Asbestos: Substitute Failures and General Hysteria

By: Richard A. Rice, PE
Mutual Engineering, Inc.
2045 Mt. Zion Road
Suite 162
Morrow, GA 30260

Abstract

Because of the United States (US) Environmental Protection Agency (EPA) attempted bans on using asbestos in certain products sold in the US, the marketplace had responded with asbestos substitutes to help those products perform as if they contained asbestos. One of those products is asphalt roofing shingles (ARS) used primarily on single family residential structures. The use of asbestos in ARS was common until the 1970's. Since that time, the manufactures of ARS have attempted asbestos substitutes to gain the strength and durability of past ARS products.

This paper will be divided into two sections. The first section will be the history of asbestos from antiquity until today. Major elements of discussion in the history of asbestos will be:

- *A Snapshot of Asbestos Use*
- *Selected Asbestos Substitutes*
- *Confusion Regarding Types of Asbestos*
- *EPA Banning of Asbestos*
- *Legal/Regulatory Environment of Asbestos*
- *Point-Counterpoint on White Asbestos*

The second section of this paper will be a discussion of asbestos as it relates to ARS. Major elements of discussion regarding ARS will be:

- *A Snapshot of Asphalt Roofing Shingles*

- *EPA's Position of Substitutes for Asbestos in ARS*
- *Recent Testing of ARS without Asbestos*
- *Reintroduction of Asbestos into ARS: An Economic Forecast*

Key Words: asbestos, substitutes, white asbestos, blue asbestos, brown asbestos, EPA, OSHA, building codes

I. History of Asbestos

A Snapshot of Asbestos Use-

Humans have been using asbestos in various ways for over 4500 years.[1] Archeological finds have shown that inhabitants of the Lake Juojarvi region in Finland used asbestos to strengthen the clays used for their pots and cooking utensils. It has been written that an asbestos table cloth was a favorite of Hannibal because he could throw the soiled table cloth into a fire to clean it. It was not until the Industrial Revolution in the late 18th century that the use of asbestos began to flourish as an additive to many products. Because of its unique combination of being chemically inert, fire resistant, and having the ability to bind itself into the mixture it is being added into, asbestos exponential growth continued in the US into the mid 20th century. In 1920, the apparent consumption of asbestos products in the US was 151,766 metric tons. At its height in 1970, the apparent consumption of asbestos products in the US was 668,129 metric tons. While asbestos is banned in the US and other countries for use as pipe insulation, spray-on fire protection, and insulation for hot water tanks, it is currently used in the US as roofing felt, automatic transmission components and gaskets just to name a few examples. The most recent figures (2003) show that the US Apparent Consumption of asbestos products is 4,634 metric tons[15]. Because the regulatory and legal environment in the US has made the use of asbestos in products practically impractical at any allowable level, asbestos substitutes have been presented by manufacturers in many industries.[1]

Selected Asbestos Substitutes-[9]

The New York Times published an article in 1982 entitled, "Technology; Has Asbestos a Substitute?" From this article, we have:

"So far, despite more than a decade of broad, well-financed research for asbestos substitutes, the answer seems to be no."

In spite of the difficulties with finding a comparable asbestos substitute, the Environmental Protection Agency (EPA) attempted to completely ban asbestos in 1989 with the Asbestos Ban and Phase-Out Rule. However, in 1991 much of this rule was vacated by the US Court of Appeals. The EPA then attempted to have the automobile industry voluntarily use braking systems without asbestos. The asbestos industry threatened an anti-trust action which ended the EPA actions. From this time forward, the EPA and the Occupational Safety and Health Administration (OSHA) has been concentrating on limiting asbestos exposure by reducing the Permissible Exposure Limit (PEL).[6]

According to the EPA[11], there have been many substitutes for asbestos fillers and reinforcement. The problem is that it takes two or three of these substitutes to achieve the material characteristics that asbestos provides. This implies that these substitutes possess only a few of the desired characteristics of asbestos. The ideal substitute or substitutes would serve the same function as asbestos.[13]

