

FILE NAME: Military Specifications (MS)

DATE: 1984 Aug 26

DOC#: MS009

DOCUMENT DESCRIPTION: Robert N. Anderson, Military Specifications, and Related Material by Stephen L. Berger

ROBERT N. ANDERSON, MILITARY SPECIFICATIONS, AND RELATED MATERIAL

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August 26, 1984

Robert N. Anderson

A search of the Engineering Index from 1958 to June 1984 revealed no articles by Anderson other than ones directed to nuclear engineering.

Thesis

Parts of Anderson's Master's thesis, dealing with the effect of ultrasonic energy on the rate of heat transfer to water, are enclosed. It is interesting that in the apparatus used in his experiment two different types of insulation were employed. On page 6, rockwool was used to insulate the heater and on page 10, the lower calming section was insulated with Fiberglas (see drawings on pages 7 and 8). The temperature of the water, after heat transfer, was in the 85-95°F range.

Affidavit

Anderson claims that, after reviewing the literature, only "asbestos would satisfy the requirements of military specifications MIL-I-2781, grade II class c or grade III class f." He does not state anything about the other grades or classes, nor does he compare the properties of molded asbestos insulation with other types.

Patents and Literature

Since he has claimed to have conducted a broad literature and patent search, he should be questioned about various types of molded insulation which might have meet the requirements (tests) of MIL-I-2781. (See section on Military Specifications). Mineral wool, for example, can withstand higher temperatures than asbestos. I have enclosed the following patents and references:

2,101,921 -- Disclosed mineral wool insulation in cylindrical form (Figures 7 and 8).

2,184,316 -- Disclosed bonded glass wool pipe insulation good up to 1200°F.

2,288,072 -- Bonded mineral wool pipe covering (see Figure 11, p. 1, right, lines 19-23, and p. 4, right, lines 23-30).

2,309,206 -- Fibrous^{insulation} (see claims) which can contain mineral wool (p. 2, right, lines 39-42).

2,609,312 -- Bonded fibrous insulation containing asbestos, glass fibers, or mineral wool (col. 2, lines 49-53).

2,941,904 -- Bonded glass fiber pipe insulation good up to 1200°F.

2,941,899 -- Similar to 2,941,904.

3,053,715 -- High temperature glass fiber pipe insulation consisting of an outer layer of bonded fibers and an inner layer of unbonded fibers (col. 2, lines 65-71). Might not be

3,346,016 -- High temperature pipe insulation containing bonded fibers, such as glass, mineral wool, asbestos, or alumina-silica fibers. Might not be considered a molded type.

Allcut, E.A., "Tests of Steam-Pipe Insulation," Transactions of the American Society of Mechanical Engineers, 65:407-419 (1943). -- Bonded spun rock wool type of insulation, used as an alternative to magnesia, good up to at least 1000°F (see abstract, p. 410, and Figure 17).

Swain, P., "Types and Shapes of Heat Insulation," Power, 94:118-119 (Mar. 1950). -- Shaped mineral wool pipe insulation good to 1000°F (p. 119).

Thomas, p. and Turner, W.C., "Insulation for Heat and Cold," Chemical Engineering, 61:221-225 (June 1953). -- Table 1 gives the characteristics of various insulations. The 6th one down is a bonded mineral wool having a temperature limit of 1700°F. The density is 18 lb./cu. ft., but this is less than the maximum density of 25 for Grade III, class f.

"Insulation -- How to Install It," Power Plant Engineering, 48:96-100, 162, 164 (Sept. 1944). -- Molded mineral wool pipe insulation good up to 1200°F (see Table III, Figures 12 and 13, and p. 99).

Wilson, Allen C., Industrial Thermal Insulation, 1959. -- Describes a molded mineral wool pipe insulation good up to 1800°F (p. 67).

