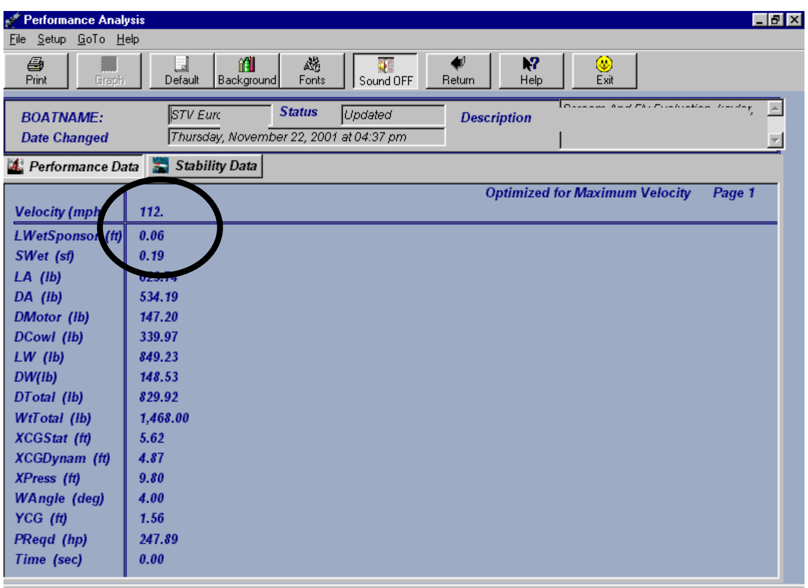
Triad STV Euro Ski 19 Performance Analysis
by AeroMarine Research® *www.aeromarineresearch.com*

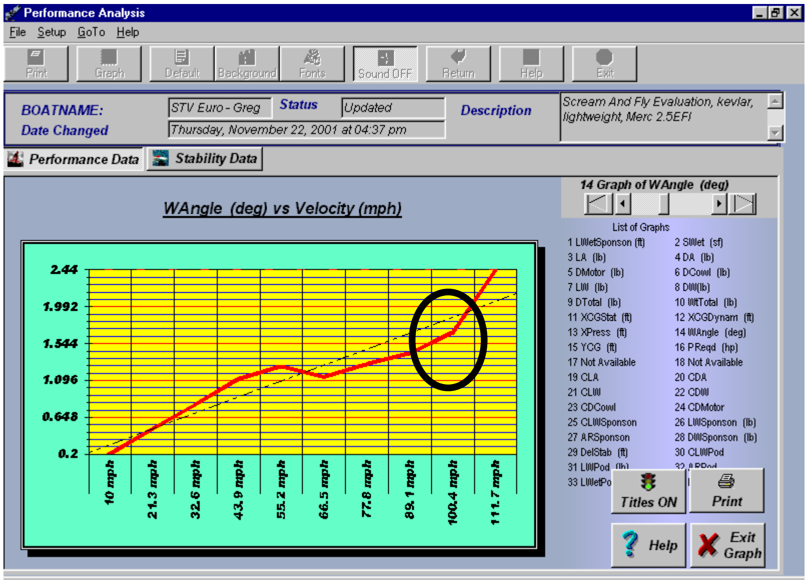
We have had many requests for a "boat report" on the STV Euro with a Merc 2.5efi power plant. This is just such a great river/lake racer that we had to do it!

We have done a short analysis of top speed, and acceleration simulation. I used some assumed setup details available from the boat test in Hot Boat Magazine's February 1994 issue, and from a lightweight boat set-up published on ScreamandFly.com. Admittedly, we have assumed a boat with somewhat more power than the HB mag test had bolted on. The results should be, nevertheless, representative of the hull's upper end capabilities. I used the new AeroMarine Research "Tunnel Boat Design Program©", Version 6.5.1 for Windows 98/98se to do the analysis, since it has many new features that make "tuning" the analysis easy for top speed, acceleration and stability simulation. The screen shots are right out of the software. Here are the results and a few of my conclusions.

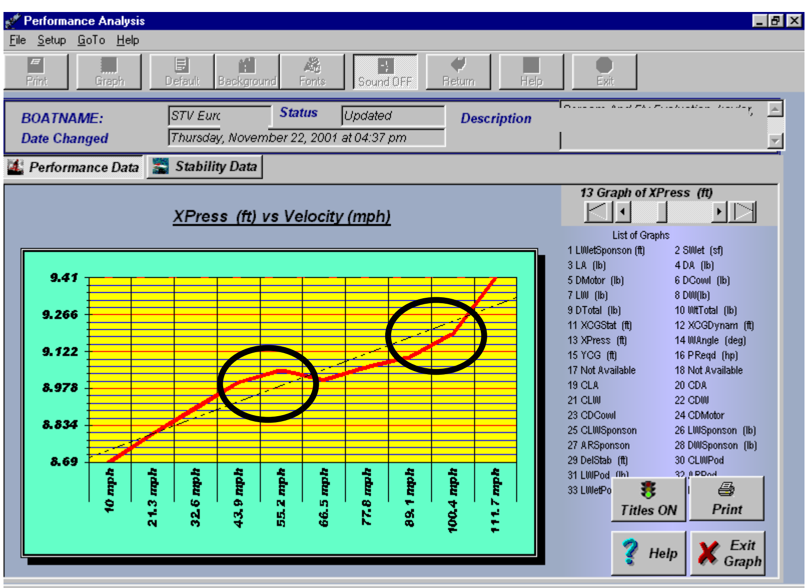
You will see that the TBDP© results are very similar to those that the Hot Boat Magazine boat test recorded. This boat is really something special! The hull design has been well refined over the years, originated by Roark Summerford, one of the best "modified tunnel style" boat designers around. This boat just wants to "go" and "go". Top speed is almost determined as "where you have to take your foot off"!