Man-Made Vitreous Fibers (MMVF) (i.e. glass or mineral fibers) were developed because of the adverse health effects associated with asbestos.[8] Asbestos fibers, because of their crystalline structure, breaks longitudinally and does not lose its length. MMVF's break into shorter pieces when loaded making them materially inadequate for the purpose intended, and making their pieces more susceptible to inhalation. Binders, lubricants, and changing the size of the MMVF's are used to replicate the asbestos characteristics, but have proven to significantly increase the cost. Research into the dangers of using MMVF's has shown that:[8]

"…there is sufficient animal evidence to consider that glass wool, glass microfibers, mineral wools (rock and slag) and refractory ceramic fibers may be carcinogenic."

Confusion Regarding Types of Asbestos-

Another imposition regarding asbestos is the belief that asbestos was a danger in any form and with any type of contact.[3] Asbestos, like many other minerals, is a common substance in nature. Asbestos is such a common substance that it is estimated that each human normally breaths in 14,000 microscopic asbestos fibers each day. It is estimated that that the lungs of any human over fifty years of age contains over 200 million asbestos fibers. How can "asbestos" be found in any person given that it is widely believed that asbestos is an absolute killer? The answer is based on the type of asbestos a person is exposed to, and the duration and amounts of asbestos involved.[3]

One form of asbestos that is known to be the cause of Mesothelioma is known as Amphibole Asbestos. Mesothelioma is a tumor of the lining in the lungs, heart and stomach[3]. The most common forms of Amphibole asbestos are brown and blue asbestos. These types of asbestos can easily penetrate lung tissue and cannot be dissolved or taken away by the human body's natural defenses. It is estimated that these types of asbestos have a "half-life" of 150 years inside the human body. It should be noted that for the past 100 years, Amphibole Asbestos has been the least used asbestos in the world.[3]

Another form of asbestos that comprises approximately over 90% of the asbestos used in the world today is known as chrysotile or "white" asbestos. White asbestos is easily dissolved by the acids in the human body. White asbestos is estimated to have a half-life of only two days inside the human body.[3]

In 1871, a company named Turner Brothers in Lancashire, UK started using, for the vast majority of its products, the recently discovered White Asbestos found in Canada. In addition, they

started using, to a lesser degree, crocidolite asbestos, a form of Amphibole Asbestos. The company eventually became known as Turner and Newall and was at one time the world's largest producer of asbestos products. As the leader in the asbestos industry, and because of dust problems that were identified in the Turner and Newall factories, dust collection methods were employed.[3]

In 1955, Turner and Newall commissioned a study to evaluate the health of their employees. The study was performed by Dr. Richard Doll. Dr. Doll's study was not favorable to Turner and Newall. Dr. Doll examined 113 Turner and Newall employees. Each employee was assumed to have been exposed to **only** chrysotile (white) asbestos fibers. Dr. Doll found that the incidence of cancer in this study group was 20 times higher than a non-exposed group. Based on his findings at the time, Dr. Doll concluded a direct link to white asbestos and lung cancer.[3]

Approximately twenty five years later, and after other epidemiologist's studies, the findings of Dr. Doll were called into question; specifically, the direct link between white asbestos and lung cancer. Using the advances in electron microscopy at the time, Dr. Doll examined the tissue samples of 103 former Turner and Nevall employees that died between 1964 and 1975. It was crocidolite asbestos, not white asbestos that was found in these tissue samples at 300 times the UK's average level. Dr. Doll's 1955 study assumed that only white asbestos was used in the Turner and Newall factory. Dr. Doll's further research revealed that Turner and Newall used crocidolite between 1931 and 1970 to assist the weaving process. Based on the new evidence, Dr. Doll stated that, "…the disease could no longer be attributed with any certainty to chrysotile (white) asbestos." These findings caused Dr. Doll and others to begin further studies. Dr. Doll studied an additional 3,639 Turner and Nevall employees. In a published paper for the UK Health and Safety Commission, it was stated that workers exposed to Amphiboles asbestos were more at risk than

anyone else in the populations. In addition, it was stated that exposure to white asbestos would cause an additional one death per year. A risk that was described by Dr. Doll and "negligible."[3]