The UNARCO 2,620,513 patent (later sold to Pittsburgh

Corning) may be for apparatus and methods for manufacturing Unibestos. It disclosed an

insulating material such as asbestos fibers, glass fibers, or mineral wool alone or mixed with organic fibers such as wool, cotton, rayon or the like... mixed with a binder such as sodium silicate...

The insulating material was formed into semi-cylindrical lengths of pipe insulation (col. 2, lines 34-46). Apparently, UNARCO acknowledged that glass fibers or mineral wool fibers could have been used. Anderson should be questioned on this even if the product is not Unibestos.

Anderson might also be asked about the properties of asbestos, including the temperature at which it starts to lose strength. The Product Engineering article states this is at 700°F (p. 3) and the SAE Journal article states this starts at 600°F (p. 21).

Military Specifications

A previously written report "Review of Military Specifications," along with supporting documentation, is enclosed.

A requirement of the "Insulation Pipe Covering, Thermal" specifications was that the supplied pipe covering had to be split in half (as examples, see Section 3.5 of MIL-I-2781A, Section 3.6 of MIL-I-2781B, and Section E-1a of 32P3a, Aug. 1, 1934). This means that a molded type (as opposed to a blanket type) of pipe covering was necessary to meet this

requirement. (See section on Patents and Literature under Anderson).

In the evolution of MIL-I-2781 and its prior forms, the various requirements and tests had changed somewhat. Originally, in 32P3, the material required was diatomaceous earth. This was changed to "a suitable high-temperature heat-resisting compound" in 32P3a and then to "heat-resisting compounds suitable for the temperature conditions and the purpose intended" in 32P8. This language was apparently used until the asbestos-free requirement was added in MIL-I-2781D, 9 Jan 1973. Also note that 32P3d (Nov. 1, 1939) was the first specification to mention, under Section A-1, 32P6 -- Pipe-Covering, Molded-Asbestos, and, under Section C-2, changed the language so that the outer layer of a "combination pipe covering shall conform to the requirements of Navy Department Specification 32M2 or 32P6....."

Types of Physical Tests

The types of physical tests required in the specifications have changed little over the years. 32P3a required conductivity, density, hardness, resistance to abrasion, heating loss and shrinkage, and moisture absorption (Section F). 32P8 added a stability test and a modulus of rupture test. 32P8b (July 16, 1945) did not change the types of tests; however, it was the first to have the fibrous classifications of Grade II, class c and Grade III, class f. The **resistance to abrasion test** was not

required for these classes (see Table 1 and compare to Section F-3 of 32P6). MIL-I-2781C removed the stability test and substituted for it an almost identical simulative service test. MIL-I-2781E added a fire resistance and smoke density test, and a compatibility test. MIL-I-2781D eliminated the hardness test.

Methods for Conducting Physical Tests

Although I did not analyze the methods for conducting the physical tests in depth, it is my impression that only minor changes were made. MIL-I-2781C (Feb. 15, 1960) was the first to specify ASTM tests for density and thermal conductivity. In MIL-I-2781D all of the tests were conducted according to ASTM standards. In MIL-I-2781E all tests were made according to ASTM standards except the fire resistance and smoke density one and the compatibility one. Comparing the MIL-I-2781(A, for example) tests with the ASTM tests shows that the methods are nearly identical. Copies of the various Astm standards for 1982, the earliest year readily available to me, are enclosed.

Approved Pipe Coverings in the Mid-1930s

Two enclosed articles described the various types of pipe insulations that were approved by the Navy in the 1930s (assumably under the specifications in effect at that time). The 1935 article from the Journal of the American Society of Naval Engineers was entitled "Pipe Covering Materials for High Temperatures" and stated:

The materials which have been approved and are now used in the Service as pipe coverings for temperatures above 500 degrees F. are grouped into the following categories:

- (1) Sectional and segmental molded pipe covering.
- (2) Felted mineral wools.
- (3) Aluminum foil. (limited approval).
- (4) Insulating cements. (p. 247)

