MarineFAST®
SEWAGE TREATMENT SYSTEMS

SCIENCO/FAST®
a division of Bio-Microbics, Inc.

DESIGN GUIDELINES

— Building FAST® Systems Into Ships' Tanks

SCOPE

These design guidelines are intended to assist naval architects and engineers in determining the feasibility of and the requirements for building FAST® sewage treatment systems into ship's tanks.

The guidelines are general in nature, are subject to change without notice and shall not be used for design without prior review and written approval by FAST® Systems specific as to each case.

GENERAL

The FAST® process is unique in that its application is relatively independent of tank shape. Therefore, the process can usually be built into ship's tanks.

For most marine applications, the process requires two tanks:

1. A Media Tank to convert raw sewage into water and
2. A Wet Well to provide chlorine contact volume and/or to act as a sump for automatic control of discharge pumps.

The Media Tank is sized by the organic load and the Wet well is sized by the hydraulic load. The sizing and other requirements for these tanks depend upon:

1. The effluent standard to be met.
2. Whether or not long term sludge storage will be required and the length of the storage period required.
3. The types of domestic wastewater to be treated.
4. The number of persons to be served.
5. Whether vacuum or conventional toilets will be employed.
6. Whether chlorine or UV disinfection will be employed.

USCG & IMO REQUIREMENTS

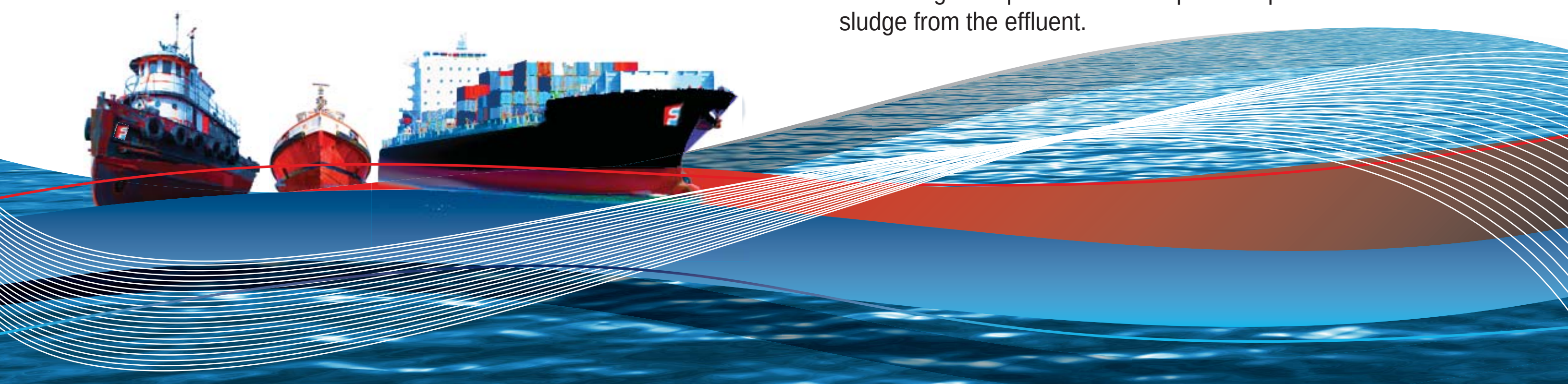
1. These certifications are based upon a ten day test.
2. The regulations do not require performance testing of the individual system after installation and the question of performance after the ten day period is not addressed.
3. These regulations also incorporate a loophole which permits a system to meet the requirements using dilution rather than removal of BOD5 and TSS.

