class V	NL							Gas Class 3	0.2y		
								Gas Class 2	y		
								Gas Class 1	3y		

TABLE 67

**A Comparison Of Quantity Factors Used To Establish Comparable Use-Closed Threshold Limits By Hazard Category And Class**

2.75 Combustible liquids		1.2 Combustible dust	1.3 Combustible Fiber		1.4 Cryogenic flammable or oxidizing		2.75 Explosives	3.1 Flammable solid	3.2 Flammable gas		3.3 Flammable liquid	
liquids x=120		solids x=1	solids x=100		liquids x=45		solids liquids x=1	solids x=125	gases y = 250 y'=15		liquids x=30	
II	x	x	Loose	x	flammable	x	0.25x	0.2x	gaseous	3y	IA	x
IIIA	2.75 x		Baled	10 x	oxidizing	x			liquefied	y'	IB	2x
IIIB	110x										IC	3x
											Comb	4x

TABLE 67 Continued

4.1, 4.2 Organic Peroxides		4.3 Oxidizer Solids/liquids		4.4 Oxidizing Gas		5.1 Pyrophoric		6.1 Unstable (reactive)		7.1 Water Reactive	
solids/liquids x=5		solids/liquids x=10		gases y= 15		solids/liquids x=4 gases y=50		solids/liquids x=5 gases y = 250		solids/liquids x=5	
UD	0.05x	Class 4	0.025x	Gaseous	100y	Solids liquids	0.25x	Class 4	0.05x	Class 4	n/a
Class I	0.2x	Class 3	0.2x	Liquefied	y	Gases	0.2y	Class 3	0.2x	Class 3	x
Class II	10x	Class 2	25x					Class 2	10x	Class 2	10x
Class III	25x	Class 1	100x					Class 1	25x	Class 1	25x
Class IV	100x							Gas Class 4	0.008y		
Class V	NL							Gas Class 3	0.04y		
								Gas Class 2	y		
								Gas Class 1	3y		

TABLE 68

**A Comparison Of Quantity Factors Used To Establish Comparable Use-Open Threshold Limits By Hazard Category And Class**

1.1 Combustible liquids		1.2 Combustible dust		1.3 Combustible Fiber		1.4 Cryogenic flammable or oxidizing		2.1 Explosives		3.1 Flammable solid		3.2 Flammable gas		3.3 Flammable liquid	
liquids x=120		solids x=1		solids x=100		liquids x=45		solids liquids x=1		solids x=125		gases y = 250 y'=15		liquids x=30	
II	0.25x	x	Loose	0.2x	flammable	0.22x	0.25x	0.2x				gaseous	n/a	IA	0.33x
IIIA	0.66x		Baled	2x	oxidizing	0.22x						liquefied	n/a	IB	0.5x
IIIB	0.25x													IC	0.66x
														Comb	x

TABLE 68 Continued

4.1, 4.2 Organic Peroxides		4.3 Oxidizer Solids/liquids		4.4 Oxidizing Gas		5.1 Pyrophoric		6.1 Unstable (reactive)		7.1 Water Reactive	
solids/liquids x=5		solids/liquids x=10		gases n/a		solids/liquids x=4 gases n/a		solids/liquids x=5 gases n/a		solids/liquids x=5 gases n/a	
UD	0.05x	Class 4	0.025x	Gaseous	n/a	Solids liquids	0.25x	Class 4	0.05x	Class 4	n/a
Class I	0.2x	Class 3	0.2x	Liquefied	n/a	gases	n/a	Class 3	0.2x	Class 3	x
Class II	2x	Class 2	5x					Class 2	10x	Class 2	10x
Class III	5x	Class 1	20x					Class 1	25x	Class 1	25x
Class IV	20x							Gas Class 4	n/a		
Class V	NL							Gas Class 3	n/a		
								Gas Class 2	n/a		
								Gas Class 1	n/a		

**5.5 Health Hazards**

**5.5.1 Corrosives**

**5.5.1.1 Definition and Basis 1988 UFC.** The definition of corrosive liquids first appeared in the 1985 Edition of the UFC. It appears to have been based in part on a definition of the term that was published in the 1956 Edition of the *AIA Fire Prevention Code*. A clause found in the AIA Code which followed the first sentence was deleted. The term was expanded in the 1988 Edition of the UFC to include a general term of



corrosive applied to solids, liquids and gases. The term *corrosive* was based on a definition developed by OSHA.<sup>202</sup>

The 1956 AIA definition was as follows:

***Corrosive Liquids*** shall mean and include those acids, alkaline caustic liquids, and other corrosive liquids which, when in contact with living tissue, will cause severe damage of such tissue by chemical action; or are liable to cause fire when in contact with organic matter or with certain chemicals.<sup>203</sup>

The 1985 UFC definition was as follows:

***Corrosive Liquids*** are those liquids which, when in contact with living tissue, will cause destruction or irreversible alteration of such tissue by chemical action. Examples include acid, alkaline or caustic materials.

The 1988 UFC definition revised the definition to correlate with the OSHA definition as follows:

***Corrosive*** is a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. A chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described in the U.S. Department of Transportation in Appendix A to CFR 49 Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

#### **5.5.1.2 Definition and Basis 2000 IFC.**

***Corrosive*** is a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. A chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described in the U.S. Department of Transportation in Appendix A to CFR 49 Part 173, ~~it~~ such chemical destroys or changes irreversibly the structure of the tissue at the ~~site~~ point of contact following an exposure period of four hours. This term ~~shall~~ does not refer to action on inanimate surfaces.

The definition for corrosive was taken from the 1997 Edition of the UFC and modified in an editorial fashion. The modifications are shown in legislative format above.

#### **5.5.1.3 Definition and Basis 2003 NFPA 1 UFC.**

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<sup>202</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53346.

<sup>203</sup> *Fire Prevention Code*, 1956 Edition, American Insurance Association, p. 112.

**3.3.54\* Corrosive.** A chemical that causes visible destruction of, or irreversible alterations in, ~~living tissue~~ materials by chemical action at the site of contact.

**A.3.3.54 Corrosive.** A chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces.

**3.3.101.2 Corrosive Gas.** A gas that causes visible destruction of or irreversible alterations in, living tissue by chemical action at the site of contact.

The modifications to the definition for *corrosive* in NFPA 1 creates a conflict with the definition for corrosive as published in NFPA 5000. The basis for the definition as published in NFPA 5000 was the 2000 Edition (same as 1997) of the UFC. The base definition of corrosive has been changed to focus on “materials” rather than “living tissue” with the adoption into NFPA 1. The annex note correlates with the 2000 Edition of the *Uniform Fire Code*,<sup>204</sup> however, the base definition appears to be in conflict with the annex note to the extent that the use of the term “materials” can include inanimate surfaces which otherwise are excluded by the last sentence of the annex note. The definition for corrosive gas was extracted into NFPA 1 from NFPA 55. The effect on “materials” is not included and the definition is consistent with the 2000 IFC.

#### 5.5.1.4 Threshold MAQ and Basis 1985 UBC.

TABLE 69

**Corrosive Materials – 1985 UBC Table No. 9-A**

Category	Exempt Amount
Corrosive Liquids	55 gal

Corrosive liquids were the only category of corrosive materials regulated under the requirements of the 1985 UBC. A permit limit quantity of 55 gallons had been

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<sup>204</sup> *Uniform Fire Code*, 2000 Edition, Western Fire Chiefs Association, Fallbrook, CA, p. 1-12.

established in the 1970 Edition of the AIA Fire Prevention Code.<sup>205</sup> There were no additional increases allowed under the footnotes to the table.

### 5.5.1.5 Threshold MAQ and Basis 1988 UBC.

TABLE 70

**Corrosive Materials – 1988 UBC Table No. 9-B**

Material <sup>4</sup>	STORAGE <sup>3</sup>			USE <sup>3</sup> - CLOSED SYSTEMS			USE <sup>3</sup> - OPEN SYSTEMS		
	Solid Lbs. <sup>5,6</sup>	Liquid Gallons <sup>5,6</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons <sup>5</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons (Lbs.) <sup>5</sup>	Gas Cu.Ft.
6. Corrosives	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup> The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>3</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>For carcinogenic and radioactive materials, see the Fire Code.

<sup>5</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 6 also applies, the increase for both footnotes may be applied.

<sup>6</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 5 also applies, the increase for both footnotes may be applied.

The *Analysis of Revisions* indicates that the exempt amounts of chemicals presenting a health hazard were established by professional judgment.<sup>206</sup> A base quantity of 500 gallons of liquid was established for the categories of *corrosive, irritant, sensitizer* and *other health hazard* materials. This quantity initially evolved from considering small operations that might have up to a nominal ten 50-55 gallon drums of chemical in storage and/or use. The stored quantity of 500 gallons was established for use-closed systems and reduced to one fifth (20%)

<sup>205</sup> *Fire Prevention Code*, 1970 Edition, American Insurance Association, p. 156.

<sup>206</sup> *1988 Analysis of Revisions to the Uniform Building Code, et al.*, p. 12.

or 100 gallons for use-open systems. Solids were then determined based on a conversion from liquid to solid using 10 pounds per gallon equivalent or 500 gallons \* 10 lb/gallon = 5,000 lbs.

The quantity of gas for the categories of *corrosive, irritant, sensitizer* and *other health hazard* materials was established at 650 cubic feet and indexed to a single cylinder of anhydrous hydrogen chloride, a corrosive gas, with nominal 60 pound content.

**5.5.1.5.1 Restrictions on MAQ.** There were no special restrictions imposed in people sensitive occupancies on corrosive materials.

**5.5.1.6 Threshold MAQ and Basis 2000 IBC.**

TABLE 71

**Corrosive Materials – 2000 IBC Table 307.7(2) Maximum Allowable Quantity Per Control Area of Hazardous Material Posing A Health Hazard<sup>a, b, c</sup>**

Material	STORAGE <sup>d</sup>			USE - CLOSED SYSTEMS <sup>d</sup>			USE - OPEN SYSTEMS <sup>d</sup>	
	Solid Lbs. <sup>e, f</sup>	Liquid Gallons <sup>e, f</sup> (pounds)	Gas Cu. Ft. <sup>e</sup>	Solid Lbs. <sup>e</sup>	Liquid Gallons <sup>e</sup> (pounds)	Gas Cu. Ft. <sup>e</sup>	Solid Lbs. <sup>e</sup>	Liquid Gallons (pounds) <sup>e</sup>
Corrosive	5000	500	810 <sup>g</sup>	5000	500	810 <sup>g</sup>	1000	100

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies shall not be limited provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

<sup>c</sup> For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 414.2.4, see Table 414.2.4.

