T/V Golden Bear
Ballast Treatment Test Facility Concept Design

Prepared for
Russell P. Herwig, Ph.D.
University of Washington
Seattle, Washington

Revision A
File No. 05111.01
January 2006

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Consulting Engineers Serving the Marine Community

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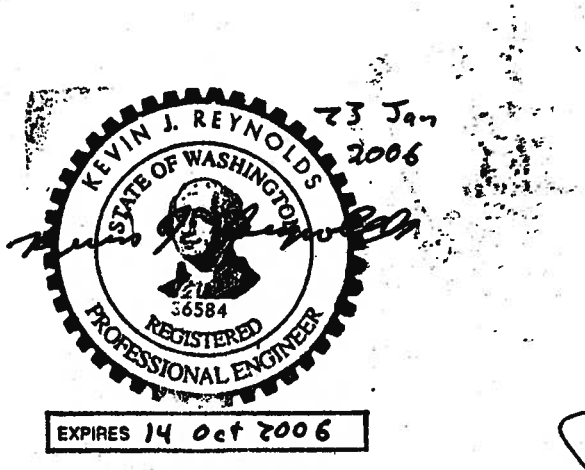

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TS GOLDEN BEAR
BALLAST TREATMENT TEST FACILITY CONCEPT DESIGN

DOCUMENT REVISION LOG			
REV	DESCRIPTION	BY	DATE
-	Initial issue	KJR	10 Jan 2006
A	Section 1 - Training Ship Golden Bear. Corrected U.S. 'Maritime Academy' to 'U.S. Maritime Administration.'		
	Section 1 - Ballast Treatment Test Facility: Testing Needs. Clarified Environmental Technology Verification program roles and sponsorship.	KJR	23 Jan 2006

TS GOLDEN BEAR
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TABLE OF CONTENTS

1. OVERVIEW

Training Ship *Golden Bear*

The Training Ship *Golden Bear* was built in 1989 by Bethlehem Steel Corporation at Sparrows Point, Maryland, and originally named the *USNS Maury* (T-AGS 39). Designed as an oceanographic survey ship for the U.S. Navy, its original mission was to conduct ocean surveys and provide essential geophysical bathyrretric, gravity, and geomagnetic data. At the time of construction, the *Maury* was the largest and fastest oceanographic ship ever built, capable of maintaining speeds up to 20 knots.

The *USNS Maury* was transferred to the California Maritime Academy in September of 1994 and renamed the *Golden Bear*. Upon transfer the vessel underwent more than $6 million worth of repairs and modifications to adapt it to function in a training environment. The U.S. Maritime Administration is the vessel Owner and provides maintenance and operational assistance to support academy activities.

Now registered in Vallejo, California, the *Golden Bear* provides a comprehensive training platform to those interested in working in the marine industry. The California Maritime Academy operates two 2-month training cruises during the summer months of each year, during which time students from other universities such as California State University, California Polytechnic Institute or California State University, Monterey Bay join the academy to conduct biological and cultural research.

Ballast Treatment Test Facility: Testing Needs

The International Maritime Organization adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments in February 2004 with the stated objective to "prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments." Annex 3 of this Convention, *Guidelines for Approval of Ballast Water Management Systems (G8)*, details the "technical procedures for evaluation and the procedure for issuance of the Type Approval Certificate of the Ballast Water Management System." These guidelines supply detailed requirements for both land-based and shipboard testing efforts.

This international effort is echoed and supported by various national and regional requirements and test programs. Of significant note is the United States Environmental Technology Verification Program (ETV). This program has a land-based ballast water treatment test facility at the U.S. Navy Naval Research Laboratory at Key West, Florida, and is scheduled to begin beta-testing in 2006. In addition, the ETV program is planning to launch a test facility in the Great Lakes. Also of note is a Washington State Ballast Program in which the Department of Fish and Wildlife works with Department of Ecology to evaluate promising ballast treatment systems. If a system shows promise to meet State efficacy standards and is acceptable environmentally, it can gain approval for single vessel shipboard test installations.

Ballast Treatment Test Facility: *Golden Bear* Capabilities

The modifications proposed herein will provide the *Golden Bear* the following capabilities that fulfill the immediate needs of a variety of treatment vendors. These modifications are **designed to meet the IMO *Guidelines* for both shipboard ballast treatment system trials and land-based testing criteria.** In this way, the proposed modifications could provide treatment vendors one

evaluation location to gain the needed treatment system testing required for Type-Approval. Type-Approval is a special status assigned by flag administrations to a particular product, indicating that it can be consistently manufactured to meet applicable standards.

The modifications are designed to keep testing costs, schedule and vessel impact to a minimum through the following arrangements. A comparison of the facilities to the IMO Guidelines is provided in Table 1.

- *Plug-and-play* arrangement permits treatment system interface without further vessel modifications. This arrangement supports successive treatment system evaluations with reduced trial set-up costs.
- Ballast modification arrangement permits treatment application on ballast water uptake, ballast water discharge or both.
- Ballast modification piping sizes and variable frequency drive booster pump permits flow rates control up to a maximum of 220 cubic meters per hour. This limit keeps flow rate velocities and pump speeds low, in an effort to **limit organism mortality during transfer**. This flow range covers those typical for container ships, car carriers, cruise ships, bulk carriers and various special service (research fleet) vessels.
- Testing and evaluation efforts are made simpler and more reliable through purpose designed piping interfaces and permanent science facilities.
    - Vessel arrangement and new outfitting will permit utilization of a **253 metric ton port side tank for control**, and the mirrored **253 metric ton starboard side tank for test**. The vessel's numerous other ballast tanks could be accessed in the future if needed.
    - New access opening and sampling lines in the control and test ballast tanks will facilitate **in-tank testing** of ballast water to evaluation treatment progress after uptake and before discharge, providing insight into treatment system process.
    - Slip stream **ballast water test ports provide four opportunities for ballast water testing**: ballast uptake before treatment, ballast uptake after treatment, ballast discharge before treatment, ballast discharge after treatment.
    - Ballast modifications include test equipment for in-line monitoring: **flow rate, temperature, pressure**. In addition, sampling ports and tank access permit portable equipment to measure: **salinity, pH, total suspended solids, turbidity (NTU)[3], particulate organic carbon, dissolved organic carbon, dissolved oxygen**.
    - Basic laboratory facilities on board the vessel permit on-site ballast water evaluation in a timely manner and a controlled environment.

	IMO Criteria		Proposed Modifications		
			Vessel	IMO Comparison	
	Shipboard	Land-based	Capability	Shipboard	Land-based
Ballast Tanks					
Control capacity (m^3)	1:1 scale	200	**253**	☑	☑
Test capacity (m^3)	1:1 scale	200	**253**	☑	☑
Holding time	N/A	5 days	**5 days**	N/A	☑
Treatment Rate Capacity (TRC)					
Less than 200 m^3/hour	1:1 scale	1:1 scale	**220**	200	200
200 to 1000 m^3/hour	1:1 scale	1:5 scale	**220**	220	1,000
Greater than 1000 m^3/hour	1:1 scale	1:100 scale	**220**	N/A	22,000
Sampling Collection > 50 μm					
Influent test pre-treatment	Three x 1 m^3	Three x 1 m^3	**Three x 1 m^3**	☑	☑
Influent test post-treatment	N/A	Three x 1 m^3	**Three x 1 m^3**	Exceeds	☑
Influent control	N/A	Three x 1 m^3	**Three x 1 m^3**	Exceeds	☑
Discharge test pre-treatment	Three x 1 m^3	Three x 1 m^3	**Three x 1 m^3**	☑	☑
Discharge test post-treatment	N/A	N/A	**Three x 1 m^3**	Exceeds	Exceeds
Discharge control	Three x 1 m^3	Three x 1 m^3	**Three x 1 m^3**	☑	☑
In tank test	N/A	N/A	**Three x 1 m^3**	Exceeds	Exceeds
In tank control	N/A	N/A	**Three x 1 m^3**	Exceeds	Exceeds
Measurements, Physical					
Temperature	Required	Required	**In-line**	☑	☑
Ballast water flow rate	N/A	Required	**In-line**	Exceeds	☑
Ballast water pressure	N/A	N/A	**In-line**	Exceeds	Exceeds
Treatment power consumption	N/A	Required	**Portable**	Exceeds	☑
Salinity	Required	Required	**Sample**	☑	☑
pH	N/A	Required	**Sample**	Exceeds	☑
Total suspended solids	Required	Required	**Sample**	☑	☑
Turbidity (NTU)[3]	N/A	Required	**Sample**	Exceeds	☑
Particulate organic carbon	Required	Required	**Sample**	☑	☑
Dissolved organic carbon	N/A	Required	**Sample**	Exceeds	☑
Dissolved oxygen	N/A	Required	**Sample**	Exceeds	☑

Notes:

1. IMO criteria gathered from Annex 3, Resolution MEPC.125(53), Guidelines for Approval of Ballast Water Management Systems (G8).
2. IMO criteria does not appear to consider treatment upon discharge methods.
3. Sample collection below 50 μm will utilize portable containers: nine 20 liter containers and nine 1 liter containers.
4. Sample containers to be washed and reused between influent and discharge cycles.
5. Land-based performance is based on required organisms occurring naturally in the test water, no provisions to add cultured organisms have been considered at this time.

Table 1 – Comparison of Proposed Modifications to IMO Shipboard and Land-based Test Facility Criteria

Ballast Treatment Test Facility: *Golden Bear* Modification Overview

A visual overview of the modifications proposed herein, extending from the 04 deck to the lower engine room, is provided in Figure 1. These modifications would provide the *Golden Bear* with a *plug-and-play* capability to effectively perform successive shipboard trials with multiple treatment systems. At one time, the *Golden Bear* can have two to four treatment systems on board ready for

testing. Installation of each successive treatment system would not require further vessel modifications.

This is achieved by bringing the vessel's ballast water to an accessible location where the treatment systems to be tested are temporarily fastened to the ship's deck within the confines of standard ISO containers. A service station would be located near the container fastening location, such that hoses and cables would provide ballast water and support services (power, air, fresh water) to one treatment system at a time. Following testing of each treatment system, another could take its place without the need for further modifications to the ship. The modifications are arranged such that treatment can be executed upon uptake, discharge or both. The *Modification Details* section provides a complete review of the proposed work shown in Figure 1.

