Frequently Asked Questions (FAQs) on Luxury Submarines, Tourist Submarines and Deep Submersibles

Luxury Submarines

1. How safe is the submarine?

Last year, approximately 2 million passengers took dives aboard the world's commercial tourist submarine fleet, generally to depths of 50-100 meters. In the 14 year operating history of the industry there has never been a single serious injury or fatality to any passenger. The industry has a perfect safety record and so, civil submarines are statistically the safest form of transportation in the world today.

All of U.S. Submarines' vessels are classed +A1 Manned Submersible by the American Bureau of Shipping. Like FAA certification of aircraft, the ABS classification procedure is arduous, but results in unsurpassed safety. And, U.S. Submarines management team has experience with over 65 submarines and submersibles, including all of the diesel electric civil submarines built world-wide in the last 15 years.

2. What about crew training?

U.S. Submarines will provide crew training for the owner and/or his selected crew. Ideally, we like to have the crew participate in the last several weeks of assembly and trials of the submarine so that they can get intimate, hands on experience with the installation, operation and maintenance of critical systems. The crew will then have additional pilot and maintenance training during sea trials.

We can also provide experienced submarine pilots and maintenance technicians for an owner.

3. Is a license required to operate the submarine?

A private owner does not need a license to operate the submarine for leisure purposes but our in-house training program must be satisfactorily completed by the operator. In addition, if the submarine will be carrying passengers for hire in U.S. waters, then the crew must meet U.S. Coast Guard manning requirements. This means that the Captain is required to have a U.S.C.G. Master's license for a surface vessel of equivalent tonnage (500 tons in the case of the Seattle 1000) and will have to complete our training course which includes 40 hours of pilot in command time and 40 dives and surfaces and then take a U.S.C.G. examination based on our manuals. The successful applicant will then have a submarine endorsement added to their license.

4. How comfortable is it inside the submarine? Are there any changes in cabin pressure?

The inside of one of our luxury submarines is air conditioned and temperature controlled. Regardless of the operating depth of the submarine, the interior of the passenger cabin remains at surface pressure, which is one atmosphere. As a result, there are none of the pressure induced physiological effects experienced by SCUBA divers. A guest aboard a submarine can stay comfortably submerged for as long as desired, and the submarine can dive or surface at any rate.

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The interior of the submarine is very luxurious with rich fabrics, beautiful woods and replete with the finest leathers. An owner can choose one of our interiors or work with an interior designer of their choice.

5. How does the air stay fresh inside the sub?

The submarine has a sophisticated central air conditioning and life support system. Basically, oxygen stored in high pressure bottles outside the pressure hull is injected into the passenger cabin in order to maintain a level of 21% by volume. The carbon dioxide respired during breathing is scrubbed out of the air by a special granular chemical contained in the main scrubbing system. The air is also dehumidified and heated or cooled as necessary. The Seattle 1000 carries enough oxygen to remain submerged for over three weeks without surfacing.

6. How flexible is the Seattle 1000 design in terms of accommodation plans?

The original interior calls for 5 staterooms and spacious common areas. We can change the interior accommodation to meet the owners needs and we can lengthen the pressure hull to provide more space if necessary. We also have designs for luxury submarines that are both larger and smaller than the Seattle 1000.

7. How deep can the submarine dive?

The Seattle 1000 is designed to dive to 305 meters, or 1000 feet. This is an optimum compromise that allows exploration at significant depth but also allows us to have very large viewports for exceptional visibility. If necessary, a small deep submersible could be carried "piggy back" by the Seattle, allowing a small group of 2-3 people to board the deep submersible through a transfer lock and dive to depths of up to 3000 meters or more.

8. What is the difference between surface and submerged travel?

While surfaced, the submarine acts very much like a yacht, although the submarine is heavier and has a lower profile. Cruising speed for the Seattle is approximately 14 knots, and the submarine has transatlantic range allowing the owner to travel virtually anywhere. When the submarine is surfaced the captain controls the vessel from inside the acrylic cabin in the superstructure or deck house. From here, he has an excellent view and access to all the necessary instrumentation for control and navigation, including radar, GPS, etc.

When it is time to dive the captain shuts down the diesel engines and switches to battery power. He then goes below to the pilot's compartment located in the bow of the submarine forward of the main lounge. From here he has an excellent view of the underwater environment through an immense forward viewport.

