14 December 1944

UNITED STATES COAST GUARD
SPECIFICATION
FOR COMPASSES: MAGNETIC, LIQUID FILLED, MARINERS, COMPENSATING, FOR LIFEBOATS (WITH MOUNTING) FOR MERCHANT VESSELS

This specification contains the detail requirements for the compass required in lifeboats on ocean and coastwise vessels by Section 33.3-1(d) of the Tanker Regulations and Section 59.11(d)of the Ocean and Coastwise General Rules and Regulations.

A. APPLICABLE SPECIFICATIONS

A-1. The following Federal Specifications, of the latest issue in effect on date of manufacture, shall form a part of this specification.

A-la. Federal Specifications

L-P-406a Plastics, Organic; General Specifications, Test Methods
QQ-B-691b Bronze: Castings
TT-R-58 Radioactive-Luminous-Compound and Adhesives

A-lb. Navy Department Specifications

46-M-6g Metal, Gun (Composition G): Castings

B. TYPE AND GRADE

B-1. Compasses for lifeboats shall be of the type and grade herein described.

C. MATERIALS AND WORKMANSHIP

C-1. Materials- All materials used shall be of a good quality, suitable for the purpose intended, and shall conform to the requirements of this specification.

C-la. All materials of the compass and mounting, with the exception of magnets, shall be non-magnetic.

C-lb. Copper-base alloy parts of the compass and mounting shall be in accordance with one of the following compositions at the option of the contractor:

Navy Department Specification 46-M-6g Metal, Gun (Composition G) castings. Wrought alloys - copper not less than 85%, remainder zinc.
Federal Specification QQ-B-691b Bronze: Castings, Composition 1 and 2.

The iron content of any of the above alloys shall be not greater than 0.15%. Finished parts shall be free from excessive porosity so as to be leakproof.

C-lc. The choice of material used when none is specified or where a choice is permitted shall be such that maximum resistance to corrosion, shock, temperature, and wear will be insured. The use of dissimilar materials in combination shall in general be avoided, but when such contacts are necessary, means shall be taken to prevent such deleterious effects as galvanic corrosion, freezing or buckling of moving parts, and loosening or tightening of joints due to differences in coefficients of thermal expansion.

C-2. Workmanship - Shall be first-class. Compasses shall be free from defects which affect appearance or which might affect serviceability.

D. GENERAL REQUIREMENTS - (See Detail Requirements)

E. DETAIL REQUIREMENTS

E-1. Construction - The compass shall be an instrument designed for use at sea to determine angular distance from the earth's magnetic meridian. It shall consist essentially of a compass bowl, card with magnets, jewel and pivot, two lubber lines, liquid, compensating mechanism, including magnets and mounting. A gimbal ring and float chamber may or may not be furnished, provided that all other requirements of this specification are met. The compass shall be rugged in character and it shall be so designed that jars, vibrations, and atmospheric conditions likely to be encountered in an open lifeboat will not affect its serviceability or accuracy. The arrangement shall be identical to that of the approved model.

E-la. Compass Bowl - The bowl shall be circular in shape and shall be made of a cast or spun copper-base alloy, or a high-impact type, fully cured molded phenolic material. The inside surface of the bowl shall be black. Means shall be provided to allow for expansion of the liquid from minus 40°F. to plus 160°F. without the formation of a visible bubble. The top of the bowl shall be covered with a flat or dome shaped crystal or transparent heat resistant methyl methacrylate resin material or of well cushioned toughened glass. The crystal shall be not less than 3/16" in thickness if glass is used and not less than 1/4" in thickness if plastic is used. It shall be secured to the sides of the bowl by a bezel ring in such a manner as to provide for a leakproof unit.

E-la(l). Compass Fluid Resistance (Phenolic Resin Bowls Only) - After the compass bowl is totally immersed in the compass fluid as specified in paragraph F-3c(1), it shall not appreciably swell or change its dimensions. There shall be no discoloration of the compass fluid or evidence of precipitation or sedimentation in the fluid or on the surfaces of the bowl. The increase in weight of the bowl immediately after immersion shall be not greater than 5%, and after reconditioning the weight of extracted material shall not exceed 2%.

E-la(2). Impact Resistance - (Phenolic Resin Bowls Only) - The bowl shall not crack, chip, or fracture when tested in accordance with paragraph F-lc(2).