EPA's Attempted Banning of Asbestos-[2]

Before the EPA can regulate or outright ban a product, it must be determined that the product causes an "unreasonable risk." A benefit-cost analysis (B-CA) is part of that determination. As part of the B-CA, the benefit of removing/mitigating the risk must be compared to the cost of removing/mitigating the risk. Christine M. Augustyniak's wrote a paper outlining the EPA's methods to remove asbestos from the marketplace. Her paper was excellent at describing the assumptions and methods used by the EPA in their B-CA to justify their total ban of asbestos. Of particular interest were her criticisms of the EPA that caused the legal reversal of many of the EPA edicts in 1991. She states:

> *"Failure to allow the public to comment on the solution that was developed later allowed the overturn of the rule on procedural rather than substantive grounds. How could such an extreme oversight occur?"*

Augustyniak's conclusion was not flattering:

> *"Part of the problem may have been a* ***lack of experience*** (emphasis added) *of the part of the agency with a regulatory framework in which economic analysis is used to justify a regulation. The far more common experience, which arises from the form of most environmental legislation, is that economic information is developed after the parameters of the proposed regulation are set, and serves merely to indicate the economic consequences of a regulation. The impact of this lack of experience meant that no one anticipated the*

> *controversy that would arise, for example, from incorporating assumptions about occupational and non-occupational exposures that would serve as surrogates in cases where no direct measurements were available. In hindsight maybe the rule should have been proposed to allow public examination of the methods introduced into the analysis after the original proposal."*

Legal/Regulatory Environment of Asbestos-

That the unfettered, unprotected inhalation of copious amounts of certain types of asbestos fibers causes various types of upper respiratory problems (cancer, etc…) has been suspected for 1000's of years, and scientifically/medically known for over 100 years[3]. In 1900, asbestos was recognized as a cause of asbestosis in patients in the Charles Cross Hospital in London, England.[7] Even though asbestos was legal and was specifically cited and required in building codes, and federal/state regulations for many construction assemblies, asbestos litigation has flourished. It would seem that builders, manufacturers, and property owners are being penalized for using a product that was, and continues to be, legal. Rachel Maines' 2012 publication regarding excessive asbestos litigation says it best:[7]

> *In effect, the tort law system that supported asbestos litigation since 1973 drove much older and well-established building law, and the engineering standards incorporated into it, into a legal shadow from which it has yet to emerge, penalizing the makers and owners of products manufactured in compliance with construction regulations as negligent and characterizing all products that contained asbestos as "defective" and "unreasonably dangerous." Historians will recognize this as an*

economically consequential case of the fallacy of presentism: the imposition of modern values on the past.

Examples of specifications where asbestos was referred to by OSHA can be found in Figures 1A and 1B.[7] While the OSHA regulations in Figure 1A and 1B are from 1987, it should be noted that asbestos was allowed as recently as 1992 in the Council of American Building Officials (CABO) One and Two Family Dwelling Residential Building Code, and the Standard Building Code – 1997 Edition. Subsequent commercial and residential building codes no longer refer to asbestos, but refer to the use of organic fibers in asphalt shingles.

Of the thousands of asbestos legal cases examined by Maines[7], only two were discovered where the defense used building code issues to prevail at trial. In both cases, the defense prevailed. In Horne v. Owens-Corning Fiberglass, the US Fourth Circuit on August 25, 1993, the court asserted:

"…as a compliment to state-of-the-art evidence, industry standards may be introduced…They are often set forth in some type of code, such as a building code or electrical code…OSHA regulations are close cousins."

In Clarksville-Montgomery County School System v. United States Gypsum, the deposed architects for a school project testified that, *"The use of asbestos and asbestos-containing products was required by state and local codes."* In affirming the defense verdict, the Sixth Circuit stated:

"Compliance by a manufacturer or seller with any federal or state statute or administrative regulation existing a the time a product was manufactured and prescribing standards for design, inspection, testing, manufacture, labeling, warning or instructions for use of a product, shall raise a rebuttable presumption that the product is not in an unreasonably dangerous condition in regard to matters covered by those standards."

