

# TUG AND WORKBOAT DESIGN GUIDE

## Tug and workboat design guide

This design guide is meant to provide a basic primer for the general reader to help understand the many types of tugs, workboats and other small commercial craft which ply our waters and some of their features and capabilities. Working closely with Robert Allan Ltd., we have developed the following compilation. Robert Allan Ltd. has, over its 82 years of business, designed many hundreds of working vessels of all types customized to fit the specific needs of their clients worldwide. The descriptions and samples below are just that — a sample of the myriad vessel types in this category.

### Tugboats:

Tugs and barges are the primary means of cargo transportation used on the B.C. Coast, but this is an application rather unique to this area. Worldwide, tugs are most recognized for their work in assisting large ships to and from their berths and for their role as salvage vessels when ships get into trouble. Typically, tugs are categorized according to the type of work they do, and then by the configuration or type of propulsion system used. The following are the most common descriptions used for the latter, as well as a few other commonly used terms in the industry.

**Azimuthing Stern Drive (ASD)** — a tug with steerable propulsion units located aft in a more or less conventional propeller position.

**Bollard pull** — the maximum thrust which can be generated by a vessel at zero speed (usually measured by pulling on a “bollard”). This is the typical measure of tugboat performance.

**Kort nozzle** — an annular foil-shaped device used to accelerate the flow through a propeller, thus generating more thrust than a comparable open propeller.

**RAVE tug** — a new concept developed by Robert Allan Ltd. in collaboration with Voith Turbo Schneider Propeller for a tug with two VSP units located fore and aft, rather than in the typical side-by-side tractor configuration.

**Reverse tractor** — an alternate term (seldom used today) to describe an ASD tug.

**Rotor® tug** — a patented configuration of tug with three Z-drive units located in a triangular pattern below the hull, typically with two drives forward and one drive aft.

**Screw propeller** — the “conventional” device used to develop thrust in water, usually driven by a diesel engine. Vessels are often described as single, twin or triple screw, depending on the number of propellers they have.

**Tractor** — a tug with the drive units (either VSP or Z-drive) located in the bottom of the vessel, approximately one-third of the length from the bow. (This term is often very erroneously used to describe any tug with omni-directional propulsion, including ASD tugs).

**Voith-Schneider Propeller (VSP)** — a cycloidal propeller, comprised of a rotating circular plate in the bottom of the vessel from which a number of vertical foil-shaped blades project, and each

of which changes their angle of attack as the disc rotates, thereby generating thrust in the desired direction.

**Z-Drive** — a drive system using a screw propeller driven through two right angle gears and which can be rotated through 360 degrees.

### Tug types (or functions)

Broadly speaking, tugs are designed to perform one or more very specific functions and are thus categorized accordingly. Of course many tugs also tend to get used to perform more than one of these duties and thus become more “multi-purpose”. As with all things, the more diverse the duties the more compromised the design becomes in terms of its ability to do any one function very well!

Robert Allan Ltd. is the world’s leading designer of tugboats today, accounting for something in the order of 35 to 40 per cent of all tugs built worldwide. They have developed specific families of tug designs to address the diverse needs of their clients, and although these are portrayed as “classes” of existing designs, every vessel is still customized to the specific application and new designs are continuously developed for unique projects.

*All photos in the design guide courtesy of Robert Allan Ltd.*



*Z-drive units in the stern of an ASD tug.*



*VSP units on a RAVE tug.*

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## Ship-handling (ship-assist)/harbour towage

This is the classic “Little Toot” tug operation, assisting large ships onto and off of a berth by pushing and pulling as required. Tugs are necessary because most large ships have no control over their own steering when operating at very low speeds, and they are thus very susceptible to the forces of wind and current.

Today the vast majority of modern ship-assist tugs are fitted with Z-drive or VSP propulsion. Harbour tugs typically range from 20 to 32 metres in length, and have power ranging from 2,000 to 4,000 kW, although there are exceptions to this depending on the size of port and types of ships handled. Many harbour tugs are simple day boats where the crew is aboard only to do each job.

### Cates

The class name honours Robert Allan Ltd.’s long-time close relationship with this historic Vancouver towing company and the early compact Z-drive tug designs developed here for B.C.’s Coast.



*Charles H. Cates I.*

### Z-Tech

An international award-winning ship-assist tug design developed for the Port of Singapore but now in wide use around the world, including throughout the Panama Canal.



*Z-Tech™ 7000 Star Admiral.*

### RAmparts

The typical ASD tug, often equipped for coastal towing and other duties, represents the most multi-purpose design in the RAL portfolio. The RAmparts 3200 tug “Ocean Pioneer” is one of the latest of 100 of this class of tugs built to date.