E-lb. Moving element - The moving element shall consist essentially of the card, magnets, jewel or pivot, and card support or float chamber. It shall be as light as possible in weight and in no case shall weigh more than 150 grains in the liquid at 70°F. The moving element shall not leave the pivot or jewel at any temperature within the specified range, and the entire assembly shall be such that after inverting and returning the compass to its upright position the action of the card shall be normal.

E-lb(l). Card - The card shall be a light, flat, annular ring or disc made of brass, aluminum, magnesium, plastic or fabric sheet, finished in black. When mounted in a flat top compass its diameter shall be not less than 3-3/4". When mounted in a spherical type compass it shall have a virtual diameter not less than 4". It shall not warp, discolor, or suffer other deleterious effects when subjected to the accelerated aging test discussed in paragraph F-lb(l).

E-lb(la). Markings - The periphery of the card shall be divided into degrees. The arrangement and shape of all markings shall be in accordance with figure 1, which is a part of these specifications. All markings, numerals, and lettering shall be treated with a high grade radioactive luminous material not inferior to grade 38M of Federal Specification TT-R-58. The lettering and numerals shall be large and easily readable.

E-lc. Jewel and Pivot - The pivot and jewel chamber shall be fitted with a sapphire, synthetic sapphire, or hardened glass jewel. The hardness of the jewel shall be not less than 8 on the Moh's scale. The jewel shall have a high polish and shall contain a suitable central depression to receive the pivot point. A pivot of stellite, osmium, iridium, or platinum alloy shall be used. The chamber, pivot arrangement, and moving element shall be so designed as to maintain a static balance in a horizontal plane and to permit the card to incline not less than 10°. Pivoting shall center at the intersections of the coordinate diameters.

E-ld. Magnets - All magnets shall be made of suitable magnet steel such as cobalt or alnico steel, and shall be suitably aged and suitably balanced to comply with paragraph E-21 and F-la(5). Magnets shall be magnetized to saturation and reduced 30 to 10% of the maximum theoretical magnetic moment, in such a manner as to insure permanence of magnetic properties. Magnets used on the same card shall be balanced within 2% of each other.

E-lc. Lubber Lines - Two lubber lines shall be positioned on the finished interior of the bowl on a vertical plane passing through the center of the compass. Each line shall be treated with a high grade radioactive luminous material not inferior to grade 38M of Federal Specification TT-R-58. The width of the lubber lines shall be not less than 1/32" and not more than 1/16". If an alcohol- water combination filling liquid is used, a suitable binder shall be used for the radioactive material so that it will not be deleteriously affected by the alcohol.

E-if. Filling Liquid - The compass bowl shall be filled with either a compass fluid conforming to the requirements of paragraph F-10 of Federal Specification TT-R-58, or a Grain alcohol-distilled water combination which will meet satisfactorily the requirements of paragraph F-10 (with exception of paragraph F-10(2) of above specification).

E-1g. Leveling Mechanism - The compass shall be so designed that the card will maintain a horizontal position when the mounting is level or when it is tilted in any direction through an angle of not less than 35°. This shall be accomplished either by the use of a gimbal ring or by the provision of a 35° card tilt. If the gimbal ring is used it shall be made of copper-base alloy. The leveling mechanism shall be so designed that it will not stick in any operating position.

E-1h. Compensating Mechanism - A simply controlled permanent magnet corrector system shall be provided to compensate for semi-circular deviation. The system shall be capable of correcting for not less than 5O° of "B" error and 50° of "C" error in 34-45° north latitude. The fixed correcting magnets shall be installed in an arrangement which will allow variable control of the "B" and "C" correctors, so that compensation for semi-circular deviation can be effected for any error between 0 and 50°. If a gimbaled compass is furnished, the compensating mechanism shall be in the mounting of the compass. If a non-gimbaled compass is furnished, the compensating mechanism shall be attached to either the compass or the compass mounting. Simple instructions for compensating the compass, including the use of diagrams and illustrations, when necessary, shall be provided on the outside of the mounting or compass bowl and shall be identical to those supplied with the approved model. These instructions shall be marked in a plain, readily visible, permanent manner.