<sup>d</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>e</sup> Quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>f</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, or exhausted enclosures as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>g</sup> A single cylinder containing 150 pounds or less of anhydrous ammonia in a single control area in a nonsprinklered building shall be considered a maximum allowable quantity. Two cylinders, each containing 150 pounds or less in a single control area shall be considered a maximum allowable quantity provided the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

As the code evolved, the base quantity of corrosive gases was increased in the UBC/UFC from 650 cubic feet to 810 cubic feet. The increase first appeared in the 1994 Edition of the UBC. The expressed intent was to include a single 150 pound cylinder of chlorine (810 cubic feet) as the basis for the threshold limit. Chlorine is a toxic, corrosive and oxidizing gas by definition. Footnote “g” was established to allow a single 150 pound cylinder of anhydrous ammonia (3,390 cubic feet) to be the base threshold MAQ without further increasing the MAQ for all corrosive materials. The exemption was based on precedent changes in the BOCA and SBCCI Fire Prevention Codes.<sup>207</sup>

### 5.5.1.7 Threshold MAQ and Basis 2003 NFPA 1 UFC.

TABLE 72

**Corrosive Materials – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Corrosive	NA	4	5,000 <sup>e,†</sup>	500 <sup>e,†</sup>	810 <sup>e,†,m</sup>	5,000 <sup>†</sup>	500	810 <sup>e,†,m</sup>	1,000 <sup>†</sup>	100 <sup>†</sup>

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code TM*. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>207</sup> 1998 Proposed Changes to the First Draft of the International Fire Code, International Code Council, Country Club Hills, IL, Item F1319-98, p. 628.

<sup>m</sup> A single cylinder containing 150 lb or less of anhydrous ammonia in a single control area in a nonsprinklered building is considered to be the maximum allowable quantity. Two cylinders, each containing 150 lb or less, in a single control area is considered to be the maximum allowable quantity, provided that the building is equipped throughout with an automatic sprinkler system in accordance with NFPA 13.

The concept of MAQs as adopted into NFPA 1 UFC were patterned after the UFC approach adopted in the 1988 UFC with changes that increased the MAQ for corrosive gases based on a chlorine index and excepting a single cylinder of ammonia as an exception to the table as had been done in the IFC process. These changes resulted in harmonization between NFPA 1 UFC and the I-Codes for this hazard category.

#### **5.5.1.8 Anomalies, Inconsistencies and Gaps.**

(a) The base definition of corrosive has been changed to address “materials” rather than “living tissue” with the adoption into NFPA 1. The annex note correlates with the 2000 Edition of the *Uniform Fire Code*;<sup>208</sup> however, it has been separated into a base definition along with an informational note published in the Annex. The definition appears to be in conflict with the annex note to the extent that the use of the term “materials” can include inanimate surfaces which otherwise would be excluded by the last sentence of the annex note. The definition is in conflict with the definition published in NFPA 5000 which was based on the 1997 Edition of the UFC.

### **5.5.2 Carcinogens**

#### **5.5.2.1 Definition and Basis 1988 UFC.**

***Carcinogen** is any substance that causes the development of cancerous growths in living tissue. A chemical is considered to be a carcinogen if: (a) it has been evaluated by the International Agency for Research on Cancer (IARC) and found to be a carcinogen or potential carcinogen, or*

*(b) It is listed as a carcinogen or potential carcinogen in the latest edition of the Annual Report on Carcinogens published by the National Toxicology Program (NTP), or*

*(c) It is regulated by OSHA as a carcinogen.*

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<sup>208</sup> *Uniform Fire Code*, 2000 Edition, Western Fire Chiefs Association, Fallbrook, CA, p. 1-12.

The definition was based on the OSHA definition. The first sentence was added by the UFC code development committee with the balance being the OSHA definition.<sup>209</sup>

**5.5.2.2 Threshold MAQ and Basis 1985 UBC.** The category of carcinogen was not included in Table No. 9-A of the 1985 UBC.

**5.5.2.3 Threshold MAQ and Basis 1988 UFC.**

TABLE 73

**Carcinogens, Irritants, Sensitizers and Other Health Hazard Materials Exempt Amounts  
UFC Table 80.315-A<sup>1,2</sup>**

Condition	Exempt Amount		
	Solids (Pounds)	Liquids (Gallons)	Gases (Cubic Feet at NTP)
Unprotected by sprinklers or cabinets	5,000	500	650
Within cabinet in unsprinklered building	10,000	1,000	1,300
In sprinklered building, not in cabinet	10,000	1,000	1,300
In sprinklered building, within cabinet	20,000	2,000	2,600

<sup>1</sup> For carcinogens, see applicable federal and state OSHA guidelines.

<sup>2</sup> The exempt amounts in this table apply independently to each material category. Accordingly, carcinogens, irritants, sensitizers and other health hazard materials are each allowed up to the exempt amount shown in the table.

Carcinogens were not included in Table No. 9-A of the 1988 UBC. Footnote 4 of the UBC table referred the user to the UFC for direction. Table No. 80.315-A (above) was included in the 1988 Edition of the UFC under a category of health hazards<sup>210</sup>.

<sup>209</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53346.

The category of carcinogens was deleted from regulation under the tables of exempt amounts integral to the Uniform Codes with the publication of the 1999 Supplement by a code change approved by the IFCI code development committee in 1997. The stated reason for deleting requirements was as follows:<sup>211</sup>

*The revisions were made because carcinogens and radioactives are more effectively regulated by other laws and agencies. The change correlates the Fire Code with the Building Code by eliminating the existing conflicts related to these materials.*

**5.5.2.4 Threshold and Basis 2000 IBC.** The category of carcinogen was not carried to the IBC.

**5.5.2.5 Threshold and Basis 2003 NFPA 1 UFC.** The category of carcinogens was not included in NFPA 1 UFC.

### **5.5.3 Highly Toxics**

**5.5.3.1 Definition and Basis 1988 UFC.** The definition for *highly toxic material* was first published in the 1985 Edition of the UFC. The 1985 definition was modified to correlate with the OSHA definition promulgated in the *Hazard Communication; Final Rule*.<sup>212</sup>

***Highly Toxic Material*** is any substance which falls within any of the following categories:<sup>213</sup>

1. *Produces death within 14 days in half or more than half of a group of 10 or more laboratory white rats, each weighing between 200 and 300 grams, at a single dose of 50 milligrams or less per kilogram of body weight, when orally administered.*
2. *Produces death within 14 days in half or more than half of a group of 10 or more laboratory white rats, each weighing between 200 and 300 grams, when inhaled continuously for a period of one hour or less at an*

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<sup>210</sup> *Uniform Fire Code*, 1988 Edition, p. 355.

<sup>211</sup> *1999 Accumulative Supplement to the Uniform Fire Code and the Urban-Wildland Interface Code*, International Fire Code Institute, Whittier, CA, Table 8001.15-B, p. 21.

<sup>212</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53346.

<sup>213</sup> *Uniform Fire Code*, 1985 Edition, pp. 27-28.



atmospheric concentration of 200 parts per million by volume or less of gas or vapor or two milligrams per liter by volume or less of mist or dust.

3. Produces death within 14 days in half of more than half of a group of 10 or more rabbits tested in a dosage of 200 milligrams or less per kilogram of body weight, when administered by continuous contact with the bare skin for 24 hours or less.

Mixtures of these materials with ordinary materials, such as water, may not warrant a classification of highly toxic. While this system is basically simple in application, any hazard evaluation which is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

The 1985 UFC definition was revised when it was promulgated in the 1988 Edition of the code as follows. The modifications are shown in legislative text below:

**Highly Toxic Material** is ~~any substance~~ a material which produces a lethal dose or lethal concentration which falls within any of the following categories:<sup>214</sup>

- a) A chemical that has a median lethal dose (LD50) of ~~Produces death within 14 days in half or more than half of a group of 10 or more laboratory white rats, each weighing between 200 and 300 grams, at a single dose of 50 milligrams or less per kilogram of body weight, when administered orally administered. to albino rats weighing between 200 and 300 grams each.~~
- b) A chemical that has a median lethal dose (LD50) ~~Produces death within 14 days in half of more than half of a group of 10 or more rabbits tested in a dosage of 200 milligrams or less per kilogram of body weight, when administered by continuous contact with the bare skin (or less if death occurs within for 24 hours) or less. with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.~~
- c) A chemical that has a median lethal dose (LD50) in air ~~Produces death within 14 days in half or more than half of a group of 10 or more laboratory white rats, each weighing between 200 and 300 grams, when inhaled continuously for a period of one hour or less at an atmospheric concentration of 200 parts per million by volume or less of gas or vapor, or two 2 milligrams per liter by volume or less of mist, fume or dust. when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats, each weighing between 200 and 300 grams each.~~

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<sup>214</sup> Hazard Communication; Final Rule, November 25, 1983, p. 53346.

*Mixtures of these materials with ordinary materials, such as water, may not warrant a classification of highly toxic. While this system is basically simple in application, any hazard evaluation which is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.*

#### **5.5.3.2 Definition and Basis 2000 IFC.**

**Highly Toxic Material** is a material which produces a lethal dose or lethal concentration which falls within any of the following categories:

- 1) *A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight, when administered orally to albino rats weighing between 200 and 300 grams each.*
- 2) *A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight, when administered by continuous contact (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.*
- 3) *A chemical that has a median lethal dose (LD50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust when administered by continuous inhalation for one hour (or less if death occurs within 1 hour) to albino rats, weighing between 200 and 300 grams each.*

*Mixtures of these materials with ordinary materials, such as water, may not warrant a classification of highly toxic. While this system is basically simple in application, any hazard evaluation which is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.*

The definition for highly toxic materials promulgated in the 2000 Edition of the IFC was based on the definition as it appeared in the UFC beginning with the 1988 Edition of the code through the 1997 Edition of the UFC.

#### **5.5.3.3 Definition and Basis 2003 NFPA 1 UFC.**

**Highly Toxic Material** is a material which produces a lethal dose or lethal concentration which falls within any of the following categories: (1) A chemical that has a median lethal dose (LD50) of 50 ~~mg/kg milligrams~~ or less ~~per kilogram~~ of body weight, when administered orally to albino rats weighing between 200g and 300 g ~~grams~~ each, (2) A chemical that has a median lethal dose (LD50) of 200 ~~mg/kg milligrams~~ or less ~~per kilogram~~ of body weight, when administered by continuous contact (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 ~~kg~~ and 3~~kg kilograms~~ each, (3) A chemical that has a median lethal dose (LD50) in air of 200 parts per million by volume or less of gas or vapor, or 2~~mg/L milligrams per liter~~ or less of mist, fume or dust when

*administered by continuous inhalation for one hour (or less if death occurs within 1 hour) to albino rats, weighing between 200g and 300 g grams each. Mixtures of these materials with ordinary materials, such as water, may not warrant a classification of highly toxic. While this system is basically simple in application, any hazard evaluation which is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.*

The definition for *highly toxic* is consistent with the 1988 UFC with minor editorial revisions to units of measure and format. The basis for definitions used in the 2003 Edition of NFPA 5000 was the 2000 Edition of the UFC.

