Armor™	
	TECHNICAL INFORMATION

CES-301
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SPECIFICATION FOR CONCRETE VESSELS TO BE LINED WITH BRICK

1. SCOPE

1.1 This specification is meant to provide general guidelines for good brick lining practice when used in a concrete vessel to receive a brick lining. It is not meant to be all-inclusive nor take priority over specifications of designers skilled in the science of concrete process vessel design or experience of contractors who have extensive history installing brick linings in a concrete tank.

1.2 Consult and follow the best practices of concrete construction as recommended by the American Concrete Institute and the Portland Cement Association. The slab on which the vessel rests shall have sufficient reinforcing and strength to support the vessel without any deflections no matter how unstable the ground may be below the slab. The walls, bottom, and reinforcing shall be designed in sufficient size, thickness, and strength, to hold without any deflection of the walls or floor when filled with liquid of specific gravity of the vessel contents at a level of not less than 3" (75 mm) from the top of the vessel. Brick linings are inherently weak in tension and shear, and the external support structure must be sufficient to carry all loads without deflection.

2. BRICK LINED VESSEL DESIGN CONSIDERATIONS

2.1 Brick linings may exhibit growth over time whether through irreversible brick growth or repeated process thermal cycling effects. A brick lining is freestanding by design and is not anchored or bonded to the substrate, thus allowance for this growth must be made. Accordingly, the design of the sides of rectangular or other straight sided vessels shall consider a design along the lines of the following; preference in order given.

2.2 The preferred design assures all walls are bowed outward so that the walls form a continuous outward curve from corner to corner, the distance between opposite walls being greater at the midpoint. The amount of bow outward shall be a minimum of 1% of the length of the longer side and 2% of the length of the shorter side, but in no case less than 1½” (38 mm) or more than 6" (150 mm) out of a straight line, measured at the midpoint. Where excessive or repeated thermal shock may be anticipated, the percentage of the bow should be increased up to 4% of any side. In tanks with near square configuration the percentage should be between 1% and 2%. The curve shall be uniform for the full tank depth and be the same at the bottom as at the top.

2.3 If it is not possible to construct a tank with outwardly bowed walls, the next best method is to construct all walls straight and completely flat with an outward slope (batter) of 7½ to 10 degrees from bottom to top so that the lines are straight, but the inside dimensions are greater at the top than at the bottom. If there is presence of any inward facing bulges or deflections, they must be ground smooth. Unlike the bowed wall

design above, this method of tank construction will require additional consideration in the form of stress relief joints in the brickwork and any cost saving thought to be realized by not bowing the walls will be offset by the longer time and extra cost to install these allowances in the brickwork.

2.4 The least desirable concrete tank design uses walls that are dead straight and vertically true and plumb. Any bow or lean inward of any portion of any wall from bottom to top shall be reason to reject the tank until the condition is corrected. Stress relief joints in the brickwork must also be allowed with this design to insure the brick forces are absorbed. Failure to do so will result in collapse of the brick lining even under relatively moderate operating conditions.

2.5 Good construction practices for the design of reinforced, below grade concrete vessels which are to receive acid resistant brick masonry, should specify a quality grade exterior waterproofing system. This may be particularly important where a high ground water table exists.

3. MEMBRANES

3.1 The selection of the membrane to be employed in the lining shall be dependent on the chemical and thermal conditions anticipated. Best practice dictates the concrete tank should be tested to verify it is completely liquid tight before proceeding with the membrane and brickwork. If the membrane is installed by a different trade than the brickwork, then the membrane should be tested before turning over to the bricklaying contractor. If the bricklaying contractor's scope of work includes both membrane and brick lining installation, then responsibility for the liquid tightness of the composite lining can be assigned to the bricklaying contractor.

4. BRICK AND MORTAR SELECTION AND BRICK THICKNESS CONSIDERATIONS

4.1 Selection of the type of brick and mortar to be used depends on service conditions anticipated and consultation with the installation contractor, vessel designer and mortar and membrane manufacturer should confirm material suitability.

4.2 Brick linings are self-supporting and, therefore, must depend on their thickness for stability. The thickness of the brick lining shall generally be in accordance with the following guidelines:

3.2 In small sump pits and trenches, acid brick laid on edge (2¼" or 2½" thick – 57-63 mm) are acceptable, provided that the depth of the brickwork is not greater than 2' (0.6 m), provided the length of the wall is 20' (6 m) or less, or deeper than 1' (0.3 m) if the wall is longer. In general, a brick thickness of less than 2.25" (57 mm) is not used in a brick lined concrete tank.