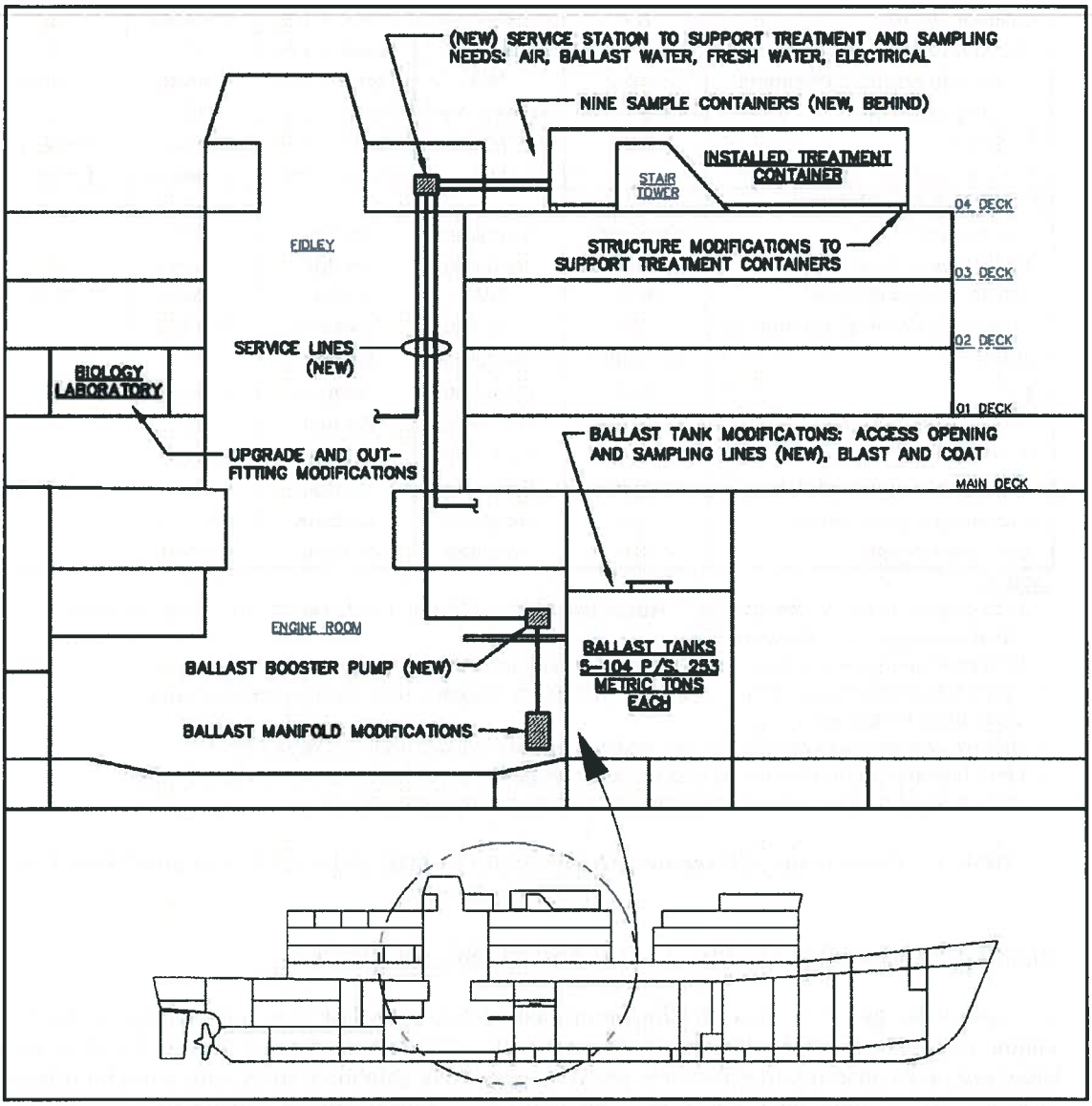


Figure 1 – Profile View Showing Modifications

Ballast Treatment Test Facility: *Golden Bear* Strategic Position

This design package provides details on the execution of these technical aspects. The non-technical advantages of this platform are listed below but not further elaborated.

- Vessel schedule includes annual dockside periods of about 8 months. This will enable testing to take place during this period without the waiting and transit times inherent with underway vessel operations.

- Vessel location in San Francisco Bay area is heavily laden with non-indigenous species, offering challenging water for treatment system trials, decreasing the likelihood that ballast water will need to be spiked with surrogate organisms.

- Vessel mobility and San Francisco Bay location offers the opportunity for testing in fresh, brackish and salt water all in relatively close locations.

- Vessel is operated by MARAD, is a training vessel for ships' officers and is staffed with some of the best officers in the United States merchant fleet. The support structure offered by this stable and capable team will yield intangible benefits.

- Vessel is an integrated part of a university educational environment, offering the mutual benefits of staff support and pedagogic opportunities.

- Vessel primary function is as a training vessel for future merchant ship officers who will be given a first-hand opportunity to learn ballast management issues as they enter their professional careers.

It is an advantage that the *Golden Bear* is strategically positioned for further modifications to improve testing efficiencies. It is also recognized that application of the IMO *Guidelines* to the satisfaction of an Administration (U.S. Coast Guard for example) may differ than those envisioned here, perhaps requiring modifications not currently envisioned. It should be understood that the modifications proposed here are versatile, offering much flexibility as the science and regulations change over time. The following modifications are not proposed, but are presented to outline expansion capabilities of the *Golden Bear*.

- Forward lower hold engineering laboratory area is adjacent to ballast pumps and testing tanks. It is possible to outfit this laboratory area to dual usage to support testing of ballast water. The location would permit direct plumbing of sample lines to the laboratory. The larger area could support more testing procedures and equipment.

- The proposed modifications outfit a pair of ballast tanks with ease of access and simplicity of construction. However, several pairs of the vessels 28 ballast tanks present significant kinetic engineering (considerations of tank fluid dynamics) challenges to ballast treatment systems. It is likely that the complex structures of some of these tanks present opportunities for advanced ballast treatment testing in way of tank dead zones and trapped sediment. Like the tanks selected for the current modifications, there are more tank pairs which also meet the IMO Guidelines for land-based testing.

- Current arrangement requires a shore side crane to lift the treatment system containers on board. It is possible to outfit vessel with shipboard crane to lift these containers to and from the 04 deck location.

2. MODIFICATION DETAILS

Summary

A visual overview of the modifications proposed herein, extending from the 04 deck to the lower engine room, is provided in Figure 1. The description below provides an overview of the specific modifications, with the following sections providing concept level details. Contract level details will be provided as part of a separate package based on these concepts and pertinent feedback from review efforts.

Treatment system support modifications would provide the *Golden Bear* with a "Plug and Play" capability to effectively perform successive shipboard trials with multiple treatment systems. Table 2, below, provides a listing of treatment system types and interface particulars. These particulars, the requirements in Table 1 and classification rules of American Bureau of Shipping were used as the design basis in developing this modification concept.

Treatment System Interface Matrix				**Vessel Interface**
Sample Treatment Technology	Chemical Injection	Electro chlorination	UV / Filtration	
ISO Container Size	20 foot	40 foot	20 or 40 foot	**Tie-downs for 20 and 40 foot ISO containers**
Equipment Weight	~1 ton	~10 tons	~5 tons	**Structure supports up to 40 tons**
Ballast Water				
Flow Rates of 220 m^3/hr Acceptable ...	YES	YES	YES	**Variable up to 220 m^3/hr, 8" ANSI flange**
Treatment Application Upon Ballast ...	Uptake	Uptake and Discharge	Uptake and/or Discharge	**Uptake and/or Discharge**
Services				
440 VAC Electrical	10 Hp	50 kVA	50 kVA	**Recepticle, 100 kVA**
120 VAC Electrical	30 amp service	30 amp service	30 amp service	**Recepticle, 30 Amp**
Compressed Air	NO	OPTIONAL	NO	**Service air, 3/4" npt**
Fresh Water	YES	YES	NO	**Potable supply, 3/4" npt**

Table 2 – Treatment System Interface Matrix

The following sections describe the envisioned modifications to support the testing needs and treatment system interfaces detailed in Tables 1 and 2, and outlined in Figures 1 and 2.

- **Container mounted treatment systems** will be supported by new above deck structure and fasteners for securing either four 20 foot ISO containers, or two 40 foot ISO containers.

- **Support services station** will be positioned near the ISO container mounts. Services include compressed air, fresh water and 120 VAC and 440 VAC electrical power. Ballast water supply and sampling lines are also located at this station, but are detailed elsewhere.

- **Ballast system modifications** will be performed in order to transport the ballast water to and from the container mounted treatment systems, on uptake and on discharge. Modifications will include new piping runs, discharge manifold modifications and a new booster pump.

- **Sampling and instrumentation** will be provided for in order to meet the monitoring and testing requirements. This includes slip stream test ports in the ballast piping as well as sample lines and new access opening in the selected ballast tanks. This also includes the various storage tanks required. This section also details the various instrumentation efforts required in the electrical system and piping system.

- **Ballast tank modifications** are mostly covered in the sampling and instrumentation section. Beyond sampling, the selected ballast tanks will be blasted and coated.

- **Marine biology laboratory** will be outfitted with basic laboratory facilities to provide the ability to conduct testing in a controlled environment in a timely manner.

Container Mounted Treatment Systems

Container mounted treatment systems will be supported by new above deck structure and fasteners for securing either two 20 foot ISO containers, or one 40 foot ISO container on the 04 deck of the aft house. This position is shown in Figure 2.

There are main girders, 17" x 13.87# web with 7" x 13.87# flange, located on the centerline and 11 feet to port and starboard of centerline running longitudinally under the 04 level of the aft house just forward of the exhaust stack (Figure 1). The 04 level deck plating, 11.49#, is also supported transversely every 2.5 feet by 4 x 3 x 3/8" L deck beams. In order to use 20 or 40 foot ISO container(s) on this level additional supporting structure is required to carry a load of 20 LT (44.8 kips).

ABS Steel Vessel Rules were used. Using the desired load of 44.8 kips a load of 16.8 kips is applied at each of the 4 corners of the 40 foot container. This load applies the 44.8 kips container load evenly and adds a 0.5g vertical load for the accelerations experienced due to ship motions. The maximum bending moment is 440 kips-inches, modeled with a simply supported beam. The section modulus of the existing structure is inadequate to support the container load by itself. The following modifications are suggested to reinforce the 04 deck of the aft house.

- It was determined that 6" x 6" steel structural tubing meets the support requirements. These structural tubing pieces will be installed transversely at frames 98 and 114 connecting the centerline girder and girder located 11 feet port of centerline. Container sockets can be attached to these girders to fasten the container corners. In order to mount 20 foot containers, the same size steel tubing should be welded to the deck just forward and aft of frame 106. The structure installed at frames 98 and 114 shall also be used for the ends of the 20 foot containers.

- L shaped stiffeners can be installed as support structure in place of the steel tubing with additional brackets installed in order to stiffen the angles to prevent bending. Angle stiffeners may allow for easier access for welding on one side of the supporting structure.

- The steel tubing will be welded to the 04 deck. No internal welding below the deck is required. The joiner material will need to be removed temporarily to prevent the risk of fire and allow for a fire watch to monitor the welding process.

- Twist-locks, bars, and/or turnbuckles are to be used to secure and lash down the containers to the deck.

- Stability of the vessel with containers mounted on the 04 level is adequate, as verified by the Chief Mate using the stability program on the vessel.

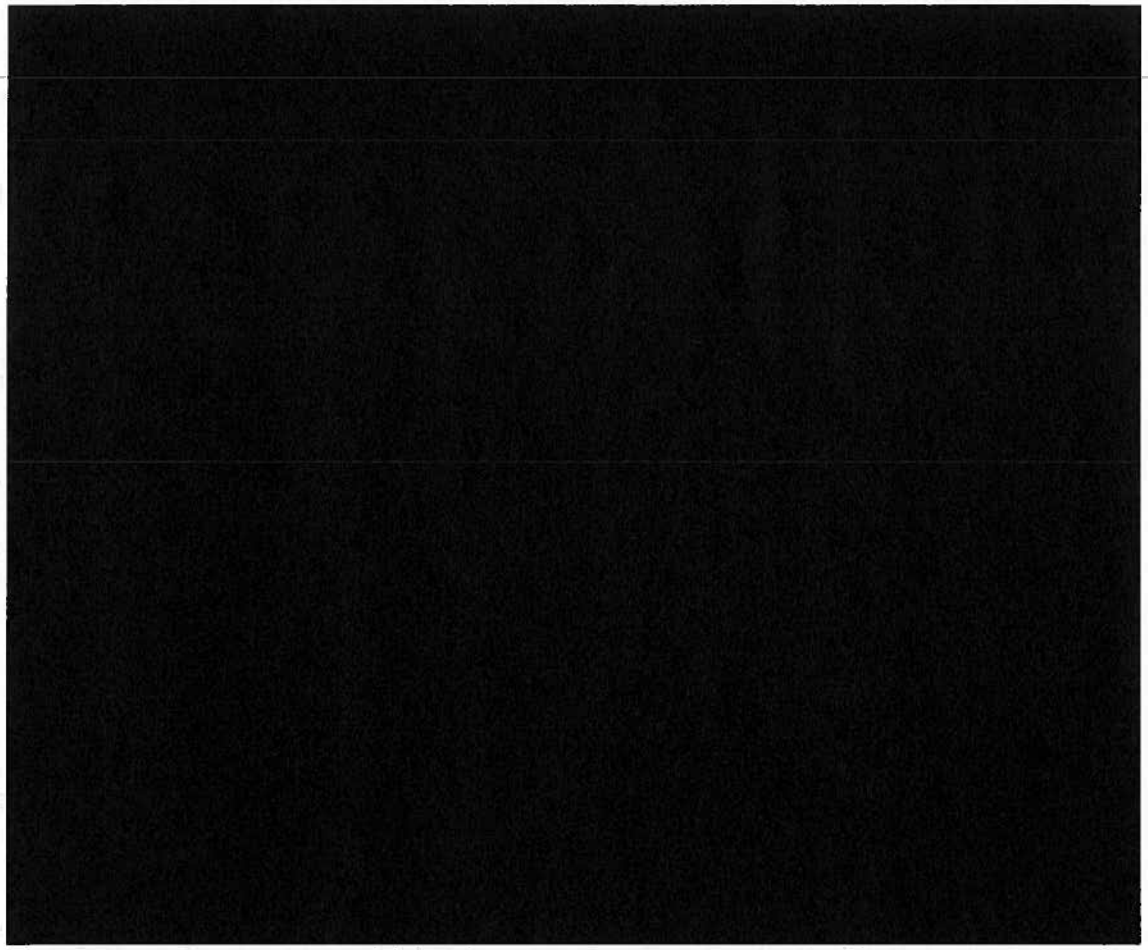


Figure 2 – Plan View Showing 04 Aft Deck Installations

Support Services

Support services station will be positioned near the ISO container mounts, as shown in Figure 2. Services include compressed air, fresh water and 120 VAC and 440 VAC electrical power. Ballast water supply and sampling lines are also located at this station, but are detailed elsewhere.