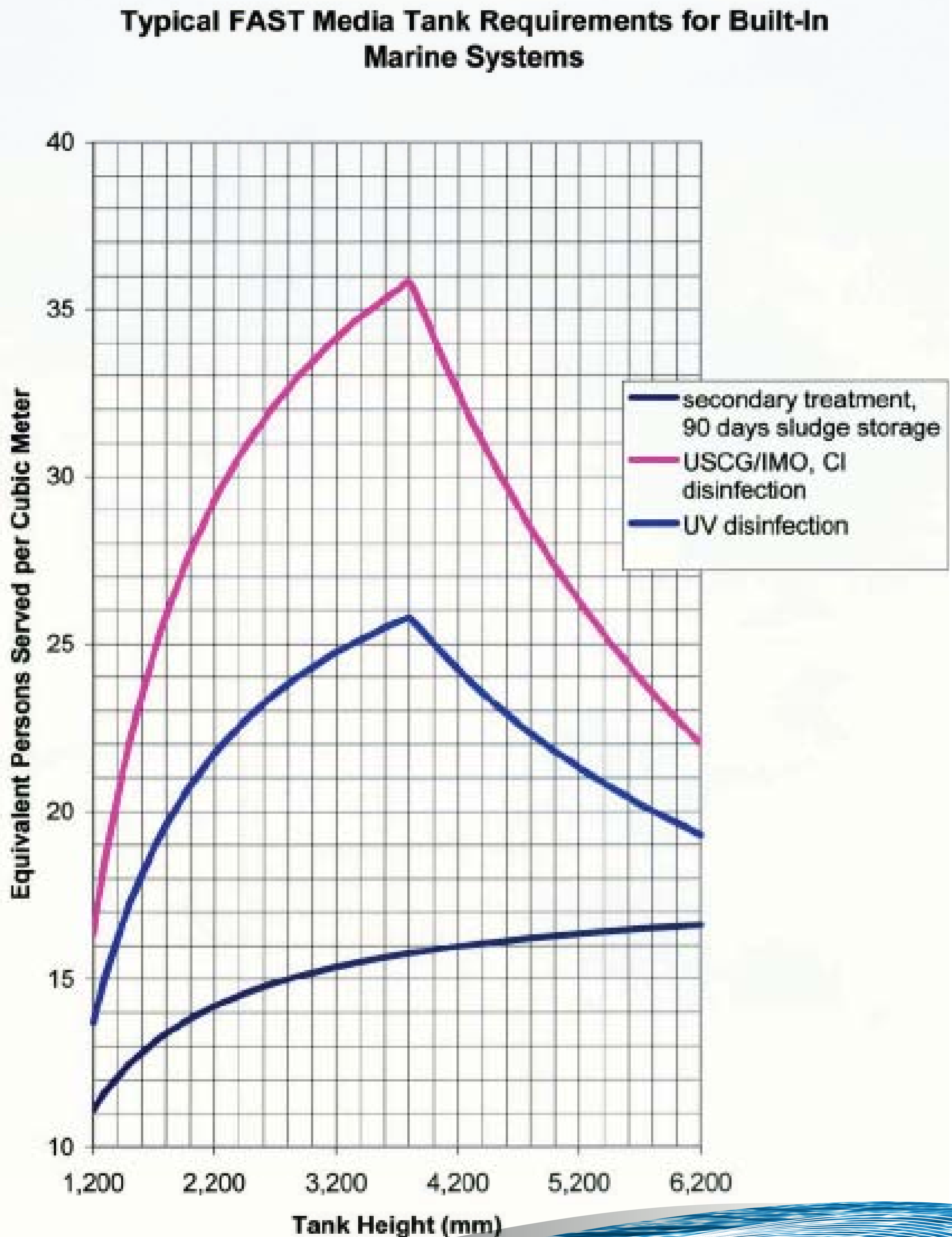
Secondary Treatment

1. Based upon a 30 day average, EPA defines secondary treatment as removal of 85% of applied BOD5 and TSS and effluent containing an average of not more than 30 mg/l of either parameter (45 mg/l average during a 7 day period).
2. In industrial applications where diluting water might be added to the water for process purposes, the required effluent parameters must be adjusted for the dilution.

That is, if 2 gallons of seawater are added to 1 gallon of wastewater to produce chlorine or for any other reason, the diluted effluent must contain not more than 10 mg/l BOD5 and TSS.

