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TANK SYSTEM REQUIREMENTS ADVISORY

A Guide for Reviewing the Tank System Portions of a Part B Permit Application

Prepared by

**Ohio EPA
Division of Hazardous Waste Management
RCRA Engineering Section**

OAC Rule 3745-50-44(C)(2) and
OAC Rules 3745-55-90 thru 3745-55-93

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1.0 INTRODUCTION

The advisory's principal purpose is to facilitate Ohio EPA reviews of Part B permit applications which contain proposals for hazardous waste storage and treatment tank systems. The integral parts of this advisory are the completeness checklist and the narrative discussion which is contained in the text. The checklist is structured to enable the reviewer to determine whether an applicant has followed the regulations and touched on each of the applicable requirements in an orderly and logical fashion.

This document provides guidance on how to best implement the Ohio EPA regulations to facilitate permitting decisions for hazardous waste tank storage and treatment systems with statewide consistency. It also provides guidance to the public and regulated community on how Ohio EPA intends to implement its regulations.

More specifically, this advisory describes and discusses the nature of the information an applicant is required to supply in order to comply with the tank rules, primarily the requirements of OAC Rule 3745-50-44(C)(2). Much of this discussion will center on two documents that are required by the rules. The first document is the written assessment of the design for new and existing tanks; and the second document is known as the certification of installation (see also OAC Rule 3745-55-91 and 92). This advisory presents a uniform approach that can be used to determine whether the Part B information submitted as required by Ohio's hazardous waste tank system standards is complete. The tank standards consider, among other things, requirements for proper installation of new tanks, structural integrity, foundation design, corrosion protection, and secondary containment. The tank standards were originally promulgated to address potentially adverse environmental consequences of a spill or release of hazardous waste from tank systems. The principal causes of reported tank failures and therefore potential avenues of contamination were identified as tank fabrication, external corrosion, installation problems, structural failure, spills and overflow due to operator error, and ancillary equipment failure (see also 51 FR 134 at 25422, July 14, 1986).

The advisory is organized to describe and discuss each of the elements of a written assessment. There are four major elements to a written assessment. Each element is discussed in-depth, first as a general section providing regulatory background information. Then, that element is expanded upon in a companion section with specific details on the actual information that would be found in a typical assessment. The Table of Contents indicates sections where the reviewer may quickly find general or specific information on the element(s) of interest. It is recommended that the advisory be considered in its entirety in order to put tank assessments and design parameters into perspective. While what is presented here is not the only approach to complying with applicable tank standards, it is one standardized method to efficiently determine the completeness and technical adequacy of a submittal. It is not intended to be

used in place of a comprehensive tank audit procedure, the current tank rules, or any of the detailed references available from U.S. EPA.

2.0 APPLICABILITY

This document is directed to all tank systems subject to RCRA permitting that store or treat hazardous waste

3.0 DEFINITIONS/ACRONYMS

1. **"Tank"** as defined in OAC Rule 3745-50-10(A)(105):

A stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials which provide structural integrity and support.

2. **"Tank system"** as defined in OAC Rule 3745-50-10(A)(106):

A hazardous waste storage or treatment tank and its associated ancillary equipment and containment system.

3. **"Ancillary equipment"** as defined in OAC Rule 3745-50-10(A)(6):

Any device including, but not limited to, such devices as piping, fittings, flanges valves, and pumps, that is used to distribute, meter or control the flow of hazardous waste from its point of generation to a storage or treatment tank(s), between hazardous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal off-site.

4. **Acronyms:**

ACI	American Concrete Institute
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
FR	Federal Register NACE - National Association of Corrosion Engineers
P.E.	Professional Engineer
STI	Steel Tank Institute
UL	Underwriters Laboratories, Inc.

4.0 RESERVED

5.0 TANK SYSTEM REQUIREMENTS

5.1 Existing versus New Tank Systems

An "existing" tank must be in operation or in the installation process prior to the effective date of the federal regulations, 40 CFR 264.191, July 14, 1986 (see OAC Rule 3745-50-10(A)(31)). OAC Rule 3745-55-91 requires an assessment of the existing tank(s) integrity when that tank system does not have secondary containment. The rule establishes the required time frames (tank age maximum of 15 years) for the addition of secondary containment to an existing tank system that is without containment and not leaking (OAC Rule 3745-55-93(A)(2)-(4)). All tanks without secondary containment require an annual leak/integrity test as per OAC Rule 3745-55-93(I) and if the tank is found to be leaking or unfit for use the owner or operator must comply with the requirements of OAC Rule 3745-55-96 (secondary containment may now be required in accordance with OAC Rule 3745-55-93 if a leak has occurred in any portion of a tank system component that is not readily accessible for visual inspection, e.g., the bottom of an on-ground tank).

A "new" tank system means a tank system that will be used for the storage or treatment of hazardous waste and for which installation has commenced after July 14, 1986 (OAC Rule 3745-5010(A)(72)). New tanks require secondary containment before being put into service (OAC Rule 3745-55-93(A)(1)).

It is important to note that the age of the tank itself or when it was manufactured has nothing to do with the determination of whether it is existing or new; the determination depends upon **when the tank or tank system was or will be installed** to manage hazardous waste. The term "new tank system" means not only newly-manufactured tank systems that will be put into service for the first time but also those pre-existing tank systems that (even if in existence and in use prior to the promulgation date of the regulations) are first installed for hazardous waste treatment or storage. Likewise, an existing tank system that is not being used for the storage of hazardous waste, but is then put into service or converted to use as a hazardous waste storage or treatment tank system subsequent to the promulgation date of the regulations, is considered to be a new tank system (52 FR 134, July 14, 1986). An example of this would be a Permit Modification which proposes today to convert an existing product tank to hazardous waste storage. The requirements of the written assessment and installation certification is now triggered for the "new" tank (see OAC Rule 3745-55-92). It should be noted that a "replacement in kind" (i.e., a replacement tank that meets the same design standards and capacity) requires a Permit Modification as a Class 1 change and some form of documentation may still be required to assure that the proposed replacement tank is sufficiently similar to eliminate the need for additional written assessments.

The required contents of the written assessments for tank systems are similar but vary somewhat between new and existing tanks.

5.2 Information Required and Contents of the Part B application for Tanks

5.2.1 Written Assessment of Tank Systems

Applicability

Owners and operators of new tank systems or components must obtain and submit to the Director, at the time of the submittal of Part B information, a written assessment, reviewed and certified by an independent, qualified, registered professional engineer. The assessment will attest that the tank system has sufficient structural integrity and is acceptable for the storing and/or treating of hazardous waste (OAC Rule 3745-55-92(A)).

For existing tank systems that do not have secondary containment meeting the regulatory requirements of OAC Rule 3745-55-93, a somewhat similar P.E. certified written assessment is required. This assessment is used to determine that the tank system was not leaking or unfit for use (OAC Rule 3745-55-91). Tanks found to be leaking or unfit for use must then comply with the requirements of OAC Rule 3745-55-96.

The information required in both of these assessments as described in the rules are generally similar but there is a fundamental difference. Written assessments for both new and existing tank systems require demonstrations relating to the sufficiency of the tank system's integrity; and a demonstration that the systems are adequately designed and have sufficient structural strength and compatibility with the waste to be stored or treated to ensure that it will not collapse, rupture or fail. Existing tank systems without secondary containment are also examined to determine (via the written assessment) if the tank is leaking or unfit for use so that it would be either taken out of service, repaired, or provided with a secondary containment. The assessments for existing tanks were to be completed within thirty days from December 8, 1988 (OAC Rule 3745-55-91).

It is possible that a facility may propose to permit an existing tank with secondary containment. The facility may question the need to submit a written assessment since OAC Rule 3745-55-91(A) seems to imply that an assessment is only required if the existing tank does not have secondary containment. In this instance, it is important to determine initially if and when the tank is being converted from non-hazardous to hazardous storage (possibly making it a new tank system) and that the secondary containment actually satisfies the requirements of OAC Rule 3745-55-93 (i.e., does adequate secondary containment really exist ?). If it is verified that we are actually dealing with an existing tank system, then the certified written assessment requirement is triggered for this existing tank system. In other words, if the present tank's secondary containment satisfies the rules and the tank can be classified as "existing", DHWM would require a certified written assessment for the permitting process since it still must be determined if the tank system is adequately designed, has sufficient structural strength, and is compatible with the waste(s) to

be stored or treated (OAC Rule 3745-55-91(B)). The preamble for the final tank Rules (51 FR 134, pg.25436) clearly states that “for **both new and existing tank systems**, the final rule requires that the primary tank system be designed properly and that it be compatible with the wastes that are stored or treated”.

The written assessment for new tank systems requires more comprehensive and detailed information as a result of the need for addressing the design considerations for foundation and support requirements and installation procedures for the proposed tank system.

The remainder of this discussion will deal with the installation of new tank systems as they pertain to the Part B application.

Analysis and Design Phases

As indicated above, the written assessment is the facility's way to show the sufficiency of the tank system's integrity and adequacy of design. OAC Rule 3745-55-92(A) (new tanks) provides a focus (although it is not an exhaustive list) as to those items that the written assessment must contain such as information about the foundation, structural supports, seams, connections, and pressure controls (if applicable). The written assessment will allow Ohio EPA to reasonably conclude that the proposed system(s) will meet the standard, i.e., they are adequately designed and that the tank has sufficient structural strength, compatibility with the waste(s) to be stored or treated, and corrosion protection to ensure that it will not collapse, rupture, or fail.

For the reviewer of the proposed tank system, it is necessary that this information be presented not only in a complete manner, but also in a logical sequence that can be easily followed, describing how the analysis has resulted in the particular tank design to satisfy the standards. DHWM views this written assessment as a comprehensive document containing not only the required information as listed in OAC Rule 3745-55-92, but also that described in OAC Rule 3745-50-44(C)(2)(b) - (j) for the rest of the Part B submittal. Therefore, the written assessment in itself can satisfy the requirements for a new tank system installation if it contains all the information necessary to determine if the tank standards are met for the particular waste to be stored or treated.

The assessment may be written by any qualified person, whether or not a registered professional engineer (P.E.), but it must be reviewed and certified by an independent (i.e., an engineer not on the facility's staff or an employee of the owner/operator), qualified (has had training & experience in tank system design and installation), and registered P.E..

Besides the assessment of the design of the tank system, OAC Rule 3745-55-92(B) requires the owner/operator of a new tank system to ensure that proper handling procedures are adhered to in order to prevent damage to the system during installation. Before putting a new tank system or component into use, an

independent, qualified installation inspector or an independent, qualified, registered P.E., either of whom is trained and experienced in the proper installation of tank systems or components, must inspect the system for all possible structural damage or inadequacies. All discrepancies must be corrected before the system is put into use (See also, Section 4.4 Installation Certification Requirements).