While these defenses were not used in any other trials, Maines found that these defenses were used to reduce the settlement values for defendants.[7]

Even with the apparent defenses that could be used for cases where the use of asbestos was justified, the legal environment is very strong for plaintiff attorneys wanting to sue asbestos manufacturers and property owners where asbestos was required by law. Plaintiff attorneys all over the United States are advertising their services to any sick individual who was possibly exposed to asbestos, regardless of type or duration. Television and radio advertisements tout the "18 Billion Dollar Asbestos Trusts" that have been created by asbestos manufacturers to pay current and future asbestos claims.

Point-Counterpoint on White Asbestos-[10]

The research into the debate between those who support the use of white asbestos and those that do not is, to put it mildly, contentious. To illustrate, please read the following web posts from 2013. For proper context, the post is presented in its entirety with all misspellings and bad grammar:

Pradeep Moudgil, a Chemical/Environmental Engineer of the Central Pollution Control Board in Delhi, India posts the question/inquiry:

> *"Is white asbestos (crystal) not so harmful to human health? Is there any impact of white asbestos on plants/trees? An industry manufacturing white Asbestos cement sheet is claiming that white asbestos has no any adverse impact on human health. They said it was just a global false economic problem. They also stated they had more than 25 yr experience in this field of manufacturing and facing no any such problem. So please tell me if someone*

has any experience with white asbestos with documents/links. Also tell me the procedure of fiber count?"

The following responses reflect the diametric views with regards to white asbestos:

Dr. Tee Guidotti, MD, and occupational exposure expert replied with the following:

"White asbestos (chrysotile) is very dangerous to health and causes cancer. Compared to other forms of asbestos, which persist unchanged, chrysotile fibers dissolve slowly in the lung, but that takes time. This is the reason that people claim that it is less dangerous. However, what they say is misleading, because being less dangerous does not mean that chrysotile is not dangerous. The health effects, such as cancer and severe lung disease, take time to develop and often occur after workers have left the company. The scientific literature is clear. Chrysotile asbestos causes cancer and the same lung diseases as other forms of asbestos and should not be used. Period. The sampling process is the same as for other forms of asbestos."

In response, Dr. Boris Katsnelson, toxicologist and public health employed by the Medical Research Center for Prophylaxis and Health Protection in Industrial Workers in Russia rebutted Dr. Guidotti with the following:

"Dear Tee: (you wrote) "Chrysotile asbestos (1) causes cancer and the same lung diseases as other forms of asbestos and (2)should not be used. Period." The first statement is based on facts while the second one reflects but a debatable opinion. So before putting the period (full stop) may I discuss these two statements separately.

Indeed, in this problem there is so much political and economical interests mixed with scientific and quasi -scientific argumentation that it is rather difficult to distinguish between facts, prejudices and opinions (either honest or prepaid ones).

First, the chrysotile is both fibrogenic and tumorigenic (inducing not only cancers but also mesotheliomas) - it is a fact established above any reasonable doubt by a number of animal experimental and human epidemiological studies. If any scientists try to negate this FACT - shame on them! It is a pity that some of such liars are my compatriots.

Second, the matter of chrysotile and amphybole asbestoses comparative cancer risk assessment is less clear. Some facts tell that chrysotile is somewhat less dangerous, others do not confirm it. Anyway, difference is not great enough to justify advertising "white asbestos" as something angelically white and clean.

Third, international experience shows that well controlled mining, milling and usage of chrysotile (for instance, in manufacturing asbestos-cement sheets and tubes) can hold fiber concentrations in the workers breathing zone air and in ambient air at very low levels. However up to now nobody proved conclusively either safety or hazard of these low levels.

Fourth, many experimental studies (mine included) demonstrated that many types of manmade mineral fibers (widely advertised as a safe alternative) were capable to induce pleural mesotheliomas.

I believe that the above 4 statements summarize all that is really factual. The following is only an opinion of mine.