9. What advantages would there be to purchasing a Seattle 1000.

The owners of the Seattle 1000 would have, if desired, international notoriety for becoming the

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owners of the world's first large personal luxury submarine. Few subjects have captured the imagination of the public like personal luxury submarines. But beyond that, the owners of a Seattle would have the opportunity to explore areas that no human has ever seen before, from the brightness and splendor of tropical coral reefs to the silent depths of the sea at 1000 feet, a new frontier awaits. The sheer impact of the experience of cruising smoothly below the waves defies description.

10. What are the terms of purchase?

Initially, the owners would retain us to modify the design and develop the interior to meet their specific requirements. Subsequently we would sign a manufacturing contract that would require a 10% initial payment followed by four 20% payments made at easily verifiable milestones in the construction process with the final 10% on delivery. The price of the Seattle 1000 is $19.7 million. Construction time would be 24 months.

And for the Press:

11. What type of people buy luxury submarines?

Interested buyers tend to share one trait, they are all wealthy. We group them in to three additional categories.

The most interesting are the avid SCUBA divers and ocean aficionados who are very interested in the subsea world and view a luxury submarine as a vehicle for exploration.

With 2300 megayachts operational around the world, some costing in excess of $150 million, the stakes in the game of one upmanship are rising. Some yacht owners like the idea of having a larger and more unique toy.

The luxury submarine also attracts individuals who have never owned a yacht, but are fascinated with the idea of traveling beneath the surface of the world's oceans.

At U.S. Submarines we deal with all types of potential buyers, from wealthy Arab sheikhs, to world leaders and hi-tech mega-millionaires. However, virtually all insist on confidentiality.

ADDENDUM

I have been following your company for years and have enjoyed receiving your literature and recently going through the web site.

I am looking the possibility of buying a sub for personal use in a few years - similar to buying a yacht. I am looking at living on it with my wife and entertaining business partners etc., similar to what I might do in a yacht. The *Nomad* and Seattle information files on the web site are very interesting; however, the information leads to some questions. If you have some time, I would like to pass the questions on to you. I realize the questions may seem to be nit-picky - but I am trying to resolve my previous surface craft and submarine experiences with the possibility of having a personal sub built in the manner of your designs.

1. **My wife is not so sure about this idea of living on a submarine. Can you provide an idea about what the available space is? What the view is out the side/front viewports. I went through the file about the Argos (ftp://ussubs.com/consub.pdf) and though that is of some help - it is still a very different configuration.** ➥

Answer: The floor plan arrangements taken in conjunction with the general dimensions of the submarine found in the specifications are the best method of getting an idea of the space. Basically, the *Nomad* has a pressure hull diameter that is about 8 feet (2.45m) and so it can best be thought of as a motor home size interior.

The *Seattle* has a much larger pressure hull in the central section and as a consequence there is sufficient space for both upper and lower decks. In this case a mid-sized yacht is a good analogy in terms of available space.

The view out the viewports is simply stunning. We go to great lengths to maximize the size of the viewports (up to 6 feet [1.8m] in diameter on the Seattle) and to place them in appropriate spots for convenient viewing. The viewports are also convex spherical sectors so the downward view is improved over the flat type. All of the viewports are composed of polymethyl methacrylate which is remarkably transparent and very strong under compressional hydrostatic load.

2. **I would want to be able to run the boat with just one of us at the controls- without a dedicated crew - is that feasible given the control console locations/visibility/above water deck configuration – etc? In this regard, the Nomad seems to be about the right size for handling, while the Seattle might be a bit much to handle with only one person on the controls and one on deck for lines etc.**

Answer: Both the Seattle and the Nomad have very sophisticated digital proportional F-16 style joystick control systems that allow for pinpoint maneuvering while submerged or on the surface. With lateral thrusters the subs can sidle sideways or spin in their own length. When submerged vertical thrusters make accurate placement in the water column quite simple. The above deck control stations are situated so that visibility is quite good. On the Nomad, you can open the acrylic hatch above the pilot's compartment and pass up the remote consolette which allows you to walk around the main deck and maneuver the submarine. A deck plug-in on the Seattle is also available.