3. Achieving this performance requires separation of residual sludge from the effluent.





Typical FAST Media Tank Requirements for Built-In Marine Systems
Equivalent Persons Served per Cubic Meter
40
35
30
25
20
15
10
1,200
2,200
3,200
4,200
5,200
6,200
Tank Height (mm)
secondary treatment, 90 days sludge storage
USCG/IMO, Cl disinfection
UV disinfection

Sludge Storage

1. Residual sludge is a by-product of the FAST® process, as it is of any process capable of removing BOD5 and TSS.

2. The sludge comprises non-biodegradable materials and those biodegradable materials which have not been fully oxidized to CO_2 and water.

3. Process tanks of practical size will produce a residual sludge and that sludge can be separated from the effluent and stored for separate disposal.

4. A system designed to meet minimum USCG and IMO requirements does not require long term sludge storage.

5. Many FAST® units incorporate internal sludge storage for periods ranging from 90 days to one year. Such long storage periods can be useful to vessels which never leave controlled waters.

6. If the vessel does leave controlled waters from time to time, the stored sludge can be discharged at sea.

Types of Domestic Wastewater

1. Marine regulations define sewage as human waste and the water which transports that waste (black water). Gray water and ground food waste from the galley are not included in that definition.

SEWAGE SERVICE FACTORS	
Type of waste	**factor**
blackwater (bw)	1.00
laundry - greywater (gw)	0.36
personal washwater (gw)	0.32
dishwashing (gw)	0.80
total bw & gw above	2.48
(+) ground food waste	1.06
total of all domestic waste	3.54

If one or more other sources of domestic sewage are added to the black water, then the organic loading per capita will be correspondingly increased.

This is illustrated by the factors shown in the table.

1. The service factor for all black water and gray water is

1.00 + 0.36 + 0.32 + 0.80 = 2.48

This means that the organic loading associated with the black and gray water from 100 persons corresponds to sizing for 248 "equivalent persons".

2. If required, the FAST® process will handle all or part of the gray water and ground food waste and it will do so effectively and efficiently.

Vacuum Versus Conventional Toilets

1. The organic loading associated with the sewage is not affected by the volume of water which transports it.

Hence, the type of toilets employed will have little effect upon sizing of the Media Tank.

2. However, the volume of water will affect the sizing of associated piping, pumps and the Wet Well.

Effect of Disinfection Upon Media Tank Requirements

1. FAST® can be used with UV disinfection because the effluent is inherently clear and solids-free.

2. Disinfection with UV requires a higher standard of treatment than disinfection with Chlorine. The UV radiation cannot penetrate suspended solids in the effluent.

3. Some form of sludge separation and storage is required so that the effluent will be consistently solids-free and the UV sterilizer can provide reliable disinfection.

MEDIA TANK REQUIREMENTS

1. From a process standpoint, taller tanks have greater volumetric efficiency than do shorter tanks. The percentage of tank height employed as air gap and structure is reduced.

2. But, there are limits to the height which can be used for processing and the effects of these limits become evident in very tall tanks.

3. These factors and the effect of sludge storage are shown in the following example:

Consider processing all black and gray water from a crew of 200 persons. Tank height is approximately 8 feet ~ 2,400 mm.

The service factor is 2.06 and the number of "equivalent persons" is 200 X 2.06 = 412.

If the system is designed to meet minimum USCG/IMO requirements, the tank will handle 30.5 persons per cubic meter and minimum tank capacity will be 412 ÷ 30.5 = 13.5 cubic meters, about 3,600 gallons.

If consistently good effluent quality is required for UV disinfection or for other reasons but 90 days sludge storage is not required, the "UV disinfection" curve can be used.

Minimum tank capacity will be 412 ÷ 22.5 = 18.3 cubic meters, about 4,800 gallons and the tank will incorporate sludge storage capacity of 4 to 6 weeks.