There are so many well proven human carcinogens produced and/or used by industry and polluting both workrooms and environment that it is difficult to understand why just asbestos caused such "banning itching" instead of honestly trying to promote a safe husbandry. Let us cry: ban chromium! ban nickel! ban arsenic (and seal all wells in many immense areas of the globe)! ban tobacco (instead of advising people about dangers of smoking)! ban smoked fish and meat (because these foods are enriched with

benzo(a)pyrene! Have I to continue?

So, dear Pradeep, if somebody maintains that it is " just a global false economic problem" I would not be so sure that this somebody is very far from the truth."

II. Asphalt Roofing Shingles and Asbestos

A Snapshot of Asphalt Roofing Shingles (ARS)-[16]

ARS were an American invention first used in 1901. The first asphalt shingles used organic cotton rags dipped in bitumen, then rolled into sheets/shingles. Eventually, aggregate granules were added to the surface. Asbestos fibers were added to the mix to provide fire protection, tear resistance, and product durability. In the years before the major ban on asbestos by the EPA, the typical life expectancy of asphalt cement shingle roof with asbestos was given as 30 years. However, it was not uncommon to find cement and asphalt shingles with asbestos that were 50 years old in good condition.[5] Because of the relatively low cost to initially purchase and install ARS, it will continue to be the dominate roofing material selected for residential and commercial construction. Four of every five residential structures have ARS.

EPA's Position of Substitutes for Asbestos in ARS -

Prior to the major ban on asbestos, the EPA published a report in 1982 entitled, *"Asbestos Substitute Performance and Analysis.*[8] Section 5 labeled "Asbestos-Cement Sheet" deals with flat products such as asphalt roofing shingles. Within Section 5, the EPA states:

"The most promising substitute fibers for use in place of asbestos in cement sheet are the specially treated wood fibers used in the cement/wood board…, and the alkali-resistant glass used in the glass-fiber reinforced cement (GRC)."

With regards to the treated wood fibers, the EPA apparently used rumor and hearsay to support its position. The EPA states in this report that Cement/Wood Board has a greater modulus of rupture and a greater resistance to impact compared to Asbestos-Cement (A/C) board. However, no test results are given. Examples of rumor and hearsay are:

"…is said by some to be virtually impervious to the influences of any weather condition. (Page 156).[11]

"Its weather characteristics are reported to be similar to those of marine plywood." (Page 156).[11]

Recent Testing of ARS without Asbestos-[4]

Subsequent to the hopeful findings of the EPA, actual tests were performed on ARS by Condren and Gumpertz[2] on a variety of asbestos substitute roofing materials. Five producers of wood (cellulose) fiber cement shingles were investigated for strength, water absorption, and extended environmental exposure using the applicable American Standard for Testing and Materials (ASTM) standards at the time. The Summary section of the Condren and Gumpertz report states the following:

- ***ALL*** (emphasis added) *of the materials we have encountered are inherently defective. Most do not even conform to the requirements of the applicable ASTM standard after a few years of service.*
- *The ASTM standard does not necessarily set values to assure that the fiber-cement slates are fit for use as roofing.*
- *The strength requirements set by ASTM C1225 may not be sufficient to support the weight of a mechanic installing the product.*

- *The ASTM standard C1225 does not establish flexibility requirements that would ensure the product will survive expected service conditions.*

It would seem that no manufacturer at the time of the Condren and Gumpertz report had provided a suitable asbestos substitute for asphalt shingle roofing. It is the experience of the author that the current asphalt shingle products in the current market are just as inadequate. After hundreds of inspections of standard three-tab wood/cellulose fiber and fiberglass asphalt shingles since 1993, few, came close to achieving the 20 year warranty provided by the manufactures. Thicker, higher quality architectural asphalt shingles are used on many more expensive homes. These type shingles are given a 30 year warrantee. However, many fall short of the warranty period.