At 72 tons one person can tie up the Nomad without too much difficulty. The Seattle, at 380 tons displacement has fairly stout mooring lines and while one person could tie the sub up under normal conditions it would be a good idea to have more than one person aboard in inclement weather or areas of significant current. Of course, if there are any people at all on the dock you'll have many curious on-lookers willing to take the lines.

3. **For extended living/cruising etc. referring to the drawings in the .pdf files, the Nomad seems to be a bit short on space for food/ clothes/personal gear/navigation charts ... especially if there are guests on board - is this a true condition or is there a lot more storage than shown? How much more room is available in the "extended" Nomad?**

Answer: Each of these submarines is built on a custom basis and the interior layout and storage reflects the mission profile and owner's lifestyle. On the Nomad there is space in the

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overhead and drawers under the furniture and seats as well as some closet space. People make month-long trans-Pacific crossings on 30 foot sail boats so with a little ingenuity the Nomad can hold everything you need for extended voyaging. But keep in mind that with a range of 1000 nautical miles you won't be offshore for weeks at a time.

The extended Nomad adds a private stateroom to the basic configuration.

4. **Comparing to other yachts and surface craft and water current speeds, both the Nomad and Seattle seem to be underpowered and have cruising speeds that are too low for any serious cruising or distance traveling. Are there options available for increased power plant sizes with increased surface and underwater speed capability? Options for additional diesel fuel tanks to extend cruising range?**

Answer: Like most sailboats, tug boats, cargo ships and work boats, submarines are displacement craft as opposed to planing speedboats and semi-displacement vessels like crew boats or some yachts. Displacement vessels are limited due to wave making resistance and the formula for determining hull speed in knots is generally 1.3 times the square root of the waterline length in feet. So, in the case of a boat with a 65' waterline the hull speed would be 10.5 knots. You can drive the vessel over hull speed and derive an extra knot or so, but above that the power requirements for extra speed increase exponentially.

Cruising on the surface at 10 knots in the Nomad or 14 knots in the Seattle is a reality that can't be changed. There is no such thing as a planing submarine speedboat as planing and semi-displacement hulls are comparatively lightweight with high power to weight ratios. Because a submarine must weigh as much as the water it displaces there is no such thing as a lightweight submarine.

The average port to port speed for a contemporary cruising sailboat is usually less than 4 knots. I myself have crossed the Pacific on a power boat at 8 knots. Serious offshore sailors understand the speed limitations of the environment. If you want to get there in a hurry, take an airplane.

An interesting thing does happen when a submarine submerges. The wave making resistance is eliminated and parasitic drag becomes the limiting factor. This is why most submarines have higher submerged burst speeds than surface speeds. However, once the submarine is submerged most are powered by batteries and the power consumption goes up exponentially with speed. So, you can go flat out submerged for one hour or you can cruise at low speed for days – you make the choice. Today there are submerged power alternatives to batteries. Other AIP (Air Independent Propulsion) systems used successfully in submarines include closed cycle diesel power and proton exchange membrane (PEM) fuel cells. A closed cycle Stirling option is available on both the Nomad and the Seattle to dramatically increase submerged speed and endurance, but it adds considerable to the price and the overall complexity of the submarine.

Another alternative is to fit the submarine with a streamlined induction mast so that the diesels can be run while the submarine is just a few feet underwater. In this condition most wave making resistance is eliminated and the submarine can easily exceed hull speed by a considerable margin. However this is an option limited to our patrol and surveillance

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submarine models with highly trained crews.

Added diesel tankage is possible.

5. **Is the mechanical room accessible when submerged? The Nomad drawing appears to show no access. Is the only access via the shower?**

Answer: The access is through a water tight door in the bulkhead behind the shower. The shower can be moved to another location if this is a problem.

6. **High-pressure air is available for surfacing etc. - are air fittings and filters/ regulators etc. available to provide for SCUBA tank fills? Is low-pressure air available for floats/inflatable boats etc.? Are there air fittings in the above water cabin for divers to use the sub as a "taxi" down to a dive area? What a great way to explore a shallow water reef or wreck - non-divers inside monitoring, watching, and talking to the divers on the outside - everyone enjoying themselves.**

Answer: Yes, HP fittings are available for SCUBA tank fills and low-pressure air is also available. External connections for a hookah rig are available as an option. With external divers care must be taken to carefully control the speed of ascent and descent to prevent equalization problems and air embolism.