#### 5.5.3.4 Threshold MAQ and Basis 1985 UBC.

TABLE 74

**Highly Toxic Materials – 1985 UBC Table No. 9-A**

Category	Exempt Amount
Highly toxic material and poisonous gas	No exemptions

No exemptions meant that any quantity in storage or use exceeded the threshold which resulted in declaring the occupancy to be Group H. The division within Group H depended in part on the hazard classification of the gases involved. For example, if the gas was also flammable the occupancy would revert to Group H, Division 2.

#### 5.5.3.5 Threshold MAQ and Basis 1988 UBC.

TABLE 75

**Highly Toxic Materials – 1988 UBC Table No. 9-B**

Material <sup>4</sup>	STORAGE <sup>3</sup>			USE <sup>3</sup> - CLOSED SYSTEMS			USE <sup>3</sup> - OPEN SYSTEMS		
	Solid Lbs. <sup>5,6</sup>	Liquid Gallons <sup>5,6</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons <sup>5</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons (Lbs.) <sup>5</sup>	Gas Cu.Ft.
2. Highly Toxics <sup>8</sup>	1	(1)	20 <sup>7</sup>	1	(1)	20 <sup>7</sup>	1/4	(1/4)	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas

within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup> The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>3</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>For carcinogenic and radioactive materials, see the Fire Code.

<sup>5</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 6 also applies, the increase for both footnotes may be applied.

<sup>6</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>7</sup>Permitted only when stored in approved exhausted gas cabinets, exhausted enclosures or fume hoods.

<sup>8</sup>For special provisions, see the Fire Code.

The small threshold quantities established for the MAQ recognized precedent history of having a “zero” exempt amount established for 15 years prior. The quantity of 1 pound for solids and liquids was patterned after the one pound limit established for the higher order physical hazard materials such as Unclassified detonable organic peroxides, Class 4 oxidizers, Class 4 Unstable reactives, etc. The 20 cubic foot limit for gases was based on a single small cylinder of highly toxic gas or gas mixture. The typical “small” cylinder was approximately 4 inches in diameter by 12 inches long.

**5.5.3.5.1 Restrictions on MAQ.** There were no occupancy specific restrictions regarding the storage or use of toxic or highly toxic solids and/or liquids. There were restrictions placed on toxic and highly toxic compressed gases in people sensitive occupancies. The exempt amount (threshold MAQ) for toxic and highly toxic compressed gases allowed in Group R Occupancies and in offices, classrooms or retail sales portions of Group B Occupancies was zero (none). A zero quantity was also established for Occupancies of Groups A, E, I and M excepting a quantity not exceeding 20 cubic feet at NTP when stored within a gas cabinet or fume hood. The exception was primarily designed to address educational uses which could include lecture halls (Assembly – Group A), classrooms (Groups E and B), and hospital or similar institutional laboratories (Group I). The effect was a

reduction from 40 to 20 cubic feet for the category of highly toxic gases in these particular occupancies under the imposed conditions.<sup>215</sup>

### 5.5.3.6 Threshold MAQ and Basis 2000 IBC

TABLE 76

**Highly Toxic Materials - 2000 IBC Table 307.7(2) Maximum Allowable Quantity Per Control Area of Hazardous Material Posing A Health Hazard** <sup>a, b, c</sup>

Material	STORAGE <sup>d</sup>			USE - CLOSED SYSTEMS <sup>d</sup>			USE - OPEN SYSTEMS <sup>d</sup>	
	Solid Lbs. <sup>e, f</sup>	Liquid Gallons <sup>e, f</sup> (pounds)	Gas Cu. Ft. <sup>e</sup>	Solid Lbs. <sup>e</sup>	Liquid Gallons <sup>e</sup> (pounds)	Gas Cu. Ft. <sup>e</sup>	Solid Lbs. <sup>e</sup>	Liquid Gallons <sup>e</sup> (pounds)
Highly Toxic	10	(10) <sup>i</sup>	20 <sup>h</sup>	10	(10) <sup>i</sup>	20 <sup>h</sup>	3	3 <sup>i</sup>

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies shall not be limited provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

<sup>c</sup> For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 414.2.4, see Table 414.2.4.

<sup>d</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>e</sup> Quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>f</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, or exhausted enclosures as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>h</sup> Allowed only when stored in approved exhausted gas cabinets or exhausted enclosures as specified in the *International Fire Code*.

<sup>i</sup> Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The threshold MAQ for *highly toxic* solids and liquids was revised from the UBC/UFC threshold levels during the development of the IFC/IBC. The increases were intended to correlate with the quantity shown for these same materials when

<sup>215</sup> *Uniform Fire Code*, 1991 Edition, Table No. 80.303-A, p. 374.

contained in an outdoor control area based on the logic that business owners with 5 pounds of material may decide to move the material outside (and out from under control) just to get below the control area limitations. Further concern was expressed about the impact on neighboring buildings. A similar approach was used for toxic materials as well.<sup>216</sup>

It should be noted that outdoor control areas were established to address requirements applicable to all hazardous materials when the MAQ was exceeded. There was a consensus reached that some quantity of hazardous materials should be allowed outdoors that did not have the same set of requirements as those stored or used indoors. Threshold levels for outside storage and use were established for certain, but not all hazardous materials based on an increased MAQ applied outdoors. Outdoor control areas do not trigger occupancy requirements; rather they trigger the use of other controls such as secondary containment, drainage, etc.

### 5.5.3.7 Threshold and Basis 2003 NFPA 1 UFC

TABLE 77

**Highly Toxic Materials – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area <sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Highly toxic	NA	4	10 <sup>e, f</sup>	(10) <sup>e, f</sup>	20 <sup>t, n</sup>	10 <sup>t</sup>	(10)	20 <sup>t, n</sup>	3 <sup>t</sup>	(3) <sup>t</sup>

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code TM*. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>216</sup> 1998 Proposed Changes to the First Draft of the International Fire Code, ICC, February 1998, Item F1320-98, p. 628.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>n</sup> Allowed only where stored in approved, exhausted gas cabinets or exhausted enclosures, as specified in NFPA 1.

The tabular limits in NFPA 1 are correlated as they have evolved from the initial publication in the 1988 UBC and subsequently revised through to the publication of the 2000 Edition of the IBC.

**5.5.3.8 Anomalies, Inconsistencies and Gaps.** None noted.

#### 5.5.4 Irritants

**5.5.4.1 Definition and Basis 1988 UFC.** The definition of irritant in the 1988 UFC was promulgated as follows. The source of the definition was OSHA's Hazard Communications; Final Rule:<sup>217</sup>

***Irritant** is a chemical which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for four hours' exposure or by other appropriate techniques, it results in an empirical score of 5 or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.*

**5.5.4.2 Definition and Basis 2003 NFPA 1 UFC.** The term "irritant gas" is included in NFPA 1 UFC to address the category as follows:

**3.3.101.7 Irritant Gas.** *A chemical that is not corrosive, but that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A gas is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41, for an exposure of 4 or more hours or by other appropriate techniques, it results in an empirical score of 5 or more. A chemical is classified as an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other approved techniques. [55:3.3]*

The definition has been extracted from NFPA 55.

**5.5.4.3 Threshold MAQ and Basis 1985 UBC.** The category of irritants was not included in the 1985 Edition of the UBC.

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<sup>217</sup> Hazard Communication; Final Rule, November 25, 1983, p. 53346.



### 5.5.4.4 Threshold MAQ and Basis 1988 UBC.

TABLE 78

**Irritants – 1988 UBC Table No. 9-B**

Material <sup>4</sup>	STORAGE <sup>3</sup>			USE <sup>3</sup> - CLOSED SYSTEMS			USE <sup>3</sup> - OPEN SYSTEMS		
	Solid Lbs. <sup>5,6</sup>	Liquid Gallons <sup>5,6</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons <sup>5</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons (Lbs.) <sup>5</sup>	Gas Cu.Ft.
3. Irritants	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup> The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>3</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>For carcinogenic and radioactive materials, see the Fire Code.

<sup>5</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 6 also applies, the increase for both footnotes may be applied.

<sup>6</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 5 also applies, the increase for both footnotes may be applied.

**5.5.4.4.1 Restrictions on MAQ.** There were no special restrictions on the quantity of irritants in people sensitive occupancies.

**5.5.4.5 Regulation of Category Discontinued.** The category irritant gases had been retained through the development of the First Draft of the IBC. Regulation of the category for solids and liquids had not been included with the first draft. The category was not included in the 2000 IBC, and the regulation for gases was dropped from the first draft based on a code change that provided the following rationale from the proponent:

*Irritant gases are chronic health hazards, which are regulated in the workplace by Federal OSHA and by Federally-approved state OSHA plans. Irritant solids and liquids have already been eliminated from regulation in all of the model codes. The main reason for retaining regulations for irritant gases was to provide emergency response personnel with information as to the*



*presence of the gases in occupancies. However, emergency response personnel are informed of the presence of these gas [sic] through Federal SARA's Tier I and Tier II reporting forms. There is no reason –based on life safety issues – to retain regulation of these materials in the fire code.*<sup>218</sup>

There may be reason to question the substantiating statement, including the fact that the irritant effects are “chronic” and not acute and the comment that these materials are reported on the SARA Tier I and II reporting forms, the membership approved the deletion of the category in the MAQ tables. Regulation of the category remained in the IFC through provisions that established requirements for ventilation in occupancies where irritant gases were present and the building was occupied.<sup>219</sup> A similar approach is used in NFPA 1 UFC, and although the category is not regulated under MAQ, concepts, ventilation is required.<sup>220</sup>

**5.5.4.6 Anomalies, Inconsistencies and Gaps.** The definition for irritant gas depends on the use of “other approved techniques.” The category is outside of the MAQ threshold scheme of control, however, ventilation is required when these materials are stored or used.<sup>221</sup>

## 5.5.5 Sensitizers

**5.5.5.1 Definition and Basis 1988 UFC.** The definition was based on the OSHA definition promulgated in the Hazard Communication Standard.<sup>222</sup>

*Sensitizer is a chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.*

**5.5.5.2 Threshold MAQ and Basis 1985 UBC.** The category of sensitizers was not included in the 1985 UBC.

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<sup>218</sup> *1998 Proposed Changes To The First Draft of the International Fire Code*, International Code Council Country Club Hills, IL, First Printing, February 1998, Item F1321-98, p. 629.

