



HISTORIC EXPOSURES FROM ASBESTOS-CONTAINING DRYWALL JOINT COMPOUND

JEROME E. SPEAR, CSP, CIH, FAIHA

The drywall industry began during World War II when construction projects evolved from building plaster-based walls to building walls using drywall. Before World War II, houses and commercial buildings had walls made of plaster. Building plaster walls required a long multi-step process to complete. The process began by installing a wall and covering it with many small pieces of wood called lathing. Several coats of plaster would then be applied to the wall, but each coat needed to thoroughly dry before the next could be applied. This resulted in a long construction cycle which was problematic, especially during a wartime situation where many military buildings needed to be constructed quickly. Drywall – also known as Sheetrock®, wallboard, and gypsum board – was the solution to this dilemma. After World War II, builders continued to favor drywall because it allowed them to get the job done quicker and it was less expensive.

Sheetrock® was invented around 1916 by the US Gypsum Company and consists of gypsum sandwiched between sheets of durable paper, which eliminated the need for plaster, thus, was referred to as “drywall.” The sheets are typically less than

one-inch thick and come in standard 4' x 8' sizes, although other sizes are available.

The drywall installation process consists of two parts – 1) installing the drywall and 2) taping. In the construction of a commercial building, wallboards are fixed to metal studs with screws, while in residential houses, the gypsum wallboards are nailed onto wooden studs. The resulting joints are subsequently covered with a loose woven fabric tape. The tape, in turn, is covered by troweled-on joint compound, sometimes called spackling compound or mud. Joint compound is also used to cover other flaws such as nail dents and other holes and to feather the joints between wall edges. This process is called “taping and floating.” A major portion (65-70%) of the working day is spent applying drywall joint compound (Verma & Middleton, 1980).

The taping and floating process leaves the drywall surface uneven. Hand or pole sanding is required to smooth out the surfaces and joints so that the wall system looks like one continuous surface. Often after the first sanding, the application of more joint compound is necessary to

obtain the desired surface. Sanding is required after each application of mud. Three to four coats of mud are usually applied. Approximately 20-50% of the drywall surface area is sanded. Verma and Middleton (1980) estimated that 25-30% of the total time installing drywall involves sanding (Verma & Middleton, 1980). Whereas Fischbein et al. (1979) estimated that drywall workers spend approximately 5-10% of their time sanding dried spackling (Fischbein, Rohl, Langer, & Selikoff, 1979). According to Verma and Middleton (1980) most of the sanding is performed by pole sanding.

Plaster of Paris is supposedly the major constituent in spackling and drywall taping compounds, but other light-colored materials including clays, micas, quartz, talc, and ground limestone, supplement or replace the plaster in many formulations. Analyses of samples of spackling, patching, and jointing compounds have shown that some compounds contain asbestos minerals (Fischbein, Rohl, Langer, & Selikoff, 1979) (Rohl, Langer, Selikoff, & Nicholson, 1975). Chrysotile is added to some products, apparently because these fibers act as reinforcing agents. The presence of amphibole asbestos in some products results from its natural occurrence in talc,

carbonates, and other rocks used as raw materials (Rohl, Langer, Selikoff, & Nicholson, 1975). Asbestos may also be found in some drywall; thus, the EPA lists drywall as a suspect asbestos-containing material (U.S. EPA, 1990).

Dry joint compound powder is normally contained in paper bags. The bag is opened by a knife and the powder dumped into a container. Water is then added according to the manufacturer's directions and the compound is mixed by means of a portable electric drill equipped with a mud and paint mixer. Fischbein et al. (1979) reported that mixing about a half 25-pound bag of drywall taping compound in a bucket containing about two gallons of water took approximately 60 to 90 seconds. Until pre-mix material came into use in approximately 1975, mixing drywall joint compound was done several times a day (Fischbein, Rohl, Langer, & Selikoff, 1979). Verma and Middleton (1980) reported that it usually takes five to 10 minutes to mix a batch of joint compound and in most instances one to three batches are required daily. Joint compound sold as a pre-mix paste only required a small amount of water to prepare the mixture in a putty-like form after wetting (Verma & Middleton, 1980).