In the Seattle 1000 a diver lock out/decompression chamber is available as an option allowing divers to exit and re-enter the submarine while submerged. A special training program is a requirement of sale.

7. **Are there storage areas available (perhaps in the above water cabin) for snorkeling/ diving gear; inflatable boat for shore access where water is too shallow; shore lines; overside ladders/ramps for pier or water access?**

Answer: Yes, there is ample storage in the superstructure. A pressure proof compartment for outboard storage is also available,

8. **It is not obvious in the drawings, but are there remote controls/ storage/housing areas for anchors and shore lines? How are they handled so as to not interfere with the front and side viewing portals?**

Answer: There is an anchor windlass and storage system as well as a collapsible bowsprit for anchor deployment.

9. **An auto-nav system is referenced - does it also have controls for maintaining submerged course/speed and/or for positional hover accounting for currents (in case a bottom set down is not physically or environmentally feasible?**

Answer: Yes, there is basic autopilot/autodepth system. Dynamic positioning is an option and also requires a Doppler sonar velocity navigation system to maintain bottom station regardless of current changes.

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10. Are the engine air intakes mounted up on the mast or on a snorkel system that would permit cruising with most of the sub below water level to avoid wave action in rough weather? Are there any "periscope" or camera video feeds from the mast to assist surfacing safely? Could be a big surprise if the sub came up in the path of a surface craft.

Answer: Semi-submerged cruising or snorkeling is not possible with a standard configuration. If it gets too rough, simply submerge and proceed on battery power.

There is a remote video camera on the mast. A telescoping mast with integrated video is an option.

Passive and active sonar systems are available and must be used prior to surfacing. Training in their operation is given in our mandatory owner training program.

11. Do your designs include desalinization units for fresh water or are the subs dependent upon shore water?

Answer: Reverse osmosis watermakers of varying capacity are available as an option and are recommended.

12. Any thought or possibility of recharging the batteries via solar power arrays on the upper deck - so as to provide at least a low speed propulsion in case of loss/over consumption of diesel fuel?

Answer: With both a large battery bank and a substantive quantity of diesel fuel there is plenty of power management and "get home" capability. The small battery charging capability of a solar array wouldn't be sufficient to make much difference in motive power of the submarine.

13. Is the sonar installation - upward looking as well as downward/ forward looking?

Answer: The optional high resolution color imaging sonar is trainable in up, down and forward directions.

14. Are there any provisions for radio transmission/reception while submerged? Any pop-up radio buoys in case of emergencies while submerged?

Answer: Radio waves do not propagate underwater. All of our submarines are equipped with dual frequency underwater telephones with emergency pinger/locators. A radio and/or satellite antenna-equipped surface buoy with retractable cable and hydraulic level-wind is an option.

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Deep Submersibles

We will use the terms manned submersible and deep submersible interchangeably. “Manned submersible” has recently been determined to be politically incorrect with the suggested substitute being “human occupied submersible vehicle”. We’ll use “deep submersible” for the sake of simplicity.

Where are deep submersibles used today?

Deep submersibles are used primarily in the area of marine science research where there are approximately 40 vehicles world wide attributed to that purpose. Some are laid up and others get little use. However, most marine scientists feel that there is no substitute for “in situ” direct observation and they refuse to accept remote methods of observation (e.g. ROVs).

Has deep submersible use declined? If so, why?

Deep submersibles were used extensively by the offshore oil companies in support of survey, drilling and production operations. They were used as an adjunct to extend the capabilities of shallow water and saturation dive teams. Over time, their use became supplanted by remotely operated vehicles (ROVs) which have made continual gains in sophistication and capability. Compared to deep submersibles, ROVs are less costly to operate, maintain and insure. Today, there are virtually no deep submersibles in use in the commercial offshore business.

Just what is an ROV?

An ROV is a tethered remotely operated vehicle where power and control capability is provided through an umbilical cable. The vehicle is controlled by an operator from a control van using joysticks, video monitors and various instrument readouts. ROVs range in size from small portable units that cost $10,000 or less, to large, high horsepower behemoths costing millions of dollars. Depending on the task at hand, ROVs are equipped with a myriad of devices from sensitive spatially correspondent manipulators to special jetting and trenching attachments,

What about deep submersibles for personal use?