<sup>219</sup> *International Fire Code*, 2006 Edition, International Code Council, Country Club Hills, IL, §3007, p. 276.

<sup>220</sup> *NFPA 1 Uniform Fire Code*, 2003 Edition, National Fire Protection Association, Quincy, MA, §63.2.13, p. 224.

<sup>221</sup> *NFPA 1 Uniform Fire Code* 2003 Edition, §63.2.13.

<sup>222</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53346.

### 5.5.5.3 Threshold MAQ and Basis 1988 UBC.

TABLE 79

**Sensitizers – 1988 UBC Table No. 9-B**

Material <sup>4</sup>	STORAGE <sup>3</sup>			USE <sup>3</sup> - CLOSED SYSTEMS			USE <sup>3</sup> - OPEN SYSTEMS		
	Solid Lbs. <sup>5 6</sup>	Liquid Gallons <sup>5 6</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs <sup>5</sup>	Liquid Gallons <sup>5</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons (Lbs.) <sup>5</sup>	Gas Cu.Ft.
4. Sensitizers	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup> The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>3</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>For carcinogenic and radioactive materials, see the Fire Code.

<sup>5</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 6 also applies, the increase for both footnotes may be applied.

<sup>6</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 5 also applies, the increase for both footnotes may be applied.

The threshold quantity for solid and liquid sensitizers was increased to an unlimited amount in the 1996 Supplement by a code change that followed an unsuccessful attempt to delete the regulation of the category.<sup>223</sup> The threshold quantities for gases were retained with a footnote that allowed these quantities to be increased to unlimited amounts when exhaust ventilation was provided.<sup>224</sup> The category was dropped from regulation entirely during the development of the first draft of what became the 2000 Edition of the *International Building Code*.

<sup>223</sup> *Accumulative Supplement to the Uniform Building Code, et al., 1996*, International Conference of Building Officials, Whittier, CA, p. 267.

<sup>224</sup> *IFCI Fire Code Journal, Fall 1994, Part II 1995 Submittals for Proposed Revisions to the Uniform Fire Code and Provisions of the Uniform Building Code Maintained by IFCI*, International Fire Code Institute, Austin, TX, Item 70, pp. 53-54.

The reasons cited to increase the quantities to unlimited amounts included a need to eliminate building construction limitations currently imposed through the Group H, Division 7 Occupancy classification. In an unsuccessful attempt to achieve a code change to delete the categories of carcinogens, irritants, sensitizers and other health hazards rationale was presented expressing a concern that, in pertinent part as follows:<sup>225</sup>

*Fire and emergency responders are concerned with materials which have an immediate effect, i.e., "acute toxicity." Carcinogens, irritants, sensitizers and other health hazard materials may cause health effects over long term exposure and/or repeated contact. It is highly unlikely that any of these materials are dangerous to responders, since responders are present for a short time in emergency situations. Regulations [sic] of these materials is appropriate for OSHA, where regulations have been promulgated to protect workers who are continually exposed to these materials in the work place.*

In discussing acute and chronic hazards OSHA explained the difficulty in attempting to categorize health effects in pertinent part as follows, noting that irritation and sensitization were viewed as "acute" and not "chronic" effects.<sup>226</sup>

*There have been many attempts to categorize effects and to define them in various ways. Generally, the terms "acute" and "chronic" are used to delineate between effects on the basis of severity or duration. "Acute" effects usually occur rapidly as a result of short-term exposures, and are of short duration. "Chronic" effects generally occur as a result of long-term exposure, and are of long duration.*

*The acute effects referred to most frequently are those defined by the American National Standards Institute (ANSI) standard for Precautionary Labeling of Hazardous Industrial Chemicals (Z129.1-1982) - irritation, corrosivity, sensitization and lethal dose. Although these are important health effects they do not adequately cover the considerable range of acute effects which may occur as a result of occupational exposure, such as, for example, narcosis.*

*Similarly, the term chronic effect is often used to cover only carcinogenicity, teratogenicity, and mutagenicity. These effects are obvious a concern in the workplace, but again, do not adequately cover the area of chronic effects,*

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<sup>225</sup> *IFCI Fire Code Journal, Fall 1993, Part II 1994 Submittals for Proposed Revisions to the Uniform Fire Code, UFC Standards and Provisions of the Uniform Building Code and UBC Standards Maintained by IFCI, International Fire Code Institute, Whittier, CA, Fall 1993, Item 93, p. 60*

<sup>226</sup> *Hazard Communication; Final Rule, November 25, 1983, Appendix A to §1910.1200 Health Hazard Definitions, p. 53346.*

*excluding, for example, blood dyscrasias (such as anemia), chronic bronchitis and liver atrophy*

*The goal of defining precisely, in measurable terms, every possible health effect that may occur in the workplace as a result of chemical exposures cannot realistically be accomplished. This does not negate the need for employees to be informed of such effects and protected from them.*

The code change to delete the regulation of carcinogens, irritants, sensitizers, and other health hazards was defeated when it was first submitted, the regulatory community decided to bypass the regulation of these materials as the codes evolved in the process to develop the 2000 IBC.

**5.5.5.3.1 Restrictions on MAQ.** There were no special restrictions of the category in people sensitive occupancies that were included in the 1988 UFC.

## **5.5.6 Other Health Hazards**

**5.5.6.1 Definition and Basis 1988 UFC.** There was no definition for the category of *other health hazard* materials until introduction into the 1993 Supplement to the Uniform Codes.<sup>227</sup> The definition was developed around the OSHA concept of “target organ effects” which was a category established in the *Hazard Communication Standard*.<sup>228</sup>

***Other Health Hazard Material** is a hazardous material which affects target organs of the body, including, but not limited to, those materials which produce liver damage, kidney damage, damage to the nervous system, act on the blood to decrease hemoglobin function, deprive the body tissue of oxygen, or affect reproductive capabilities, including mutations (chromosomal damage) or teratogens (effects on fetuses).*

The category of *other health hazard* materials was not regulated after the publication of the 1997 Edition of the *Uniform Codes*.

**5.5.6.2 Threshold MAQ and Basis 1985 UBC.** The category of Other Health Hazard was not included in the 1985 UBC.

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<sup>227</sup> 1993 *Accumulative Supplement to the Uniform Building Code, et al.*, International Conference of Building Officials, Whittier, CA, 1993, p. 622.

<sup>228</sup> *Hazard Communication Standard; Final Rule*, Item 7, p. 53347

### 5.5.6.3 Threshold MAQ and Basis 1988 UBC.

TABLE 80

**Other Health Hazards – 1988 UBC Table No. 9-B**

Material <sup>4</sup>	STORAGE <sup>3</sup>			USE <sup>3</sup> - CLOSED SYSTEMS			USE <sup>3</sup> - OPEN SYSTEMS		
	Solid Lbs. <sup>5,6</sup>	Liquid Gallons <sup>5,6</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons <sup>5</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>5</sup>	Liquid Gallons (Lbs.) <sup>5</sup>	Gas Cu.Ft.
5. Other Health Hazards	5000	500	650 <sup>6</sup>	5000	500	650 <sup>5</sup>	1000	100	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two. The number of control areas in buildings with other uses shall not exceed four.

<sup>2</sup> The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>3</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>For carcinogenic and radioactive materials, see the Fire Code.

<sup>5</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 6 also applies, the increase for both footnotes may be applied.

<sup>6</sup>Quantities may be increased 100 percent when stored in approved storage cabinets or safety cans as specified in the Fire Code. When Footnote 5 also applies, the increase for both footnotes may be applied.

The threshold quantity for solid and liquid other health hazard materials was increased to an unlimited amount in the 1996 Supplement by a code change that followed an unsuccessful attempt to delete the regulation of the category.<sup>229</sup> The threshold quantities for gases were retained with a footnote that allowed these quantities to be increased to unlimited amounts when exhaust ventilation was provided.<sup>230</sup> The category was dropped from regulation entirely during the development of the first draft of what became the 2000 Edition of the *International*

<sup>229</sup> *Accumulative Supplement to the Uniform Building Code, et al., 1996*, International Conference of Building Officials, Whittier, CA, p. 267.

<sup>230</sup> *1995 Submittals for Proposed Revisions to the Uniform Fire Code and Provisions of the Uniform Building Code Maintained by IFCI*, IFCI Fire Code Journal, Part II, Fall 1994, International Fire Code Institute, Austin, TX, Item 70, pp. 53-54.

*Building Code.* Refer to the discussion on sensitizers and the reasons for their not being included in the evolution of the *Uniform Building Codes* published after 1997.

**5.5.6.3.1 Restrictions on MAQ.** There were no additional restrictions placed on other health hazard materials in people sensitive occupancies in the 1988 UFC.

## 5.5.7 Toxics

**5.5.7.1 Definition and Basis 1988 UFC.** The definition for *toxic material* was first published in the 1988 Edition of the UFC. The definition was consistent with the OSHA definition published in the *Hazard Communication Standard*:<sup>231</sup>

**Toxic Material** is a material which produces a lethal dose or lethal concentration within any of the following categories:

- a) A chemical or substance that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight, when administered orally to albino rats weighing between 200 and 300 grams each.
- b) A chemical or substance that has a median lethal dose (LD50) of more than 200 milligrams or less per kilogram but not more than 1000 milligrams per kilogram of body weight, when administered by continuous contact (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
- c) A chemical that has a median lethal concentration (LD50) in air [of] more than 200 parts per million but not more than 2000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats, each weighing between 200 and 300 grams each.

### 5.5.7.2 Definition and Basis 2000 IFC

**Toxic.** A chemical falling within any of the following categories:

- d) A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

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<sup>231</sup> *Hazard Communication; Final Rule*, November 25, 1983, p. 53346.

- e) *A chemical that has a median lethal dose (LD50) of more than 200 milligrams or less per kilogram but not more than 1000 milligrams per kilogram of body weight when administered by continuous contact (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.*
- f) *A chemical that has a median lethal concentration (LD50) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats, each weighing between 200 and 300 grams each.*

The definition is consistent with the 1988 UFC.

#### **5.5.7.3 Definition and Basis 2003 NFPA 1 UFC**

**3.3.130.8 Toxic Material.** *A material that produces a lethal dose or a lethal concentration within one of the following three categories: (1) A chemical or substance that has a median lethal dose (LD50) of more than 50 mg/kg, but not more than 500 mg/kg of body weight when administered orally to albino rats weighing between 200 and 300 grams each. (2) A chemical or substance that has a median lethal dose (LD50) of more than 200 mg/kg but not more than 1000 mg/kg of body weight when administered by continuous contact (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kg each, (3) A chemical or substance that has a median lethal concentration (LD50) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume or dust, when administered by continuous inhalation for 1 hour, or less if death occurs within 1 hour, to albino rats, each weighing between 200 g and 300 g each.*

The term was taken from the 2000 UFC. It is consistent with the term as published in the 1988 UFC. The term *toxic gas* found in 3.3.101.17 of NFPA 1 UFC is consistent with part (3) of the definition as gases are assessed based on inhalation hazards or LC50.