E-1i. Mounting - The compass shall be mounted in a wooden copper-base alloy, or phenolic resin housing, or combination thereof. The housing shall be designed to withstand the shock, salt spray and weather tests specified in the applicable paragraphs under section F-1 of this specification without cracking, fracturing, or suffering any other detrimental effects which might affect the serviceability

of the compass or mounting. The mounting shall be so designed that the compass may be installed in a permanent location above the stern sheets or a thwart and also be easily removable from its mounted position and stowed. The construction of the mounting shall be such that the compass can be mounted only in its designated position and shall be in accordance with figure 2 which is a part of these specifications. A fore-and-aft reference line shall be inscribed on the mounting to facilitate installation above the keel line. Provision for draining the housing shall be provided.

E-Ij. Instructions for Finding Compass Error - The following instructions shall be permanently engraved in plastic and mounted conspicuously on the binnacle:

"To find compass error using the sun, moon, star or cloud while near the horizon.

Suppose the sun is rising and the compass is mounted in place. Head boat west by compass and you decide the sun is bearing 70° by the compass. Head boat east by compass and suppose the sun bears 100°. These added together make 170° and when halved makes 85° which is the correct bearing of the sun at that moment.

Now suppose you want to steer S.W. Head the boat 225° by compass and take another bearing of the sun. It now bears 65°; it should bear 85°. Therefore the compass card is turned 20° too far to the right giving a 20° error, thus you should steer 20° to the left to offset it or 205° by compass to make good 225°, the direction you want. If it is desired to remove this error, proceed as outlined in manufacturer's instructions."

E-2. Performance Requirements

E-2a. Pivot Friction - When the compass is deflected 5° in either direction at each cardinal point, the card shall in all cases return to its original position of rest within 1°, without tapping.

E-2b. Accuracy - When tested in accordance with paragraph F-la(l), the combined calibration and centering error in any direction shall not exceed 2°.

E-2c. Tilt Error - When the compass is tilted as specified in paragraph F-la(2), the card shall be free to revolve on its pivot and shall read correctly within 2°.

E-2d. Period - The time of vibration (one-half swing when the card has been deflected 11°), shall be between 7 and 14 seconds when the compass liquid is at 20°F. temperature and where the horizontal magnetic field is approximately 0.17 gauss. After the compass card is released from an 11° deflection the returning overswing shall not exceed 4°. The period of vibration and tilt shall be in such combination as to result, for the particular design of card, magnet system and filling fluid, in the greatest possible steadiness of the card and closest alignment to the magnetic meridian when used in a lifeboat in a seaway.

E-2e. Balance - The card and magnet assembly shall be balanced on its pivot so that its E-W meridian shall be horizontal ± 2° and shall be balanced on its N-S meridian for the following conditions:

(a) Where in paragraph E-lc the card inclines 15° or more the north seeking end shall neither tilt down more than 3° of arc when the vertical field is approximately 0.52 gauss downward, nor tilt up more than 7° when the field is reversed.

(b) Where in paragraph E-lc the card inclines 10° to 15° the north seeking end shall neither tilt down more than 2° of arc when the vertical field is approximately 0.52 gauss downward nor tilt up more than 5° when field is reversed.

E-2f. Effect of Temperature - There shall be no leakage, and the compass shall read within the specified accuracy after being subjected to the tests specified in paragraph F-la(B).

E-2g. Effect of Vibration - When the compass is subjected to vibration as specified in paragraph F-la(4) the card shall remain on the pivot whether the bowl is fixed rigidly to the vibration table or is mounted in its binnacle on the table. The sum of the numerical values of the deviations produced when the motion is clockwise and counter-clockwise shall not exceed 3° when the bowl is fixed rigidly to the vibration table, and shall not exceed 5° when the compass is mounted in its binnacle on the vibration table.

E-2h. Higher Harmonics - When the compass is subjected to the test for higher harmonics specified in paragraph F-la(5), the algebraic difference of the extreme deviations shall not exceed 10°. The semi-circular corrector system shall be capable of compensating the error produced as described so that the values of the resulting B and C coefficients are not more than 1°.

E-3. Physical Requirements

E-3a. Light Stability - There shall be no appreciable discoloration or deterioration of the compass card or plastic crystal when subjected to the light stability test described in paragraph F-lb(l).

E-3b. Water Immersion Resistance - The compass shall not leak or appreciably warp when subjected to the water immersion test described in paragraph F-lb(2).