The 1936 article from the Society of Naval Architects and Marine Engineers Transactions was entitled "Heat Insulation" and written by Ormond Cox, the Director of the U.S. Naval Engineering Experiment Station at that time. He described in greater detail the types of insulation approved, the appropriate specifications (pp. 474 and 477), the test methods, and characteristics of the various insulations. The 32P5b specification entitled "Rock Wool; Pipe Covering, Blanket, Cement and Fiber" might be useful to look at if it can be located. The article does not seem to mention molded amosite asbestos pipe covering nor any specification for it. On page 486, first paragraph, Cox stated that 3 types of mineral wool insulation were approved by the Navy.

Defendant's Memo of Law Dated August 6, 1984

On page 9, it states that "No substitute asbestos-free product meeting all the requirements of those classes was ever found." Were insulations, other than asbestos-containing ones such as Unibestos, submitted for testing under Grade II, class c or Grade III, class f? Olsen states on page 5 of his Affidavit that other products were submitted but does not say if they

contained asbestos. It seems that these classes were modeled after 32P6, which was probably created specifically for Unibestos. Most of the requirements in Table 1 of 32P8b for Grade II, class c are nearly the same as those in Section D of 32P6. Comparisons are somewhat difficult because the test temperatures for the conductivity test and the soaking heat test changed.

On page 10, it is mentioned that the specification was revised when the Navy prohibited the use of asbestos. Besides a possible change in density requirements, the only difference was elimination of the "Changes under soaking heat for 6 hours -- Loss in weight" requirement. However, Exhibit "16" states that the reason for the difference in loss of weight is simply the difference in weight between asbestos fibers and the replacement cellulose and alkaline treated glass fibers. Note that cellulose-containing calcium silicate coverings were equivalent to the asbestos-containing calcium silicate coverings "from a standpoint of flamespread, smoke development and fuel contribution."

On page 16, Pittsburgh Corning claims that Unibestos was qualified under specifications which "had been in existence for several years before Unarco first submitted samples of the product for testing." This is supposedly explained in the affidavit of Joseph Olsen. There are several misleading or inaccurate statements in this affidavit. On page 4, part 5e, he states that the "samples were submitted for testing to

determine their compliance with Navy Department specifications 32M2 and 32P3." If this means approval under 32M2 or 32P3, this statement cannot be true because 32M2 dated Mar. 2, 1925(?) and 32M2b dated June 1, 1935 both specified an insulation containing not less than 85% hydrated magnesium carbonate. Likewise, 32P3 dated Feb. 1, 1927 specified that the outer layer shall conform to 32M2. Since Unibestos was predominately amosite asbestos, it certainly could not meet these requirements. 32P3a dated Aug. 1, 1934 also required that the outer layer conform to 32M2 and was apparently in effect when Unibestos was submitted for testing. The letter dated 21 Jan 1936 from the Bureau of Engineering stated that Unibestos was to be tested as a possible substitute for magnesia, and as an outer cover of a combination pipe covering. This seems to define the use of Unibestos and does not really mean it would be approved under 32M2 or 32P3.

In Exhibit "21" the letter dated Feb. 5, 1937 from Bruner certified Unibestos under "Pipe Covering, Insulation, Molded Amosite Asbestos" and apparently not under 32P3a entitled "Insulation, High-Temperature: Blocks, Cement, and Pipe-Covering." The first version in the Exhibits of 32P6(INT) was dated 15 Nov 1937. Therefore, it is logical to assume that 32P6 was written about the same time Unibestos was approved and written specifically with Unibestos in mind.

Also, on page 4, part 5g, Olsen states "In 1938, Navy

Department specification 32P3 was superseded by specification 32P6-Int, "Pipe Covering, Insulation, Molded Amosite Asbestos." In fact, 32P3 (the last version in the Exhibits is 15 June 1941) was superseded by 32P8 (the earliest version is 1 August 1942).