Fischbein et al. (1979) reported that during pole sanding, the fiber concentrations (by PCM analysis) ranged from 1.2 to 19.3 f/cc with a mean fiber concentration of 10 f/cc [n=10]. During hand sanding, the fiber concentrations ranged from 1.3 to 16.9 f/cc with a mean fiber concentration of 5.3 f/cc [n=11]. Two samples collected during dry mixing of drywall taping compounds resulted in fiber concentrations of 35.4 and 59.0 f/cc. Samples collected 15 and 35 minutes after sweeping resulted in fiber concentrations of 41.4 and 26.4 f/cc, respectively. TEM analyses of these air samples showed a large number of smaller fibers too fine to be seen by PCM analysis (Fischbein, Rohl, Langer, & Selikoff, 1979).

Lauderdale (1972) from the Texas Department of Health conducted an industrial hygiene survey of a

Georgia-Pacific (GP) joint compound manufacturing operation. He conducted personal air sampling (PCM analysis) in the breathing zone of workers using GP Triple Duty Joint Compound containing about 7% asbestos fibers. The worker mixing the asbestos into the dry joint compound material in a hopper with exhaust ventilation was exposed to an average of 7 f/cc. In addition, sampling collected in the breathing zone of the worker stacking sacks of the mixed joint compound resulted in a fiber concentration of 13.7 f/cc. Lauderdale recommended, among other things, that effective engineering controls and proper respiratory equipment be provided (Lauderdale, 1972).

Soule (1973) conducted an industrial hygiene survey for the Gypsum Association. The purpose of the survey was to determine the concentrations (by PCM analysis) of airborne asbestos during mixing and sanding of joint cement compounds. A total of four joint compound products, two dry mix and two pre-mixed, were evaluated. Dry mixing resulted in breathing zone concentrations of 31.4 and 7.6 f/cc. The breathing zone concentrations during sanding joint compounds ranged from 3.7 to 43.6 f/cc. Ten of the 31 samples collected during sanding were "too heavily loaded for direct analysis", which indicates the highest reported concentration (43.6 f/cc) likely underestimated the highest concentration during the sanding task. Soule recommended "...to eliminate asbestos from joint formulations if this is feasible" (Soule, 1973).

Kaiser Gypsum conducted short-term air sampling during mixing and sanding activities performed on their own products. Sheahan (1974) reported worker breathing zone concentrations of:

- 54.6 f/cc while mixing joint compound with a drill mixer;
- 66.5 f/cc while mixing with a potato masher; and
- 1.1 – 4.3 f/cc while sanding [n=3].

(Sheahan, 1974)

Rohl et al. (1975) studied the mineral content of 15 consumer spackling and patching compounds and 10 industrial drywall taping compounds produced in the 1970s. The products were analyzed for mineral content. They noted that none of the 25 industrial and consumer spackling and taping compounds examined had warning labels or indication that they may contain toxic or hazardous materials. Rohl et al. (1975) reported the following mineral content of consumer spackling and patching compounds and industrial drywall taping compounds:

Consumer products:

- Chrysotile: 5-10% [n=3]
- Tremolite: 4-6% [n=1]
- Anthophyllite: 10-12% [n=1]

Commercial products:

- Chrysotile: 5-12% [n=9]
- Tremolite: 5-7% [n=1]

(Rohl, Langer, Selikoff, & Nicholson, 1975)

Rohl et al. (1975) reported airborne fiber concentrations during the use of drywall taping compounds containing asbestos during mixing, hand and pole sanding, and sweeping the floor. Their results were as follows:

- Pole sanding: 1.2 – 19.3 f/cc [n=10, mean = 10.0 f/cc]
- Hand sanding: 1.3 – 16.9 f/cc [n=11, mean = 5.3 f/cc]
- Dry mixing: 35.4 – 59 f/cc [n=2]
- Sweeping: 26.4 – 41.4 f/cc [n=2]

They also measured asbestos fiber concentrations in the same room and in an adjacent room during pole sanding, hand sanding, and dry mixing activities. The adjacent room concentrations ranged from 0.7 to 8.8 f/cc [n=2] during pole sanding, 1.5 to



7.1 f/cc [n=2] during hand sanding, and 2.1 to 3.1 f/cc [n=2] during dry mixing. The area concentration in the same room ranged from 3.5 to 19.8 f/cc [n=3] during pole sanding, 2.1 to 2.5 f/cc [n=2] during hand sanding, and 0.5 to 12.1 f/cc [n=3] during dry mixing (Rohl, Langer, Selikoff, & Nicholson, 1975).

Fischbein et al. (1979) reported analytical results for the 15 industrial samples of drywall joint compound. Either chrysotile or amphibole asbestos or both were found in 13 out of 15 industrial products; 12 of the samples contained chrysotile asbestos (5-12%) and four contained tremolite (2-12%). Analysis of spackling compounds, which are used in home repair work, demonstrated that they also contain from 5 to 12% by weight of asbestos minerals (Fischbein, Rohl, Langer, & Selikoff, 1979).