Some variation of who actually composes the written assessment can occur. The written assessment contains the technical information (such as calculations, data and materials) required by OAC Rule 3745-55-92(A). It could be prepared by in-house staff of the facility or by outside consultants. The certification of the written assessment, which is typically a signed, one page statement, is prepared by the independent P.E. attesting that the tank system was properly designed. The certification statement should contain the specific language required by OAC Rule 3745-50-42(D).

This will potentially result in the production of two separate documents: the written assessment for the design of the tank system, and the certification statement for the written assessment. The certification statement and assessment must be kept on file at the facility (OAC Rule 3745-55-92(G)).

The following section suggests a format and the types of information that must be contained in the analysis/design portion of any written assessment. The analysis/design portion should be subdivided into discrete elements so that the reviewer can follow the process that led to the resulting tank system design for the particular waste(s) to be handled.

5.2.2 Critical Elements of a Written Assessment

The following is a list of the major elements that should be found in the analysis/design portion of any written assessment. The existence of these elements will assure both that assessment was prepared in a logical fashion and that an orderly review can be conducted and determine whether the applicable standards are met. (NOTE: Each element should be well documented, i.e., a list of references used, and copies of selected pages or a list of formulas used and assumptions should be supplied.)

- 1) Tank analysis and design.
- 2) Tank Foundation analysis and design.
- 3) Ancillary Equipment analysis and design (includes piping, instrumentation, and process flow).
- 4) Secondary Containment analysis and design.

5.3 Discussion of the Critical Elements of a Written Assessment/Examples

5.3.1 Tank Analysis and Design - General

Adherence to nationally accepted design standards would facilitate compliance with the structural integrity requirements of the rules. The design standard for the particular tank or tanks for the written assessment should be stated or listed in the assessment report (**see OAC Rule 3745-55-92(A)(1)**). Tables of applicable design standards for tanks are available from reference documents and can be used to see if an appropriate standard has been proposed or selected given the type of tank material and liquid to be stored. Examples of common standards that will be found in the assessments are UL 142 (standard for steel above-ground tanks for flammable and combustible liquids) and API 650 (Welded steel tanks for oil storage). The permit applicant must also demonstrate that all ancillary equipment complies with similar national design standards such as those listed in ANSI/ASME. These again should be contained in the applicant's report and listed under a subject like "piping". Most facilities purchase tanks based on their needs from a tank manufacturer (e.g. Hamilton Tanks) and the tanks are built according to the standard. The supplier will normally provide their tank drawings showing design and dimensions which the applicant should include in the report.

It is possible that an applicant may want to use a tank or construct one in-house that will be considered a non-standard tank system. Without a tank standard, the facility will need to supply detailed design calculations (i.e., thickness, loading, pressures, corrosion, etc.) to demonstrate that the system is constructed in accordance with sound engineering principles and will safely contain hazardous waste. Non-standard ancillary equipment (i.e., piping) must also be assessed in a similar fashion.

OAC Rule 3745-50-44(C)(2)(b) requires the submittal of the dimensions, capacity, and shell thickness of each tank. Information about tank dimensions and capacity is required for the Part B application so that any tank described in the application can be accurately identified and classified. It helps to ensure that tanks are properly designed and constructed in accordance with recognized guidelines and standards. Each individual waste tank should be described independently in the Part B, with its dimensions and capacity clearly indicated. Each general tank description (i.e., shape, material, inside diameter, outside height, nominal/maximum capacities, wall thickness, appurtenances, etc.), should be accompanied by detailed scale, cross-sectional plans, and elevation drawings that specify all dimensions of the tank. A tank manufacturer's specification sheet should be included with the permit application along with a gauge chart if available indicating capacity per foot of length or height.

OAC Rule 3745-50-44(C)(2)(c) requires a description of the equipment used in the transfer of waste material to storage tanks at the facility be included with the Part B, namely feed systems, safety shut-off, by-pass systems, and pressure controls (e.g., vents). These guidelines and standards are designed to prevent

explosions, fire, emissions of hazardous vapors, and spillage of waste as a result of overfilling or drainage of transfer lines. Much of the information on this equipment will come from the tank manufacturer and descriptions should include statements as to whether or not items such as welded flanges and joints, seal-less valves, seal-less or magnetic coupling pumps, and piping shut off devices are used. The description should address the following system components: feed systems including level sensors and alarm systems (for high levels) and liquid transfer (fill pipe design, connections, couplings, check valves, etc.), safety shut-off or by-pass systems to control overflow situations, and pressure controls (vents, relief valves) for pressure relief if exceedence of normal operating pressure occurs in the tank. It should be noted that the location of pressure-relief vents and the point of vapor release should be detailed in the description of venting devices. The point of vapor release must be noted by the permit applicant so that Ohio EPA may assess the potential safety hazards resulting from the discharge of vapors in a confined area, fire hazards, and possible blockage of vent openings.

In addition, **OAC Rule 3745-50-44(C)(2)(i)** similarly requires owners or operators to provide a description of controls and practices to prevent spills and overflows, as detailed under **OAC Rule 3745-55-94(B)** which states that the owner or operator must use appropriate controls and practices to prevent spills and overflows from tank or containment systems, including at a minimum:

- (1) Spill prevention controls (e.g. check valves, dry disconnect couplings);
- (2) Overfill prevention controls (e.g. level sensing devices, high level alarms, automatic feed shut-off, or by-pass to a stand-by tank); and
- (3) Maintenance of sufficient freeboard in uncovered tanks to prevent overtopping by wave or wind action or by precipitation.

This provision requires appropriate controls and practices to prevent spills during transfer operations, loading or unloading of a tank. Spills can occur at any storage facility because of tank overfilling and drainage from waste transfer hoses. It is important to note that these regulations apply not only to the tank(s) but also to all ancillary equipment including such devices as piping, hoses and pumps that are used in the handling of the waste from its point of generation to the storage tanks and if applicable, from the tanks to a point of disposal on-site or to a point of shipment for disposal off-site. There is no single best device or operating procedure that will suit every situation, however there are some standard procedures for preventing transfer spills and overfills.

Recommended elements for a complete overfill protection system include the following equipment and practices:

- Automatic shutdown (shut-off) controls or automatic flow-diversion controls to prevent overfilling.
- Sensors for detecting the level of liquid in the tank.
- High-level alarms which are activated when an overfill is about occur.
- Provisions for collecting emergency overflow materials into adjacent tanks.
- Daily monitoring of the system by a reliable individual
- Transferring of wastes at established stations equipped with curbing, paving, and catchment facilities.
- Use of dry-connect couplings/check valves on transfer pipes and hoses.
- For uncovered tanks, 14 to 18 inches of freeboard is considered adequate for most tanks.

A Part B Permit application must include a description of the transfer spill/overflow prevention procedures employed at a given facility.

The tank system must be compatible with its contained waste, mixture of wastes or treatment reagents. The report should contain a detailed chemical analysis of the contained waste (see OAC Rule 3745-55-92(A)(2)). To demonstrate the compatibility of stored waste(s), data may be used from publications as Perry's Chemical Engineering Handbook, NACE, facility tests and manufacturer's literature. Tables are available (e.g., Table 4-3 in the OSWER Policy Directive No. 9483.00-1) which present the compatibility of common tank construction materials with various chemicals. The reviewer could use these to spot check incompatibility problems. For instance, a recent Permit Modification tank assessment submittal contained a computer generated analysis of the waste to be contained in each tank (called a "maxmin" report) and numerous data sheets from manufacturers on protective coatings, linings, etc. used in the containment area to demonstrate compatibility of the system with the wastes. The hazardous characteristics of the wastes, as required in the written assessment, will also more than likely be incorporated into OAC Rule 3745-5044(C)(2)(j) which requires for tank systems in which ignitable, reactive, or incompatible wastes are to be stored or treated, a description of how operating procedures and tank system and facility design will achieve compliance with the requirements of OAC Rules 3745-55-98 and 99.

The requirement for the determination of external corrosion factors by an expert is applicable only if the metal tank or any external metal component of the tank

system will be in contact with soil or water (i.e., an underground storage tank, see OAC Rule 3745-55-92(A)(3)). "A metal tank system in contact with water" pertains to contact with in-ground water (high water tables) or saturated soils. It does not typically pertain to the temporary aftermath of a rain fall event. The Ohio EPA expects the corrosion expert to possess both the professional knowledge and related practical experience to be qualified to provide corrosion-control services for metal tanks and/or piping in contact with soil. Independent, registered PEs with appropriate corrosion-protection experience with buried or submerged metal tank systems may also perform the corrosion potential assessment.

Therefore, a tank located in a concrete secondary containment area and elevated on legs would not normally be required to have the corrosion information factors as listed in OAC Rule 3745-55-92(A)(3) included in the written assessment. However, it should be noted, that even though a tank may be above ground and initially assumed that no external corrosion factors are required, the metal piping leaving the tank may be entering the soil and creating a current effect back to the tank. Nearby metal structures can also be inadvertently connected to a tank system, for example, through electrical and/or water system connections. This situation should be prevented by using electrical isolation devices (e.g. insulated joints, flanges, bushings).

In all cases, where a tank is in contact with the soil or water, the information as listed in OAC Rule 3745-55-92(A)(3)(a)(i)-(viii) and (b)(i)-(iii), as determined by a corrosion expert, should be found in the written assessment. Once a corrosion expert has assessed the environmental conditions surrounding a tank system (as required in OAC Rule 3745-55-92(A)(3)(a)(i)-(viii)), he/she will have a good idea of the extent of the corrosion protection measures needed (as required in OAC Rule 3745-55-92(A)(3)(b)(i)-(iii) via OAC Rule 3745-50-44(C)(2)(e)). The rule lists examples of possible corrosion protection materials and methods. Additional detail and information about each approach can be found in the reference source. External corrosion via electric current fields) should not be confused with internal tank corrosion or metal loss) from contact with the wastes stored in the tanks where the use of linings and coatings may need to be incorporated in the design. This internal corrosion should be addressed and covered in the previous section on hazardous characteristics of the wastes and their compatibility with tank construction materials. External corrosion of an aboveground tank system (not in contact with soil or water) may occur from exposure to varying climatic, weather, or atmospheric conditions (i.e. vapor emissions released from stored wastes) around the tank if not protected via coatings and covers. A corrosion assessment should therefore be included and address these possible areas of internal and external corrosion even when dealing with aboveground tank systems.

To avoid premature structural failure, a tank system (i.e. containment, underground piping) should be designed and installed so that it can support expected vehicular loads (see OAC Rule 3745-55-92(A)(4)). In many instances

trucks are moving around tank systems and even entering containment areas to load or unload wastes. The assessment should contain information such as the cover in traffic areas, for example; the cover will be a minimum of 36 inches--30 inches of compacted backfill and 6 inches of asphaltic concrete.