**5.5.7.4 Threshold MAQ and Basis 1985 UBC.** The category of toxic (other than highly toxic) was not included in the 1985 UBC.



**5.5.7.5 Threshold MAQ and Basis 1991 UBC.** The category of toxic was added to the 1991 Edition of the UBC as follows:

TABLE 81

**Toxic Materials – 1991 UBC Table No. 9-B**

Material <sup>4</sup>	STORAGE <sup>3</sup>			USE <sup>3</sup> - CLOSED SYSTEMS			USE <sup>3</sup> - OPEN SYSTEMS		
	Solid Lbs. <sup>4 5 6</sup>	Liquid Gallons <sup>4 5 6</sup> (Lbs.)	Gas Cu. Ft. <sup>5</sup>	Solid Lbs. <sup>4 5</sup>	Liquid Gallons <sup>4 5</sup> (Lbs.)	Gas Cu. Ft.	Solid Lbs. <sup>4 5</sup>	Liquid Gallons <sup>4 5</sup> (Lbs.)	Gas Cu.Ft.
<b>6. Toxics</b>	500	(500)	650 <sup>6</sup>	500	(500)	20 <sup>5 7</sup>	125	(125)	-

<sup>1</sup>Control area is a space bounded by not less than a one-hour fire-resistive occupancy separation within which the exempted amounts of hazardous materials may be stored dispensed, handled or used. The number of control areas within a building used for retail and wholesale stores shall not exceed two and the number of control areas in other uses shall not exceed four.

<sup>2</sup> The quantities of medicines, foodstuffs and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies are unlimited when packaged in individual containers not exceeding four liters.

<sup>3</sup>The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>4</sup>The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid health hazard materials within a single control area of Group B, Division 2 Occupancies used for retail sales may exceed the exempt amounts when such areas are in compliance with the Fire Code.

<sup>5</sup>Quantities may be increased 100 percent in sprinklered buildings. When Footnote 6 also applies, the increase for both footnotes may be applied.

<sup>6</sup>Quantities may be increased 100 percent when stored in approved storage cabinets, gas cabinets, fume hoods, exhausted enclosures or safety cans as specified in the Fire Code. When Footnote 5 also applies, the increase for both footnotes may be applied.

<sup>7</sup>Permitted only when stored in approved exhausted gas cabinets, exhausted enclosures or fume hoods.

<sup>8</sup>For special provisions, see the Fire Code.

As the code evolved, the base quantity of toxic gases was increased in the UBC/UFC from 650 cubic feet to 810 cubic feet. The increase first appeared in the 1994 Edition of the UBC. The expressed intent was to include a single 150 pound cylinder of chlorine (810 cubic feet) as the basis for the threshold limit. Chlorine is a toxic, corrosive and oxidizing gas by definition.

**5.5.7.5.1 Restrictions on MAQ.** There were no occupancy specific restrictions regarding the storage or use of toxic or highly toxic solids and/or liquids. There were restrictions on toxic and highly toxic



compressed gases. The exempt amount (threshold MAQ) for toxic and highly toxic compressed gases allowed in Group R Occupancies and in offices, classrooms or retail sales portions of Group B Occupancies was zero (none). A zero quantity was also established for Occupancies of Groups A, E, I and M excepting a quantity not exceeding 20 cubic feet at NTP when stored within a gas cabinet or fume hood. The exception was principally designed to address educational uses which could include lecture halls (Assembly – Group A), classrooms (Groups E and B), and hospital or similar institutional laboratories (Group I).<sup>232</sup>

### 5.5.7.6 Threshold MAQ and Basis 2000 IBC

TABLE 82

**Toxic Materials - 2000 IBC Table 307.7(2) Maximum Allowable Quantity Per Control Area of Hazardous Material Posing A Health Hazard<sup>a, b, c</sup>**

Material	STORAGE <sup>d</sup>			USE - CLOSED SYSTEMS <sup>d</sup>			USE - OPEN SYSTEMS <sup>d</sup>	
	Solid Lbs. <sup>e, f</sup>	Liquid Gallons <sup>e, f</sup> (pounds)	Gas Cu. Ft. <sup>e</sup>	Solid Lbs. <sup>e</sup>	Liquid Gallons <sup>e</sup> (pounds)	Gas Cu. Ft. <sup>e</sup>	Solid Lbs. <sup>e</sup>	Liquid Gallons (pounds) <sup>e</sup>
Toxics	500	(500) <sup>i</sup>	810 <sup>f</sup>	500	(500) <sup>i</sup>	810 <sup>f</sup>	125	(125) <sup>i</sup>

<sup>a</sup> For use of control areas, see Section 414.2.

<sup>b</sup> In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics containing not more than 50 percent of volume of water-miscible liquids and with the remainder of the solutions not being flammable in retail sales or storage occupancies shall not be limited provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

<sup>c</sup> For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 414.2.4, see Table 414.2.4.

<sup>d</sup> The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

<sup>e</sup> Quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both footnotes shall be applied accumulatively.

<sup>f</sup> Quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, or exhausted enclosures as specified in the *International Fire Code*. Where Note d also applies, the increase for both footnotes shall be applied accumulatively.

<sup>232</sup> *Uniform Fire Code*, 1991 Edition, Table No. 80.303-A, p. 374.

<sup>i</sup>Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

The increase in the base amount of toxic gases from 650 to 810 cubic feet which was established in the 1994 UBC was maintained as the MAQ transitioned from the Uniform Codes to the IBC. The MAQ threshold was reduced to “none” for toxic and highly toxic compressed gases in Group A, E, I, R or U occupancies, and in offices, retail sales and classrooms of Group B, R, M or S occupancies. Exceptions were provided to allow the use of cylinders not exceeding 20 cubic feet at NTP in gas cabinets or fume hoods in Groups A, E, I or U occupancies or in classrooms of Group B occupancies.<sup>233</sup>

### 5.5.7.7 Threshold MAQ and Basis 2003 NFPA 1 UFC

TABLE 83

**Toxic Materials – 2003 NFPA 1 UFC Table 60.2.2.1(a) Maximum Allowable Quantity of Hazardous Materials per Control Area<sup>a</sup>**

MATERIAL	CLASS	High Hazard Protection Level	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet	Solid pounds (cubic feet)	Liquid gallons (pounds)
Toxic	NA	4	500 <sup>e,f</sup>	(500) <sup>e,f</sup>	810 <sup>e,f</sup>	500 <sup>f</sup>	(500)	810 <sup>e,f</sup>	125 <sup>f</sup>	(125) <sup>f</sup>

<sup>a</sup> See 34.1.3.2 of NFPA 5000 for exceptions to tabular amounts. For use of control areas, see 34.2.4 of NFPA 5000. Table values in parentheses correspond to the unit name in parentheses at the top of the column.

<sup>b</sup> The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 34.1.3.2 of NFPA 5000.

<sup>e</sup> Quantities are permitted to be increased 100 percent where stored in approved cabinets, gas cabinets, exhausted enclosures, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1, *Uniform Fire Code TM*. Where Footnote f also applies, the increase for both footnotes is permitted to be applied accumulatively.

<sup>f</sup> Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote e also applies, the increase for both footnotes is permitted to be applied accumulatively.

The threshold MAQ for toxic materials as it transitioned to NFPA 1 UFC remained consistent with that established in the 1994 Edition of the Uniform Codes and was

<sup>233</sup> *International Fire Code*, 2000 Edition, § 3704.1.1, p. 317.

consistent with that established in the 2000 Edition of the IBC. Occupancy specific restrictions that reduced the MAQ for toxic gases to zero in Assembly, Business and Industrial Occupancies, in offices or classrooms of Mercantile or Storage occupancies, Educational occupancies, Daycare, Health Care, Ambulatory Health Care, and Detention and Correctional Occupancies. Exceptions were provided to allow up to 20 cubic feet at NTP when cylinders were located in gas cabinets or fume hoods consistent with the approach established in the 1991 Edition of the Uniform Codes.<sup>234</sup>

**5.5.7.8 Anomalies, Inconsistencies and Gaps.** None identified.

### **5.5.8 Radioactives**

**5.5.8.1 Definition and Basis 1988 UFC.** The definition of radioactive material published in the 1988 Edition of the UFC was not new to the 1988 Edition. It was identical to that published in the 1985 UFC. The definition was also published in the 1956 Edition of the AIA *Fire Prevention Code*.<sup>235</sup>

*Radioactive Material is any material or combination of materials that spontaneously emits ionizing radiation.*

**5.5.8.2 Threshold MAQ and Basis 1985 UBC.** The category of radioactive was not included in the 1973 UBC, nor was the category addressed in the 1985 UBC. Under the requirements of the AIA Fire Prevention Code, a permit was required for the storage or handling at any installation of more than one microcurie of radium not contained in a sealed source; or more than one millicurie of radium or other radioactive material in a sealed source or sources, or any amount of radioactive material for which a specific license from the US Atomic Energy Commission was required.<sup>236</sup>

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<sup>234</sup> NFPA 1 *Uniform Fire Code*, 2003 Edition, § 60.2.3.1 through 60.2.3.5, pp. 204 – 206.

<sup>235</sup> *Fire Prevention Code*, 1956 Edition, American Insurance Association, p. 112.

<sup>236</sup> AIA *Fire Prevention Code*, 1970 Edition, pp. 156-157.

### 5.5.8.3 Threshold MAQ and Basis 1988 UFC.

TABLE 84

**Radioactive Materials – 1988 UFC Table No. 80.313-A**

Condition	Exempt Amount
Any storage condition	<ol style="list-style-type: none"><li>1. Less than the permit amount (See Section 4.101 (No. 40))</li><li>2. Licensed, sealed sources for instruments, calibration devices and equipment</li></ol>

**5.5.8.3.1 Restrictions on MAQ.** There were no additional restrictions placed on radioactive materials in the 1988 UFC.

**5.5.8.4 Regulation of Category Discontinued.** Between 1988 and 1997 threshold MAQs for alpha, beta and gamma emitters in storage and use, were developed. The regulation of radioactive materials was discontinued with the publication of the 1998 Supplement. The reason cited for removal of this category from regulation was indicated in the published reason from the code development committee, in pertinent part that, “carcinogens and radioactives are more effectively regulated by other laws and agencies.”<sup>237</sup> At the time the category was removed from the UFC in 1998 the ICBO staff analysis to the code change indicated that neither carcinogens nor radioactives were regulated by the UBC (having not been listed in Table No. 9-A or 9-B) and that the code change to delete these categories would eliminate the conflict between the two codes.<sup>238</sup> The staff analysis raised a question as to applicability given the fact that the UBC referenced the user to the UFC through the use of footnotes. The removal of the categories was supported by the fire service and the categories of carcinogens and radioactive materials were removed from the *Uniform Codes*. The category was not carried into the IBC, IFC or NFPA 1 UFC.