E-3c. Salt Spray Resistance - There shall be no corrosion of any parts of the compass or housing which might affect the serviceability of the compass or compensating mechanism when subjected to the 100-hour salt spray test described in paragraph F-lb(B).

E-3d. Shock Resistance - The compass shall read within the required accuracy after the shock test described in paragraph F-1b(4). There shall be no leakage of fluid or cracking, chipping, or fracturing of any part of the compass and mounting after the test.

E-4. Finish - Exposed metal surfaces, except contact surfaces of gimbals, shall be thoroughly cleaned and uniformly coated with a good quality water and weather resistant gray or black enamel. Wood surfaces, both inside and outside, shall be smooth, thoroughly sealed with spar varnish, and then uniformly coated with at least two coats of a good quality water and weather resistant paint. After the tests of paragraphs F-la(3) and F-lb(l), (2) and (3), there shall be neither deleterious effects such as cracking, checking, blistering, or loss of adhesion, nor more than slight softening or whitening of the protective coatings.

E-5. Marking - Each approved compass shall be permanently marked with the name of the manufacturer, the place of manufacture, the type or model number and the words "approved, U. S. Coast Guard".

E-6. This specification calls attention to certain features, but does not purport necessarily to cover all details entering into the design of the compass. In all respects not specifically covered by this specification, the compass including the mounting shall be equal to the approved model.

F. TESTS

F-1. Methods of Test

F-la. Performance Tests - Compasses shall be tested for conformance to paragraphs E-ii, E-2a, and E-2e, in addition to the following:

F-la(l). Accuracy - The card error shall be determined by comparing the uncompensated compass with the correct magnetic reading, and recorded successively at 0, 45, 90, 135, 180, 225, 270, and 315 degrees to determine conformance to the requirements of paragraph E-2b.

F-la(2). Tilt Test - A base to hold the compass shall be mounted on a special fixture, so that the base may be tipped to an angle of 10° in any direction and rotated through 360°. The compass shall be mounted on this base (without gimbals) and tilted from its normal upright position to several positions within an angle of 10° to determine conformance to the requirements of paragraph E-2c.

F-la(3). Temperature Test - The compass shall be placed in a chamber and held at minus 40°F. for one hour, 160°F. for one hour, and 70°F. for one hour. After each temperature the compass shall be examined for evidence of leakage. The accuracy test shall be repeated after the temperature cycle.

F-la(4). Vibration Test - The compass bowl shall be fixed rigidly to a vibration table which can be subjected to circular translational motion in a horizontal plane of frequency approximately 1700 r.p.m, and amplitude (diameter of circle traced by a point on the table surface) approximately 0.01 inches. The table shall be subjected to clockwise and counter-clockwise vibrations. The procedure shall be repeated with the compass in position in its binnacle but with correcter system removed, the binnacle being mounted on the Vibration table as it would be mounted on a lifeboat thwart.

F-la(5). Higher Harmonic Test - The compass in its binnacle but with semi-circular correctors removed (or in the neutral position) shall be placed at the center of an azimuth-calibrated revolvable platform so that the reading of the forward lubber line is 0° when the platform scale reads 0°. A cylindrical magnet, the moment of which is greater than 5000 c.g.s, units, shall be placed on a block on the platform at a relative bearing from the compass of 315°, on the same level as the compass magnets, with the extended axis of the magnet passing through the center of the card. The platform shall be turned through 45° so that the magnet is west of the compass. The magnet shall then be moved toward or away from the compass until it produces a deviation of 59°. The semi-circular error thus produced shall be compensated by the replaced semi-circular corrector-system, the following procedure being observed:

(1) With the platform scale reading 0° the N-S corrector is adjusted so that the compass deviation is 0°.

(2) With the platform scale reading 90° the E-W corrector is adjusted so that the compass deviation is 0°.

(3) With the platform scale reading 180° the compass deviation is observed, and is halved by adjusting the N-S corrector.

(4) With the platform scale reading 270° the compass deviation is observed and halved by adjusting the E-W corrector. The platform shall then be revolved so that the reading of the forward lubber line is in turn 0°, 15°, 30°, etc., up to 345°, the deviation of the compass being obtained on each of the 24 heads by subtracting the lubber line reading from the reading of the platform scale.