The problem with deep submersibles is their weight. Imagine, if you will, trying to push a large beach ball completely underwater. It’s a struggle. In order to get that beach ball to sink and be neutrally buoyant, you have to weigh it down significantly. In fact, according to Archimede’s Principal the weight must be equivalent to the volume of water the beach ball displaces, and water is quite heavy. It’s the same thing with a submersible. Depending on the depth requirement the vehicle will be constructed of medium to high tensile steel, but in most cases lead weights will have to be added to achieve neutral buoyancy. A typical contemporary two passenger submersible will weigh a minimum of about 3 tons. A three passenger unit about 4.5 tons, minimum. If you need more interior space for equipment, the weight increases rapidly such that older 3-passenger commercial subs are likely to weigh in at 7 - 9 tons.

It is very difficult to transport a deep submersible on a trailer behind a conventional car or truck. Once at the water, they must be launched from a crane or travel lift, because most designs draw too much water to be launched from a boat ramp. Once in the water they must be used in close proximity to the launching point because being battery powered they have very limited range and

endurance. And, because of their weight and cross sectional area, they tow like bricks. A maximum towing speed is generally 4 knots.

However, U.S. Submarines has developed a unique submersible that can be used effectively as a personal vehicle. Our Triton 650 takes advantage of a unique catamaran style configuration to reduce draft, and the low volume approach minimizes weight while the transparent pressure hull provides exceptional viewing.

What about operating deep submersibles from a yacht or ship?

Deep submersibles used for marine science research have virtually always been launched from and retrieved to a surface support ship. But, because of the weights involved the ships have been large, typically at least 35 meters in length, and the launch and recovery equipment has been specialized, expensive and heavy. These launch and recovery systems themselves can easily cost over $350,000. They are usually "man rated" by the American Bureau of Shipping so that scientists can enter and exit the submersible on the deck of the ship. Launching a 5 to 25 ton submersible from and recovering it to a support ship is no trivial task, particularly in marginal sea conditions where lateral and snatch loads can be greatly increased due to the motion of the ship and the submersible.

However, if the launch and recovery requirement is taken into consideration early in the yacht construction process and matched to a specialized submersible the systems can be well integrated. But, for this to happen the submersible must be designed to be entered and exited while in the water because the construction requirements for a man rated launch and recovery system are much more pronounced. At U.S. Submarines we worked with the world leader in launch and recovery systems and developed a unit that was stern mounted and would launch, recover and carry our 7 ton Discovery 1000. The submarine and the launch and recovery unit could be easily removed from the deck of the yacht and placed in a 40 foot container and shipped anywhere in the world. Our small, lightweight Triton 650 can be launched from most large yacht davit systems with minimal modification.

What about the cost of deep submersible operations?

You can rent time on a research sub from one of several marine science research groups. Generally, the cost will be about $5,000 per day for the submersible and crew and about $12,500 per day for the support ship and crew. The high cost of operations is one significant contributing factor to the decrease in deep submersible utilization.

In a luxury yacht environment the situation is much different. A contemporary purpose-built deep submersible like our $640,000 Triton 650 is a light weight, low maintenance design that minimizes the expense and difficulty of launch and recovery and the operating costs are virtually unnoticeable in the yacht's overall budget. One crew member can be trained to maintain the submersible and the owner or crew can be trained to pilot the submersible in a relatively short period of time.

Some older deep submersibles are listed for sale. Are they viable to operate?

There are a large number of older deep submersibles that are advertised for sale. Generally, they are large and heavy and require significant maintenance due to their old and outmoded systems. Many are not stable on the surface and so must have man-rated launch and recovery systems that

are very expensive. To be used in practical applications, these submersibles require large support ships and any money saved by buying an older heavy submersible will be spent several times over in the support ship and launch and recovery system requirement. If you have a commercial or scientific task and substantial financial resources to pay a highly specialized trained crew for the sub and a large support vessel, then an older submersible may make sense. Otherwise, these older deep submersibles make good static displays and museum pieces.

Are there any conditions where the use of older submersibles might be practical?