The piping and electrical equipment installed in the modification will interface with existing systems in such a way as to eliminate the possibility of interfering with normal ship operations. Added electrical equipment, potable water piping, and compressed air lines will all terminate at a single location against a bulkhead outside the 04 deck aft house fan room, just forward of the exhaust stack. Isolation valves will be present at the termination points for the potable water and compressed air piping, and power receptacles will be installed for the 440 VAC and 120 VAC electric take-offs. This creates a "service station" from which treatment systems may be easily integrated into existing ship systems.

The service station on the 04 deck will connect to treatment containers by means of hoses and cables. This provides a plug and play capability that will allow treatment systems to be exchanged quickly and easily. Since most ballast water treatment systems have similar support service requirements no further modifications will need to be made with each successive treatment installation.

Photos 1 and 2 – Electrical Locations
(lighting panel shown left, motor controller spaces shown right)

Electrical Power

Electrical power aboard the *Golden Bear* is generated using three high speed diesel generators, two of which are running at any given time during normal operation. The electrical distribution consists of 440 VAC and 120 VAC, 3 phase systems. The main 440V bus and 120V branch lie within the Engine Operation Station (EOS). At present there are no spare breakers available for either power option; however there are blank spaces in the main bus board (Table 10) where

additional breakers and fuse units could be added to provide power for the treatment system. This same method will be used to support the booster pump and laboratory modifications, which are detailed elsewhere.

The ballast water treatment container will be provided with 440VAC and 120VAC power. The Contractor shall provide and install one 150 amp, 400V receptacle, and one 120V, 30 amp receptacle, with integral circuit breakers, and break-before-make contact pins, on an exterior bulkhead adjacent to the container location. A new 150 amp circuit breaker, AQB-A252, or equal, shall be installed in a blank space in the 440V ship service switchboard. Cable, LSTSGU-100, shall be installed from the circuit breaker to the receptacle. Three, single-phase, 30 amp circuit breakers, ALB-1, or equal, shall be provided and installed in a blank space in a local 120V load center panel. Cable, LSTSGU-9, shall be installed from the load center panel to the 120V receptacle.

Compressed Air

Compressed air aboard the ship is used in three separate systems: Engine Start Air, Control Systems Air, and Ship Service Air. For the purpose of supplying compressed air to the treatment package Ship Service Air, maintained around 100 psi with a 120 psi maximum pressure, will be used. Ship Service Air may either be routed from the compressed air distribution manifold on the EOS deck of the main engine room to the 04 deck aft house (1-1/2 inch line available), it could be piped from the Machine Shop to the 04 deck aft house (3/8 inch line available), or it might be accessed directly from the 04 deck aft house through one of the existing compressed air fittings.

Fresh Water

Potable water is available in the engine room and may be piped from the overhead of the Officer's Tool Room, directly up through Fidley, and out to the O4 deck of the aft house via the Fan Room. The existing line is made of Copper-Nickel and has a 2-1/2 inch nominal diameter.

Ballast System Modifications

Ballast system modifications will be performed in order to transport the ballast water to and from the container mounted treatment systems, on uptake and on discharge. Modifications will include discharge manifold modifications, new piping runs and a new booster pump. These modifications are shown in the flow diagram below (Figure 3).

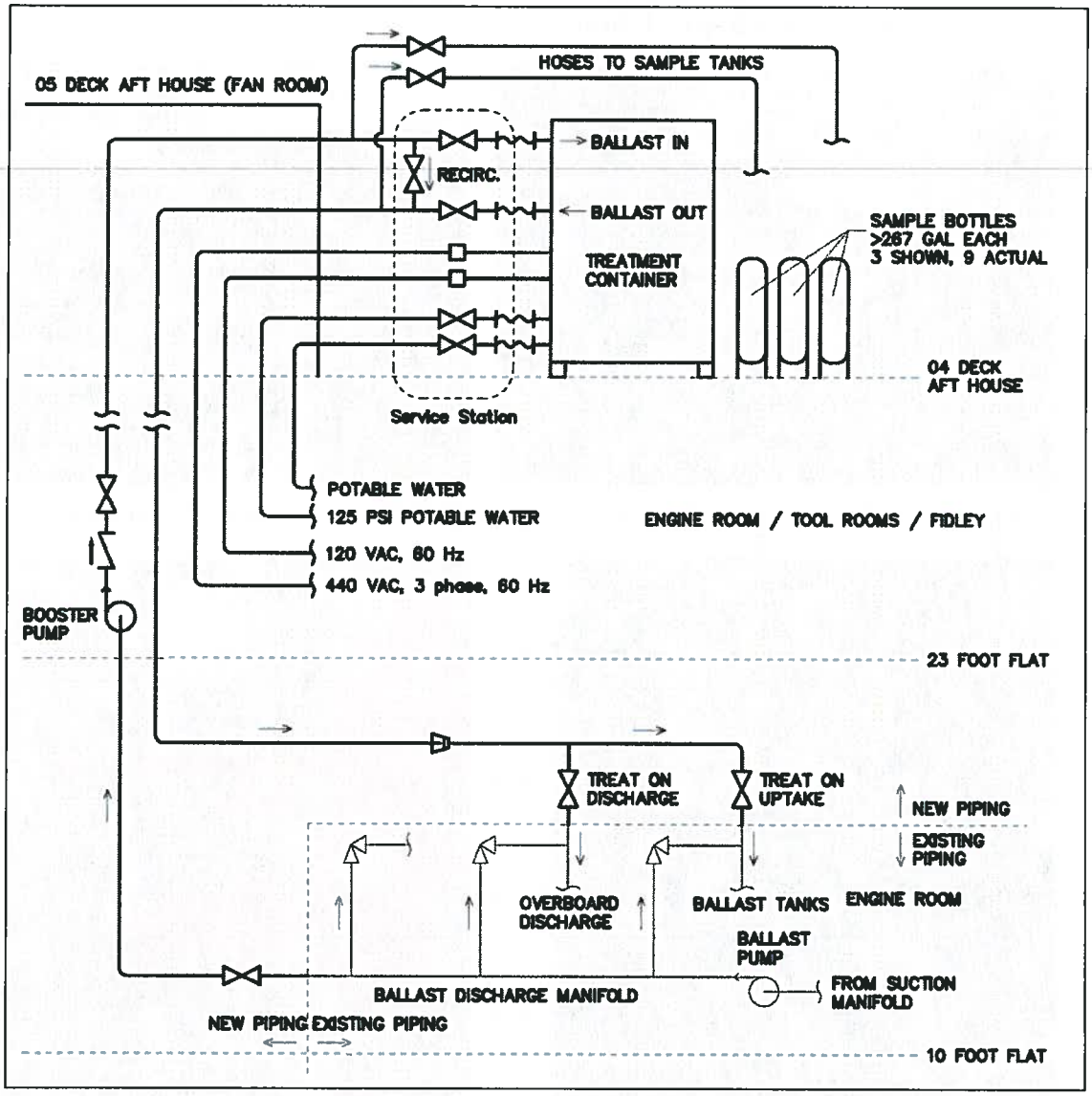


Figure 3 – SW Ballast / Treatment System

Discharge Manifold Modifications

The existing ballast manifold is shown below in Figures 6 (discharge) and 7 (suction). In order to treat the ballast water it must first be taken from the discharge manifold. Photo 5 shows the end of the discharge manifold where suction will be taken. This discharge manifold has a six inch nominal diameter, which will be maintained in the new installation upon discharge from the manifold. There is a space limitation of 16-1/2 inches beyond the flange at the end of the discharge manifold due to a fuel transfer line shown in the far left of Photo 3, and also visible at the bottom of Photo 5. A 90 degree elbow must be used immediately after the flange, which will divert the flow upward to overcome this space limitation.

Photo 3 – SW Ballast Discharge Manifold

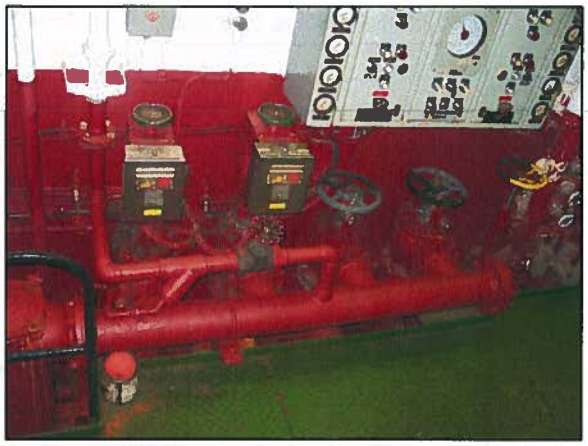


Photo 4 – SW Ballast Suction Manifold

Photo 5 – Ballast Discharge Manifold End Cap

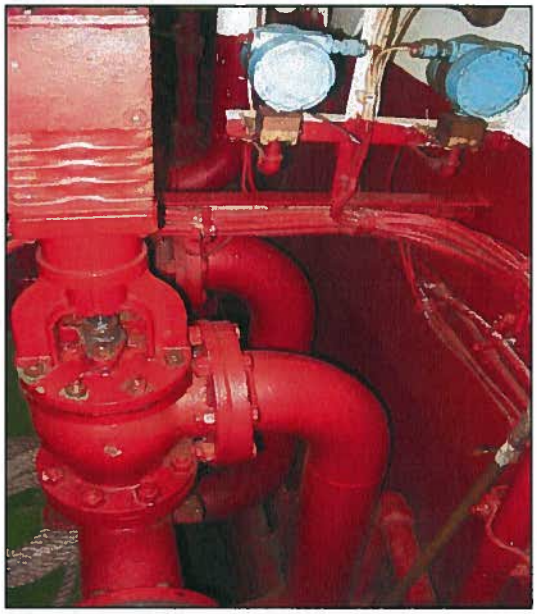


Photo 6 – Ballast Discharge Remote Valves

In Photo 6 the Ballast Fill and Discharge Overboard pipes are shown leaving the ballast discharge manifold after their respective remote isolation valves. They are the same valves shown in Photo 3. The Ballast Fill and Discharge Overboard pipes have five inch nominal diameters and may be

spliced into with return lines from the treatment system by replacing the 90° elbows following the remote valves with five inch tees. A cluster of alarm sensors (upper right of Photo 6) may have to be relocated to allow installation of the new tees.

New Piping Runs

The capped end of the discharge manifold will be replaced with a eight inch nominal diameter, 90° elbow to divert ballast water to the 23' flat. Eight inch nominal diameter pipe will then be installed to connect the discharge manifold to the suction end of the booster pump one deck up on the 23' flat. The pipe size will remain eight inch nominal as it passes up one more deck from the Booster Pump into the Electric Shop Tool Room. It will then turn inboard and enter the Officer's Tool Room, where it will travel upward through the overhead into Fidley. Upon reaching the 04 deck the new ballast line will penetrate the Fan Room and exit through the forward side of that space. It will join with the Service Station mounted on one of the external bulkheads of the 04 aft deck Fan Room. The return line will also be eight inches and will follow the same path as the supply line, aside from the fact that it will not couple with the booster pump. Just before branching to merge with the Overboard Discharge line and Ballast Tanks line the pipe will be reduced from eight inches to five inches. It will then split into two lines using a tee and merge with both of these lines downstream of their respective remote isolation valves. This will allow ballast treatment on both the uptake and discharge.

Isolation valves for the new components will be installed on both the suction and discharge of the ballast booster pump, at the service station on both the discharge and return, and just before splicing into the Overboard Discharge and Ballast Tanks lines (one valve for each line). A check valve will also be installed on the discharge side of the booster pump. New ballast pipe installed in this arrangement will be Copper-Nickel.