If the system is designed to provide secondary treatment with sludge storage of 90 days, the tank will handle 14.5 persons per cubic meter and minimum tank capacity will be 412 ÷ 14.5 = 28.4 cubic meters, about 7,500 gallons.

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WET WELL REQUIREMENTS

– Cl Disinfection, Conventional Toilets

1. Chlorine contact time should be not less than 15 minutes at peak flow. This is 4.0 times average for most marine applications.

2. Expected flow with conventional toilets would be 200 persons X 46 gpcd = 9,200 gpd and peak flow would be 9,200 ÷ 1,440 minutes/day X 4.0 = 25.6 gpm. Minimum contact volume would be 25.6 X 15 minutes = 383 gallons.

3. Sizing the Wet Well at 150% of minimum contact volume produces a Wet Well requirement of 575 gallons. Note that this is only 16% of Media Tank Capacity.

– Cl Disinfection, Vacuum Toilets

1. For the case above, expected flow with vacuum toilets would be 200 persons X 28 gpcd = 5,600 gpd and peak freshwater sewage flow would be 5,600 ÷ 1,440 minutes/ day X 4.0 = 15.6 gpm.

2. If desalinated water is used, then some seawater should be added to the Media Tank to provide the minerals essential to biological stability (this is not be required when conventional toilets are employed using seawater as the flushing medium).

3. Assuming a seawater injection rate of 4.2 gpm, peak flow will be 15.6 + 4.2 = 19.8 gpm.

4. Minimum chlorine contact volume will be 19.8 gpm X 15 minutes = 297 gallons and Wet Well capacity will be about 150% X 297 = 446 gallons.

– UV Disinfection

1. If UV disinfection is required, then chlorine contact time is not relevant.

2. The only requirement is to prevent the discharge pump from overheating due to too frequent starts. This requires that the volume between pump-on and pump-off levels provide not less than 3 minutes between pump starts during periods of peak flow.

3. For the case above with conventional toilets, max flow is 25.6 gpm and minimum spacing should provide not less than 25.6 X 3 = 77 gallons.

4. For the case above with vacuum toilets, max flow is 19.8 gpm and minimum spacing should provide not less than 19.8 X 3 = 59 gallons.

5. Sizing the Wet Well at 150% of these volumes produces a tank of 77 X 150% = 116 gallons for conventional toilets and 59 X 150% = 89 gallons for vacuum toilets.

PRACTICAL CONSIDERATIONS

1. If one tank of sufficient capacity is not available, two Media Tanks can be connected in series to obtain the required capacity.

2. If available tanks are larger than the minimum capacity required, the additional volume will provide improved effluent quality and greater sludge storage capacity.

3. Oxygen transfer efficiency is proportional to release depth, more efficient at greater depths than at shallower depths. For the same organic loading, taller tanks will require less air, power consumption will be reduced and the pipe sizes required for air and vent piping can be made smaller.

4. The Media Tank can be integrated with a vacuum collection system to eliminate the need for a separate collection tank and transfer system.

5. In smaller systems, it is more practical to provide a separate factory-built Wet Well than to partition a ship's tank. In larger systems, a ship's tank may be used to good effect.

6. The FAST® process scales linearly so that the same rules can be used to size systems of widely varying capacities.

Example:

Consider an aircraft carrier with two identical systems, each rated for all black and gray water from 2,500 persons.

Applying the service factor, this corresponds to 2,500 X 2.06 = 5,150 equivalent persons. Assume a tank height of 4,800 mm and UV disinfection.

Per the chart, Media Tank capacity should be 5,150 ÷ 22 persons per cubic meter = 234 cubic meters, about 62,000 gallons.

With conventional toilets, estimated flow will be 46 X 2,500 = 115,000 gpd and peak flow will be 115,000 ÷ 1,440 X 4.0 = 319 gpm.

Minimum volume between pump-on and pump-off levels should be not less than 319 X 3 = 958 gallons and Wet Well capacity should be about 150% X 958 = 1,400 gallons.

For more information on the MarineFAST® Systems:
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