Rhodes (1977) conducted air sampling in a two-story residential structure that resulted from two prior consumer uses of asbestos-containing tape-joint compound. Asbestos fiber concentration was measured during spackling and drywall removal and replacement. The work was done at widely separated locations (i.e., 2nd floor and basement) over a five-day sequence. The drywall replacement involved one wall approximately 11 feet long, which included removing the existing drywall and installing three pieces of new 3/8-inch gypsum board. A five-pound box of dry mix joint compound (Durabond Wallboard Compound, Ready-to-Mix Powder) was mixed in a bucket. The powder was gradually added to the prescribed amount of water with vigorous mixing, allowed to stand, and re-mixed with the viscosity adjusted via additional water as needed. The overall mixing operation took about 17 minutes. After application of the joint compound and when dry, the joint compound was sanded with sandpaper attached to a block. After each sanding step was completed, the dust was swept up with a pan and brush and deposited in a trash bag. The sanding and clean-up operations lasted for 93 minutes. The PCM results during ripping out the old drywall was 0.3 f/cc. The results during

the sanding and cleaning step ranged from 0.1 to 0.3 f/cc. The highest fiber level found through the test sequence was 0.5 f/cc, which occurred as a 10-minute sample while work clothes were placed in a washing machine (Rhodes, 1977).

Verma and Middleton (1980) evaluated worker asbestos exposures during the application, mixing (dry powder and premix), hand sanding, pole sanding, and sweeping. They reported concentrations of chrysotile asbestos in these products ranging from 3-6%. They reported the following airborne fiber concentrations during the drywall taping process:

- Application: 0.4 – 1.3 f/cc [n=10]
- Mixing (dry powder): 9.0 – 12.4 f/cc [n=3]
- Mixing (pre-mix): 1.2 – 3.2 f/cc [n=7]
- Hand sanding: 2.1 – 24.2 f/cc [n=22]
- Pole sanding: 1.2 – 10.1 f/cc [n=104]
- Sweeping: 4.0 – 26.5 f/cc [n=20]

(Verma & Middleton, 1980)

Longo and Hatfield (1997) measured fiber concentrations during hand sanding Kaiser Gypsum joint compound. Bulk analysis indicated that the material contained chrysotile (10%) and trace amounts of tremolite/actinolite. Other ingredients in the joint compound were calcium, kaolinite, mica, talc, and titanium dioxide. The breathing zone fiber concentrations (by PCM) during sanding ranged from 3.42 to 4.11 f/cc [n=4]. The TEM results for fibers greater than five microns ranged from 207.92 to 442.38 f/cc [n=4]. Analysis of clothing fabric also resulted in heavily contaminated clothing from sanding the joint compound (Longo & Hatfield, 1997).

Georgia-Pacific manufactured asbestos-containing products (i.e., acoustical plaster, joint compounds, textures, and specialty products)

from 1956 through 1977 (U.S. EPA, 1990). Dry mixed joint compound was manufactured from 1956 to 1977 and contained approximately 2.5-7% asbestos. Wet mixed joint compound was manufactured from 1963 to 1977 and contained about 1.5 to 5% asbestos. Talc was a constituent ingredient of a few of the joint compounds and industrial plaster products manufactured by Georgia-Pacific (Georgia-Pacific Corporation, 2005).

The first asbestos-free joint compound was developed circa 1974. The U.S. patent for the first asbestos-free joint compound was issued on June 24, 1975 (Deposition of Terrance L. Williams Re: Kamada, 2006; United States Patent No. 3,891,453, 1975; U.S. Gypsum, 1974). USG internal documents note in regard to the elimination of asbestos in USG joint compounds and textures, "By mid-1976, we fully expect to be able to manufacture the entire USG Joint Compound line, the Durabond line, the Ready-Mixed line, the IMPERIAL QT line, and all other specialty products without loss of quality; however, there may be some instances of increased raw material cost" (U.S. Gypsum, circa 1974; Maynard, 1975). Material Safety Data Sheets for non-asbestos USG Joint Compounds were developed in 1978. USG notes that some formulas may contain non-fibrous talc (Freeman, 1979).