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<sup>237</sup> *1998 Supplement to the Uniform Fire Code and the Urban-Wildland Interface Code*, International Fire Code Institute, Whittier, CA, 1998, p. 23

<sup>238</sup> *IFCI Fire Code Journal*, Part II, Submittals for Proposed Revisions to the Uniform Fire Code and the Urban-Wildland Interface Code, September-October 1996, IFCI, Whittier, CA, Item 40 p. 29.

**5.5.9 Comparability of Hazards – Health Hazard Materials.** As in the case of physical hazard materials the development of MAQs for inclusion in the 1988 Edition of the UBC established quantities based on control area concepts with increases granted through the application of controls including sprinkler systems, approved storage cabinets, etc. The tabular limits for *corrosives, irritants, sensitizers* and *other health hazard* materials were established with identical quantity limits for each hazard category. The exception was the category of *highly toxic* which had been established with a “zero quantity” threshold beginning with the publication of the 1973 UBC. One of the reasons to establish identical quantity limits for the categories of *corrosives*, etc. was based on a recognition that dilution of a material such as a corrosive would result in creating materials where the hazard had been reduced to that of an *irritant*, or perhaps that of *other health hazard*. One of the primary reasons to include materials such as those that were *irritant, sensitizer* or *other health hazards* (the target organ toxins, including mutagens and teratogens) was that the array of health hazard materials was based on OSHA’s Hazard Communication Standard. It was recognized that MSDS were now required to inform the user of the hazard qualities of hazardous materials in a defined manner.

The *Analysis of Revisions* indicates that the exempt amounts of chemicals presenting a health hazard were established by professional judgment.<sup>239</sup> A base quantity of 500 gallons of liquid was established for the categories of *corrosive, irritant, sensitizer* and *other health hazard* materials. This quantity initially evolved from considering small operations that might have up to a nominal ten 50-55 gallon drums of chemical in storage and/or use. The stored quantity of 500 gallons was established for use-closed systems and reduced to one fifth (20%) or 100 gallons for use-open systems. Solids were then determined based on a conversion from liquid to solid using 10 pounds per gallon equivalent or 500 gallons \* 10 lb/gallon = 5,000 lbs.

The quantity of gas for the categories of *corrosive, irritant, sensitizer* and *other health hazard* materials was established at 650 cubic feet and indexed to a single cylinder of anhydrous hydrogen chloride with nominal 60 pound content. Hydrogen chloride is a corrosive gas.

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<sup>239</sup> 1988 *Analysis of Revisions to the Uniform Building Code, et al.*, p. 12.

The threshold MAQs for *highly toxic* solid and liquid materials was established at 1 pound for storage and use-closed conditions. It was reduced to one quarter (25%) or ¼ pound for use-open systems based on rounding to the nearest quarter pound. A quantity of 20 cubic feet was established for gases, but at the time it was not indexed to any particular gas.

## 6 INTERPRETATIONAL CHALLENGES IN THE USE OF THE CLASSIFICATION SYSTEM

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**6.0 Physical State of Material.** The current regulatory approach recognizes three forms of material, i.e., *solid, liquid* or *gas*. For the average code user the classification system is easily applied. There are questions that may arise with the application of the definitions that require the user to carefully consider the application of the definitions. The following examples can illustrate some of the problems that users can face when the materials being evaluated are not in the form expected.

**6.0.1 Material Form as a Basis for Classification.** The determination of hazard class is dependent in part on the form of a material stored or used to the extent that it falls into one of the three physical states, i.e., solid, liquid or gas. The form of the material for the purpose of classification may not be the form expected by the user. For example, sulfuric acid [CAS 7664-93-9] 98% is a corrosive liquid. It is also water reactive and toxic. The hazard class for water reactivity varies with the concentration across the spectrum of definitions inherent to the hazard rating system established by the definitions contained within the applicable edition of NFPA 704. For the 98% material its water reactive nature is based on the liquid form and the heat generated when mixed with water. As concentration of the acid is reduced there is a corresponding decrease in the hazard class rating as the heat of decreases when dilute solutions are tested. Toxicity of materials is determined based on exposure to life forms.

Toxicity is determined by the measurable impact of a chemical agent on biological systems. The degree to which a biological system responds to the action of a toxic material is influenced by the rate and the route of exposure. There are other means of exposure that may be considered, such as intravenous injection, the code considers only exposure through ingestion, inhalation or skin contact. The basis for the exposure scenarios is founded in the definitions for toxicity established by OSHA.<sup>240</sup> The use of these definitions may assume

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<sup>240</sup> *Hazard Communication; Final Rule*, November 25, 1983, definitions for toxic and highly toxic materials, p. 53346.

conditions that are other than the form in which the material is found. Amdur, in an explanation of factors influencing the intensity of toxic action notes the following:<sup>241</sup>

*It has already been indicated that when a substance is administered as an iv injection, the material has maximum opportunity to be carried by the bloodstream throughout the body, whereas other routes of exposure interpose a barrier to distribution of the material. The effectiveness of this barrier will govern the intensity of toxic action of a given amount of toxic agent administered by various routes. Lead, for example, is toxic both by ingestion and by inhalation. An equivalent dose, however, is more readily absorbed from the respiratory tract than from the gastro-intestinal tract and hence produces a greater exposure.*

The determination of toxicity is based on exposure to any of the three exposure routes included in the definition. In the example of sulfuric acid, exposure to acid mist results in classification as a toxic material based on inhalation exposure with the LC50 established based on an inhalation-rat LC50 of 510 mg/m<sup>3</sup>/2H (two hours).<sup>242</sup>

Arsenic oxide [CAS1303-28-2] is a highly toxic solid based on an ingestion-rat LD50 of 8 mg/kg. Arsenic oxide is also a carcinogenic material, and while this hazard characteristic may be of interest to the end user for the application of suitable controls to minimize exposure, carcinogens as a hazard category are not regulated within the context of the current building or fire prevention codes.

In these examples, LC50 and LD50 are sufficient to warrant a classification of these materials (sulfuric acid and arsenic oxide) in terms of toxicity as toxic and highly toxic respectively. There may be an inclination on the part of users to argue that the sulfuric acid is not being used in the form of a mist, or that the arsenic oxide is being used in a glove box or in a system where it is not possible to ingest the material even as a nuisance dust. The code remains blind to what the user may envision may be the typical circumstances of use. If this was not done, the application of the code would be a virtual impossibility for code officials, building designers and code users as any approach that considers use specific application as a general approach to material classification would result in an unending set of conditions and any attempt to apply the regulations in a consistent manner would fail.

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<sup>241</sup> Amdur, Mary O., author of Chapter 17, *The Industrial Environment – its Evaluation & Control*, U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control National Institute for Occupational Safety and Health, Washington, D.C., 1973, pp. 67-68

<sup>242</sup> *HMEEx Assistant Software*, Version 5.1.0, published by Fluer, Inc., Paso Robles, CA.



There are forms of materials where regulation as a hazardous material may be inappropriate. For example, OSHA exempted “articles” from regulation as hazardous materials with the adoption of the Hazard Communication Standard.<sup>243</sup> An article is defined by OSHA as follows:

***Article** means a manufactured item: (i) which is formed to a specific shape or design during manufacture; (ii) which has end use functions(s) dependent in whole or in part upon its shape or design during end use; and (iii) which does not release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use.*

Aluminum metal [CAS 7429-90-5] in the form of powder or dust is regulated as a hazardous material, i.e., flammable solid, and Class 1 water reactive material when found in that form. Aluminum, when formed into tubing and designed to be an appliance connector, is not regulated by OSHA as the item is an *article* as defined.

The majority of code officials do not classify batteries such as those containing solid materials bound into a sealed metal case as found in retail sales as hazardous materials even though these batteries may contain materials that may be toxic, corrosive, reactive or other. The reason is that the form of the material is a finished form the function of which is dependent on its design during end use, and which does not release or result in exposure under the normal conditions of use. Similarly, articles found in retail sales occupancies at the sales counter such as butane fueled barbeque lighters or cigarette lighters have not been viewed as hazardous materials for regulatory purposes. When these same materials are found in storage occupancies and amassed into large quantities, most code officials raise concern related to the impact of fire or explosion in the storage area.

In most instances MAQ can be used to address the issues raised when quantity increases and form alone may not be a reasonable way to manage the risk. There has been some movement in the codes to address what might be viewed as *articles* within the context of the OSHA definition, additional consideration needs to be given to such articles. There is a parallel that appears to be obvious between OSHA’s approach to hazard communication and the need for control of hazardous materials in buildings. OSHA has also exempted from labeling certain consumer products or hazardous substances that are defined as such, when

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<sup>243</sup> *Hazard Communication Standard; Final Rule*, Articles are exempted from the requirements under §1910.1200(b) 5 and defined under §1910.1200(c), p. 53340.

subject to a consumer product safety standard or labeling requirement and/or the regulations issued under the Consumer Product Safety Act in regulations. A recent code change debated in one of the model codes involved the classification of bed mattresses constructed of synthetic materials (polyurethane foam) as flammable solids based on the definition for flammable solid.<sup>244</sup> It was not the intent of the code writers to include building furnishings, including the furniture within the scope of hazardous materials regulations.

It appears that exemptions for “articles” and “finished goods” other than chemicals regulated as consumer products should be considered in order to focus the requirements on the materials intended to be within the regulatory framework of hazardous materials control.

**6.0.2 Material State (subject to question).** A question frequently arises as to the state of a material, solid, liquid or gas when the material form appears to be neither.

- For example, the term “semisolid” is used in several NFPA Codes and Standards without definition, i.e., NFPA 704 *Standard System for the Identification of the Hazards of Materials for Emergency Response*, NFPA 820 *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*, and others. The 2006 Edition of NFPA 1 UFC did not incorporate a definition for solid which was simply defined in the 2000 UFC as a material that has a melting point greater than 68°F (20°C). Semisolids aside, by not including a definition the user is without guidance. The common dictionary definition of a solid is something of definite shape and volume; not liquid or gaseous, or something that is the same substance throughout. Semisolids are solids in transition or in some cases they may be solids that are mixed with a liquid. Expanding the code to include a category of semisolid would complicate the code from the user’s perspective. Explanatory information should be provided to guide the user with respect to how these materials should be treated. DOT uses wetting to differentiate between materials that are flammable solids or explosive in some cases. For example, trinitrophenol [CAS 88-89-1] (picric acid)

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<sup>244</sup> *International Code Council, 2007/2008 Code Development Cycle, Volume 1 2008 Final Action Agenda for the Proposed Changes to the 2006 Editions of the International Building Code, International Fire Code, International Wildland-Urban Interface Code*, International Code Council, Country Club Hills, IL, First Printing, July 2008, item F288-07/08, p. 222.

wetted with not less than 30% water is a flammable solid, while it is classified as a mass explosion hazard Division 1.1D when the water content is less than 30%. An analogy may be drawn between physical state (solid or liquid) in a similar fashion. It could be as elementary as establishing a threshold where the liquid component is  $<X\%$  the material would be treated as a solid. Where the liquid component is  $>X\%$  the material would be treated as a liquid.