Reintroduction of Asbestos into ARS: An Economic Forecast-

The past several years has seen an increase in the number of roof damage hail insurance claims. There are hundreds of thousands of hailstorms annually in the United States with a 2009 estimated roof repair cost of 1.6 billion dollars[17]. From the top ten states for hail insurance losses in the years 2000-2013, the average cost to repair a hail damaged roof was $7510. The average total amount paid out by insurance companies for hail losses from the top ten states in the years 2000-2013 was $249,305,000/year (ten states). This is an average of 33,200 insurance claims per year for those ten states combined.[18]

It was stated earlier that pre-EPA asbestos cement and asphalt shingles where known to maintain their durability and to have service lives of 30 to 50 years. The durability and service lives of these shingles have been greatly reduced due to the removal of asbestos. It can be reasonably assumed from an engineering cost standpoint that the reintroduction of asbestos, specifically white

asbestos, into the shingle composition will improve the durability of the shingle. If it is assumed that there would be a 25% reduction in the number of paid insurance claims by the introduction of white asbestos, the average number of insurance claims for the top ten states for hail insurance losses would be reduced from 33,200 to 24,900 claims. Because of fairly fixed material and labor costs, the average cost per claim would not change ($7510). With the reduced number of claims (24,900) times the average cost to repair a hail damaged roof ($7510), the new average total amount paid to those ten states is now $186,999,000. This is a reduction of insurance payouts of $62,306,000 for those top ten states. A reasonable accounting for all fifty states with hail claims, the reduction of insurance payouts could easily exceed one billion dollars.

Conclusions and Observations

The author of this paper has been retained as a forensic engineer who has been qualified as an expert witness on various civil/structural engineer matters. As an expert witness, my work requires me to research and review the evidence available and provide conclusions based on that evidence. As such, my research into the history of asbestos, the current use of asbestos substitutes, and the legal status of asbestos reveals the following conclusions:

- Many industries are still struggling to provide asbestos substitutes that provide the same economic benefits and engineering properties as asbestos. Many of the asbestos substitutes were rushed to market in response to the EPA regulations. As a result, these asbestos substitutes have not been properly tested. As a result, asbestos products that had stood the test of time are being replaced with asbestos substitutes that quickly fail when exposed to environment and working loads. Tests on the asbestos substitutes are showing that they are just as carcinogenic as natural asbestos.

- While it could be reasonably argued that manufacturers who knew of problems with asbestos exposure and did not address the "dust" problem in a timely manner, current owners and constructors of buildings and machines where asbestos was used are being unfairly penalized. The evidence that asbestos products were required by code and regulation is generally being ignored.
- In all the government (i.e. EPA and OSHA) documents reviewed, no distinction was made between white asbestos and the other, demonstrably more dangerous types of asbestos. That there was not a distinction is a glaring omission given the data that in the early 1980's it was shown the white asbestos was much less dangerous than the other types of asbestos. The EPA's proposed ban on asbestos was in 1989. Yet, there was no mention of the earlier data. Does this indicate a bias?
- A cursory search revealed that there are many, on both sides of the white asbestos issue, who are financially and professionally anchored to the opinions they have espoused. It appears that the most fanatical "camp" of this issue belongs to those who believe that white asbestos, like all asbestos, should be totally banned; even in the face of solid evidence that would make a ban unnecessary. So, as Dr. Katsnelson opined, why is there such "banning itching?"
- It would be extremely naive to believe the all the engineering logic and reason espoused in this paper would convince others that the reintroduction of asbestos, especially white asbestos, would be welcomed by industry or the public in general. The current political and legal environment regarding asbestos has fostered an ignorance and oversimplification that has removed such a beneficial and naturally occurring material from common use. Perhaps, when calmer and more reasonable

heads prevail, a serious look into the reintroduction of white asbestos will be considered.