5.3.2 Tank Analysis and Design - Specific

The factors to be considered in the design of a tank are listed below.

The principal and initial factors to be considered are:

- 1) quantity of the liquid to be contained;
- 2) certain properties of the liquid to be contained, mainly,
 - (a) corrosivity,
 - (b) vapor pressure (at maximum anticipated storage temperature), and
 - (c) specific gravity; and
- 3) operating conditions for the tank, e.g., access requirements, connections required and operating temperature range.

The corrosivity of the liquid influences materials selection, e.g., carbon steel, painted, coated or lined carbon steel, stainless steel, and fiberglass.

The vapor pressure determines the selection of an open or closed tank, need for venting and/or vapor control.

The specific gravity of the liquid influences hydrostatic pressure in the tank.

The access and connections determine the need for welded connections, access ports and supports.

The operating temperature range defines the need for materials with adequate notch toughness (i.e., no cold weather brittleness).

Once these major factors are defined, most of the tanks can be specified in terms of existing experience, a large amount of which has been assembled in the various codes and standards.

Some standards or codes are stated in terms of design procedures, e.g., a set of steps using values from various tabulation of data. Other standards or codes are stated in terms of final specifications, e.g., a range of conditions is described and final specifications (e.g., tank wall thickness) is given.

Similarly, standards have been written for the procedures for fabrication, construction, inspection and testing of tanks.

These existing standards, developed by consensus and experience over a period of time, usually deal with the welding of metal tanks. Only recently, such standards have become available for fiberglass-reinforced tanks.

Specific design details should include the following:

Design Standard

Design Standards consist of the specifications of materials, physical measurements, processes and performance of products. They are established by individual manufacturers, trade or professional associations, and national or international standards organizations. Their purpose is to realize operational and manufacturing economics, to increase the interchangeableness of products, and to promote uniformity of definitions of product characteristics.

Design Standards also determine the design practice. When the specifications give data on strength and performance as well as the usual dimensions, it is only necessary to compute loads approximately and then select the nearest standard sizes. Much design effort is thereby saved, especially on detailed drawings and bills of material.

National Standards Organizations

The principal industrial countries have official agencies, called National Standards Organizations, which approve, consolidate, and in some cases establish standards. The German Institute for Norms, and the American National Standard Institute, which issue the DIN, and ANSI (formerly ASA) standards, respectively, are among them. ANSI is a federation of about 900 companies, and 200 trade, technical, professional, labor, and consumer organizations. It does not itself develop standards, but coordinates and promotes the voluntary development of national standards by industries provided that these have been established according to detailed rules for achieving a consensus among producing industries, consumers (through ANSI's Consumer council), relevant government agencies, and other interested parties.

There are about 10,000 approved ANSI standards, dealing with dimensions, terminology and symbols, test methods, and performance and safety specifications for equipment, components, and products. Their major applications are in construction, electrical and mechanical products and processes, piping and welding, heating, air conditioning and refrigeration, information systems and photography. Most activities in the private and public sectors use standardized products and specify them routinely in their purchases. ANSI standards have been embodied in building codes and many other government regulations.

Many of the Design Standards used in the Design and Construction of Hazardous Waste Tank Systems are approved by ANSI. After approval ANSI gives its own Standard Number, e.g., American Concrete Institute's Standard ACI 301-84 "Specifications for Structural Concrete for Buildings," was approved on December 23, 1986, and is now called ANSI/ACI 301-84.

The applicant must specify the specific standard used for the tank design and the date of the applicable standard. Much information about the general applicability of the tank for the storage of hazardous waste is known by knowing the applicable tank standard.

Non-standard tanks will require detailed engineering analysis to verify that such tank can safely be used in a hazardous waste facility.

The applicant must provide full details of the analysis (design calculations), design (selection), and drawings. In preparing the Written Statement the applicant must closely follow the calculation steps in the design standard used.

The Analysis and Design should be clarified with simple sketches such as given in Figure (1).

Corrosion Allowance

Corrosion allowance is defined as the difference between the actual thickness of a tank wall at a given time and the required minimum thickness of the tank wall. Because corrosion is a continuous process, the corrosion allowance decreases the wall thickness. If the rate of corrosion is closely predictable, additional metal thickness over and above that required for the initial operating conditions should be provided at least equal to the expected corrosion loss during the desired service life of the tank.

When corrosion effects are indeterminate prior to the design of the tank, although known to be inherent to some degree in the service for which the tank is to be used, and when corrosion is incidental, localized, and/or variable in rate and extent, the best judgment of the designer must be exercised in establishing reasonable maximum excess tank wall thicknesses.

A minimum corrosion allowance of 1/16 inch should be provided. This minimum allowance may, of course, be increased according to the judgment of the designer.

Service Life

Expected service life is defined as the corrosion allowance divided by the corrosion rate of the waste upon the construction materials of the tank. The expected service life is the amount of time that the hazardous waste can be stored in a tank before the corrosive action of the waste causes the thickness of the tank wall to equal the minimum required thickness. This information on the

expected service life is necessary in determining the frequency of inspection and renewal dates of the permit.

Service Life of the Tank (in years)

$$= \frac{\text{Corrosion Allowance in the Tank Wall Thickness (in inches)}}{\text{Corrosion Rate of the Waste (in inches per year)}}$$

The applicant must provide the expected service life of the tank.

Operating Conditions

The operating conditions that are important in designing a tank for hazardous waste storage include:

- 1) pressure,
- 2) temperature, and
- 3) liquid level.

The shell of a tank should be adequate to withstand specified design pressure. The design pressure is a function of the working pressure of the tank. If the tank is open to the atmosphere, even if through a small tube, then the working pressure is dependent only on the height and specific gravity of the liquid stored in the tank.

For example, if the liquid height is 30 feet and the density of the liquid is 62.4 lb./cu.ft. (the same as water) then the pressure at the bottom of the tank is equal to:

$$(30 \text{ feet} \times 62.4 \text{ pounds})/\text{cubic foot} = 1872 \text{ pounds/square foot} = 13 \text{ pounds/square inch}$$

The strength of a material is also a function of temperature, with the strength of a material declining as temperature increases. However, the effect of temperature need not be considered for metals unless it exceeds 300 degrees F.

The applicant should clearly state the operating conditions. The calculation of resultant stresses on the tank should take into account the following:

- 1) stresses due to hydrostatic head,
- 2) additional stresses imposed by
 - (a) the effects of the weight of the tank components and their contents, and

- (b) the method by which the tank is supported, e.g., supported on a ring-wall or placed on a base or supported on legs.

Sizes of Nozzles and fittings

The size of an overflow outlet (a port or pipe) should be larger than an inlet.

Sizes of Vent Pipes

Vent pipes must be no less than 1 1/4 inch diameter and may vary with tank size up to 4 inches in diameter.

Thickness of Bottom plate

The minimum thickness of the bottom plate of a tank should be 1/4 inch.

5.3.3 Tank Foundation Analysis and Design - General

OAC Rule 3745-55-92(A)(5)(a) requires that design considerations in the written assessment must ensure that tank foundations will maintain the load of a full tank.

The owner or operator and the independent, qualified, registered P.E. must be familiar with the characteristics of the surrounding geological environment and the history of similar structures in the vicinity. This requirement applies to all types of tank systems: aboveground, on-ground, in-ground, and underground. Tank foundation design calculations should be found in the assessment usually on a computation sheet of the facility or consultant. These are often hand written, but should still be presented in a manner that can be followed and be legible. The full load of a tank calculations normally found in the assessment uses the specific gravity 1.0 or the density of water (8.34 lbs/gal) for a liquid waste, but if the density of the waste is determined to be greater than water, using the density of water will result in too low a total weight on the foundation and should be noted and checked.

Information on the design of anchor systems (**see OAC Rule 3745-55-92(A)(5)(b)**) will only be seen in the assessment if the tanks are underground or in-ground and are subject to floatation and/or dislodgement when placed in zones that may be saturated at some time from seasonal precipitation, a floodplain location, storm water runoff, etc.

It should also be noted that as the seismic fault zone is defined in OAC Rule 3745-54-18, there will be no assessment for design considerations for dislodgement needed for any locations in Ohio. Even though much of Ohio is located in a seismic impact zone ($> .1g$), there are no Holocene faults present

near the surface in Ohio. They are all much greater than 200 feet below the surface.

Frost heave calculations (see **OAC Rule 3745-55-92(A)(5)(c)**) should be present in virtually all written assessments due the fact of Ohio's northern climate allows tank systems that are underground or partially underground to be subjected to forces from frost heave and thaw instability. Piping systems are subject to the greatest potential problems from frost and thaw damage, since they are generally at shallower depths and are weaker structures than the tanks. Other site specific climatic conditions may need to be addressed and present in the assessment if the overall design of the system (as height, weight, geometry) and its location/orientation these extreme climatic conditions warrant. Examples would be tank system design based on wind and snow loads.

5.3.4 Tank Foundation Analysis and Design - Specific

This is perhaps the most difficult (non-standardized) part of the written assessment to review. Specific standards for the design of foundation are not available, probably because of the complexity of the subject and the numerous solutions available to the engineer for solving varying site conditions.

The most important aspect in the review is that the design must have been prepared by a qualified professional such as a geotechnical or a foundation engineer.

A properly designed foundation is one that transfers the load throughout the soil without over stressing the soil. Over stressing the soil can result in either excessive settlement or shear failure of the soil, both of which cause damage to the structure. Thus, geotechnical and structural engineers who design foundations must evaluate the bearing capacity of soils.

It is customary to construct the entire structure over a concrete pad. This is called a matt foundation.

Slab foundations should also be investigated for shear, either beam type or punching shear.

Extreme care should be taken to insure that shear reinforcement is accurately placed and properly anchored, especially in the slab.

Investigate the shear stresses in the region of the columns. Also investigate the amount of steel needed for negative bending moments. Specific design details should include the following:

Subsurface

1. A description of the subsurface conditions at the tank site must be given in order to estimate the amount of settlement and the probable results.

(This information may be obtained by exploratory work, consisting of making deep boring and by review of experience and history of similar structures in the vicinity.)

2. Soil bearing tests and/or other information defining conservative soil bearing values.
3. Calculations of the design loading, weight of the tank and its contents when full.
4. An estimate of the amount of settlement showing that the settlement will not continue to a point where the tank bottom is below the surrounding ground surface.

Tank grade

5. The grade or surface upon which the tank bottom will rest should be constructed as a minimum one (1) foot above the surrounding ground surface.
6. The top 3 or 4 inches of the finished grade should consist of clean sand, gravel, crushed stone (not over one inch in maximum size), or some similar inert material which can be readily shaped to the proper contour.
7. The finished tank grade should be crowned from the outer periphery to the center. At a minimum it should have a slope of 1 in 120.

