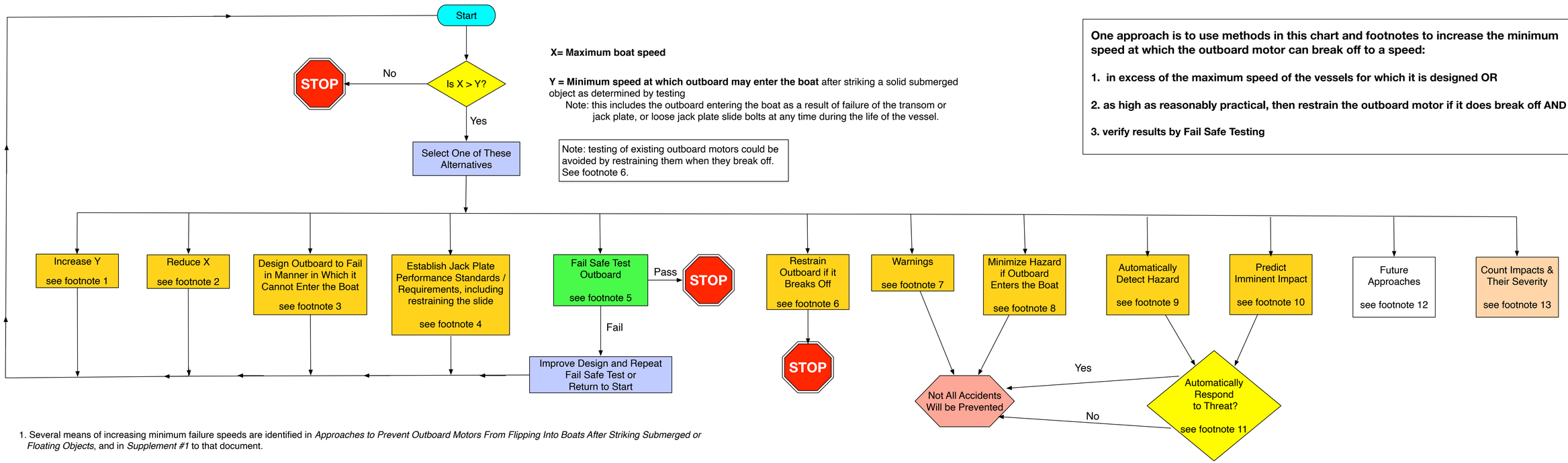
Bass Boat & Motor Design Flow Chart for Preventing Injuries & Fatalities From Outboard Motors Entering the Boat After Striking Submerged Objects



X= Maximum boat speed

Y = Minimum speed at which outboard may enter the boat after striking a solid submerged object as determined by testing

Note: this includes the outboard entering the boat as a result of failure of the transom or jack plate, or loose jack plate slide bolts at any time during the life of the vessel.

Note: testing of existing outboard motors could be avoided by restraining them when they break off. See footnote 6.

One approach is to use methods in this chart and footnotes to increase the minimum speed at which the outboard motor can break off to a speed:

1. in excess of the maximum speed of the vessels for which it is designed OR

2. as high as reasonably practical, then restrain the outboard motor if it does break off AND

3. verify results by Fail Safe Testing

1. Several means of increasing minimum failure speeds are identified in *Approaches to Prevent Outboard Motors From Flipping Into Boats After Striking Submerged or Floating Objects*, and in *Supplement #1* to that document.

2. Select a lower horsepower outboard motor or map the existing outboard motor to detune itself after a certain boat speed or engine RPM has been reached for a certain time. Outboard motor manufactures often "detune" outboard motors in order to sell the same basic unit at multiple horsepower ratings (like 200, 225, 250 horsepower). Any changes in maximum horsepower rating for a given boat model would need to be reflected in the maximum horsepower rating on the boat's Coast Guard Capacity Plate. Note the opportunity exists to conditionally limit speed such as in Yamaha U.S. Patent 8,277,266 based on tilt angle.

3. Design the skeg to breakaway before the gearcase / lower unit breaks away. Design the gearcase / lower unit to breakaway before the swivel bracket or other critical structural components fail that could allowing the entire outboard to break away. The skeg and gearcase must not breakaway under normal operation.

4. Establish standards/requirements for jack plate performance. The goal is to try to keep an outboard motor from breaking off the transom and entering the boat. When jack plates are placed between the transom and the outboard motor, ignoring jack plate structural integrity and impact performance is inconsistent with the goal.

5. Impact test outboard motor at speeds up to maximum boat speed into a fixed object. No parts of the outboard are to enter the boat, including the cowl. Horsepower, maximum engine rpm, propeller pitch, previous experience, and testing can reasonably define a maximum bass boat speed for each model of each outboard motor. Testing must include potential failure of jack plate or transom. Any dry land test stand results to confirm the safety of those on board must accurately correspond to on water test results.

6. Restrain or tether the outboard to the transom so it cannot enter occupied areas when underway. The Leash is a commercially available tether. Note: Tethers / restraints would need to be tested.

7. When X > Y and well designed warnings are chosen as the alternative, four types of accidents will NOT be prevented:
   (A) Passengers struck by motor or propeller if no warning is on the vessel where they can see it,
   (B) Those who failed to see, read, understand, remember, or follow the warnings,
   (C) Open water collisions with submerged hazards that cannot be seen at speed in smooth and/or choppy water or anticipated before impact such as deadhead logs (logs floating vertically), logs floating below the surface, unmarked dredge pipes, and uncharted hazards.

8. Automatically kill the engine when the outboard motor breaks off the transom. This slows or stops the propeller and reduces the amount the outboard bounces and dances around the boat, thus reducing the hazard to those in the vessel. Early patents include U.S. Patent 2,917,019 Krueger, U.S. Patent 3,036,543 Sperry Rand, U.S. Patent 3,136,287 Kiekhaefer Corporation (Mercury), U.S. Patent 4,734,065 Sanshin (Yamaha).

9. Automatically detect the hazard via technology (sonar, radar, fish finders, depth finders, laser scanning, machine vision, cameras, infrared, etc). See U.S. Patent 9,290,252 & U.S. Patent 9,944,375 Brunswick, and numerous FLIR patents,

10. Predict presence of hazard such as using GPS in combination with nautical charts (water depth) and database of previous impacts of this or other vessels. See U.S. Patent 10,272,977, U.S. Patent 10,746,552 & U.S. Patent 10,281,928 Brunswick, U.S. Patent 10,272,977 & U.S. Patent 10,746,552 Honda, and our own log strike mapping / charting invention (page 56 of *Supplement #1*)

11. Some systems automatically respond by raising the drive, trimming/tilting the drive, using trim tabs, slowing engine, stopping engine, steering boat, etc. See U.S. Patent 10,281,928 Brunswick, U.S. Patent 10,272,977 & U.S. Patent 10,746,552 Honda.

12. This spot left blank in note of continued developments in this field.

13. Counting impacts and recording severity can be used to estimate future impact life of this drive AND provide data for hazard prediction systems (location and severity). See U.S. Patent 10,214,271 & U.S. Patent 10,577,068 Brunswick, U.S. Patent 10,272,977 & U.S. Patent 10,746,552 Honda, and Japanese Patent JP5810881B2 Suzuki,

Additional information on each approach is available in *Approaches to Prevent Outboard Motors From Flipping Into Boats After Striking Submerged or Floating Objects* AND *Supplement #1* to the document just cited.

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