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Table 1 Specifications for asbestos incorporated by reference into OSHA rules and regulations

Standard	SDO	Title	OSHA 1971 29 CFR 1910 Section(s)	OSHA 1987 29 CFR 1910 Section(s)	Specification(s) for asbestos
	AAI-RMA	Specifications for Anhydrous Ammonia Hose	111	111	Fiber reinforcement of hose
	ACGIH	Industrial Ventilation 9th edition 1966	94		Heat shielding, air filters
ANSI Z21.30-1964	ANSI	Standard for the Installation of Gas Appliances and Gas Piping	264	265	Thermal insulation, heat shielding
ASA B31.1-1955	ANSI/ ASME	Code for Pressure Piping	106	21	Gaskets
USAS B31.1-1967	ANSI/ USAS	Standard Code for Pressure Piping	103, 104, 106, 218, 252, 261, 264	103, 104, 105, 252	Gaskets
ASME Boiler Code 1970	ASME	Boiler and Pressure Vessel Code Section VIII	103, 104, 106, 107, 110, 111, 168, 169, 261, 262	102, 103, 104, 106, 107, 110, 111, 169, 217, 261, 262, 263	Gaskets and seals
API/ASME Code 1951	API/ ASME	Unfired Pressure Vessels for Petroleum Liquids and Gases	110, 168	110	Gaskets and seals
ANSI B31.1-1967	USAS/ ASME	Fuel Gas Piping	106	261 (1968)	Gaskets
NFPA 11-1970	NFPA	Standard for Foam Extinguishing Systems	108	Appendix C	Porous asbestos tubes
NFPA 13-1961	NFPA	Standard for the Installation of Sprinkler Systems	107, 109, 159, 165a, 177	Appendix C	Underground pipe coating
NFPA 16-1968	NFPA	Standard for the Installation of Foam-Water Sprinkler Systems	N/A	160, 163	Asbestos–cement pipe lining
NFPA 20-1970	NFPA	Standard for the Installation of Centrifugal Fire Pumps	156	Appendices B and C	Asbestos–cement pipe
NFPA 22-1970	NFPA	Standard for Water Tanks for Private Fire Protection	156, 158	Appendices B and C	Joint packing, gaskets, roof covering
NFPA 24-1970	NFPA	Standard for Outside Protection	156, 177	Appendix B	Asbestos–cement pipe

Figure 1A

Table 1 (*Continued*)

Standard	SDO	Title	OSHA 1971 29 CFR 1910 Section(s)	OSHA 1987 29 CFR 1910 Section(s)	Specification(s) for asbestos
NFPA 31-1968	NFPA	Standard for Installation of Oil-Burning Equipment	263	N/A	Thermal insulation, heat shielding
NFPA 33-1969	NFPA	Spray Finishing Using Flammable and Combustible Materials	94, 115	94, 99, 115	Heat shielding
NFPA 51b-1962	NFPA	Cutting and Welding Processes	253	253	Heat shielding
NFPA/NBFU 54-1969	NFPA/ NBFU	Installation of Gas Appliances and Gas Piping	110	265	Thermal insulation, heat shielding, asbestos–cement vents
NFPA 70-1968	NFPA/ ANSI	National Electrical Code (ANSI C-1-1968)	68, 94, 143, 177, 178, 309, 314, 320, 322, 330	N/A	Electrical insulation, asbestos–cement conduit
NFPA 70-1971	NFPA	National Electrical Code	N/A	66, 68, 94, 103, 110, 178	Electrical insulation, asbestos–cement conduit
NFPA 86A-1969	NFPA	Standard for Ovens and Furnaces: Design, Location and Equipment	108	108	Asbestos rope duct seals
NFPA 91-1961	NFPA/ ANSI	Blower and Exhaust Systems (ANSI Z33.1)	94, 107	94, 261, 265	Duct insulation, rope seals, asbestos–cement duct
NFPA 91-1969	NFPA	Standard for the Installation of Blower and Exhaust Systems	108	108	Duct insulation, rope seals, asbestos–cement duct
NFPA 96-1970	NFPA	Ventilation of Cooking Equipment	110	110	Thermal insulation
NFPA 203M-1970	NFPA	Manual of Roof Coverings	109	109	Roof coverings
NFPA 220-1969 (1961)	NFPA	Standard Types of Building Construction	103	103	Incombustible construction materials
NFPA 251-1969	NFPA	Fire Tests of Building Construction Materials	106	106	Asbestos–cement board and millboard, pads
CGA P-1	CGA	Safe Handling of Compressed Gases	101	102	Asbestos gloves

Figure 1B