- Compressed gases generated as a result of the process. Compressed gases are defined and the code regulates them easily when they are confined to a system or package (the cylinder, vessel, tank, container, etc.). A question sometimes arises regarding gases that evolve or which are generated. For example, is the hydrogen gas [CAS 1333-74-0] generated from the charging of a battery or other gases which may evolve as the result of activity within a plating bath the subject of regulation within the context of the threshold MAQ limits? The answer to this question is NO; there are other controls in place to address requirements for ventilation and other controls that are to be applied in these cases.
- Cryogenic gases or fluids vs. compressed gases. A cryogenic fluid is a gas, but it is in the form of a liquid or fluid in the cryogenic or super-cooled or refrigerated state. Cryogenic fluids are in fact gases that are regulated as liquids within the context of the threshold MAQ tables. They are not regulated as liquefied gases per se as there have been separate MAQs established to address the cryogenic form of these materials.
- Waxes and similar materials that do not melt until the temperature exceeds room temperature would be considered to be solids if the NFPA 5000 or the 2000 UFC definition is adopted. Melting point is the criteria used to make the distinction between solids and liquids. Melting point is NOT included as a defined term in NFPA 1 UFC. Greases are substances that may be viewed as semisolid, however, if they are able to flow at room temperatures they are not solids. Melting point can be used to make the distinction between solid and liquid forms of these materials. Guidance is needed in the form of annex notes to advise users how to interpret or use information from MSDS in this regard.

**6.1 Package Dependent Classification (finished goods, DOT packaging or other).** In some cases there is a need to evaluate the hazards of a material “in-process” as compared to the hazards of the materials when contained in original shipping containers. The threshold MAQs reduce the quantities when the materials are found in use-open systems. The reduction in quantity expressed by open-use conditions may not address the true hazards of the material when they have been removed from their containers. There are some materials packaged as “kits”, pharmaceuticals, foodstuffs and cosmetics which may be considered for exemption based on package (size) as well as the intended end use.

- **Organic Peroxides.** The classification of certain materials including organic peroxides, and explosives are said to be package dependent. For example, the organic peroxide *t*-butyl peroxy-2-ethylhexanoate in a concentration of 97% is classified as a Class III organic peroxide when packaged in a 5 gallon container, and as a Class II organic peroxide when packaged in a 55 gallon container.<sup>245</sup> Whether the classification changes at >5 gallons is not known. No guidance is given to code officials, designers or users as to hazards when this material is outside of the container or where the quantity exceeds the 5 gallon limit, but is less than the 55 gallon limit. If the 55 gallon container limit is exceeded does the classification change? This question illustrates the dilemma for classifiers which is in need of resolution when matters of package dependency are involved.
- **Kits.** There are some materials other than “articles” that are commonly found in industrial, mercantile and storage occupancies and others where the classification of the material can be dependent on the components found within the kit. For example, the common resins packaged with catalysts where the resin is found as Part A and the catalyst is found as Part B to the “kit.” A number of chemicals that are used in laboratory operations are found packaged in a similar way as boxed items containing more than one individually packaged ingredient that has been combined into a box for ease of use. It could be that kits containing materials where the individual quantities are less than some threshold level, perhaps in terms of ounces by weight, could be exempted. If not guidance is needed so that users are able to recognize that individual components must be assessed on order that the individual components are classified.

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<sup>245</sup> *NFPA 432, Code for the Storage of Organic Peroxide Formulations*, 2002 Edition, National Fire Protection Association, Quincy, MA, Table B.1, p. 13.

- **Pharmaceuticals.** The threshold MAQ for hazardous materials found in medicines, foodstuffs, and cosmetics have been granted unlimited quantities when located in mercantile, storage and industrial occupancies providing these materials contain no more than 50 percent by volume of water-miscible fluids with the remainder not being flammable, providing the container size is limited to less than one gallon.<sup>246</sup> Whether solids are considered within the context of the exemption is not entirely clear. Footnotes to the MAQ tables make it clear that pharmaceuticals in retail sales may be exempted. Pharmaceuticals in institutional uses are not exempted. This inconsistency leads to circumstances where the code official either ignores their presence or takes the view that institutional pharmacies are equivalent to retail sales uses. It would appear that pharmaceuticals (medicines) and cosmetics packaged for personal use or distribution from containers not exceeding a certain size should be exempt regardless of the occupancy. The control may be a combination of package dependency as well as quantity. Many toxic and/or highly toxic pharmaceuticals are used in physician's offices and hospitals for outpatient treatment as well.
- **Explosive Materials.** The classification of explosive materials is also package dependent. In other words, the classification of the explosive hazard may be different when the material is removed from the original packaging and employed for use, or the material as it is manufactured may be at a different level than the finished product. NFPA 495 *Explosive Materials Code* addresses the issue by providing requirements for the classification of explosive materials utilized in process operations.<sup>247</sup> The classification system now included across the spectrum of hazards, e.g., Division 1.1, 1.2, 1.3, etc. has not yet been coordinated between NFPA 495, 5000 and NFPA 1 UFC, and NFPA 1 UFC and 5000 are out of sync with other model codes.
- **Unstable (reactive) materials.** It should be expected that unstable reactive materials may exhibit similar properties to organic peroxides or explosive materials such that the hazard classification may be different for "in-process" materials compared with the hazards as identified in their original shipping container.

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<sup>246</sup> NFPA 1 *Uniform Fire Code*, 2006 Edition, §60.1.3.3.2.2, p. 236.

<sup>247</sup> NFPA 495, *Explosive Materials Code*, 2006 Edition, National Fire Protection Association, Quincy, MA, §5.3, Electronic Version, 2007 Fall Revision Cycle Edition, April 2008.

**6.2 Combustible Dusts.** Combustible dust has proven to present a major problem in industry. Efforts to regulate dust through the application of a threshold MAQ were rejected by the code community in favor of requiring sprinklers in certain applications, i.e., woodshops. Dust-producing operations are required to have a permit under Table 1.12.20(a). The permit description is limited to grain elevators, flour mills, starch mills, feed mills, or plant pulverizing aluminum [sic], coal, cocoa, magnesium, spices, sugar, or other similar combustible material.<sup>248</sup> The permit description is not correlated with the list of standards referenced in Chapter 40. For example, wood processing and woodworking facilities, coal mines, combustible metals, etc. There are other dusts that have been identified as being of concern, including just about anything that is captured by dust collectors, bag houses or similar entrainment devices. As currently drafted, any quantity of dust regardless of concentration or particle size must be installed and maintained in accordance with the listed standards. Chapter 40 *Dust Explosion Prevention* of the 2006 Edition of NFPA 1 UFC in pertinent part applies to:

*Equipment, processes, and operations that involve the manufacture, processing, blending, repackaging, or handling of combustible particulate solids or combustible dust...*

An annex note would be useful to explain to the code user what is meant by operations or handling within the context of the code. The term *handling* is a defined term meaning *the deliberate movement of material by any means to a point of storage or use.*<sup>249</sup> Whether handling was intended to be included in the list of activities regulated by Chapter 40 is not clear.

The application of the standards referenced in §40.1 are intended to address the intent of the code. For example, woodworking facilities are addressed in NFPA 664 *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities.*<sup>250</sup> Section 1.1.2 of NFPA 664 applies to woodworking operations that either occupy more than 5000 square feet in area, or where dust producing equipment requires an aggregate dust collection flow rate of more than 1500 cubic feet per minute. Under these requirements woodworking operations without dust collection equipment that occupy areas of <5000 square feet are exempt from requirements for the prevention of dust

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<sup>248</sup> NFPA 1 *Uniform Fire Code*, 2006 Edition, Table 1.12.20(a), p. 17.

<sup>249</sup> Ibid, definition 3.3.127, p. 35.

<sup>250</sup> *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, NFPA 654, National Fire Protection Association, Quincy, MA, 2007 Edition,

explosions as are operations that use dust collection with a volumetric flow rate of less than 1500 cfm. Therefore, the MAQ concept has been replaced by an area and/or volume concept of control.

## 7 ENHANCEMENT OF THE HAZARDOUS MATERIALS CLASSIFICATION SYSTEM

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**7.0 General.** The review of definitions and application of the MAQ system of control uncovered a number of anomalies, inconsistencies and gaps that need to be addressed by the special hazards technical committees involved with hazardous materials.

**7.1 Gaps.** The gaps in the regulatory scheme may have been deliberately established, or perhaps they are not gaps in the true sense of the word, rather they are subjects that have been chosen to be regulated by requirements other than those that are tied to the MAQ concept of control. For example, OSHA has identified a number of hazard categories that require chemical manufacturers and importers to provide information to users when MSDS are prepared, and the list of *physical hazards* identified by OSHA correlate with the list of physical hazards identified in the MAQ tables and under the list of physical hazards integral to NFPA 1 UFC. Those materials designated as *health hazards* by OSHA are not correlated with the list of *health hazards* regulated under the provisions of NFPA 1 UFC. The intent not to do so has been deliberate and the following categories are not regulated under the control concepts developed for the control of hazardous materials which include the use of threshold MAQs:

- Carcinogens
- Irritants
- Sensitizers
- Target organ toxins, formerly identified in the UBC as *other health hazards*, including but not limited to reproductive toxins, lung damaging agents, blood damaging agents, and others.
- Radioactive materials

The appropriateness of creating these gaps was a matter of public debate. The decision not to regulate these categories of materials, or some of these categories, may leave a hole in the regulations particularly those that regulate pesticides, herbicides and similar materials. Whether this was fully understood by the groups debating these issues is not clear from the record reviewed. In some cases, there may be regulations to address these materials that accomplish the objective of



meeting public safety. It would seem appropriate that the rationale not to address these categories of materials within the context of the MAQ approach could be provided in the form of Annex information so that code users that identify hazards of the type outside of the scope of regulation would be informed as to how to approach the safe storage and use of materials in these categories.

Combustible dusts and fibers, once under the regulation of the MAQ concepts have been removed from the list of materials integral to the threshold tables. These two categories of material are controlled by specific requirements of Chapters 40 and 45 respectively and protection level controls are not applied to uses where these materials are employed.