Booster Pump Installation

From the discharge manifold ballast water will need to be pumped to the 04 deck by means of a supplemental treatment system booster pump. The pump will be placed one deck above the discharge manifold (10' flat) between the Central Fresh Water (CFW) pumps and heat exchangers (23' flat). There exists an open deck space in this location at the top of the port ladder that connects the 10' flat and 23' flat. The booster pump installed in this space will most likely be a vertically mounted centrifugal pump. The vertical mounting is preferable as this will have the smallest profile on deck.

From operational testing of the existing ballast system onboard the TS Golden Bear it was found that typical flow rates range from 120 to 205 cubic meters per hour. By connecting the suction of a booster pump on the 23' Flat of the Main Engine Room to the discharge manifold of the ballast system on the 10' Flat ballast water may be diverted to the 04 deck (~85 ft above the keel), while maintaining flow rates near the current normal operating range. The booster pump selected for this application is a Goulds Process Pump, type 3996 MT. The outlet/inlet pipe diameters would be 4x6 inches, with an impeller diameter of 13 inches and with full flow at a rotational speed of 1150 rpm. In utilizing a Variable Frequency Drive (VFD) the system will be able to control flow between 100 and 220 cubic meters per hour to meet various test protocol.

Electrical

A new 25 amp circuit breaker, AQB-A102, or equal, shall be installed in the 440V ship service switchboard, or a local 440V power panel, to feed the new ballast booster pump (see Ballast Modifications section). Cable, LSTSGU-9, shall be installed from the circuit breaker to the new pump supplier-provided variable frequency drive (VFD), and from the VFD to the pump motor.

Sampling and Instrumentation

Vessel arrangement and new outfitting will permit utilization of a 253 metric ton port side tank for control, and the mirrored 253 metric ton starboard side tank for test. The vessel's numerous other ballast tanks could be accessed in the future if needed. New access opening and sampling lines in the control and test ballast tanks will facilitate in-tank testing of ballast water to evaluation treatment progress after uptake and before discharge, providing insight into treatment system process.

Slip stream ballast water test ports provide four opportunities for ballast water testing: ballast uptake before treatment, ballast uptake after treatment, ballast discharge before treatment, ballast discharge after treatment. Nine (9) new sample tanks will be positioned on the 04 deck as shown in Figure 2, in a position that allows flushing of sea water to nearby deck drains. These tanks will be capable of holding at least one metric ton of water each. These tanks will be filled by hoses which can be readily flushed on the weather deck between sampling efforts. These hoses will be 1-1/2 inch to limit fluid velocity, minimizing sample mortality due to transport.

In order to monitor the ballast system performance instrumentation will be added to the new piping runs. This will include flow meters, pressure transducers, and temperature transducers. One of each will be installed on the new ballast water supply line to the booster pump and on the return line before the flow branches. The equipment will be installed on a vertical pipe sections near the ballast water discharge manifold to ensure complete coverage of the sensors. Readings will be taken locally using a notebook computer with properly calibrated data acquisition software. The following instruments would be preferable for this system:

- Flow Meters; Transit-Time flow meter model F-200-FLVS12; indicator, transmitter and associated model F-200-FLW41 transducer; mounting track kit; NEMA 6 enclosure, switch
- Pressure Transducer; Autoline Controls model ABB 2600T; suitable for seawater service; NPT connection; NEMA 4 enclosure; mounting kit
- Temperature Transducer; suitable for seawater service; NEMA 4 enclosure; mounting kit

Additional taps will be added to the new ballast supply and return lines near the transducers for future instrumentation. These taps may be used to add sensing equipment for testing conductivity and turbidity.

Laboratory instrumentation is detailed in the *Marine Biology Laboratory* section.

Ballast tank sampling is detailed in the *Ballast Tank Modifications* section.

Ballast Tank Modifications

Tank Selection

The seawater ballast tanks selected for use in this project are tanks 5-104-1 and 5-104-2, with the option of extending use of other ballast tanks in future studies. Both tanks are virtually identical and mirrored about the ship's centerline, each with a capacity of 66,833 gallons. The tank tops reside on the 2nd deck, approximately 33 feet above the keel. Both tanks are easily accessible through their tank tops, which for tank 5-104-1 is located in an equipment storeroom adjacent from the halon room where the tank-top for 5-104-2 is located. Both tanks extend down to the double bottom, approximately six feet off the keel, and aft to frame 114, the forward most frame in the main engine spaces.

Approximately 9-1/2 feet below the tank-top for both seawater ballast tank 5-104-1 and 2 there is a shelf in which two, seven foot square openings give access down to the tank bottoms (Figure 3). The current manhole covers are offset from these openings, which rule out the possibility of them acting as access from which to collect biological samples via plankton net casting.

Figure 3 – Shelf Opening in Tank 5-104-1

Figure 4 – Tank Top in Tank 5-104-1

Access Hatches

Biological sampling access through the 5-104-1 and 2 tank-tops may be made possible through the use of a raised coaming, bolted, watertight hatch. It would be ideal to have at least a 24 x 24 inch clear opening for ease of plankton net casting. Safety guard arrangements are also considered to protect personnel from falling hazards. The hatch would be raised above the deck to minimize ballast water spilling through it when open due to sloshing within the tank. The supporting members in the tank tops are spaced by roughly 30 inches (Figure 4).

Sample Collection

Sample tubes will be dispersed throughout the 5-104-1 and 2 ballast tanks in order to draw seawater samples from various levels and locations within these two tanks. The sample tube system for each tank will consist of 3/8 inch or 1/2 inch plastic tubing connected to permanent fixtures, such as ladders and beams within the tanks, for support (Figure 3). The tubes will pass through the tank-top using deck penetrations of ¾ inch threaded, carbon steel pipes. The pipes will join into a common manifold with individual isolation valves (most likely 90 degree ball valves). A single diaphragm pump for each of the two manifolds will be used to draw seawater from the

tanks and return it through a final deck penetration back down to a remote part of the ballast tank. This will allow recirculation of the water through the sample system in order to flush the sample tubing. On the discharge of the sample pump, but before the final deck penetration, a bleed valve will allow collection of ballast water into clean five gallon buckets. The samples may then be carried to laboratory facilities for analysis. One model diaphragm pump suitable in this application would be a Wilden P.025 Metal Pump, with ¼ inch suction and discharge connections, which would be capable of flow rates up to 5 GPM.

Tank Features

Both tanks lie on the Longitudinal Center of Buoyancy (LCB) of the vessel, so that routine filling and discharge operations may take place without affecting the ship's trim. The deck of the tank tops is clear and unobstructed, which will permit easy access for the addition of biological sampling hatches and piping for water sample pumping systems. The deck space of each tank top is isolated from the main traffic areas of the ship, allowing for study of these tanks without interfering with routine vessel operations. Also, these spaces are protected from the weather, which will increase the reliability of gathered ballast samples. There is no finished joiner work in either of these areas, so it would be permissible for the tank top spaces to become wet should some water spill out from the ballast tanks while sampling operations are underway. Their location on the ship also makes these tanks easy to access from the existing marine biology lab on the port side of the main deck. These tanks are only one deck below the marine biology lab and nearly equal longitudinally on the vessel.

Tank Coating

Internal tank inspections show moderate coating failures of the subject ballast tanks. The introduction of seawater into these tanks, normally kept full of fresh water, will increase corrosion rates. It is proposed that this affect be mitigated by blasting and coating the tank internals of the tank pair.

Marine Biology Laboratory

Fixtures

Several modifications should be made to the existing marine biology laboratory in order for it to be more useful to scientists who will be conducting ballast water treatment research. A larger sink will need to be installed in place of the small twelve inch square sink already present. Ideally the new sink will have two deep basins, which should each be at least 15 x 15 inches (225 in^2 in area), and 12 inches deep. It would also be helpful to have additional counter space around the new sink at the same height. A drying rack would be installed above the sink. One of the desks that currently reside in that room may be kept to use as a sitting workstation, but higher countertops need also be added for standing workspace. Standing workspace may be added using either permanent or temporary fixtures (i.e. fastened counters with lower storage space, or tall detached desks). Bulkhead mounted storage cabinets would also make a helpful addition to the biology laboratory. The installation of a fume hood and chemical storage locker will be necessary as well.

Electrical Modifications

A new 120V power distribution panel, with eight single phase circuits, shall be provided and installed outside the marine biological laboratory. The panel will be equipped with (16) ALB-1, or equal, circuit breakers to serve the various loads described below.

- Three, single-phase, 50 amp circuit breakers, ALB-1, or equal, shall be provided and installed in a blank space in a local 120V load center panel. Cable, LSTSGU-23, shall be installed from the load center panel to the new 120V distribution panel described above.

- Six, single-phase, 20 amp circuit breakers, ALB-1, or equal, shall be provided to serve three new receptacle circuits.

- Two, single phase, 10 amp circuit breakers, ALB-1, or equal, shall be provided to serve one new fluorescent light circuit.

- Four, single-phase, 15 amp circuit breakers, ALB-1, or equal, shall be provided to serve two new refrigeration circuits (see section XX).

- Two, single phase, 10 amp circuit breakers, ALB-1, or equal, shall be provided to serve one new exhaust fan (hood) circuit (see section XX).

- Two, single phase, 15 amp circuit breakers, ALB-1, or equal, shall be provided to serve one new "spare" circuit.

Additional lighting will be installed in the biology lab space. Five new fluorescent lighting fixtures, Pauluhn, or equal, shall be provided and installed in the marine biological lab. The lights shall be fed from the new 120V distribution panel, described above, with LSDSGU-4 cable.

Three new 6-receptacle strips, Hubbell, or equal, shall be provided and installed in the marine biological lab. The strips shall be fed from the new 120V distribution panel, described above, with LSDSGU-4 cable.

Laboratory Equipment

In order to meet the testing requirements detailed in Table 1, specific laboratory equipment is required. New equipment will include, but not be limited to, a salinity meter, HACH spectrometer, Turner fluorometer, bacterial incubator, phytoplankton incubator, autoclave, computer, and water temperature data loggers.

3. OPERATIONS

Container Fastening

In order to connect a ballast water treatment system into the ballast system of the *Golden Bear* it must first be lifted to the 04 deck aft house approximately 50 feet above the waterline, and 30 feet inboard from the port side. This will require one of two options. The container could be lifted using a barge mounted crane from the port side of the ship, or a shore mounted crane could be used instead. The barge mounted crane could be transported to the ship, whereas the shore mounted crane would require ship movement.

After placing the treatment system container(s) over the 6" x 6" steel structural members on the 04 deck they are to be lashed down using Twist-locks, bars, and/or turnbuckles. Tie-downs will have been installed into the deck as permanent attachment points for the container anchoring system.

When the treatment system has been secured to the deck, hoses and cables connecting the treatment system to the service station may be installed. These flexible hoses and cables will be fitted in place and arranged to reduce tripping hazards as much as possible. Also, a temporary ladder will be installed over them on deck to ease in crossing. The connections will include potable water, compressed air, ballast water supply and return, and an electrical cable.

Ballast Water Operations

Non-treatment Operations

Typical system operations will not include operation and testing of a treatment system. The treatment system support modifications will not impact the ability of the vessel to perform normal operations and emergency operations provided that the three new manually operated block valves on the ballast discharge manifold are shut. This includes the new valve on the suction side of the booster pump as well as the two valves that will connect the treatment system discharge to the Overboard Discharge and Ballast Tanks lines.

Ballast Water Treatment on Uptake

Testing of ballast water treatment on uptake requires that a single tank be filled completely with non-treated ballast water (control tank), then a similar single tank be filled completely with treated ballast water (variable tank). This permits study of the affect of the treatment, in comparison to the many affects which are common to the two tanks regardless of treatment. Tanks 5-104-1 and 2 may be used interchangeably for these tests since they are identical in arrangement.

For both the control and variable tanks:

The suction manifold will be open to Sea Suction with the return from the treatment system lined up to the Ballast Tanks fill line. Ballast water treatment on uptake will take place by first diverting the ballast water from the discharge manifold to the suction side of the booster pump. From there it is pumped to the 04 deck where the flow will pass over a slip stream sample port. This sample port will collect a ballast water sample before it enters the treatment system. A slip stream port on the return from the treatment system will collect another sample after treatment, before returning to the Ballast Tanks line of the discharge manifold.