The Consumer Product Safety Commission (1977) banned consumer patching compounds containing intentionally-added respirable freeform asbestos, which have been manufactured or initially introduced into commerce after January 16, 1978. All other consumer patching compounds containing intentionally-added respirable free-form asbestos, no matter when manufactured or initially introduced into commerce, were banned effective June 11, 1978. The CPSC estimated the increased risk of death from respiratory cancer for those who used these products six hours a day, four times a year for five years to be between 1,000 and 12,000



per million (CPSC, 1977). Patching compounds which are labeled as, marketed, and sold solely for industrial use in non-consumer environments were not subject to this ban.

Based on relevant scientific literature, asbestos exposures from drywall installation and ancillary work activities are summarized in **Table 1**.

Table 1: Asbestos Exposure from Drywall Work

Year(s)	Activity	Concentration	Role
1973 1974 1975 1979 1980	Mixing dry powder joint compound (Soule, 1973; Sheahan, 1974; Rohl et al., 1975; Fischbein et al., 1979; Verma and Middleton, 1980)	7.6 – 66.5 f/cc	Direct
1975 1979	Area concentration during mixing dry powder joint compound (Rohl et al., 1975; Fischbein, 1979)	0.5 – 13.1	Bystander (Area)
1980	Mixing pre-mix joint compound (Verma and Middleton, 1980)	1.2 – 3.2 f/cc 2.4 f/cc [mean]	Direct
1980	Area concentration during mixing pre-mix joint compound (Verma and Middleton, 1980)	1.2 – 2.7 f/cc 2.0 f/cc [mean]	Bystander (Area)
1980	Applying drywall joint compound (Verma and Middleton, 1980)	0.4 – 1.3 f/cc 0.9 f/cc [mean]	Direct
1975 1979 1980	Pole sanding drywall joint compound (Rohl et al., 1975; Fischbein et al., 1979; Verma and Middleton, 1980)	1.2 – 19.3 f/cc	Direct
1975 1979	Area concentration during pole sanding drywall joint compound (Rohl et al., 1975; Fischbein et al., 1979)	0.7 – 19.8 f/cc	Bystander (Area)
1973 1974 1975 1977 1979 1980	Hand sanding drywall joint compound (Soule, 1973; Sheahan, 1974; Rohl et al., 1975; Rhodes, 1977; Fischbein et al., 1979; Verma and Middleton, 1980; Longo and Hatfield, 1997)	0.1 – 43.6*	Direct
1975 1979 1980	Area concentration during hand sanding (Rohl et al., 1975; Fischbein et al., 1979; Verma and Middleton, 1980)	0.3 – 7.1 f/cc	Bystander (Area)
1980	Sweeping associated with drywall work activities (Verma and Middleton, 1980)	4.0 – 26.5 f/cc	Direct
1975 1979	Area concentration after sweeping floor (Rohl et al., 1975; Fischbein et al., 1979)	26.4 – 41.4 f/cc	Bystander (Area)
1977	Ripping out old drywall (Rhodes, 1977)	0.3 f/cc	Direct
1972	Mixing/manufacturing dry powder joint compound in hopper with exhaust ventilation (Lauderdale, 1972)	7 f/cc	Direct
1972	Stacking sacks of packaged dry mix joint compound (Lauderdale, 1972)	13.7 f/cc	Direct
1977	Placing contaminated work clothes in washing machine (Rhodes, 1977)	0.5 f/cc [10-minute sample]	Direct

f/cc = Fibers per cubic centimeter
TWA= 8-hour time-weighted average

* – Ten of the 31 samples collected were “too heavily loaded for direct analysis”, which indicates the highest reported concentration likely underestimated the highest concentration during the sanding task.



Asbestos-Containing Gypsum Wallboard Products

Although asbestos was not typically added to standard gypsum wallboard, certain specialty or fire-rated applications incorporated asbestos-containing materials into wallboard products during specific periods. One example includes gypsum wallboards manufactured with vermiculite sourced from mines known to contain asbestiform minerals.

In 1965, Kaiser Gypsum began developing wallboard products that contained raw vermiculite. Once fire-rated and approved, Kaiser Gypsum began marketing gypsum wallboard containing raw vermiculite under its Null-A-Fire brand. It continued to market such products until April 1978. Null-A-Fire wallboards contained up to 5% (by weight) vermiculite. W.R. Grace ("Grace"), the initial supplier of the vermiculite used by Kaiser Gypsum, informed Kaiser Gypsum that the vermiculite obtained from Grace's Libby, Montana mine was contaminated with asbestiform tremolite (Kaiser Gypsum's Responses to Plaintiffs' General Interrogatories to Defendants Re: Bill Long, Jr., 2015).

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