(This crown will partly compensate for slight settlement which is likely to be greater at the center.)

Ringwall

A sketch giving details of a typical ringwall is given in Figure (2). Not all designs will use a ringwall.

8. The ringwall should be reinforced against temperature changes and shrinkage, and to resist the lateral pressure of the fill.
9. The minimum reinforcement in the ringwall should be 0.002 times the cross sectional area of the ring wall above-grade, with additional reinforcement as required to resist the lateral earth pressure.
10. Top of concrete ringwall should be smooth and level.

Footing

11. Elevation of the foundation above grade.
12. Footing depth and width.
13. The latest edition of American Concrete Institute's (ACI's) "Building Code Requirements for Reinforced Concrete," (ACI 318 and ANSI A89.1) should be used for stress values and material specifications. The applicant must provide full details of analysis (design calculations), design (selection), and drawings.
14. Strength of concrete should be at least 3,000 psi after 28 days.

5.3.5 Tank Ancillary Equipment Analysis and Design - General

OAC Rule 3745-50-44(C)(2)(d) states the owner or operator of a tank system must provide a diagram(s) of the piping, instrumentation, and process flow for each tank system. The intent of this requirement is to ensure that each tank facility is designed in a manner that minimizes the possibility of releasing waste to the environment. Diagramming of a tank system's piping, instrumentation, and process flow can range from a detailed schematic drawing of all relevant tank system components to a complex blueprint drawn to scale. Relevant tank system components that should be shown on a diagram are:

- Fill lines (inlets);
- Draw-off lines (outlets);
- Piping, including directional changes (inside diameter, materials of construction, etc.);
- Pumps and agitators (type, hp, capacity, etc.);
- Flow meters (capacity);
- Monitors for temperature and pressure;
- Flame arresters
- Gauging (measuring) lines;
- Level alarms (details on high level control to prevent the overflow of tanks);
- Valves (type);
- Vents (pressure relief vents, diameter, materials of construction);
- Leak-detection devices (type);
- Protection against frozen lines and equipment/heating and cooling systems;
- Manholes and other openings;
- Floating suction arms, if any;
- Drainage; and
- Corrosion-control system (type).

Included in the application, there should be enlarged detailed drawings of complicated portions of a system to emphasize relevant features as well as accompanying documentation with a tank system diagram to explain briefly why particular information was selected.

5.3.6 Tank Ancillary Equipment Analysis and Design - Specific

The following is a list of hardware items associated with tanks:

- 1) Tank Structural Supports,
- 2) Pumps,
- 3) Piping,
- 4) Flame Arresters and Detonation Arresters, and
- 5) Tank Blanketing Valves.

Structural Tank Supports

The design of structural supports for tanks is another matter for which there are no specific design standards. Similar to the general guidance for foundations for tanks, the most important aspect in the review is that the design must have been prepared by a qualified professional such as a structural engineer.

The applicant must provide full details of the analysis (design calculations), design (selection), and drawings.

Pumps

A pump is a machine which transfers a gas or liquid from a source or container through pipes to another container or receiver. Pumps are necessary for all tank storage/treatment facilities. There are three (3) broad classes of pumps:

- 1) centrifugal,
- 2) rotary, and
- 3) reciprocating.

The most common pump used in hazardous waste operations is the centrifugal pump.

Specific design details should include the following:

- 1) capacity,
- 2) pump head,
- 3) properties of liquid to be handled, and
- 4) materials of construction.

The capacity of a pump is determined by the volume of the liquid to be handled, given in gallons per minute (gpm). A design safety factor is used, in case the flow exceeds the normal capacity.

The height the liquid must be lifted is called pump head, given in Feet of liquid.

The properties of the liquid to be handled, are mainly:

- 1) viscosity,
- 2) volatility,
- 3) corrosiveness, and
- 4) amount of solids in suspension.

These details will determine the type of pump to be used and the materials of construction.

The Centrifugal Pump Characteristic curve /Performance Curve (Pump Curve) of a centrifugal pump is the plot of the total head, in feet of liquid, to be lifted and the capacity of the liquid to be delivered in gallons per minutes operating at a constant speed. It is important to note that at any fixed speed the pump will operate along this curve and at no other points. For a given impeller diameter and constant speed, the head of liquid to be lifted by a centrifugal pump decreases as the flow rate increases. Other operating characteristics also vary with the flow rate. These can be presented on individual graphs. However, since the independent variable (flow rate) is the same for all, common practice is to plot all characteristics together on a single graph.

Manufacturer's Performance Curves show pump performance at a limited number of calibration speeds. The desired operating point can be outside the range of the published curves. It is then necessary to estimate a speed at which the pump would give required performance.

A typical chart of pump curves is given in Figure (3).

The applicant must provide full details of the analysis (design calculations), design (selection), drawings and the pump curves of the pumps specified.

Piping.

Piping consists of the following items:

- 1) Pipes,
- 2) Flanges,
- 3) Bolts,
- 4) Gaskets,
- 5) Valves,
- 6) Fittings, and
- 7) Piping Supports.

Piping is an integral part of the tank systems. It is necessary to review its analysis and design to assure that the piping was designed for its intended use, and not as an arbitrary arrangement which has a significant risk of failure.

Specific design details should include the following:

- 1) Codes and Standards used,
- 2) Material of construction,
- 3) Details of Piping Joints,
- 4) Details of Piping supports,
- 5) Details of Valves,
- 6) Design pressure and temperature,
- 7) Effect of temperature, e.g., increased pressure due to heating of fluid in the piping system,
- 8) Impact forces such as hydraulic shock, wind, vibration, etc.,
- 9) Weight of piping and weight of medium transferred, and
- 10) Effect of thermal expansion and contraction.

Flame Arresters and Detonation Arresters

Flame arresters and detonation arresters are mechanical devices that are installed on a storage tank nozzle or in a flammable vapor piping system. The arresters' functions are:

- 1) to allow the passage of vapor under normal operating conditions, and
- 2) to stop and extinguish any flame front propagating through the flammable vapor/air mixture.

Stopping the flame protects the storage tank, or the equipment located in the piping system, from catastrophic damage that may result from uncontrolled ignition.

[Fire may be defined as rapid oxidation with the evolution of light and heat.

Fire can occur and continue only where the following three factors are present:

- 1) Fuel,
- 2) Oxygen, from the air or from another source, and
- 3) ignition source with sufficiently high Temperature to ignite the fuel and maintain combustion.

Fire can be prevented and/or extinguished by eliminating any one of the above three factors.]

The flame arrester prevents the propagation of fire, by absorbing and dissipating heat, from the fire on one side of the flame arrester, to below the ignition point of the vapors on the opposite (or interior) side of the arrester. To accomplish this, the area of the metal surface must be sufficient to absorb the heat, and the metal itself should possess high heat conductivity.

This principle was discovered by Sir Humphrey Davy. He is better known for his invention of the Miner's Safety Lamp. Davy's experiments proved that flame would not pass through a set of small tubes placed side by side. He later discovered that the length of the tubes could be shortened when the diameters were reduced. The flame arrester, as it is in use today, evolved from this work.

When storage tanks contain liquids having flash points of 110 degree F or below, flame arresters should be provided at all tank openings.

However, because of exposure to ignition sources, environment, or special operations such as the heating of heavier oils, flame arresters are recommended for liquids having flash points above 110 degrees F.

The End-of-Line Flame Arrester is the flame arrester mounted at the end of a storage tank vent pipe. This arrester permits normal tank breathing, while preventing the flash back of uncontrolled deflagration (the ignition of the vapor cloud in the open atmosphere) from flashing back past the arrester into the piping and the tank's vapor space.

The Detonation Arrester stops and extinguishes detonations, confined deflagrations and unconfined deflagrations. When tanks are connected or manifolded through common piping to a central processing unit, the closed piping systems, or vapor recovery / collection systems, create unique flammable vapor safety hazards. The piping runs in the vapor recovery systems tends to be longer and more complex. Potential sources of ignition may actually be present within the vapor collection system itself. An ignition within a piping system can result in a flame front that accelerates very rapidly and generates extremely high pressures. A low speed, low pressure confined deflagration can readily transition into a high speed, high pressure confined deflagration and then to a detonation, which is a flame front moving at the speed of sound in the vapor/air mixture.

A variety of arresters are available. The choice of a proper arrester depends on factors such as the location of the arrester with respect to the ignition source and the flammable properties of the vapor/air mixture.

Tank Blanketing Valves

Tank Blanketing is the injection of a non-reactive (inert) gas into the vapor space of a liquid storage tank. The gas, usually Nitrogen, is injected as necessary in order to maintain a non-flammable atmosphere in the vapor space.

The Blanketing Pressure is usually very low, less than 1 pound per square inch gauge (PSIG).

The purpose of tank blanketing is to maintain a blanket of gas above the stored liquid to prevent the entrance of atmospheric air into the tank system.

Atmospheric air contains oxygen, moisture and other contaminants which could cause internal tank corrosion or degradation of the stored product.

Tank blanketing is also used to prevent the collapse of the tank from the vacuum created during pump-out of the stored liquid or atmospheric cooling.

The Blanketing Valve is a device that senses the pressure in the vapor space of a storage tank and controls the flow of an inert gas into the vapor space so that the tank pressure can be maintained within an acceptable range.

A blanketing valve uses a supply of high pressure gas to maintain a blanket of low pressures gas above the stored material in a storage tank.

A blanketing valve is typically mounted on top of a storage tank along with a pressure/vacuum conservation vent and an emergency pressure relief vent. Piping from the blanketing gas supply is connected to the valve inlet, and the valve outlet is piped to the tank. A tube called Sense Line runs from the tank's vapor space to the sense port of the blanketing valve. This tube transmits tank pressure to the sense chamber, thus supplying control pressure for the valve. The pressure at which the main valve opens and flows is called the Set Point.

The blanketing valve provides primary vacuum relief for the tank. It opens and supplies gas to the vapor space when pressure decreases to the valve's set point. When vapor space pressure increases, the valve reseals. The pressure/vacuum relief vent is sized to take care of over pressure and vacuum conditions brought about by unforeseen conditions or equipment failures. The pressure setting of the vent is set at a slightly higher setting than the blanketing pressure in the tank but below the maximum pressure the tank can withstand. Similarly, the vacuum pallet is set at a higher vacuum setting than normal operating conditions bring

about and below the maximum vacuum pressure the tank could withstand. A flame arrester is provided for additional protection in the event of inert gas failure. An emergency relief vent is also placed on the tank, the setting being slightly above the conservation vent pressure setting.

A Pilot Operated Blanketing Valve consists of two separate valves (the main valve and the pilot valve) working in tandem. The main valve inlet connects to the high pressure gas supply source. The valve outlet is piped to the tank vapor space. The piston in the main valve is held in its closed position by supply line pressure accumulated in the dome volume (the space between the poppet in the pilot valve and the piston in the main valve). This accumulated pressure is called the Dome Pressure.