A bypass line just before the treatment system will allow filling of the untreated control tank, while still utilizing the treatment piping system. Samples will be taken on both the uptake and return as well by using the two slip stream ports. The sampling process requires a total of four tanks, each with a capacity of at least one metric ton of seawater (approximately 267 gallons) as per IMO Guidelines.

Tank Monitoring

The IMO Guidelines require that the ballast water remains in the ballast tank for five days prior to discharge and tank sampling efforts. While in-situ sampling during this five day period is not required by the IMO Guidelines; however, it could provide important insight into the treatment process over time. Specific concerns may be how the efficacy and/or treatment concentrations vary over time.

In order to collect plankton samples from within one of the 5-104 ballast tanks the newly installed hatch must first be opened. The hatches used for this project will be bolted in order to ensure watertight closure. They may or may not be hinged. A plankton collection net may be sent through the top of each hatch, which will provide access from the top of each tank all the way to the tank bottoms. After collection of plankton samples is complete the hatches may be lowered and secured.

The sample tube system may be operated by first closing the sample discharge line used to fill sample containers, and opening the desired suction tube and recirc line. The pump will be started and allowed to run one or two minutes to flush the line. The sample discharge line may then be opened, allowing at least one gallon to flow through before sample collection begins. This will allow the sample discharge line to flush clean as well. After collection is complete the sample discharge line will be closed, the suction tube switched to the next desired testing location, and the system allowed to flush once more before collecting the next sample. When all samples have been collected the pump is to be shut down and all valves secured.

Ballast Water Treatment on Discharge

Ballast water treatment on discharge will be done in the same manner as uptake treatment, except that the valve line up from the discharge of the treatment system will divert to Overboard Discharge, and the suction manifold will line up to the ballast tanks. The slip stream sample ports will be used to collect treatment system inlet and outlet samples from both the treatment discharge tank and the control tank (4 samples total). The control tank will once again use the bypass line around the treatment system.

Blasting and Coating

The selected tanks are currently in a condition of partial coating failure. To compensate for this condition, the vessel crew works to keep these tanks filled with fresh water to reduce corrosion rates. It is recommended that these tanks be blasted and coated as part of the modifications.

Sampling – Laboratory Facility

The previous sections detail the methods of gaining samples on ballast uptake, discharge and in-situ (ballast tank). In each case, the samples are collected within specified tank sizes or directly to a portable container. In the case of portable containers used for ballast tank sampling the containers will be moved by hand to the biology lab for analysis. This will be relatively easy since

the sample containers used should not exceed five gallons in volume and must be carried up only one deck to reach the biology laboratory. The ballast water collected on the 04 deck in the four sample tanks will be available in the required quantity as per IMO Guidelines, and will also be available for collection and transportation to the biology laboratory for analysis.

4. COST ESTIMATE/MODIFICATION SCHEDULE

The appendix contains a modification cost estimate. This cost estimate is supported by the concept design, and is intended to cover costs of performing the modifications. It is anticipated that the contract design will result in further refinement of this estimate.

5. APPENDICIES

A. Modification Cost Estimate

B. Booster Pump Specification w/ Variable Frequency Drive

Appendix A:
Modification Cost Estimate

JOB NO:	05111
CLIENT:	University of Washington
VESSEL:	T.S. Golden Bear
TASK:	Ballast Treatment Test Facility, Concept Design
BY:	KJR/DWC
DATE:	January 10, 2006

COST ESTIMATE SUMMARY

ITEM	DESCRIPTION	LABOR (HOURS)	MATERIALS ($)	SUB-TOTAL ($)	MATERIAL MARKUP	CONTINGENCY	TOTAL ($)	PERCENT
1	CONTAINER MOUNTED TREATMENT SYSTEMS	260	5,400	18,400	800	2,800	22,000	3.1%
2	SUPPORT SERVICES STATION	516	21,000	46,800	3,200	7,000	57,000	8.0%
3	BALLAST MODIFICATIONS	1,304	50,100	115,300	7,500	17,300	140,100	19.6%
4	SAMPLING AND INSTRUMENTATION	176	32,700	41,500	4,900	6,200	52,600	7.1%
5	BALLAST TANK MODIFICATIONS	400	205,100	225,100	30,800	33,800	289,700	38.3%
6	MARINE BIOLOGY LABORATORY	264	87,600	100,800	13,100	15,100	129,000	17.1%
7	SUPPORT SERVICES	280	12,100	40,100	1,800	6,000	47,900	6.8%
	SUB-TOTAL	3,200	$414,000	$588,000				
	LABOR RATE	$50	PER HOUR					
	MATERIAL MARKUP	15%		62,100				
	ESTIMATE CONTINGENCY	15%		88,200				
	TOTAL ESTIMATED COST			$738,300			$738,300	

	ITEMIZED COST ESTIMATE DETAILS								
ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT LABOR (HOURS)	UNIT MATERIAL ($)	TOTAL LABOR (HOURS)	TOTAL MATERIAL ($)	TOTAL COST ($)	REMARKS
1	CONTAINER MOUNTED TREATMENT SYSTEMS								
1.01	Prepare Structural Tubing, 6 in x 6 in	1	lot	40	4,000	40	4,000	6,000	
1.02	Removals in way of Joiner Overhead	1	lot	80	500	80	500	4,500	
1.03	Weld Structure to Deck	1	lot	80	500	80	500	4,500	
1.04	Paint Repairs	1	lot	60	400	60	400	3,400	
	Sub-Total					260	5,400	18,400	
2	SUPPORT SERVICES STATION								
2.01	Deck Station								
2.02	Outfitting	1	lot	80	6,000	80	6,000	10,000	Fittings, painting, hoses
2.03	Painting	1	lot	60	600	60	600	3,600	
2.04	Electrical								
2.05	Receptacle, 450V, 150 Amp	1	ea	8	850	8	850	1,250	Container 450V
2.06	Receptacle, 120V, 30 Amp	1	ea	8	425	8	425	825	Container 120V
2.07	Circuit Breaker, AQB-A252, 150 Amp Trip	1	ea	2	11,040	2	11,040	11,140	Treatment Container Power Feed
2.08	Circuit Breaker, ALB-1, 30 Amp Trip	3	ea	1	115	3	345	495	Treatment Container Power Feed
2.09	Cable, LSTSGU-100, 200'	1	lot	120	1,082	120	1,082	7,082	
2.10	Cable, LSTSGU-9, 200'	1	lot	60	186	60	186	3,186	
2.11	Compressed Air	100	ft	1	3	100	300	5,300	Compressed Air Pipe
2.12	Potable Water	50	ft	1.5	3	75	150	3,900	Includes Fittings/Valves
	Sub-Total					516	20,978	46,778	
3	BALLAST MODIFICATIONS								
3.01	Cu-Ni Pipe, 8 inch nom	300	feet	4	50	1,200	15,000	75,000	Includes Fittings/Valves
3.02	Pump, Goulds model # 3996 MT, 4x6-13	1	ea	40	26,500	40	26,500	28,500	Ballast Booster Pump
3.03	Pumpsmart VFD, model # PS75	1	ea	40	2,700	40	2,700	4,700	Variable Frequency Drive
3.04	Circuit Breaker, AQB-A102	2	ea	2	2,925	4	5,850	6,050	Ballast Booster & Sampling Pmp
3.05	Cable, LSTSGU-9, 50'	1	lot	20	47	20	47	1,047	
	Sub-Total					1,304	50,097	115,297	

COST ESTIMATE DETAILS

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT LABOR (HOURS)	UNIT MATERIAL ($)	TOTAL LABOR (HOURS)	TOTAL MATERIAL ($)	TOTAL COST ($)	REMARKS
4	SAMPLING AND INSTRUMENTATION								
4.01	Deck Storage Tanks	9	ea	16	2,500	144	22,500	29,700	~300 gallons each
4.02	Transit-Time flowmeter, item # F-200-FLVS12	2	ea	4	2,650	8	5,300	5,700	www.instrumentsdirect.com
4.03	Transit-Time transducer, item # F-200-FLW41	2	ea	4	750	8	1,500	1,900	www.instrumentsdirect.com
4.04	Pressure Transducer, P/N 264HSPHBAIVAE6BIN2	2	ea	4	840	8	1,680	2,080	Autoline Controls
4.05	Temperature Transducer	2	ea	4	840	8	1,680	2,080	
	Sub-Total					176	32,660	41,460	
5	BALLAST TANK MODIFICATIONS								
5.01	Tank hatch installation	2	ea	40	800	80	1,600	5,600	
5.02	Rerouting of pipe in way of tank hatch, port only	1	lot	40	200	40	200	2,200	Hatches and piping mods
5.03	Sampling pump and piping manifold	2	ea	40	600	80	1,200	5,200	Diaphragm Pump
5.04	In tank sample tubing and deck penetration	2	ea	40	400	80	800	4,800	
5.05	Paint repair	2	ea	40	400	80	800	4,800	
5.06	Existing equipment reorganization, stbd only	1	lot	40	500	40	500	2,500	
5.07	Blast and Coat Ballast Tanks	2	ea		100,000	0	200,000	200,000	Verbal On-site Quote
	Sub-Total					400	205,100	225,100	
6	MARINE BIOLOGY LABORATORY								
6.01	Fixture Outfitting								
6.02	Commercial Refrigerator	1	ea		2,000	0	2,000	2,000	
6.03	Commercial Freezer	1	ea		2,000	0	2,000	2,000	
6.04	Bulkhead Mounted Cabinets	2	ea		2,200	0	4,400	4,400	Cabinets / Shelves
6.05	Drying Rack	1	ea		500	0	500	500	Wall mount rack
6.06	Stainless Steel Counter Tops w/ Sink	2	ea		2,250	0	4,500	4,500	Two basin sink in one counter
6.07	Ductless Fume Hood	1	ea		6,000	0	6,000	6,000	
6.08	Plumbing Materials	1	lot		300	0	300	300	Sink faucet and new piping
6.09	Chemical Safety Shower / Eye Wash	1	ea		1,000	0	1,000	1,000	
6.10	Chemical Storage Locker	1	ea		2,800	0	2,800	2,800	
6.11	Installation Labor	1	lot	120		120	0	6,000	
6.12	Electrical Outfitting								
6.13	Distribution Panel, ALB-1, 8-1Ø Ckt	1	ea	12	2,565	12	2,565	3,165	Panel for Marine Biological Lab
6.14	Lighting Fixture, Fluorescent	5	ea	4	175	20	875	1,875	For Marine Biological Lab

COST ESTIMATE DETAILS

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT LABOR (HOURS)	UNIT MATERIAL ($)	TOTAL LABOR (HOURS)	TOTAL MATERIAL ($)	TOTAL COST ($)	REMARKS
6.15	Receptacle Strips	3	ea	4	125	12	375	975	For Marine Biological Lab
6.16	Cable, LSTSGU-23, 100'	1	lot	40	238	40	238	2,238	
6.17	Cable, LSDSGU-4, 200'	1	lot	60	86	60	86	3,086	
6.18	Miscellaneous Lab Equipment	1	lot		60,000	0	60,000	60,000	
	Sub-Total					264	87,639	100,839	
7	SUPPORT SERVICES								
7.01	American Bureau of Shipping Plan Review and Site Inspection	1	lot		6,000	0	6,000	6,000	
7.02	Long lead procurement and contracting	1	lot	80	100	80	100	8,100	Use $100/hr
7.03	Construction Management	1	lot	200	6,000	200	6,000	26,000	Use $100/hr
	Sub-Total					280	12,100	40,100	

Appendix B:
Booster Pump Specification w/ Variable Frequency Drive

Goulds Pumps
ITT Industries **BECKWITH & KUFFEL INC**

James Burkhart
Beckwith & Kuffel, Inc.
5930 1st Ave South
Seattle, WA 98108
Phone: 800-767-6700
Fax: 206-767-6230

Glosten and Associates

Proposal No: JB05-11-17 01
Item No: ITEM 001

November 17, 2005

Attn: Daniel Clopton

MODEL:3996 MT SIZE: 4x6-13 QTY: 1

Operating conditions

SERVICE	Ballast Treatment Pump
LIQUID	Sea Water Temp. 70.0 deg F, SP.GR 1.000, Viscosity 1.000 cp
CAPACITY Rated	600.0 gpm
HEAD	55.0 (ft)

PRICE in USD	
Pump Unit	Incl
Driver	Incl
Boxing	
Testing	
Freight	
Accessories	
Total 1 Unit	**26,464**