**7.2 Anomalies and Inconsistencies.** There were a number of anomalies or inconsistencies that were noted in the review. Most, but not all have been identified in the detail provided in previous sections of the report. They are identified here for ease of reference and include the following:

- In both NFPA 1 UFC and NFPA 5000 (2006 Editions) the table headings for tables 34.1.3.1 and 60.1.3.1 respectively, includes the use of parenthetical terms, e.g., (ft<sup>3</sup>) or (lb). The use of a parenthetical term for gas is inappropriate in all cases as its use is in conflict with Note a in each case. Parentheses are used to indicate when the unit of measure is other than that in the heading. For example, liquids are typically expressed in gallons, however, in some cases, i.e., organic peroxides, oxidizers, unstable reactives and water reactives, the liquid quantity threshold is listed in pounds. In the case of solids, there is a listing for (ft<sup>3</sup>), which had been used for combustible fibers. Combustible fibers are no longer regulated under the MAQ concept and the use of the parenthetical term is inappropriate in all cases. Therefore, the only columns where a dual set of units of measure appear, i.e., gallons/pounds need have the parenthetical terms included.
- **Class IIIB liquids.** Including quantity increased in use-open for Class III-B liquid when used in “storage cabinets” as it appeared in the 2003 Edition of the code has been corrected in the 2006 Edition of NFPA 1 UFC. See discussion in 5.4.1.8.
- **Cryogenic fluids other than flammable or oxidizing.** The most common cryogenic fluids are those that are inert. Materials such as liquid nitrogen [CAS 7727-37-9], argon [CAS 7440-37-1] and helium [CAS 7440-59-7] are widely used. Recent changes have been made to include the category of *inert* gases and *cryogenic fluids* in the 2009 Edition of NFPA 55. Changes will be carried into NFPA 1 UFC and NFPA 5000 by the extract process.

- **Explosive materials.** The use of explosives has been limited to military, mining or other operations which limited the commercial use of these materials. Commercial uses have grown with the production of power drivers, explosive bolts, automotive airbags and laboratory operations. Testing laboratories are engaged in testing these materials for development of detection equipment in support of private as well as national security efforts. Not all explosives are detonable, and not all explosives need be located in buildings or areas with Protection Level 1 controls. This subject has been addressed in the I-Codes, but has not yet been addressed by either NFPA 1 UFC or NFPA 5000. A coordination effort is needed between the technical committee on explosives and other committees that may be affected by the creation of MAQ thresholds for these materials. See discussion in 5.4.5.8.
- **Flammable solids.** The definition for flammable solid includes a statement for materials that may ignite below 212°F. The basis for this requirement could not be established beyond the fact that it was introduced by the UFC Article 80 development committee in the 1986-1988 time frame. Whether the use of 16 CFR, Part 1500.44 is appropriate for the determination of flammable solids in terms of chemicals, or whether the use of the test procedure is more appropriate to be used with consumer products such as furniture, upholstery or similar materials needs to be determined. The test criteria recommended by UN Recommendations on the Transport of Dangerous Goods, and DOT may in fact be more appropriate.<sup>251</sup> It appears that investigation of the test methodologies and results within the context of the general statement made in the definition regarding persistent burning, etc. may be warranted to avoid having items such as mattresses and furnishings classified as hazardous materials. See discussion in 5.4.6.8.
- **Flammable gases.** The definition of flammable gas has been established using the flammability of ammonia [CAS 7664-41-7] as the cutoff point between flammable and non-flammable. Although ammonia is capable of ignition it is not ignited easily. It could be that a group of gases should be defined as being “moderately flammable” to recognize that there are gases that are highly flammable versus those that are not. The existing regulatory scheme may be entirely appropriate, but the existing system of classification appears to focus on gases that are highly flammable by comparison to those where the flammable range is narrow or where the lower flammable limit may be extreme by comparison. The addition of LP gas to the MAQ tables has resulted in a major error

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<sup>251</sup> 49 C.F.R., §173.125(a), October 1, 2007, <http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=200749> visited 11/21/08.

that increases quantities by a tenfold factor. This error may need to be addressed through the use of a TIA by interested parties. See discussion in 5.4.7.8.

- **Flammable liquids.** Including criteria for pressure, i.e., pressures not exceeding 40 psia at 100°F, a in the definition of flammable liquids creates a conflict with the category of compressed gases. Materials defined as flammable liquids that are packaged as compressed gases are more commonly classified as compressed gases. The definition for flammable liquids needs to be defined to eliminate including compressed gases within its scope. See discussion in 5.4.8.8.
- **Organic peroxides.** The current classification system is package dependent, and there is no guidance given to code officials, users or designers regarding the approach to be used when these materials are removed from their packaging. There is a need to develop a methodology that leads to an “in-process” hazard classification in order that an appropriate control strategy is developed. See discussion in Section 5.4.9.8.
- **Oxidizing gases.** The definition of oxidizing gas includes a statement that accelerated burning is the result of burning when oxidizing gases are present. There is no quantitative test provided by which the determination can be made. See discussion in 5.4.11.8.
- **Pyrophoric materials.** Other than the autoignition temperature, there are no criteria to determine whether a material is pyrophoric. Some materials will ignite over time if the quantity is large enough and the time is long enough. It appears that time to ignition may have a bearing on the results. See discussion in 5.4.12.8.
- **Unstable reactive materials.** The use of NFPA 704 as a means to define hazard class has not been kept current within the context of the existing definitions, and errors have been made in 2006 NFPA 5000 with respect to the exotherm temperatures found in annex text. While the methodology prescribed by NFPA 704 may be appropriate for solids and liquids, it may not be appropriate for compressed gases. Investigation of a methodology for the classification of unstable reactive compressed gases is warranted. See discussion in 5.4.13.8.
- **Water reactive materials.** The ranking by hazard class is established in NFPA 704. Classification of water reactivity for liquids appears to be quantitative, but classification of water reactivity for solids is admittedly qualitative. It appears that a quantitative methodology is required for establishing the hazard class for water reactive solids. See discussion in 5.4.14.8.

- **Corrosive materials.** The base definition for corrosives has been changed to address “materials” which appears to be in conflict with the intent to exclude inanimate objects. The definition in the body of the code 2003 and 2006 appears to be in conflict with the annex note. There is not a quantitative method that has been developed to address corrosive compressed gases. The DOT assigns a corrosive classification to the more common corrosive gases, but this determination has been made primarily from information contained on MSDS provided by the suppliers. See discussion in 5.5.1.8.
- **Irritant gas.** Irritant gases are defined, and regulated, albeit not by the MAQ tables. Classification of irritant gases depends on “other approved techniques.” A quantitative methodology should be developed to determine what constitutes an irritant gas.

**7.3 General Recommendations.** The system of classification for hazardous materials used in the model codes including those published by the ICC and NFPA has been established in part by precedent developed through the publication of the *Fire Prevention Code* developed by the National Board of Fire Underwriters (AIA). The origin of a number of definitions has been traced to the AIA codes, while others have been traced to those established by OSHA and augmented by information from DOT or OSHA. DOT definitions as an informational base alone were deemed to be inappropriate as the categories of hazard described by DOT do not correlate with the hazard categories used in the model codes. If DOT definitions were used the array of hazard categories would be expanded beyond those that are currently regulated. NFPA has developed a system of ranking the degree of hazard within a number of the hazard categories that establishes hazard class as a system of control. The model codes have accepted the hazard ranking system as a means to recognize that all materials within a given hazard class, e.g., oxidizers, unstable reactives, etc. do not all present the same level of hazard. The utilization of the hazard ranking system provides flexibility for the user, but it adds to the complexity of the system from the user’s perspective as well as that of the regulatory authority. Without the use of such a system materials with a high material hazard, e.g., Class 4 oxidizers, would have an impact on materials in the same hazard category with a lower overall hazard, and reduced risk, e.g., Class 1 Oxidizers.

Quantitative methods are required in order to properly classify materials within the hazard ranking system used by NFPA as embodied in NFPA 704. There are apparent shortcomings in the NFPA 704 classification system in a number of areas. Section 7.2 above lists a number of anomalies and inconsistencies that may be resolved with future research including a quantitative method for the classification of oxidizers (solid and liquid) and oxidizing gases. Apparent shortcomings in the

categorization of other hazards include the need to develop a quantitative method to assign an in-process hazard classification to unstable reactive materials, and organic peroxides. A test method and procedure for the in-process hazard classification of explosive materials has been developed. It may be beneficial to refer to this system of classification when in-process hazard classification for other hazard categories is considered.

### **7.3.1 Specific Recommendations.**

- a) Resolve the apparent errors in the headings for MAQ tables in NFPA 5000 and NFPA 1 UFC by removing the use of parenthetical units of measure as appropriate.
- b) Coordinate the MAQ concept for explosive materials for Division 1.1 through Division 1.6 between NFPA 495 and NFPA 1 UFC and NFPA 5000 as appropriate.
- c) Investigate the use of 16 CFR 1500.44 as the basis for the classification testing for flammable solids. Consider and evaluate the use of UN/DOT criteria in lieu of CPSC criteria accordingly.
- d) Review the definition of flammable solids to determine the validity of the use of a 212°F ignition temperature.
- e) Develop a generic definition for the term *solid* to be carried into NFPA 1.
- f) Develop a generic definition for storage (hazardous materials) for inclusion in NFPA 1.
- g) Develop a generic definition for use (hazardous materials) for inclusion in NFPA 1.
- h) Consider the introduction of a category for highly flammable gases as compared to gases that may be considered to be moderately flammable and provide explanatory information accordingly.
- i) Revise the definitions for flammable liquids to exclude compressed gases that have inadvertently been included within the context of the definition due to the use of pressure and boiling point temperatures.
- j) Develop an in-process hazard classification system to address organic peroxides when they have been removed from their packaging or are in the process of being formulated.

- k) Develop an in-process hazard classification system to address unstable reactive materials when they have been removed from their packaging or are in the process of being formulated.
- l) Develop a quantitative methodology to assess and classify oxidizing, corrosive and irritant gases.
- m) Review the classification of pyrophoric materials to determine whether autoignition temperature alone is sufficient as a means to classify these materials or whether time and/or quantity should be a factor. Spontaneous combustion is a primary concern.
- n) Develop a quantitative methodology for the classification of water reactive solid materials.
- o) Revise the definition of corrosive materials as found in 2006 UFC to exclude the use of inanimate objects through the inadvertent use of the term “materials” in lieu of living tissue in the definition.
- p) Work cooperatively with the ICC in the harmonization of definitions to be used for the spectrum of hazardous materials being regulated. Harmonization of the model codes both with respect to definition and the use of MAQ is of benefit to all code enforcement officials, designers and building owners.