Opening and closing of the main valve is controlled by the pilot valve. The tank's vapor space pressure is transmitted, via the sense line, to the diaphragm sense chamber. Decreases in the sensed pressure result in movement of the pressure balanced poppet in the pilot valve. The poppet unseats and allows gas to flow out of the dome volume. This results in a reduced pressure in the dome volume and opening of the main valve piston to allow gas to flow into the tank. Increases in tank pressure cause the poppet to reseal, the dome pressure to increase and the main valve piston to reseal.

Pilot operated blanketing valves provide very accurate sensing of the tank pressure and also provide full open flow through the main valve at a pressure very near to the blanketing valve set point.

A Spring Operated Blanketing Valve functions in a manner similar to a spring loaded valve. The valve's inlet is connected to the supply gas and the outlet is connected to the tank. The pressure balanced poppet provides the primary seal. The tank's vapor space pressure is transmitted, via the sense line, to the diaphragm sense chamber. Decreases in the sensed pressure result in movement of the sealing, pressure balanced poppet. This results in flow through the valve, into the tank. Increases in tank pressure cause the poppet to reseal, stopping flow into the tank.

Spring operated blanketing valves are often used on smaller tanks and vessels and in situations where the very small dead band provided by a pilot operated device is not considered necessary.

Sizing and Specification of Blanketing Valves: Data concerning the flow characteristics of blanketing valves is available from the manufacturer. This information gives the maximum flow of gas through the device for a specific supply gas pressure and a specific set point, and is used in the selection of the proper blanketing valve to meet the flow requirements of the tank system.

5.3.7 Secondary Containment Analysis and Design - General

OAC Rule 3745-50-44(C)(2)(g) requires the Part B application to contain detailed plans and description of how the **secondary containment (SC)** system for each tank system is or will be designed, constructed, and operated to meet the requirements of paragraphs (A) to (F) of Rule 3745-55-93 of the Administrative Code.

OAC Rule 3745-55-93(A)(1) - (5) defines the federally mandated implementation schedule for installation of SC for new and existing tanks. Under these regulations, all hazardous waste tank systems, except those granted a variance from this rule (OAC Rule 3745-55-93(G)), will be required to be either installed or retrofitted with SC, including a leak detection capability, within a specific period of time. Basically all new tank systems or components must provide SC prior to their being put into service (OAC Rule 3745-55-93(A)(1)).

OAC Rule 3745-55-93(B)(1) - (2) states that SC systems must be:

- (1) Designed, installed, and operated to prevent any migration of wastes or accumulated liquid out of the system to soil, ground water, or surface water at any time during the use of the tank system; and
- (2) Capable of detecting and collecting releases and accumulated liquids until the collected material is removed.

This rule simply lists the necessary characteristic design properties of an effective secondary containment (SC) system and the following rules elaborate upon them in (C) for Design Parameters, in (D) for devices that will meet the criteria, and in (E) for the further requirements of these systems. The requirements and exceptions for ancillary equipment is followed in (F).

OAC Rule 3745-55-93(C)(1) - (4) state the minimum design parameters of SC systems required to satisfy paragraph (B) of this rule.

(1) Compatibility and Strength:

The SC liner or material of construction must be compatible with its contained waste(s) to ensure the containment's integrity. The detailed chemical and physical analysis of the waste(s) is used with information from various sources (i.e. Perry's Chemical Engineer's Handbook, liner manufacturers, on-site facility testing, etc.) to demonstrate that the stored waste is compatible with its SC. The SC must also have sufficient strength and thickness to prevent failure owing to pressure gradients (vertical and horizontal), physical contact with the waste to which it is exposed, climatic conditions, and the stress of daily operation (including nearby vehicular traffic). Horizontal pressure gradients generally are

only a concern for an in-ground or an underground tank located in a region with a high ground water table. A tank's SC must be compatible with a stored waste and structurally secure enough to retain any released waste material until it can be removed. Any test results indicating the containment material ability to withstand climatic extremes such as temperature, excessive moisture, UV radiation, winds, etc. would be appropriate to be included in the Part B to predict the ability of the material to remain secure. Site-specific conditions must be considered and discussed (i.e. traffic, heavy equipment, precipitation, frost, etc.) to determine if a SC system has sufficient strength to maintain its integrity in the presence of operational stresses.

(2) Foundation Integrity:

Requires the SC to be properly supported by a foundation or base to prevent failure from settlement, compression, or uplift, including the residual effects of installation. The placement, stress calculations, and type of material used for backfill around and below the SC and ground water table proximity are the likely parameters to be discussed in the application.

(3) Leak-Detection Capability:

The SC system must have a leak-detection system that is designed and operated to detect the failure of either the primary or secondary containment structure, that will detect the presence of a release within 24 hours, unless it can be demonstrated that existing detection technologies or site conditions will not permit detection within 24 hours. The design and description of the leak-detection system found in the application is one of the most important components of a containment system. Types of early warning monitoring systems that may be used and described for underground and in-ground tank systems are those that monitor the storage tank excavation (i.e. wire grids, observation wells, and U-tubes). Leak sensors used in these systems include thermal-conductivity sensors, electrical-resistivity sensors, and vapor detectors. Interstitial monitoring (monitoring for leaks between the walls) of a dual-walled tank is commonly seen. Daily visual monitoring for leaks can and should be incorporated for above ground tank systems along with the sensing elements just mentioned.

(4) Adequate Drainage:

The rule requires the design submitted in the application to have a SC system that is sloped or otherwise designed and operated so that liquids will drain to the leak-detection system and can thus be removed. The spilled or leaked waste must be removed from the system within 24 hours, or in timely a manner as possible if the owner/operator can demonstrate that removal cannot be accomplished in 24 hours. A commonly submitted design, for above-ground tanks in a diked containment area, is for any liquid release to follow the sloped floor of the containment area directing all wastes to a sump lined with compatible

materials. A liquid level detection device is installed on the sump which sends an alarm indicating a release requiring attention.

OAC Rule 3745-55-93(D) lists the types of devices that must be included (at least one or more) for secondary containment of tanks:

- 1) A liner (external to the tank);
- 2) A vault;
- 3) A double-walled tank; or
- 4) An equivalent device approved by the director.

OAC Rule 3745-55-93(E)(1) - (3) states the specific regulatory requirements for each type of tank SC system.

(1) External liner system requirements:

- (a) Designed to contain 100% of the capacity of the largest tank within its boundary;
- (b) Designed or operated to prevent run-on or infiltration of precipitation into the SC system unless the collection system has sufficient excess capacity (the precipitation from a 25 year, 24 hour rainfall) to contain run-on or infiltration;
- (c) Free of cracks or gaps;
- (d) Designed and installed to surround the tank completely and to cover all surrounding earth likely to come into contact with the waste if it is released from the tank(s), (i.e. capable of preventing lateral as well as vertical migration of the waste);
- (e) Constructed with chemical-resistant water stops in place at all joints, if any (for concrete liners only); and
- (f) Provided with an impermeable interior coating or lining that is compatible with the stored waste and that will prevent migration of wastes into the concrete (for concrete liners only).

The design and operation of the external liner submitted in the application must provide a complete "envelope", preventing both lateral and vertical migration of released material. Diking and curbing (e.g. concrete) are usually incorporated around an aboveground tank in conjunction with a liner to contain any released material and to prevent run-on and infiltration into the SC area. The material that is usually the most effective for the construction of a SC excavation liner is a synthetic, flexible membrane (FML). Other materials, such as clay, bentonite, soil cement, and asphalt can be used, if they meet the impermeability and durability

performance standards for an excavation liner (i.e., for the life of a tank). OAC Rule 3745-55-93(C)(4) requires that the containment system be sloped or designed to contain spills; therefore, any liner should have a minimum slope of 1/4 inch per linear foot to a dry well or a collection sump to allow liquids to drain for collection and removal. Cracks and gaps can develop in concrete for several reasons but all can be minimized by following accepted design and installation practices. Another design consideration for concrete liners is compatibility of the liner and waste. Coatings are very commonly incorporated for concrete containment areas (dikes) in both the waste storage and traffic areas. Since concrete is porous, the interior must be provided with a compatible, impermeable coating or lining to prevent migration of wastes into the concrete and demonstrated by the applicant to possess these qualities (via suppliers product specs). In addition, information on the compatibility of the seals used in the joints should also be included. For concrete liners all joints must be constructed with chemical-resistant water stops in place. Water stops must be chemically compatible with the wastes in a liner.

(2) Vault System Requirements:

- (a)** same as (E)(1)(a);
- (b)** same as (E)(1)(b);
- (c)** Constructed with chemical-resistant water stops in place at all joints (if any);
- (d)** Provided with an impermeable interior coating or lining that is compatible with the stored waste and will prevent migration of the waste into the concrete;
- (e)** Provided with a means to protect against the formation of and ignition of vapors within the vault, if the waste being stored or treated meets the definition of ignitable or reactive waste.
- (f)** Provided with an exterior moisture barrier or be otherwise designed or operated to prevent migration of moisture into the vault if the vault is subject to hydraulic pressure.

A vault, generally constructed of concrete, is typically an underground chamber with a roof that will contain any released tank contents. There may be one or more tanks contained within a vault and it may or may not be backfilled. In addition to ease of inspection and repair, early warning and material recovery are facilitated in a vault without backfill. An inert backfill material can be used as one method of fire protection when storing ignitable hazardous waste, though other methods/systems are available without backfilling to reduce the risk of fire and explosion. When the concrete is coated with an impermeable material, the vault

will be able to contain leaks from the tank and provide protection from potentially corrosive soil. Water stops must be chemically compatible with the waste(s) in a vault. All vault openings require waterproof seals. Since concrete is one of the most common construction materials for a vault and is porous and likely to crack, the interior must be lined with a compatible, impermeable barrier to prevent releases and demonstrated by the applicant to possess these qualities (via suppliers product specs, ACI waterproofing guide, etc.). A tank contained in a building may be considered to be within a vault. The building, with a basement structure, must meet all of the requirements of OAC Rule 3745-55-93(E)(2) concerning design capacity, run-on and infiltration, water stops, interior lining, moisture barrier, and ignitable/explosive vapors.

(3) Double-walled tanks must be:

- (a)** Designed as an integral structure so that any release from the inner tank is contained by the outer shell;
- (b)** Protected, if constructed of metal, from both corrosion of the primary tank interior and of the external surface of the outer shell (i.e. via coatings, cathodic protection, etc.); and
- (c)** Provided with a built-in continuous leak detection system (detection within 24 hours unless otherwise demonstrated).

A double-walled tank is essentially a tank within a tank (jacket), with a vacuum, pressurized, or liquid-filled space between the inner and outer walls. Guidelines for the aspects of design of underground, steel, double-walled tanks can be found in the Steel Tank Institute (STI) publication on the standards which should be referenced and discussed in the application.