Performance at 1150 RPM

PUBLISHED EFFY	76.5% (CDS)
RATED EFFY	75.5% with contract seal
RATED POWER	11.0 hp (incl. Mech. seal drag 0.14). (Run out 12.3 hp)
NPSHR	5.9 ft
DISCH PRESSURE(R)	24.1 psi g (28.6 psi g @ Shut off)
PERF. CURVE	2536-1 (Rotation CW viewed from coupling end)
SHUT OFF HEAD	66.0 ft
MIN. FLOW	Continuous Stable: 138.5 gpm Hydraulic: 138.5 gpm Thermal: N/A

Materials

CONSTRUCTION	CD4MCU
CASING	CD4MCU (max.casing.pres. @ rated temp. 285.0 psi g)
ST.BOX COVER	CD4MCU
IMPELLER	CD4MCU - Open (12.0000 in rated, max=13.0000 in, min=9.0000 in)
CASING GASKETS	Aramid Fiber with EPDM Rubber
IMPELLER O-RING	Teflon
SHAFT MATERIAL	SAE 4140
SHAFT SLEEVE	Alloy-20
LUBRICATION	Regreasable
SEAL CHAMBER	Taper bore plus with VPE
GLAND	316SS Flush quench and drain
BEARINGS	SKF 6309 (Inboard) SKF 5309 A/C3 (Outboard)
COUPLING	Rexnord - Omega Rex Elastomer- ES-5

Sealing Method

MECHANICAL SEAL	John Crane - 5610Q - XO(58)1XO(58)H (Silicon Carbide vs Silicon Carbide with Fluoroelastomer) - (Cartridge - Single)

Flanges

150# flat face

Liquid end features

Impeller balanced to ISO 1940 G6.3

Frame features

Labyrinth oil seals -Inpro VBXX-D

Piping

CPI Plan 7313 316SS tubing with 0.035in wall thickness

Testing

Non witnessed casing hydrostatic-test

Miscellaneous

Motor support ductile iron

Painting

Goulds Blue water reducible coating (Strathmore)

Warranty

3 Year Standard Warranty (All the components, manufactured by ITT Goulds pumps, in the liquid end and power end are covered).

Driver : Electric motor Manufacturer : Pump mfg`s Choice

FURNISHED BY	Pump mfg	MOUNTED BY	Pump mfg
RATING	15.0 hp (11.2 KW)	ENCLOSURE	Severe Duty/Mill and Chemical Premium Efficiency
PHASE/FREQ/VOLTS	3/60 Hz/230/460	SPEED	1200 RPM
INSULATION/SF	F/1.15	FRAME	284TSC

Weights and Measurements

TOTAL NET UNIT WEIGHT / VOLUME	973.2 lb / 19.7 ft³
TOTAL GROSS UNIT WEIGHT / GROSS VOLUME	1,138.2 lb / 33.0 ft³

Program Version 1.13.0.0

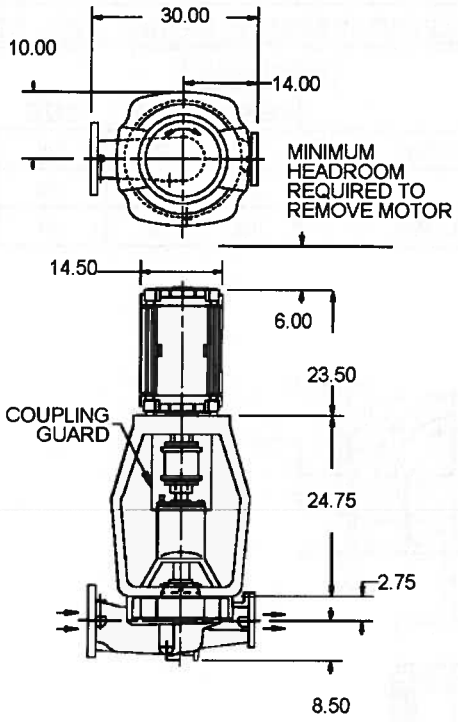
Our offer does not include specific review and incorporation of any Statutory or Regulatory Requirements and the offer is limited to the requirements of the design specifications. Should any Statutory or Regulatory requirements need to be reviewed and incorporated then the Customer is responsible to identify those and provide copies for review and revision of our offer.

Our quotation is offered in accordance with our comments and exceptions identified in our proposal.

Goulds Pumps
ITT Industries

OUTLINE DRAWING

Model 3996 MT 4x6-13



Pump specification

SUCT.FLANGE SIZE *6"*	DRILLING *ANSI 150#*	FACING *FF*	FINISH *SERRATED*		
DISCH.FLANGE SIZE *4"*	DRILLING *ANSI 150#*	FACING *FF*	FINISH *SERRATED*		
PUMP ROTATION (LOOKING AT PUMP FROM MOTOR)	*CW*				
TYPE OF LUBRICATION	*REGREASABLE*			COOLED	*NO*
TYPE OF STUFFING BOX	*TAPER BORE PLUS WITH VPE*			COOLED	*NO*
TYPE OF SEALING	*MECHANICAL SEAL*				

Weights and Measurements

PUMP	615.0 lb
MOTOR/CPLG	350.0/8.2 lb
BASEPLATE(N/A)	lb
TOTAL	973.2 lb
GR.VOLUME w/BOX	33.0 ft³
GR.WEIGHT w/BOX	1,138.2 lb

Motor specification

MOTOR BY	*PUMP MFG*	MOUNT BY *PUMP MFG*	MFG.	*PUMP MFG`S CHOICE*	
FRAME	*284TSC*	POWER	*15.0 hp*	RPM	*1200*
PHASE	*3*	FREQUENCY	*60 HZ*	VOLTS	*230/460*
INSULATION	*F*	S.F.	*1.15*		
ENCLOSURE	*SEVERE DUTY/MILL AND CHEMICAL PREMIUM EFFICIENCY*				

Notes and References

- MTR DIMENSIONS ARE APPROXIMATE

FOR PUMP TAPPED OPENINGS REFER TO DWG.:
TJB05-11-17 01 / ITEM 001

Auxiliary specification

COUPLING BY	*PUMP MFG*	CPLG TYPE	*REXNORD OMEGA REX ELASTOMER- ES-5*
CPL GUARD BY		CPLG GUARD MATL	
BASEPLATE	*N/A*		
MECH.SEAL	*JOHN CRANE 5610Q XO(58)1XO(58)H (SILICON CARBIDE VS SILICON CARBIDE WITH FLUOROELASTOMER)*		

DRAWING IS FOR REFERENCE ONLY.
NOT CERTIFIED FOR CONSTRUCTION UNLESS SIGNED.

Customer: Glosten and Associates
Serial No:
Customer P.O. No:
Item No: ITEM 001
Service: Ballast Treatment Pump

All dimensions are in inches.
Drawing is not to scale
Weights (lbs) are approximate

DRAWING NO JB05-11-17 01/ITEM 001

FORM # ED0159

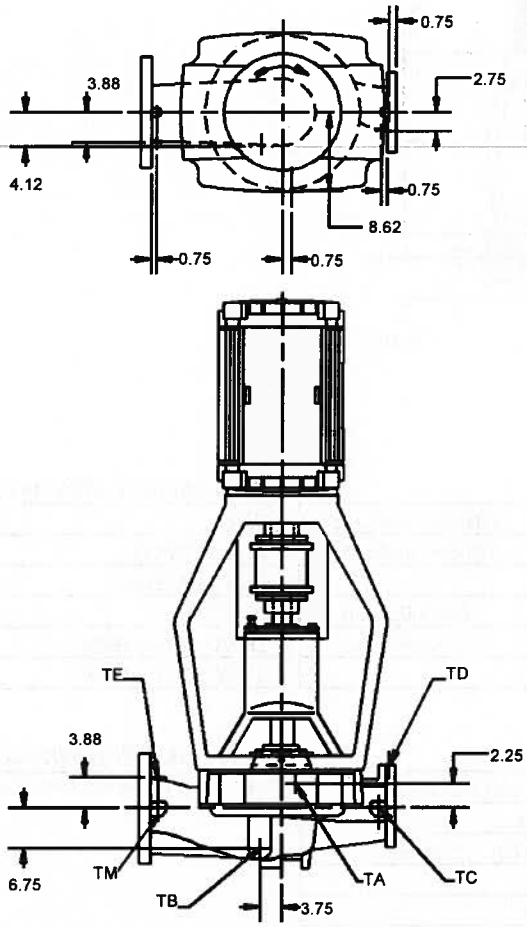
Program Version 1.13.0.0

Goulds Pumps
ITT Industries

TAPPED OPENINGS Model 3996 MT 4x6-13

TAPPED OPENINGS MODEL 3996 MT 4x6-13

NO.	SIZE	QTY.	PURPOSE	FURNISHED YES/NO	NO.	SIZE	QTY.	PURPOSE	FURNISHED YES/NO
TA	1/2	1	STUFFING BOX DRAIN	NO	TD	3/8	1	DISCH. GAUGE CONNECTION	NO
TB	1/2	1	CASING DRAIN	NO	TE	3/8	1	SUCTION GAUGE CONNECTION	NO
TC	1/2	1	BY-PASS CONNECTION	NO	TM	1/4	4	RECIRCULATION CONNECTION	YES



DRAWING IS FOR REFERENCE ONLY.
NOT CERTIFIED FOR CONSTRUCTION UNLESS SIGNED.

Customer: Glosten and Associates
Serial No:
Customer P.O. No:
Item No: ITEM 001
Service: Ballast Treatment Pump

All dimensions are in inches.
Drawing is not to scale

DRAWING NO JB05-11-17 01/ITEM 001

Model: 3996	Size: 4x6-13	Group: MT	60Hz	RPM: 1150	Stages: 1

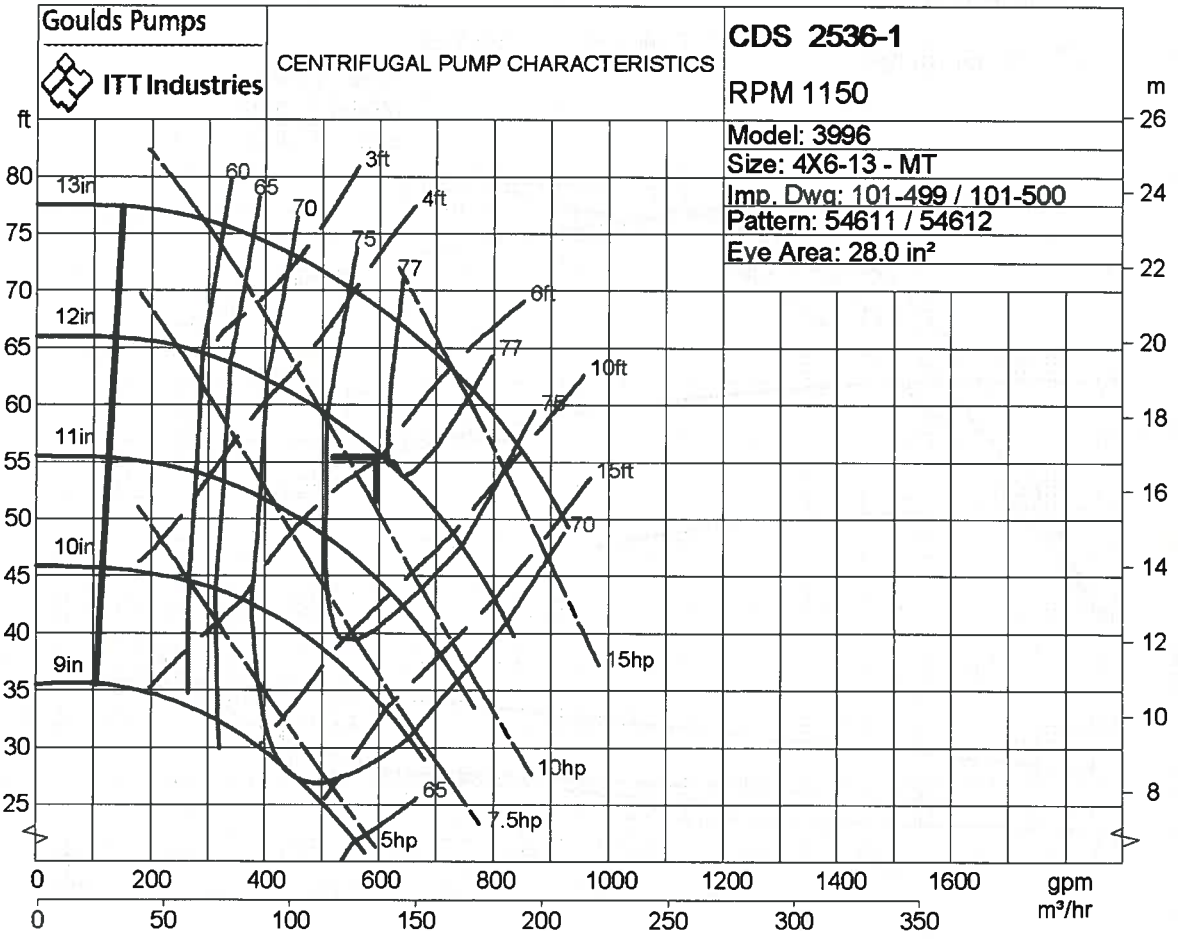
Job/Inq.No. :
Purchaser : Glosten and Associates
End User : Issued by : James Burkhart
Item/Equip.No. : ITEM 001 Quotation No. : JB05-11-17 01 Date : 11/17/2005
Service : Ballast Treatment Pump
Order No. : Certified By :