F-lb. Physical Tests - The tests on the sample shall be made in the following order, to determine compliance with the requirements of paragraph E-3:

F-lb(l). Light Stability - The compass, topside up, shall be placed under a sunlamp for 100 hours. The crystal shall be approximately 7" from the bulb. The apparatus used shall be essentially similar to that specified in method No. 6021 of Federal Specification L-P-406a.

F-lb(2). Water Immersion Test - The entire compass including housing shall be immersed under 1-foot head of a 3% aqueous solution of sodium chloride for 24 hours at 68-70°F.

F-lb(3). Salt Spray Test - Sample compass including housing shall be exposed to a finely divided spray of 20% sodium chloride (by weight) in distilled water at a temperature of 90° to 100OF. for 100 hours. The tank shall be constructed of neutral material (such as wood or soapstone) and so designed that the spray shall circulate freely about the specimen without direct impingement thereon. No liquid which has come in contact with the specimen under test shall return to the aspirator to be resprayed. Before being placed in salt spray bath, the specimens tested shall be thoroughly cleaned.

F-lb(4). Shock Test - The compass shall be mounted in its normal operating position in the center of an oak board 60" long, 11-1/2" wide, and 1-1/2" thick. The board shall be fixed rigidly at each end and supported in the middle, and shall resemble as closely as possible a thwart of a lifeboat. A 100-pound sandbag shall be dropped a distance of 10 feet onto the board so that the maximum impact occurs at a point approximately 12" from the compass. The test shall be made on each side of the compass location.

F-lc. Tests on Plastic Bowl

F-lc(l) - Compass Fluid Resistance - The sample bowl shall be conditioned for 24 hours at 70° temperature and 50% relative humidity and then weighed. Then it shall be totally immersed in compass fluid at 160°F. for 48 hours. The compass fluid used shall be identical to that being supplied for the lot represented by the sample. At the end of the 48 hours period the bowl shall be removed from the fluid and examined for compliance with paragraph E-la(l). The excess liquid shall then be removed from the surface and the bowl immediately weighed. The compass fluid shall be examined for evidence of precipitation or discoloration. The bowl shall be then reconditioned for 48 hours at 70°F. temperature and 50% relative humidity and reweighed to determine conformance to paragraph E-la(l).

F-lc(2). Impact Test - The sample bowl shall be clamped, bottom side up, rigidly to a solid surface. A steel ball approximately 1/4 pound in weight and approximately 1-1/4" in diameter shall be allowed to drop freely 6 times in succession onto the center of the bottom of the bowl. The falls shall be made at a temperature of 1O°F. and in accordance with table I.

Table I

No. of Falls	Kinetic-Energy* of Ball at Impact (inch-pounds)
2	6
2	9
2	12

* Distance of fall in inches may be found by dividing the kinetic energy of ball at impact by the weight of ball in pounds.

The bowl shall be then examined for compliance with the requirements of paragraph E-la(2).

G. APPROVAL - Approval is granted by the Commandant only. To submit the compass for approval, forward it together with four prints of the drawings of the compass and its mounting to the Commandant, U.S. Coast Guard, 400 Seventh Street, S.W., Washington, D. C. 20590.

Fig. 1 - Compass Card
Fig. 2 - Compass Mounting

COMPASS CARD

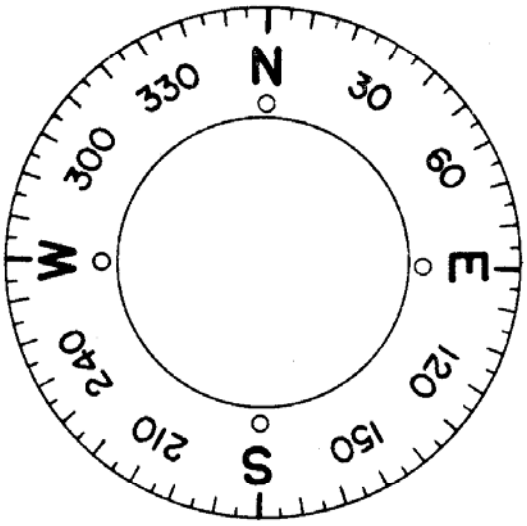


FIG. 1

U.S.C.G.