Yes, there are two possibilities that come to mind. If you are fortunate enough to live immediately adjacent to an operating area where you can keep the sub on your dock, bulkhead or marine railway and your principal operating location is within 0.5 kilometer, an older submersible may make sense. If you are willing to tow the sub at speeds of less than 3 knots you can expand the operating area in that manner. However, you must choose a submersible that has good surface stability and adequate freeboard so that you can easily enter and exit the vehicle while at sea, and you should be aware that your comparative maintenance requirement will be relatively high.

A second possibility is to purchase a complete integrated system. For instance, on a few occasions deep submersibles have been built with dedicated self powered catamaran style surface support vessels that have integrated launch and recovery and support equipment (e.g. generators, battery chargers, air compressor, spares storage) but are small enough to be cost effective to operate within a limited area from base. The Bruker Mermaid IV is one such system that is available for about $600,000 for the catamaran and the submersible. A catamaran has also been built for one of the SM-100/3 submersibles.

What sort of contemporary deep submersibles have been built in recent years?

In 1987 a Finnish company, Rauma Oceanics, built the Mir 1 & Mir 2 for the Russian Academy of Sciences. These are the submersible that were used to film the Titanic. The Mirs cost about $25 million each and have a 6,000 meter depth rating. Just before the Mirs were delivered the Japanese completed the $60 + million Shinkai 6500, which with a depth rating of 6500 meters is the deepest diving manned submersible today.

A few years ago an American company built two DR1002s which have spherical transparent pressure hulls and a depth rating of 1000 meters. These two submersibles cost $1.7 million each and are used by Canal Plus, the French television group.

Last year a French company completed the second Remora, a 2-passenger, 600 meter capable submersible that also has a transparent spherical acrylic pressure hull. The sub was delivered to the Greek Dept. of Antiquities in 1999.

What will the future be like for manned submersibles?

This is a subject of interesting speculation. There has not been much activity in the deep submersible field over the last several years. Technical advances in the use of acrylic have provided a preferred alternative for construction of these vehicles. The Remora and the DR1002 following in the footsteps of the earlier Johnson SeaLinks have proven the superiority of the acrylic hull for

depths to 1000 meters. Interestingly enough, they have also proven cost effective. Building a conventional deep submersible with 1000 meter depth rating like Pisces II for example would cost significantly more than the $1.7 million for the DR1002. So, there is an economic advantage, yet in most situations manned submersible utilization fails the basic cost benefit economic test, in large part because of the expense of the surface support ship.

It is possible that the advent of usable air independent propulsion systems (e.g. closed cycle diesel, closed cycle Stirling, PEM fuel cells, etc.) coupled with diesel electric submarine autonomy as demonstrated by our Nomad or Seattle designs could provide a cost effective and capable alternative. In this case, small to mid size submarines can transit to a dive site while on the surface and then spend days operating underwater before returning to the surface for the trip home. AIP capability can dramatically expand the undersea range and endurance and the diesel electric capability obviates the need for a surface support ship thus cutting the overall system operating costs by half.

Otherwise there will be some call for replacements for conventional deep submersibles used for marine science research that have aged to the point that they are no longer safe or cost effective. And, ROVs used in the offshore oil industry run up against limitations at depths of 3500 meters or more and new manned submersibles may prove the only viable substitute.

For more information on this topic, please see the following articles on our website:

The Future
The Future of Manned Submersibles
MTS Manned Submersibles Committee: Report on the State of the Technology

TOURIST SUBMARINES

What is a tourist submarine?

We use the terms “tourist submarine” and “tourist submersible” interchangeably. Technically, the term “submarine” denotes a degree of autonomy that tourist vehicles do not have and the term “submersible” is more appropriate. Yet because the public more easily identifies with the term “submarine”, that terminology is also appropriate.

A tourist submarine is a one atmosphere undersea vehicle that is designed to take paying passengers on subsea voyages for observation purposes. As such, t-subs have transparent viewports for external viewing. The term “one atmosphere” means that the pressure inside the submarine never varies from sea level regardless of operating depth. Typically, dives on a t-sub are less than one hour in duration and a t-sub can make up to 12 one-hour dives per day.

Are there different types of tourist submarines?

Yes, but the overall design differences are not very significant. The tourist subs differ in size and in design philosophy, but are similarly configured. The end result is that all of the tourist subs produced in the last 15 years, with just a couple of exceptions, are remarkably similar and pay tribute to the lack of imagination of their designers.