*RAmparts 3200-CL Ocean Pioneer.*

## Salvage/rescue towing

The era of the dedicated long-range salvage tug is largely gone today — some still do exist and China has recently built some dedicated large salvage tugs. These tugs used to be stationed in notorious shipping lanes in order to (get paid to) assist vessels in distress! These were typically big tugs with specialized winches and pumps, etc. which could be used to pull ships off a beach or prevent them from sinking. The demand for such tugs is thankfully somewhat less today than it was a generation ago but ships still do get in trouble and big tugs are still needed to assist. Many countries are now using dedicated, government-chartered vessels of this type to provide this “Coast Guard” service, but they do not have typical salvage rights. The cost of this safeguard process however is still a challenge for many countries.

Robert Allan Ltd. has designed a major new class of Salvage tug for these applications, designated as the “RASalvor” Class.



*RASalvor Class design.*



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## Escort towing

Escort tugs are the newest and most challenging of tug designs. These tugs are designed to provide emergency steering and braking functions to tankers (and occasionally other ships) in sensitive or critical coastal areas. Since the Exxon Valdez incident in 1989, many jurisdictions legislated that tankers within specific waters must be “escorted” by tugboats but, at the time, the ability of tugs to be effective at this mission was not well understood. In the past 15 years, the industry has developed many very powerful and effective escort tug designs, and the ability to predict their performance capabilities are well-developed amongst at least a few major design firms. Escorting is distinguished from regular ship-handling because, by definition, it takes place at higher speeds, from seven to 10 knots typically. Escort tugs generate the required ship control steering and braking forces in the “indirect towing” mode by combining the hydrodynamic forces generated by their hulls with the propulsive forces of their drive units.

Robert Allan Ltd. has been a world-leader in developing escort tug technology through an extensive internal research program. Vessel-types designed for high-performance escorting include:

- AVT Class — Escort tugs with Voith Propulsion
- ART Class — Escort Tugs in a Rotor tug configuration
- RAZer Class — Escort tugs with Z-drive Propulsion
- RAstar Class — Escort tugs incorporating a unique hull form designed to maximize indirect steering and braking forces and to provide much-enhanced sea-keeping capability.

### ART 85-35 Class Rotor tug



3D image of a new ART 85-35 Rotor tug.

### AVT 3600 Class tugs



Apex, Tenax and Phenix — owned by Ostensjo Rederi AS.

### RAZer 3000 Class tugs



Foss' America and Pacific Star.

### RAstar3900 Class Escort tug



Svitzer Kilroom — 39 metres, 116 tonnes bollard pull.

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## Log towing

The classic B.C. towing scene...a little tug with a long raft of logs dragging behind. These tugs spend many hours at full power but very low speed and are typically quite small.



*Harmac Fir (a second-generation Robert Allan design).*

## Ocean towing

There are relatively few large tugs today designed exclusively for this service but many were common in the 1960s and 1970s. Tows are typically large barges with expensive cargoes such as offshore drilling platforms. These tugs are single or more frequently twin screw; have large fuel capacity and quite large crews; and must be capable of coping with extreme ocean conditions. Today, much of this work is done by large offshore supply vessels.



*Irving Birch.*

## Coastal towing

In B.C., the majority of tugs are designed for towing barges between coastal ports. These tugs must be able to handle more weather than a harbour tug and also don't need the same degree of fendering. They have larger crews and hence more crew facilities. In general, these tugs will have conventional propulsion with single or twin screws and a towing winch aft. Since the late 1960s almost every tug built in B.C. has also been fitted with Kort nozzles for better performance. Tugs towing oil barges must be twin screw.

Robert Allan Ltd. offers the TRADER Class of tugs for this service. Many of the tugs designed by RAL in the 1960s and 1970s are still the backbone of the West Coast fleet today.



*Hamilton Baillie.*



*Jervis Crown.*



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## Terminal support

This is a relatively new category of tug used to provide ship-handling and other services at either offshore oil terminals or at LNG terminals situated in more exposed locales. Because they work in typically rougher waters, they tend to be larger and more powerful than normal ship-handling tugs and will frequently also have fire-fighting and anchor-handling capabilities. Some may also have some deck or bulk fuel or water cargo capacity.

Robert Allan Ltd. offers the RAstar Class and the larger RAmpage Class designs for these applications.

### RAstar 3800 Class



*Bourbon Yack.*

### RAmpage 4500 Class



*AOS Power.*

## Anchor-handling

Some tugs are designed to deploy, relocate or retrieve the large anchors used in offshore drilling applications. Although typically this operation is done by larger AHTS (Anchor-Handling Tug/Supply vessels), tugs are very useful for working with smaller anchors. This operation requires a large roller at deck level aft, an open stern and a powerful winch, as well as typically wooden sheathing to protect the steel deck from the impact of anchors coming aboard.

RAmpage Class tugs, such as the RAmpage 5500 Seaways 20, are specifically designed for this operation, although some smaller tugs have also been so equipped such as the recent AVT tug *Spinola*.

### RAmpage 5500 Class



*Seaways 20.*

### AVT 3800 Class tug



*Spinola.*



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## Fire-fighting

In most ports in the world, the tug fleets are equipped with fire-fighting capability to provide a “first response” capability as tugs are nearly always in the vicinity. In some cases, the “tug” function takes a back seat to the fire-fighting capabilities of the boat, as was the case for a recent project for Kuwait.