4.3 In deeper tanks a single course of nominal 4" (100 mm) thickness of "stretcher" courses of brick laid flat is acceptable if the depth does not exceed 6' (1.8 m) or the length 30' (9 m). If the walls are bowed as noted earlier these limitations do not apply.

4.4 In vessels deeper than 6' (1.8 m) or longer than 30' (9 m) where thermal variations much beyond ambient are to be anticipated two courses are recommended, each of a nominal 4" (100 mm) thickness, to a total thickness of 8" (200 mm).

4.5 Brick linings also provide thermal protection to the membrane. The required thickness of brickwork to provide that insulation shall be verified and considered in addition to stability needs.

5. SHEAR PADS AND EXPANSION JOINTS

5.1 Where walls are bowed as noted in section 2 earlier, expansion joints in walls are typically omitted. If walls are not bowed, then consideration should be given to accommodate potential for irreversible brick growth and growth from thermal expansion/contraction from the process temperatures. Floors must also make allowance for growth. If the floor is flat and not bowed, consult Armor drawing D1025 for suggestions.

5.2 To accommodate wall growth so brickwork does not heave inward it is suggested to consider placing of a compressible rubber pad layer under the brick but on top of the membrane. The pad should be thick enough so that a compression of 50% will satisfy the full anticipated movement at that point.

5.3 Expansion joints in the brickwork may be required in addition to the compressible pads under the brickwork. Expansion joints, especially in tanks will require ongoing maintenance and should only be considered should extreme thermal stresses be anticipated.

5.4 All fixed points such as drains, thermocouple thimbles, pipes, sleeves, and other penetrations though the tank walls, etc. must be points of no movement. If this is not so planned, movement of the brick can potentially shear off the protrusion, or the brick may spall.

6. INSTALLATION OF BRICKWORK

6.1 The contractor shall have a minimum of five (5) years of experience in this specialized field and provide evidence of satisfactory completion of at least three (3) jobs of similar nature.

6.2 For optimum handling of the mortar all brick masonry involving chemically curing mortars should be performed under cover from the elements, and at a minimum temperature of 50˚F (10˚C) and a maximum of 90˚F (32˚C) unless specific arrangements for exceptions are made. The temperature limitations apply not only to the air, but to all substrate with which the masonry will be in contact as well as the materials themselves. In addition, the air temperature must be maintained from start of job until cure is initiated at 5˚F (3˚C) or more above the moisture dew point. All materials to be used must be kept dry and within this thermal range for not less than 48 hours prior to use.

6.3 All mortar mixes shall be made in the proportions indicated by applicable data sheets and specifications, and no water, solvent or other foreign matter shall be added to the mix.

6.4 Mortar that has passed its working life and started to set will be discarded and no attempt be made to reclaim it.

6.5 All joints shall be made full and tight, the brick buttered on three sides and pressed into place. Cut excess mortar cleanly cut off with the trowel, care being taken to prevent smearing and to leave a neat appearance.

7. CLEANUP

7.1 All waste material, spoil, and unused brick and mortar will be removed from vessel interiors.

7.2 Consult mortar technical data sheet for the suggested cleaning solvent for trowels.

8. VESSEL STARTUP

8.1 Before starting up check with Armor for specific instructions regarding the first chemical exposure of the vessel surface.

8.2 Avoid rapid heating or rapid application of pressure on the first cycle and until the lining is fully cured.

8.3 It is good practice, when not in service, to leave vessels full of weak acid to overcome any tendency to develop shrinkage. This is particularly advisable with silicate-based mortars.

9. SAFETY PRECAUTIONS / DISCLAIMER

9.1 Consult current Safety Data Sheets before commencement of work.

9.2 Mixes and applications of this product present a number of hazards. Read and follow the hazard information, precautions and first aid directions on the individual product labels and safety data sheets before using. While all statements, technical information, and recommendations contained herein are based on information our company believes to be reliable, nothing contained herein shall constitute any warranty, express or implied, with respect to the products and/or services described herein and any such warranties are expressly disclaimed. We recommend that the prospective purchaser or user independently determine the suitability of our product(s) for their intended use. No statement, information or recommendation with respect to our products, whether contained herein or otherwise communicated, shall be legally binding upon us unless expressly set forth in a written agreement between us and the purchaser/user. For all Terms and Conditions of Sale see armor-inc.com.

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