OAC Rule 3745-55-93(F) states that ancillary equipment must be provided with secondary containment (e.g. lined trenches, jacketing, double-walled piping) that meets the requirements of paragraphs **(B)** and **(C)**, except for:

The potential for leakage from **straight runs** of aboveground welded piping, seal-less pumps and valves, and pressurized aboveground piping (with auto-shutoff) is substantially lower than for certain other ancillary equipment, therefore the requirements for SC can be waived as stated above. Most often the containment for ancillary equipment (pumps and valves) will be integrated with the tank(s) SC system (e.g., located within the same containment dike as the tanks. When this is not feasible, however, a separate SC system specifically designed for the ancillary equipment will have to be provided and submitted in the application (e.g., liners and sumps to collect pump and valve leaks). Examples of SC systems for piping that may be described in applications include; lined trenches (covered or open-topped), concrete trenches, double-walled piping and jacketing (aboveground piping only).

OAC Rule 3745-50-44(C)(2)(h)(i) - (ii) states the information that must be provided for tank systems for which a variance from the requirements of Rule 3745-55-93 of the Administrative Code is sought, and as provided by paragraph (G) of OAC Rule 3745-55-93. OAC Rule 3745-55-93(G) provides the details on the information the Director needs to grant a variance from the SC requirements. OAC Rule 3745-55-93(H) lists the procedures that must be followed to request and implement a variance from the SC requirements. The applicant may obtain a variance by demonstrating either a technology-based (i) or risk-based (ii) compliance with the SC requirements. The details can be found in the rules and further discussion is beyond the scope and intent of this document.

5.3.8 Secondary Containment Analysis and Design - Specific

The design of secondary containment for tanks is another matter for which there are no specific design standards. Similar to the general guidance for foundations for tanks, the most important aspect in the review is that the design must have been prepared by a qualified professional such as a foundation/structural engineer.

Minimum Capacity (Volume) of Secondary containment is given by the equation below.

$$\begin{aligned} \text{Minimum Capacity} &= (\text{Volume of the largest tank placed in the secondary} \\ &\quad \text{containment} \\ &\quad + \text{Volume of 25-year, 24-hour rainfall for the region}) \end{aligned}$$

The applicant must provide the capacity of the secondary containment. In addition to being able to contain the above volume of the wastes, the secondary containment, the supports of the secondary containment and the foundation must be able to transfer the load of this volume of wastes throughout the soil without over stressing the soil. Over stressing the soil can result in either excessive settlement or shear failure of the soil, both of which cause damage to the structure. Thus, geotechnical and structural engineers who design secondary containments must evaluate the bearing capacity of soils.

The applicant must provide full details of the analysis (design calculations), design (selection), and drawings of the secondary containment. The information provided should include the bearing pressure of the soil and details on how and when it was determined. The applicant must also provide information to show that the secondary containment liner or material of construction is compatible with its contained wastes.

5.4 Installation Certification Requirements

OAC Rule 3745-55-92(B) states the items of the tank system that are to be inspected for proper installation before placing it into use:

- (1) **Weld breaks;**
- (2) **Punctures;**
- (3) **Scrapes of protective coatings;**
- (4) **Cracks;**
- (5) **Corrosion; and**
- (6) **Other structural damage or inadequate construction/installation**

The intent of this rule is to ensure that new tank systems and components are properly handled during installation to prevent damage that may lead to or cause a release of waste to the surrounding environment. The installation inspection applies to both new tank systems and components, where component means either the tank or its ancillary equipment (these rules also include reinstalled and replacement tank systems and components). Note that the definition of "tank system" in OAC Rule 3745-50-10(A)(106) includes the containment system. Therefore the installation certification should include the construction/installation inspection results of the secondary containment components (i.e. foundation, liners, floors, walls, etc.) to assure it has been installed as designed. Most reputable tank manufacturers or major tank system suppliers will provide a qualified inspector who is trained in the proper installation procedures for a procured tank system. If a P.E. is used for the inspection he/she cannot be employed by the tank system owner or operator. All irregularities must be remedied before the tank system is covered, enclosed, or placed in use.

OAC Rule 3745-55-92(C) specifies the requirements for backfill material and the backfilling process for a new underground tank system or component. These requirements were developed to minimize the possibility of external corrosion from the surrounding environment and to ensure that the equipment is properly supported. The tank manufacturer often provides the specifications for backfill material and placement and the inspector will examine the material and placement plans prior to installation.

OAC Rule 3745-55-92(D) requires tightness testing of tanks and its ancillary equipment prior to being covered, enclosed, or placed in use and necessary repairs made to prevent leaking equipment from being placed into operation. For all types of tanks, testing for tightness should be done at operating pressure using air, inert gas, or water and performed by leak-testing experts. An underground tank should be tested for tightness hydrostatically or with air pressure, before being placed in the ground. Piping (above and below ground) should be tested hydrostatically at 150% (but not less than 50psi) or pneumatically at 110 % of the maximum anticipated system pressure.

OAC Rule 3745-55-92(E) requires ancillary equipment to be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction. Faulty installation of piping and pipe fittings is a major cause of leaks and spills at hazardous waste storage facilities. The

rule lists references that may be used as guidelines for the proper installation of piping systems.

OAC Rule 3745-55-92(F) states that the owner/operator must provide the type and degree of corrosion protection recommended by an independent corrosion expert on the information provided under OAC Rule 3745-55-92(A)(3). To ensure that a new tank system has adequate corrosion protection, the owner or operator must use a corrosion expert to supervise field fabricated installation of corrosion protection, particularly for a cathodic protection system.

OAC Rule 3745-55-92(G) requires the owner/operator of a new tank system to obtain and keep on file at the facility written statements by those persons required to certify the design of the tank system in accordance with the requirements of (B) through (F) of this rule, that attest the tank system was properly designed and installed and that repairs, pursuant to paragraphs (B) and (D) of this rule were performed. The P.E. who certifies a tank system's structural integrity, the installation inspector, the tightness tester, the corrosion expert, and anyone else who has supervised a portion of the design and installation of a new tank system or component must document that the tank system is in accordance with the requirements of OAC Rule 3745-55-92.

Materials accompanying and supporting these statements might include "as-built" installation drawings and photographs of tank and piping components. The certification statements must be kept on file indefinitely at the tank facility.

OAC Rule 3745-50-44(C)(2)f) states that new tank systems require a detailed description of how the tank system(s) will be installed in compliance with paragraphs (B) to (E) of OAC Rule 3745-55-92 of the Administrative Code. The requirements of paragraphs (B) and (E) have been previously discussed in this document in the section for OAC Rule 3745-55-92(B) on page 7. For the Part B application, the owners or operators must provide a detailed description of the new tank(s) system installation describing the tank handling and installation procedures, the type and installation of backfill, the tightness testing results and methodology, and the installation of ancillary equipment.

6.0 LIST OF REFERENCES:

1. U. S. EPA, Office of Solid Waste, Technical Resource Document for the Storage and Treatment of Hazardous Waste in Tank Systems, OSWER Policy Directive No. 9483.00-1, EPA/530-SW-86-044 (Washington, DC: December 1986).
2. U.S. EPA, Federal Register, Hazardous Waste Management System; Standards for Hazardous Waste Storage and Treatment Tank Systems and Generators;, 40 CFR Parts 260, 261, 262, 264, 265, 270, and 271, Vol. 51, no.134 (Washington, DC: July 14, 1986).
3. U.S.EPA, Office of Waste Programs Enforcement, Hazardous Waste Tank Systems Inspection Manual, OSWER 9938.4 (Washington, DC: September 1988).
4. Perry, R.H., Green, D.W., et al., Perry's Chemical Engineer's Handbook Sixth Edition, McGraw Hill, New York, 1984, pp. 105-109.
5. Roark, R.J., Formulas for Stress and Strain, Sixth Edition, McGraw Hill, New York, 1989.
6. Hudson, R.G., The Engineers' Manual, Second Edition, Wiley, New York, 1963.
7. Megyesy, E.F., Pressure Vessel Handbook, Third Edition, Pressure Vessel Handbook Publications, Tulsa, Oklahoma, 1975.
8. ACI Committee 317, Walter E. Kunze, Chairman, and others: Reinforced Concrete Design Handbook, ACI Publication SP-3, Third Edition, American Concrete Institute, Portland Cement Association, Concrete Reinforcing Steel Institute, Detroit, 1965.
9. AISC, Manual of Steel Construction, Ninth Edition, American Institute of Steel Construction, Inc., Chicago, 1992.
10. Gaylord, E.H. Jr., Gaylord, C.N., Design of Steel Structures, Second Edition, McGraw Hill, New York, 1972.
11. Gaylord, E.H. Jr., Gaylord, C.N., Structural Engineering Handbook, Third Edition, McGraw Hill, New York, 1990.

7.0 NEW TANK SYSTEM COMPLETENESS EVALUATION CHECKLIST

		<u>Complete (Y/N)</u>	<u>Location of Information</u>
1.0	<u>Tank System Description</u>		
1.1	Provide a general description of the type (i.e. aboveground, underground), material of construction, volume, and number of tanks, as well as the specific location of each tank.	_____	_____
2.0	Information and Contents of the Written Assessment/Part B Application *		
	Provide the necessary information for the critical elements that are to be contained in the written assessment for the design, analysis, and installation of the tanks, foundation, secondary containment, and ancillary equipment. Include at minimum the following sections for each tank (identical tanks and waste may be grouped):		
2.1	Tank Analysis and Design Section		
2.1.1	Tank standard used in design (e.g. UL 142), date of the standard, and analysis of why particular standard incorporated in the design.	_____	_____
2.1.2	If no tank standard, has facility supplied detailed design calculations to demonstrate sound engineering principles of construction?	_____	_____
2.1.3	Dimensions, capacity, and shell thickness of tank via manufacturer's spec sheet and detailed scale, cross-sectional plans, and elevation drawings.	_____	_____

2.1.4

Contents of the tank;

- a) Properties/hazardous characteristics of waste liquid (detailed chemical analysis of contained waste) and;

- b) Has compatibility of stored wastes with tank construction materials and wastes themselves been demonstrated?

- c) Specific gravity, vapor pressure and, maximum storage temperature.

- d) **volatile organic content**, B.P., and flash point,

- e) pH range and corrosion behavior.

2.1.5

Indicate whether ignitable, reactive, or incompatible wastes are to be managed in the tanks.

If yes;

- a) Has the waste been treated, rendered, or mixed before placement in the system so that it is no longer ignitable or reactive by definition?