Purpose-built tourist subs range in size from 10 passengers to 66 passengers which corresponds to a range in displacement of from 30 tons to 150 tons. They all derive their power from lead acid batteries which provide sufficient power to operate from six to 12 one hour dives per day before an overnight battery recharge. Maximum operating speed is three knots and generally, cruising speed submerged is 0.5 - 1.0 knot. Because of their limited power capacity, tourist subs are towed to their dive site in the morning by a tow boat and then remain on site for the day while passengers are transferred to and from the submarine by a passenger transport vessel. For more information see the *Anatomy of a Tourist Submarine.*

The only notable exceptions are the Deepstar design, a tourist submarine with a transparent acrylic pressure hull and precursor to our Deepview series of acrylic hulled t-subs, the deep diving Bruker Seamaid TSIV, and our diesel electric Marlin and Nomad t-subs which, when compared to conventional tourist subs have 20 times the range, dive 7 times deeper and have 4 times the surface speed.

Where do tourist subs operate?

Tourist subs operate principally in tropical waters. There are numerous operating locations in the Caribbean (Barbados, Grand Cayman, Aruba, Cozumel, St. Thomas, etc.), the Mediterranean, the Red Sea, the Atlantic, the South Pacific, the Pacific, the Indian Ocean and the South China Sea.

How expensive is to start a tourist submarine business?

A tourist submarine start-up is quite an expensive proposition due to both the high initial investment in the equipment as well as the development costs. However, well developed operations can often pay for themselves within 18 months. In correct circumstances the derived profit can be extraordinary.

Economic factors favor larger submarines because the baseline infrastructure and manning requirements do not differ substantially with vehicle size. A minimum sized sub for profitable operations is 10-passengers unless you are making very deep or specialty dives that demand a high ticker price. New tourist subs range in price from $1.5 million to $7 million and infrastructure and development costs from $750,000 to over $3 million. Available used submarine prices vary from $825,000 to $2.2 million. Therefore the least expensive operational start-up will be about $1.6 million with the most expensive costing over $10 million.

What are some of the issues surrounding the selection of an operating location?

Operating site selection is a complex subject. When we do a site feasibility study we analyze over 240 separate factors in order to predict the degree of economic success of an operation. Generally speaking, most tourist submarines operate in tropical locations where the weather is warm and the water is clear. Critical are areas with good visibility, little current and generally calm seas where the submarine can operate a minimum of 270 days per year. As a rule of thumb, and given standard capture ratios one needs about 12,500 incoming tourists per year per seat on the submarine, so to operate a 10 passenger sub at a given location you would need 125,000 incoming tourist arrivals into your limited geographic area. And, with an average ticket price of $75 a significant number of the tourists must be financially capable of paying for tickets. Other factors we consider are items like towing and transit time, operations base set-up, maintenance and haul out location, storm refuge plans, competing businesses, permits, immigration, environmental concerns, growth prospects, etc.

All of the mistakes in the tourist submarine business have been made. With professional assistance and guidance you can avoid repeating them.

What about crew training and licensing?

Licensing requirements vary from country to country but effective crew training is critical. If you purchase a submarine from us we can assist with the acquisition of experienced crew that is trained in the operation and maintenance of the submarine during the final phases of construction or refit followed by sea trials. An experienced crew can then provide further training over time to newly hired people at the operating location.

In the U.S. the Coast Guard requires that the pilot of the submarine have a Master's license for a surface vessel of equivalent tonnage and that he receive 40 dives and surfaces and 40 hours operating the submarine. The applicant is then given an exam based on the maintenance and operations manuals. Upon successful completion the applicant receives a specific submersible endorsement to his license.

If I wanted to start a t-sub business, what initial steps should I take?

You need to have access to at least $75,000 in capital to select an acceptable operating location and develop a business plan. We can assist you with both of these undertakings. Subsequently you need to identify an experienced management team, select a submarine based on the operating location and then begin a capital acquisition program to fund the project. Your ability to raise the funds will in large part be determined by the soundness and sophistication of the business plan and the erudition and experience of the management team. Keep in mind that there have been over 45 tourist submarine operations started to date which demonstrates the effectiveness of the business concept.

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