Almost any tug can be equipped for fire-fighting although due to the size and cost of the equipment involved, typically this is left to larger sizes of tugs such as the local *Seaspan Raven*.

### RAstar2800 Class



*Seaspan Raven* — Fi-Fi 1 capability — 2400m<sup>3</sup>/hr pumping capacity.

## Line-handling

Line-handling tugs are specialized tugs, typically quite small, whose function is to take the lines of incoming ships and move them into positions from which they can be secured. They frequently are distinguished by a pipe “cage” which prevents the ship’s lines from getting entangled in their masts or exhaust pipes.

### RAscal Class



*The Rascal 2000 Class Elyah.*

## Yarding

Yarding tugs are typically smaller tugs used to move barges around and assemble barge tows for large coastal towing or for river towing operations. In the latter case these are usually built in a “pusher” configuration.

## Training

In common with many other industries worldwide, the cadre of well-trained tug operators is getting older. In addition the technologies involved in modern tugs have long since surpassed the days of hanging onto the big spoked wheel with salt spray in your teeth! Robert Allan Ltd. designed the ultra-compact BRAtt training tug in order to provide a platform that would bridge the gap between simulator training and the full-size tug so that Masters-in-training would get a “real-life” experience driving Z-drive tugs without tying up the resources of a multi-million dollar working tug (and its full crew) while learning the skills necessary to handle such a vessel safely. RAL worked closely with local model-maker/trainer Ron Burchett on this project.

### BRAtt training tug



*The BRAtt.*

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## Various workboats

Other types of workboats are generally purpose-designed and can take many and diverse configurations depending upon the application and the owners objectives. The following are but a few of the many types seen on this coast and internationally.

### Patrol boats

Typically these are high-speed patrol craft intended for local police, Coast Guard or harbour patrol functions. These can be monohulls such as the Port Vancouver vessel Takaya or catamarans such as those used by the RCMP.



*Takaya — Port Metro Vancouver.*

### Crewboats

Crewboats are designed for either coastal transportation or, more typically, for crew transfer at oil field and offshore support duties. The majority of designs feature large cargo decks and are available in either aluminium or steel construction depending on speed and duty requirements.



*Zamil 40 — a RALLY 3500 class crewboat working in Saudi Arabia.*

## Fireboats

Designed as emergency response vessels for major port cities around the world, these vessels are primarily configured as fireboats but frequently serve as Command and Control centres or indeed as primary response vessels for local emergency actions such as pollution response and search and rescue. These vessels have a diverse array of configurations and fire-fighting performance and are generally custom-designed to the specific risks encountered in each port as well as to its unique operating environment.

Robert Allan Ltd. has emerged as the world's leading designer of fireboats in the past decade with many unique vessels to its credit throughout North America, Asia and the Middle East. Examples are included below.

### Port of Los Angeles



*Warner L. Lawrence — a VSP powered fireboat.*

### New York City



*Firefighter 2 and Three Forty-Three — two 42-metre, 11,500 cu.m/hr, 18-knot fireboats for FDNY.*



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## Survey and research vessels

These include vessels equipped for scientific research and survey of many types, which can be large or small, and are used for a wide range of applications including hydrographic survey, fisheries research, seismic survey and oceanographic research. Vessels are noted for their capabilities in continuous and extended operations in a full range of environments. Frequently, they include features to significantly reduce onboard and radiated noise.

Robert Allan Ltd. has recently designed several major research vessels, including three small fisheries research vessels for the Canadian Coast Guard (nearing completion in Quebec); the OFSV Fishery Research vessels, which will be amongst the first to be built under the new Canadian NSPS shipbuilding program; and the 92-metre CSIRO Oceanographic Research vessel for the Australian Government currently being built in Singapore.



*CSIRO Oceanographic Research vessel.*



*Inshore Fisheries Research/Patrol Vessels for DFO, Canada.*

## Search and rescue

This term is usually reserved for vessels dedicated to search and rescue (SAR) missions. Such vessels are typically owned by National Coast Guards and therefore also fulfill various other patrol and enforcement duties. These can be as small as a six-metre RHIB or an offshore cutter of 70 metres or more in length. Larger vessels also typically have fast rescue craft aboard which can be launched by various means including davits or stern ramps.



*CCGS Type 500 SAR Cutter Gordon Reid.*

## Icebreakers

Vessels designated as “icebreakers” typically have that as their primary mission and are thus used to keep navigation channels open and to assist other vessels beset in ice. However, increasingly, very powerful “icebreakers” have other primary missions such as oil field support, supply and anchor-handling. Many other vessels can simply be “ice-strengthened” to enable them to work occasionally in ice-infested waters.

Robert Allan Ltd. has designed many icebreaking vessels for service in Canada and more recently in such diverse areas as Sakhalin (Russia) and the Caspian Sea.



*Svitzer Aniva — one of four TundRA 3400 Class icebreaking escort tugs for support of the LNG terminal at Sakhalin, Russia.*