- b) Does the design of the system protect against ignition or reaction?, e.g. nitrogen blankets, O₂ monitoring, flame arresters, vent design, etc.

	c) Does the design of the tank system incorporate emergency use only?	_____	_____
2.1.6	Operating Conditions of Tank System		
	a) Describe how the operating pressure, temperature, and liquid level resulted in tank design incorporated.	_____	_____
	b) Describe corrosion compatibility with tank material selection. Include discussion of corrosion allowance and expected service life of tank(s).	_____	_____
	c) Describe materials and equipment used (e.g. coatings) to provide external/internal protection and corrosion protection measures used to ensure continued structural integrity and suitability of each tank system for handling hazardous waste.	_____	_____
2.1.7	External Corrosion Factors Determination		
	a) Is the metal tank in contact with soil or water? (i.e. underground tank) If so then;	_____	_____

- b) Has a corrosion expert determined the corrosion factors of the system (i.e. cathodic, stray current, etc.) and recommended the type and degree of protection needed for the system in the written assessment?

- c) If tank is aboveground, has design incorporated any external corrosion protection from exposure to varying climatic, weather, or atmospheric conditions around the tank?

2.1.8 Protection from vehicular traffic

- a) Does the assessment contain information on the design and installation of the system (i.e. containment, underground piping) so that it will support expected vehicular loads? (e.g. cover in traffic areas)

2.1.9 Feed Systems, safety cutoff, bypass systems, and pressure controls

- a) A description is required of the equipment used in the transfer of waste material to storage tanks, namely feed systems, safety cutoff, bypass systems, and pressure controls (e.g. vents).

- b) The description should address the following system components:

	Feed systems including level sensors and alarm systems (for high levels) and liquid transfer (fill pipe design, connections, couplings, check valves, etc.		
	Safety cutoff or bypass systems to control overflow situations.		
	Pressure controls (vents, relief valves) for pressure relief if exceedence of normal operating pressure occurs in the tank.		
	The location of the pressure-relief vents and the point of vapor release should be detailed in description of venting devices, so that potential safety hazards (fire, confined area of vapor discharge) may be assessed.		
2.1.10	Controls and Practices to Prevent Spills and Overflows (similar to 2.1.9 requirements)		
	a) Description of controls and practices to prevent spills and overflows during transfer, loading, or unloading of tank(s). Including at a minimum:		
	Spill prevention controls (e.g. check valves, dry connect couplings);		
	Overfill prevention controls (e.g. level sensing devices, high level alarms, auto-feed cutoff, or bypass to a standby tank); and		

	Maintenance of sufficient freeboard in uncovered tanks to prevent overtopping	_____	_____
	b) 2.1.10 applies also to all ancillary equipment including such devices as piping, hoses, and pumps that are used in the handling of the waste from its point of generation to the storage tank(s) and if applicable from the tanks to a point of disposal on-site or to a point of shipment for disposal off-site.	_____	_____
2.1.11	Describe how the given tank system will satisfy the Organic Air Emission Standards for Tanks under the requirements of Subpart CC. [IN THE FUTURE]	_____	_____
2.2	Tank Foundation Analysis and Design Section		
2.2.1	Design considerations required in the written assessment must ensure that tank foundations will maintain full load of the tank. Specific design calculations should include:	_____	_____
	a) Description of subsurface conditions and soil bearing tests.	_____	_____
	b) Calculations of design loading, weight of tank and contents when full, and estimated amount of settlement.	_____	_____

- | | | |
|--|--|--|
| c) Frost heave effect calculations and other climatic concerns such as wind and snow loads effects on tank geometry. | | |
| d) Information on tank grade, description of ringwall (if used). | | |
| e) Design calculations and design basis of footings with references and drawings. | | |
| f) Details on footing analysis including elevations, depth, and width calculations and strength of concrete. | | |
| g) Information on the design of anchor systems if tanks are underground or in-ground and subject to floatation and/or dislodgement* when placed in zones of saturation (water). | | |

* **Note** as the seismic fault zone is defined in the Rules, there will be no assessment for design considerations for dislodgement (via fault movement) needed for any locations in Ohio.

2.3 **Ancillary Equipment and Design**

2.3.1	Provide a diagram(s) of piping, instrumentation and process flow for each tank system. The diagramming can range from a detailed schematic drawing of all relevant tank system components to a complex blueprint drawn to scale.		
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2.3.2	Details of the design analysis and selection of the relevant tank		
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system components associated with the tank(s) should be provided:

- a) Tank Structural Supports - no specific design standards. _____
 - b) Pumps/Agitators -design details used to determine the type to be used and materials of construction. _____
 - c) Piping (includes pipes, flanges, bolts, gaskets, valves, fittings, nozzles, and piping supports). Specific design details should include materials of construction, details of piping joints, piping supports and valves, design pressure, effect of temperature (thermal expansion /contraction), and **codes/standards*** used. _____
- *The permit applicant should demonstrate that all ancillary equipment complies with similar national design standards (as tanks) such as those listed in ANSI/ASME.
- d) Other relevant tank system components that should be shown on a diagram are: fill lines (inlets), draw-off lines (outlet), flow meters (capacity), gauging (measuring lines), level alarms, vents (diameter, materials of construction), leak detection devices (type), manholes and other openings, floating suction arms (if any), drainage, and corrosion-control system (type). _____

**2.4 Secondary Containment
Analysis and Design**

2.4.1 The application is required to contain detailed plans and description of the design, construction and operation of the secondary containment (SC) system for each tank system.

2.4.2 The minimum design parameters of SC systems to satisfy the rules must include analysis of:

a) Compatibility and Strength

A detailed chemical and physical analysis of the waste(s) used with information from various sources demonstrating that the stored waste is compatible with its SC.

Does the design indicate that the SC has sufficient strength and thickness to prevent failure owing to pressure gradients, physical contact with the waste, climatic conditions, and the stress of daily operations (e.g. vehicular traffic?)

Test results indicating the containment material's ability to withstand climatic extremes such as temperature, moisture, UV radiation, winds, etc.

Site-specific conditions discussed (i.e. traffic, heavy equipment, precip, frost) to determine if the SC system

has sufficient strength in the presence of operational stresses.

b) Foundation Integrity

The SC is properly supported by a foundation or base in order to prevent failure from settlement, compression, or uplift, including the residual effects of installation.

The placement, stress calculations, and type of material used for backfill around and below the SC are discussed in the application.

c) Leak-Detection Capability

The design and description of the leak-detection system found in the application will detect the failure of either the primary or secondary containment structure and the presence of a release within 24 hours, unless it can be demonstrated otherwise.

d) Adequate Drainage

The design submitted has a SC system that is sloped or otherwise designed and operated so that liquids will drain to the leak-detection system (e.g. lined sump with liquid level detection and alarm) and can thus be removed within 24 hours unless otherwise demonstrated.

2.4.3 Types of Devices for SC

The Rule lists the types of devices that must be included (at least one or more) for SC of tanks. These include a liner (external to tank), a vault, a double-walled tank, or equivalent device approved by the Director.

An **external liner system** is the most likely device that a design will be submitted for aboveground tank storage. [See the complete tank advisory document for details on the other devices listed.]

- a) The design must contain 100% of the capacity of the largest tank within its boundary.
- b) The design or operation (e.g. diking & curbing) prevents run-on or infiltration of precipitation into the SC system unless the collection system has sufficient excess capacity (25 yr rainfall) to contain the run-on or precip.
- c) Design and installed so that a release from the tank(s) will not migrate laterally or vertically into the surrounding earth.

The containment system (e.g. concrete/liner) has a minimum slope of 1/4 inch per linear foot to a dry well or a collection sump to allow liquids to drain for collection and removal.

The containment area is free of cracks or gaps and the design discusses methods of their minimization (e.g. waterstops, installation practices).

The design has considered the compatibility of the concrete liner and waste. The application should contain information on **coatings** planning to be used from the manufacturer addressing compatibilities with the stored waste.

Information on the compatibility of the seals (e.g.: waterstops) used in the joints.

2.4.4 Secondary Containment for Ancillary Equipment

- a) The design indicates that the ancillary equipment is provided with secondary containment (e.g. lined trenches, jacketing, double-walled piping) that meets the requirements of section 2.4.2. except for those piping systems, pumps, and valves discussed in OAC rule 3745-55-93(F)(1) - (4).

2.5 **Certification of Written Assessment and Installation**

- 2.5.1** The owner/operator of new tank systems or components must submit with the rest of the Part B submittal, a written assessment reviewed and certified by an

independent P.E. attesting that the tank system has sufficient structural integrity and is acceptable for the storing and/ or treating of hazardous waste.

This determination can be made when the combined contents of the written assessment/Part B* includes all of the information for the critical elements found under section 2 in the checklist.

- 2.5.2** The owner/operator must provide a detailed description of how the new tank(s) system will be installed with respect to the tank handling and installation procedures, the type and installation of backfill, the tightness testing results and methodology, and the installation of ancillary equipment.

- 2.5.3** Before putting the new tank system into use, an independent installation inspector or qualified P.E. must inspect the system for structural damage or inadequacies.

The installation certification along with the written statement by the certifier that attests that the system was properly designed and installed must be kept on file at the facility.

- 2.5.4** The installation certification should include the construction/installation inspection results of the secondary containment components (i.e. foundation, liners, floors, walls, etc.) to assure it has been installed as designed.

2.5.5 The certification of the written assessments(s) must contain specific language as found in OAC rule 3745-50-42(D) and signed by an independent PE.

2.5.6 The final Part B application submittal contains the written assessment for the design of the tank system, the certification of the review of that assessment (written statement by P.E.), and the certification of proper installation.

*** RES views this written assessment as a comprehensive document containing not only the required information as listed in OAC rule 3745-55-92, but also that described in OAC rule 3745-5044(C)(2)(b) - (j) for the rest of the Part B submittal. Therefore, the written assessment in itself can satisfy the requirements for a new tank system installation if it contains all the information necessary to determine if the tank standards are met for the particular waste to be stored or treated.**

8.0 Certification Statement for Written Assessment for the Design of the Tank System

I attest that I am an independent, qualified, registered professional engineer.

I have reviewed the (Describe document and date) written assessment and I attest in writing that the tank system has sufficient structural integrity and is acceptable for the (Specify storing and/or treating) of hazardous waste.

The assessment shows that the foundation, structural support, seams, connections, and pressure controls are adequately designed and that the tank system has sufficient structural strength, compatibility with the waste(s) to be stored or treated and corrosion protection to ensure that it will not collapse, rupture, or fail.