Operating Conditions

Liquid:	Sea Water	Actual Pump Eff.:	75.5 %	Suction Specific Speed:	8,472 gpm(US) ft
Temp.:	70.0 deg F	Actual Pump Power:	11.0 hp	Min. Hydraulic Flow:	138.5 gpm
S.G./Visc.:	1.000/1.000 cp	Mech. Seal Loss:	0.14 hp	Min. Thermal Flow:	N/A
Flow:	600.0 gpm	Rated Total Power:	11.0 hp		
TDH:	55.0 ft	Imp. Dia. First 1 Stg(s):	12.0000 in		
NPSHa:		NPSHr:	5.9 ft	Non-Overloading Power:	12.3 hp
Solid size:		Shut off Head:	66.0 ft		
% Solids:		Vapor Press:			
Max. Solids Size:	1.0000 in				

Pump Performance

Notes: 1. Power and efficiency Losses are not reflected on the curve below.
2. Elevated temperature effects on performance are not included.



Model: 3996	Size: 4x6-13	Group: MT	60Hz	RPM Variable	Stages: 1

Job/Inq.No. :
Purchaser : Glosten and Associates
End User : Issued by : James Burkhart
Item/Equip.No. : ITEM 001 Quotation No. : JB05-11-17 01 Date : 11/17/2005
Service : Ballast Treatment Pump
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Operating Conditions

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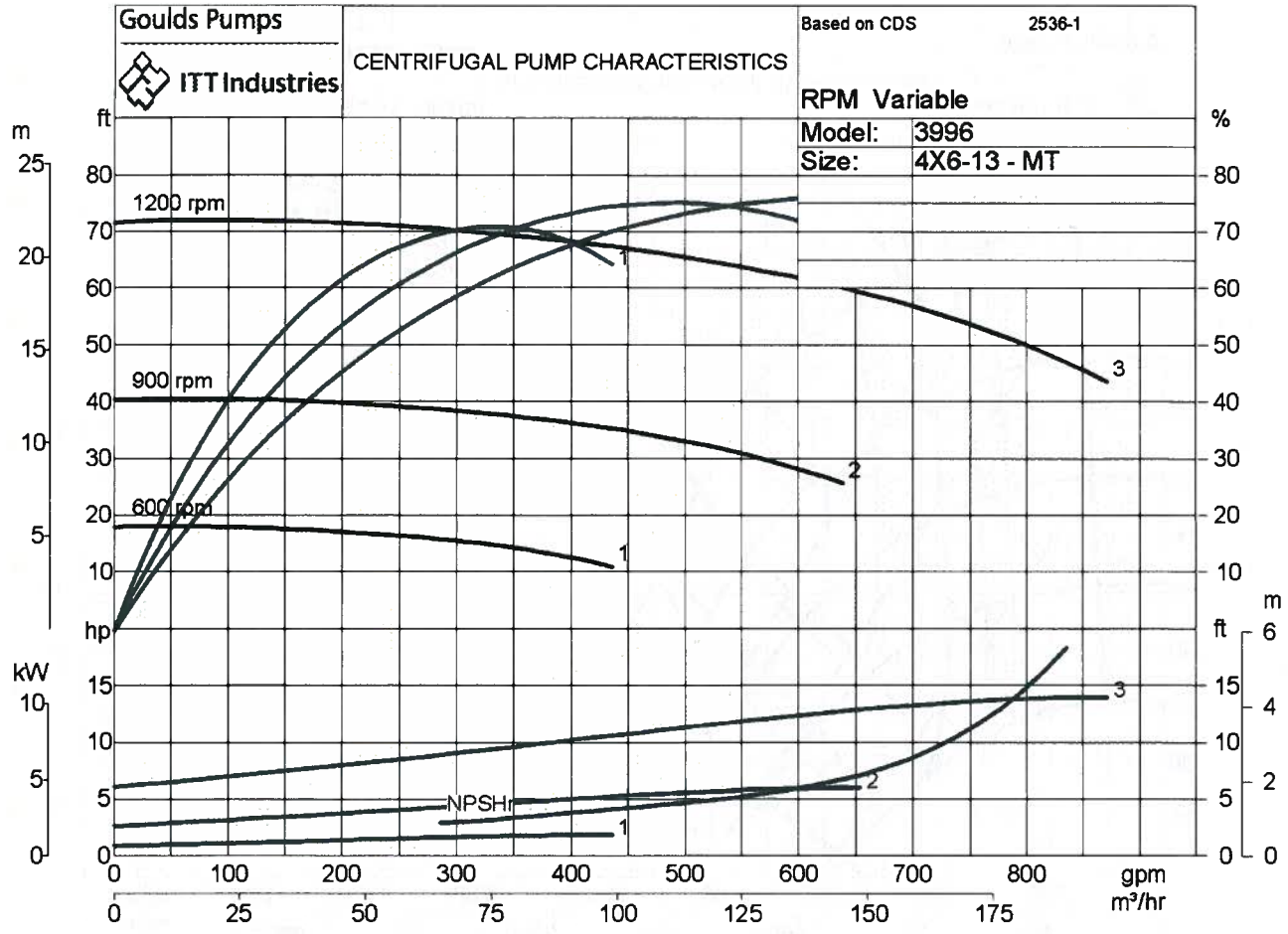
NPSHa:		NPSHr:	5.9 ft	Non-Overloading Power:	12.3 hp
Solid size:		Shut off Head:	66.0 ft		
% Solids:		Vapor Press:			
Max. Solids Size:	1.0000 in				

Pump Performance @ 1150 RPM

Notes: 1 . Elevated temperature effects on performance are not included.



PumpSmart
ITT Industries

BECKWITH & KUFFEL INC

James Burkhart
Beckwith & Kuffel, Inc.
5930 1st Ave South
Seattle, WA 98108
Phone: 800-767-6700
Fax: 206-767-6230

Glosten and Associates

Proposal No : JB05-11-17 01

Item No : ITEM 002

November 17, 2005

Attn: Daniel Clopton

PUMPSMART VARIABLE SPEED DRIVE SYSTEMS: PS75 QTY: 1

Operating conditions

INSTALLATION SITE ALTITUDE	3,300.00 ft
MAX AMBIENT TEMPERATURE	104.0 deg F

PRICE in USD	
Basic Unit	Incl
Boxing	
Freight	
Accessories	Incl
Total 1 Unit	**2,665**

Controller

SUPPLY VOLTAGE	380/460 VAC
POWER	15.0 hp
MOUNTED STYLE	Wall Mounted
ENCLOSURE	NEMA 12 - IP54
FRAME SIZE	R2
CABLE LENGTH CONTR./MOTOR	No Filter Required
CONTROLLER WEIGHT	25.0 lb
PART ID REFERENCE	A08305A07
CONTROLLER OUTPUT CAPACITY	23 (Amps) (No Correction due to Altitude or Ambient Temp.)
FIELDBUS ADAPTERS	Modbus

Pressure Transmitter

Direct Mount - ifm effector PA series (4-20mA OutputVoltage 10.8-30 VDC), (0-145psig) - 2m cable

Program Version 1.13.0.0

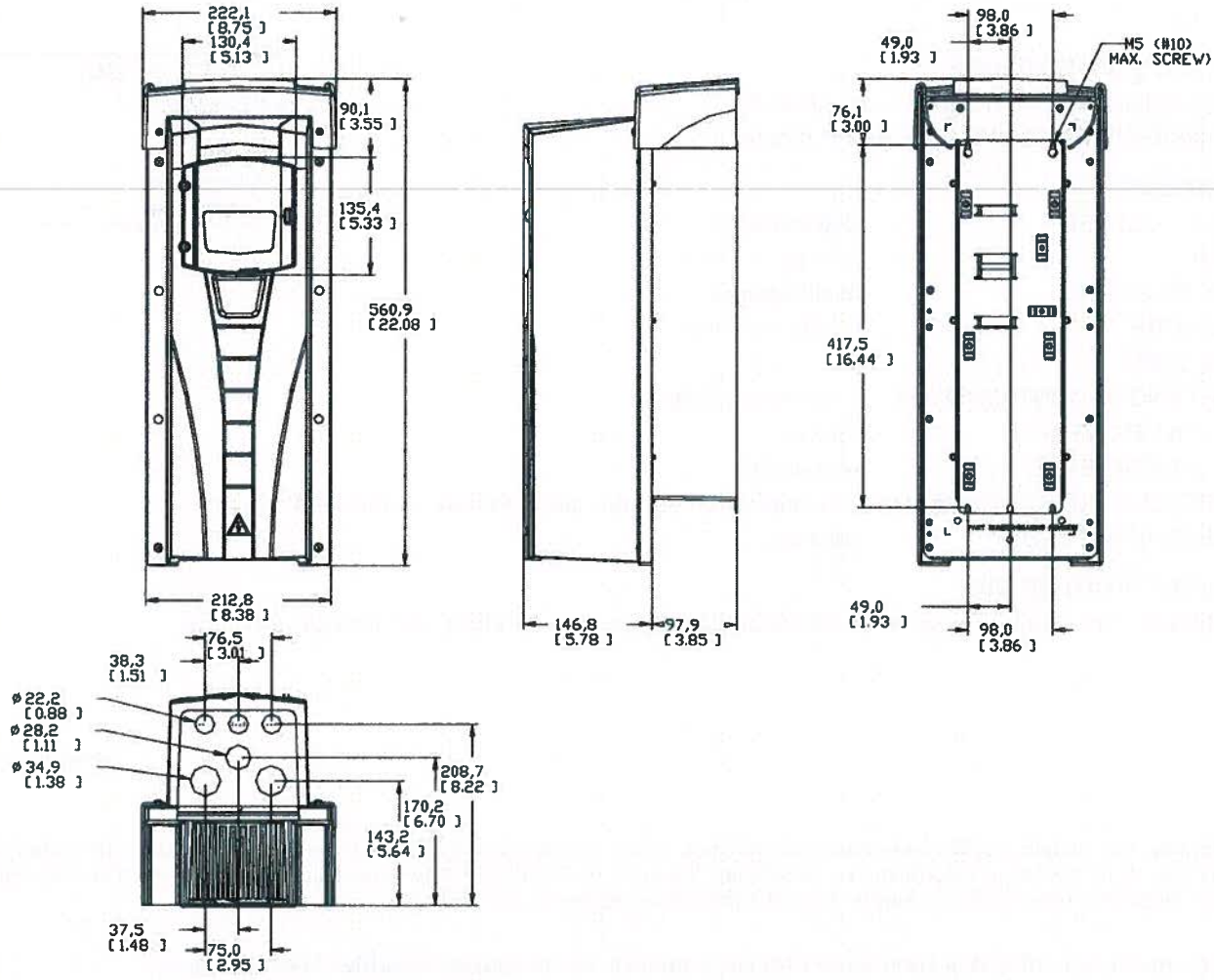
Our offer does not include specific review and incorporation of any Statutory or Regulatory Requirements and the offer is limited to the requirements of the design specifications. Should any Statutory or Regulatory requirements need to be reviewed and incorporated then the Customer is responsible to identify those and provide copies for review and revision of our offer.