FIG. 2

BOTTOM OF COMPASS BOX TO BE DRILLED & TAPPED FOR THREE 1" BOLTS AS INDICATED

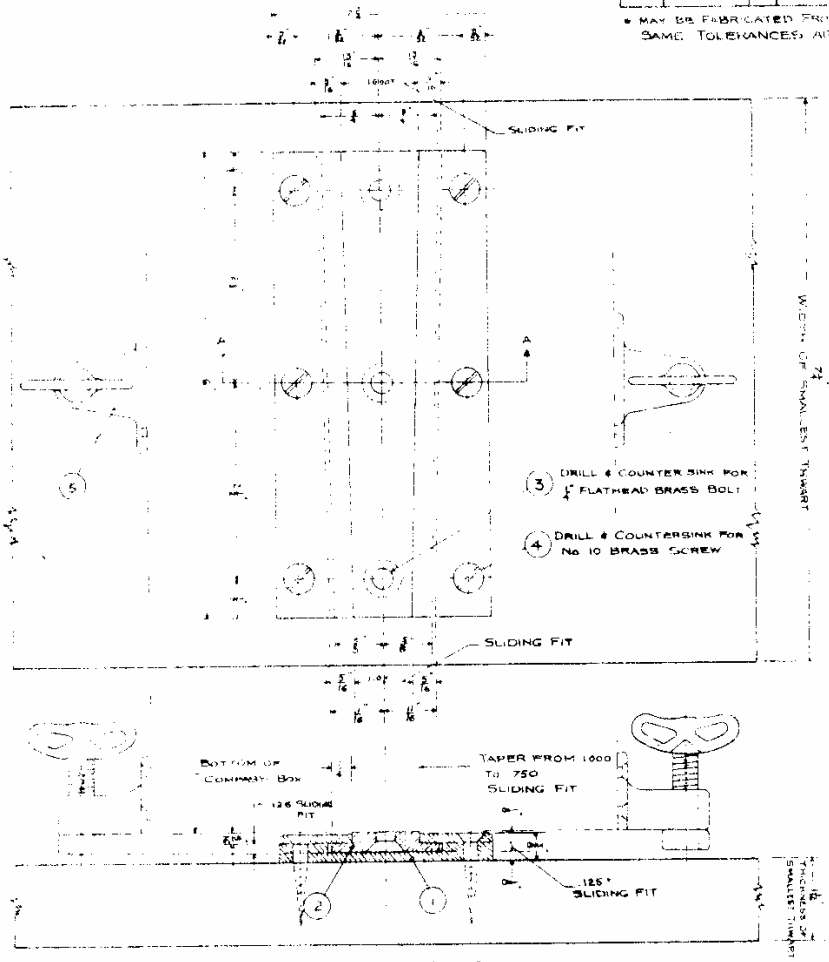
ANTI-SASH RATTLERS TO BE LOCATED ON SIDES OF COMPASS BOX SO THAT WHEN THE WING NUT IS COMPLETELY PACKED OUT THE BOTTOM OF THE ANTI-SASH RATTLERS ARE ALIGNED WITH THE NUT AS SHOWN

TWO UNITS OF PIECE No 1 TO BE SUPPLIED BY COMPASS MANUFACTURER ONE INSTALLED BY LIFEBOAT BUILDER ONE ON SUITABLE THWART FOR NAVIGATING THE OTHER UNDER SUITABLE THWART FOR STOWAGE.

BILL OF MATERIAL

PIECE No	MATERIAL	No	REMARKS
1	BRASS	2	MACHINED AS SHOWN *
2	"	1	MACHINED AS SHOWN *
3	"	3	¼" FLAT HEAD BOLTS - LENGTH TO SUIT STUDS IN COMPASS BOX
4	"	12	No 10 SCREW - LENGTH TO SUIT THWART
5	CAST BRASS	2	ANTI-SASH RATTLER WILLIS FIG No 9 PIKE OR EQUAL

* MAY BE FABRICATED FROM MORE THAN ONE PIECE PROVIDED SAME TOLERANCES ARE ADHERED TO



SECTION "A-A"

BOAT COMPASSES

SKETCH OF STANDARD MOUNTING

UNITED STATES COAST GUARD

ENGINEERING

HEADQUARTERS WASHINGTON D.C.

RESEARCH & DEVELOPMENT DIVISION

SCALE:

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SHEET OF

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