The assessment includes, at a minimum, the following information:

- (1) Design standards according to which tank(s) and/or the ancillary equipment are constructed,
- (2) Hazardous characteristics of the waste(s) to be handled,
- (3) For new tank systems or components in which the external shell of a metal tank or any external metal component of the tank system will be in contact with the soil or with water, a determination by a corrosion expert of:
 - (a) Factors affecting the potential for corrosion,
 - (b) The type and degree of external corrosion protection that are needed to ensure the integrity of the tank system during the use of the tank system or components,
- (4) Design considerations to ensure that:
 - (a) Tank foundations will maintain the load of a full tank, and
 - (b) Tank system will withstand the effects of frost heave.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Professional Seal

Signature of the Registered Professional Engineer*

***Ohio Revised Code Section 4733.18 Exemptions from registration**

- (A) The state board of registration for professional engineers and surveyors may issue temporary certification to individuals under the following conditions and qualifications:
- (1) A person not a resident of and having no established place of business in this state, practicing or offering to practice the profession of engineering or surveying in Ohio, when such practice does not exceed sixty continuous calendar days in any calendar year; provided such person is legally qualified by registration to practice the said profession in his own state in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in this chapter. The board shall establish the fee for a temporary certificate of registration issued under division (A)(1) of this section.
 - (2) A person not a resident of and having no established place of business in this state, or who has recently become a resident thereof, practicing or offering to practice herein for more than sixty days in any calendar year the profession of engineering or surveying, if he has filed with the state board of registration and has paid the required fee, such temporary certificate of registration to continue only for such time as the board requires for the consideration of the application for registration; provided such a person is legally qualified to practice said profession in his own state in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in sections 4733.01 to 4733.23 of the Revised Code;
- (B) The following persons are exempt from sections 4733.01 to 4733.21 of the Revised Code:
- (1) An employee or a subordinate of a person holding a certificate of registration or an employee of a person holding temporary certification under division (A)(1) of this section or exempted from registration by division (A)(2) of this section; provided his duties do not include responsible charge of engineering or surveying work;
 - (2) Officers and employees of the government of the United States while engaged within this state in the practice of engineering or surveying, for said government;
 - (3) An engineer engaged solely as an officer of a privately owned public utility;
 - (4) This chapter does not require registration for the purpose of practicing professional engineering, or professional surveying by an individual, firm, or corporation on property owned or leased by said individual, firm, or

corporation unless the same involves the public welfare or the safeguarding of life, health or property or the performance of engineering or surveying which relates solely to the design or fabrication or manufactured products.

9.0 Certification Statement for the Installation of the Tank System

I attest that I am an independent, qualified, installation inspector or an independent, qualified, registered professional engineer, who is trained and experienced in the proper installation of tank systems or components.

I have supervised the installation of the tank system (Describe tank system and date) and I attest that proper handling procedures were adhered to in order to prevent damage to the system during installation, and that the tank system was properly installed and that repairs pursuant to the installation activities (1) and (3) were performed.

The installation included the following activities:

- (1) Prior to covering, enclosing, or placing a new tank system or component in use, I have inspected the system for the presence of any of the following items:
 - (a) Weld breaks
 - (b) Punctures
 - (c) Scrapes of protective coatings,
 - (d) Cracks
 - (e) Corrosion, and
 - (f) Other structural damage or inadequate construction/installation, and that all discrepancies were remedied before the tank system was covered, enclosed, or placed in use.
- (2) New tank systems or components that were placed underground and that were backfilled were provided with a backfill material that is noncorrosive, porous, homogeneous substance and that was installed so that the backfill was placed completely around the tank and compacted to ensure that the tank and piping are fully and uniformly supported.
- (3) All new tanks and ancillary equipment were tested for tightness prior to being covered, enclosed, or placed in use. If a tank system was found not to be tight, all repairs necessary to remedy the leak(s) in the system were performed prior to the tank system being covered, enclosed, or placed into use.
- (4) Ancillary equipment were supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.
- (5) The piping system installation procedures described in "American Petroleum Institute (API)" publication 1615 (November 1979), "Installation of Underground Petroleum Storage Systems," or ANSI standard B31.3,

“Petroleum Refining Piping,” and ANSI standard B31.4, “Liquid Petroleum

Transportation Piping System,” were used (where applicable) as guidelines for proper installation of piping systems.

- (6) For new tank systems or components in which the external shell of a metal tank or any external metal component of the tank system will be in contact with the soil or with water, the owner or operator has provided corrosion protection recommended by an independent corrosion expert, based on the following information:
 - (a) Factors affecting the potential for corrosion;
 - (b) The type and degree of external corrosion protection that are needed to ensure the integrity of the tank system during the use of the tank system or components.
- (7) The installation of a corrosion protection system that was field-fabricated was supervised by an independent corrosion expert to ensure proper installation.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Professional Seal

*Signature of the Installation Inspector or
Registered Professional Engineer**

*** Ohio Revised Code Section 4733.18 Exemptions from registration**

- (A) The state board of registration for professional engineers and surveyors may issue temporary certification to individuals under the following conditions and qualifications:
- (1) A person not a resident of and having no established place of business in this state, practicing or offering to practice the profession of engineering or surveying in Ohio, when such practice does not exceed sixty continuous calendar days in any calendar year; *provided such person is legally qualified by registration to practice the said profession in his own state in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in this chapter.* The board shall establish the fee for a temporary certificate of registration issued under division (A)(1) of this section.
 - (2) A person not a resident of and having no established place of business in this state, or who has recently become a resident thereof, practicing or offering to practice herein for more than sixty days in any calendar year the profession of engineering or surveying, if he has filed with the state board of registration and has paid the required fee, such temporary certificate of registration to continue only for such time as the board requires for the consideration of the application for registration; provided such a person is legally qualified to practice said profession in his own state in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in sections 4733.01 to 4733.23 of the Revised Code;
- (B) The following persons are exempt from sections 4733.01 to 4733.21 of the Revised Code:
- (1) An employee or a subordinate of a person holding a certificate of registration or an employee of a person holding temporary certification under division (A)(1) of this section or exempted from registration by division (A)(2) of this section; provided his duties do not include responsible charge of engineering or surveying work;
 - (2) Officers and employees of the government of the United States while engaged within this state in the practice of engineering or surveying, for said government;
 - (3) An engineer engaged solely as an officer of a privately owned public utility;
 - (4) This chapter does not require registration for the purpose of

practicing professional engineering, or professional surveying by an individual, firm, or corporation on property owned or leased by said individual, firm, or corporation unless the same involves the public welfare or the safeguarding of life, health or property or the performance of engineering or surveying which relates solely to the design or fabrication or manufactured products.

Figure 2 Foundation with Concrete Ringwall

ADVISORY
Tank System Requirements
October 27, 1997

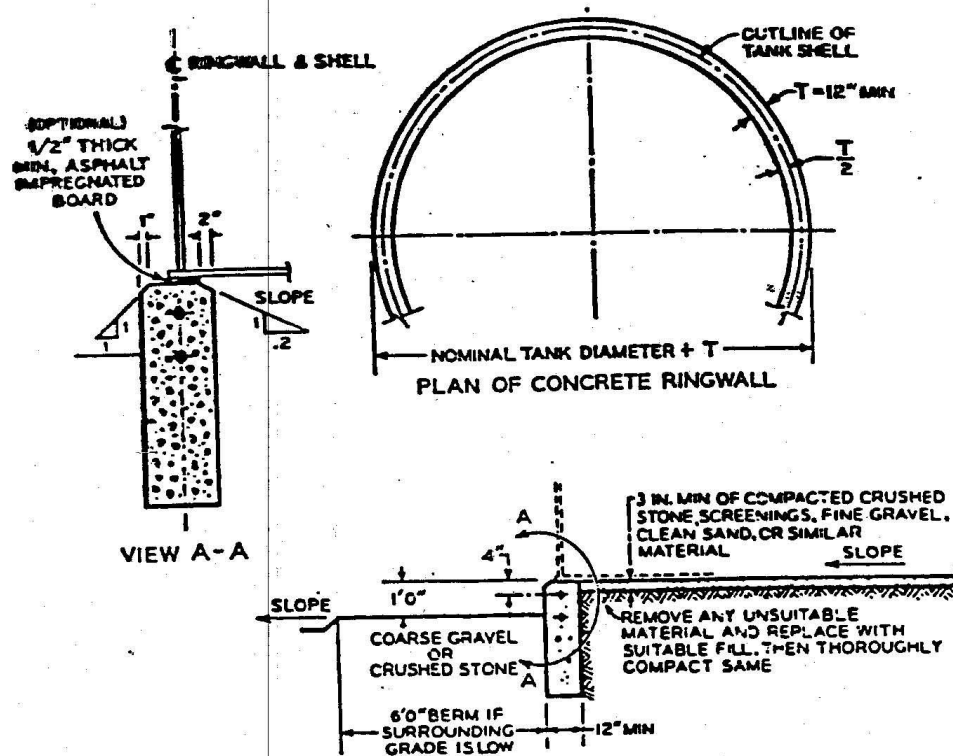


Figure (2) Foundation with Concrete Ringwall

Figure 3 Pump Curves

ADVISORY
Tank System Requirements
October 27, 1997

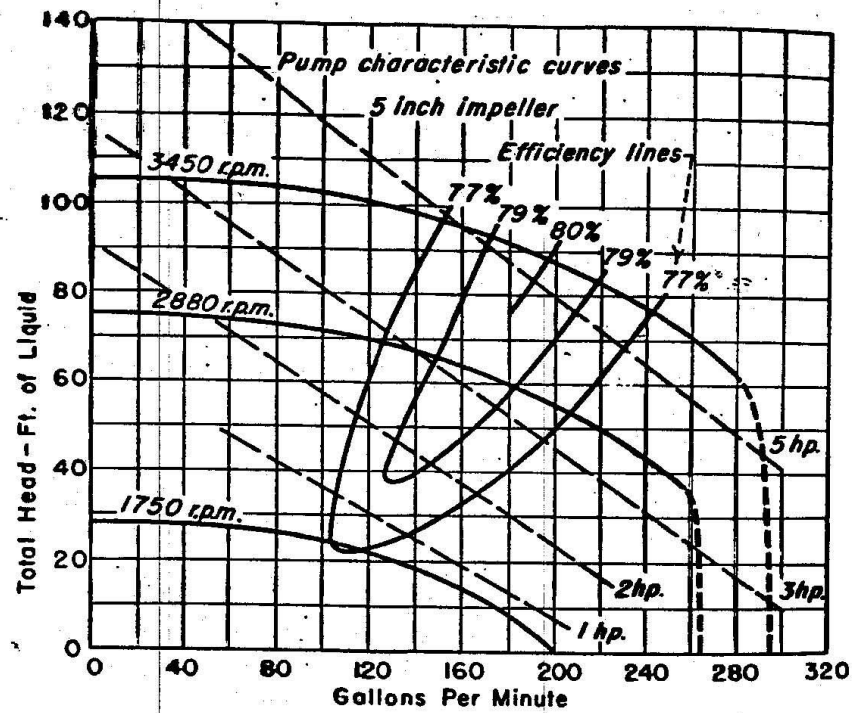


Figure (3) Pump Curves