****** Our quotation is offered in accordance with our comments and exceptions identified in our proposal.**

PumpSmart ITT Industries	PumpSmart PS75 Drive Dimensions and Ratings Frame R2 – NEMA12 / IP54	PUMPSMART CONTROL SOLUTIONS

PumpSmart PS75 Pump and Motor Control System

The PumpSmart PS75 is a pump and motor control system that provides integral starting, right sizing, pump protection and process control for all pumping applications. The PumpSmart PS75 is based upon the ABB ACH 550 variable frequency drive. PumpSmart Control Solutions has worked with ABB to incorporate proprietary pump protection & configuration algorithms into the drive to make it more suitable for pumping applications.



Drive Dimensions

Frame	Height mm [inches]	Width mm [inches]	Depth mm [inches]	Weight kg [lbm]
R2	560.9 [22.08]	222.1 [8.75]	244.7 [9.63]	11.2 [24.7]

*Dimensions not for construction

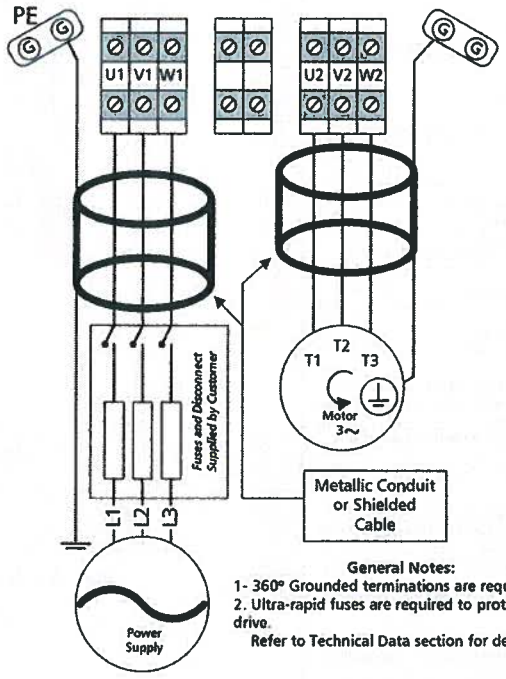
Copyright 2005 ITT Industries No Reproduction without Permission	Drawing is not to scale Dimensions in mm [inches]	Drawn: AI062304 Checked: AI062304	Issue 1- Added 575VAC ratings	Revision 1	Drawing A08392A	SHEET 1 of 4

Drive Ratings

ITT P/N	Input Voltage VAC	Power P_N[1]		Nominal Current I_{2N}[2]	Heat Dissipation		Air Flow		Frame	Enclosure Rating	Recommended Main Fuses		
		KW	HP	Amps	Watts	BTU/hr	M³/hr	CFM			IEC269gG (A)	UL class T (A)	Bussmann Type
A08303A06	230	5.5	7.5	24.2	227	776	88	52	R2	NEMA12 / IP54	25	30	JJS -30
A08303A07	230	7.5	10	30.8	285	973					40	40	JJS -40
A08305A06	380* / 460	7.5*	10	15.4	232	792					16	20	JJS - 20
A08305A07	380* / 460	11*	15	23	337	1150					25	30	JJS - 30
A08439A01	575	1.5	2	2.7	46	157					10	10	JJS -10
A08439A02	575	2.2	3	3.9	68	232					10	10	JJS -10
A08439A03	575	4	5	6.1	124	423					10	10	JJS - 10
A08439A04	575	5.5	7.5	9	170	581					16	15	JJS - 15
A08439A05	575	7.5	10	11	232	792					16	15	JJS - 15
A08439A06	575	11	15	17	337	1150					25	25	JJS - 25

Notes
[1] P_N - Nominal Power Rating at listed voltage rating
[2] I_{2N} - Continuous base current with 10% overload for 1 min / 10 minutes
*-KW rating applies to drives with 380VAC input voltage

Power Cabling Schematic



General Notes:
1- 360° Grounded terminations are required
2. Ultra-rapid fuses are required to protect drive.
Refer to Technical Data section for details

Frame Size	U1/V1/W1 - U2/V2/W2 BRK±, UDC± Terminals						Earthing PE Terminal			
	Min. Wire Size		Max. Wire Size		Torque		Max. Wire Size		Torque	
	mm²	AWG	mm²	AWG	Nm	Lb-ft	mm²	AWG	Nm	Lb-ft
R2[1]	0.75	18	16	6	1.3	1	16	6	1.3	1

1. Do not use aluminum cable with frame size R1...R4

Drawing is not to scale
Dimensions in mm [inches]

Drawn: AI062304
Checked: AI062304

Issue: 1- Added 575VAC ratings

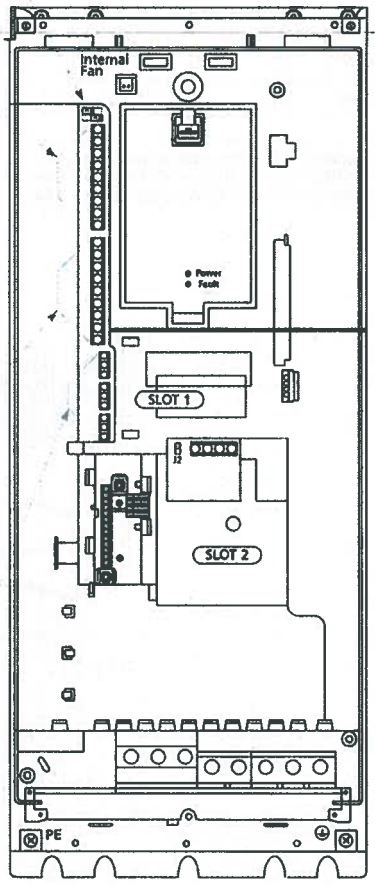
Revision: 1

Drawing: A08392A

PS75 Drive Terminal Block Schematic

	X1	Terminal Block		
1	SCR	Signal cable shield connected internally to chassis ground		Analog I/O
2	AI1 (+)	OPTION	Analog Input 1, Programmable External Setpoint J1:AI1 off 2..10VDC ON default J1:AI1 on 4..20mA ON	Analog I/O
3	AGND (-)	Analog Input 1 Ground		Analog I/O
4	+10V	AI Reference Voltage: 10V± 2%, 10mA max used for AI1 2-10VDC signals.1K ohm ≤ R ≤10K ohm		Analog I/O
5	AI2 (+)	OPTION	Analog Input 2, Programmable Primary Process Transmitter J1:AI2 off 2..10VDC ON J1:AI2 on 4..20mA ON default (Process Control Only)	Analog I/O
6	AGND (-)	Analog Input 2 Ground		Analog I/O
7	AO1 (+)	OPTION	Analog Output 1, programmable 4-20mA Output assigned in parameter 1501. Default is speed	Analog I/O
8	AO2 (+)	OPTION	Analog Output 2, programmable 4-20mA Output assigned in parameter 1507. Default is current	Analog I/O
9	AGND (-)	Analog Output Ground		Analog I/O
10	+24VDC	Process Transmitter / DI power source 24VDC / 250mA (reference to GND) Used if PumpSmart is powering the process transmitter and / or digital inputs		Digital I/O and Auxiliary Power
11	GND			Digital I/O and Auxiliary Power
12	DCOM			Digital I/O and Auxiliary Power
13	DI 1	OPTION	2 - Wire Start / Stop Change parameter 1002 to 2W DI 1 (1).Default is Keypad Start /Stop	Digital I/O and Auxiliary Power
14	DI 2	OPTION	Used with 3- Wire Start / Stop	Digital I/O and Auxiliary Power
15	DI 3	OPTION	Speed Control - Constant speed selection Process Control - Selects PID Set2	Digital I/O and Auxiliary Power
16	DI 4	OPTION	Speed Control - Constant speed selection Process Control - Programmable Digital Input Not Used	Digital I/O and Auxiliary Power
17	DI 5	OPTION	Fault Reset Input assigned in parameter 1604	Digital I/O and Auxiliary Power
18	DI 6	OPTION	Run Enable Input assigned in parameter 1601	Digital I/O and Auxiliary Power
19	RO1C COM	OPTION	Assignable Relay (RO1) The output of this relay is assignable by parameter 1401 Default: Ready (19 and 21 connected)	Relay Outputs
20	RO1 NC	OPTION		Relay Outputs
21	RO2 NO	OPTION		Relay Outputs
22	RO2C COM	OPTION	Assignable Relay (RO2) The output of this relay is assignable by parameter 1402 Default: Run (22 and 24 connected)	Relay Outputs
23	RO2 NC	OPTION		Relay Outputs
24	RO2 NO	OPTION		Relay Outputs
25	RO3C COM	OPTION	Assignable Relay (RO3) The output of this relay is assignable by parameter 1403 Default: Fault (25 and 27 connected)	Relay Outputs
26	RO3 NC	OPTION		Relay Outputs
27	RO3 NO	OPTION		Relay Outputs

J1
Dip switches
for Analog
Inputs



View of I/O Connection board (OMIO)

ACH 550

PumpSmart ITT Industries	PumpSmart PS75 Drive Dimensions and Ratings Frame R2 – NEMA12 / IP54	PUMPSMART CONTROL SOLUTIONS

PumpSmart® PS75

Hardware: ABB ACH550 Drive

CERTIFICATIONS

UL Listed
Canadian UL Listed
CE Marked

INPUT POWER

Voltage	208..240 VAC 1P and 3P +10%/-15% 380...480 VAC 3 Phase +10%/-15% 500..600 VAC 3 Phase +10% / -15%
Imbalance	Max +- 3% of Nominal Phase to Phase Input Voltage
Frequency	48..63 Hz
Fundamental Power Factor (cos Ø1)	0.98

MOTOR CONNECTION

Voltage	0 to Usupply
Frequency	0-500 Hz
Overload Capacity	Normal Use 1.1 x Rated Current for 1 min every 10 min
Switching Frequency	Default 4kHz, Selectable 1,4,8 and12 kHz 1-150 hp (.75-110 kW), Selectable 1,4 and 8 kHz 150-550 hp (110-355 kW)
Motor Control	Sensorless Vector Control
Speed Control	Static Accuracy 20% of motor nominal slip
Drive Nominal Output Current	6:1 Maximum Motor nominal Current

ENVIRONMENTAL LIMITS

Enclosures	NEMA Type 1/IP21 NEMA TYPE 12/IP54 (U1/01 Only)
Temperature	5...104F (-15..40C) No frost Allowed
Humidity	<95% Relative Humidity, Non-condensing
Altitude	0..3300 Ft (0..1000M) Standard
Shock	Not Allowed
Free Fall	Not Allowed
Vibration	5-13.2 Hz 1mm (.04 in)

STANDARD INPUT/OUTPUT

2 Analog Inputs	(0) 4...20mA, Rin>100 ohm single-ended or (0) 2..10VDC, Rin>312k ohm single-ended, resolution 0.1%, accuracy +-1%. Default: AI1 Voltage, AI2 Current Configurable
2 Analog Outputs	(0) 4...20mA, Load < 500 ohm, Configurable
Auxiliary Voltage	24 VDC +- 10%, max. 250 mA
Digital Inputs (6)	12V...24VDC with internal or external supply, input impedance 1.5 kohm Common Configurations: 2-Wire Start/Stop, 3-Wire Start/Stop, Dual Setpoints, Secondary Protect A, Secondary Protect B, Run Enable, E-Stop, Fault Reset, Constant Speed Select, PID Set Activation
Relay Outputs (3) *Configurable*	Form-C Switchover Contact Max Switching Voltage 250VAC / 30VDC Max Switching Current 6A / 30VDC 1500VA/250VAC 2A rms max continuous current Min Load:500mW (12V,10mA)
Reference Voltage	10 VDC ±2% 10mA max current R <10 Kohm

DRIVE PROTECTION

Keypad Loss	Wiring Fault
Earth Fault	Over Current
Over Voltage	Drive Overtemp
Under Voltage	Phase Loss
Motor Temp	Short Circuit
Drive Overload	Communication Failure
Run Enable	

PUMP PROTECTION

Closed Valve	Runout Flow
Loss of Suction	Sensor Failure
Low Flow	Critical Speed (Speed Control)

FIELDBUS

Modbus (built-in std)	ControlNet
DeviceNet	Profibus-DP

Certified for Construction Purposes only when signed Date.....	Customer Name ..... Goulds S/N ..... Customer P.O # ..... Item No. .....

Drawing is not to scale Dimensions in mm [inches]	Drawn: AI062304 Checked: AI062304	Issue 1- Added 575VAC ratings	Revision 1	Drawing A08392A	SHEET 4 of 4