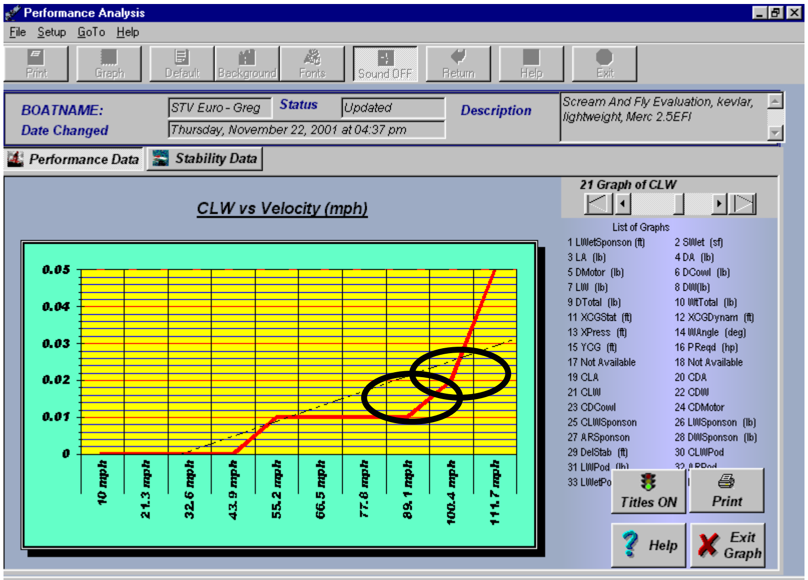
1. Top Speed is usually indicated by one or many of several performance variables. I start by using the TBDP©'s "Velocity Optimizer" feature to predict maximum attainable velocity with the 260+hp Merc 2.5efi motor. By setting an angle of attack (Wangle) that is higher than we are likely to see in practice, a bounding maximum speed can be quickly approximated. ***For the STV 19, this comes out as <u>112 mph</u>***. This is a high velocity, but as you will see later, this boat is very smooth, and frankly, probably capable of being pushed more than this. It is an incredibly fast hull! Further analysis can tell us more of the practical top speed.



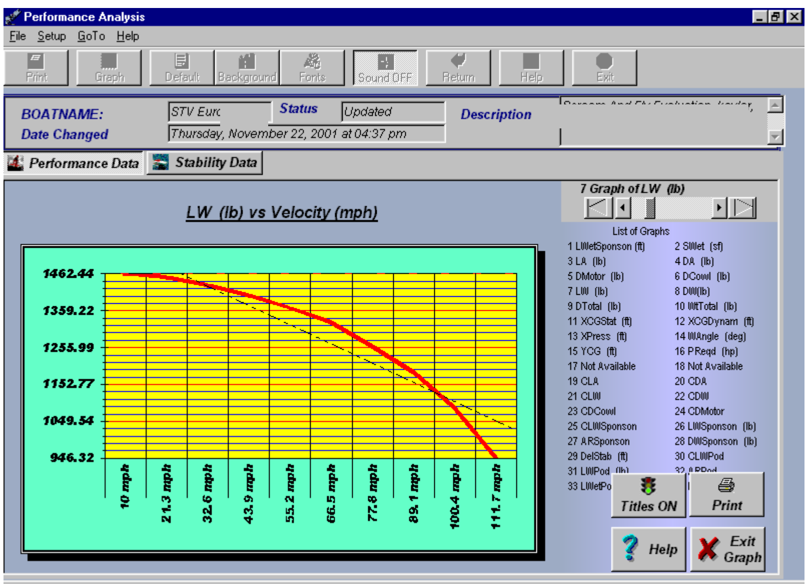
2. Often one of the determining factors is stability. Since a tunnel hull cannot be inherently aerodynamically stable, I use a measure of stability that references the dynamic CG of the hull, using in part, the aerodynamic center of pressure from the "wing" or aerofoil of the hull (referenced fore (+) of the transom). The dynamic CG and the center of pressure (XPRESS) will change throughout the range of operating velocities. (To maximize stability at operating velocity, dynamic CG should be ahead of the aerodynamic center, XPRESS). Well, this hull (like most tunnels of this size) becomes inherently unstable at about 55 mph, when the aerodynamic forces start becoming more important. In this case, I can define the stability measure as the <u>*change*</u> in the location of the XPRESS. We can see that XPRESS is constantly moving forward (getting more unstable), but as long as this change is at a reasonably slow and <u>constant</u> rate, the driver's attention and skill will be able to compensate. This hull maintains a remarkably consistent rate of change in XPRESS, indicating that it will have a very stable "feel" to it throughout it's velocity range. ***We can see from the graph of XPRESS (ft) vs. Velocity that the stability of the hull changes at around <u>100 mph</u> and the rate increases even further at 112 mph. This indicates the onset of this hull's "instability"***. There's more top speed indicator's…



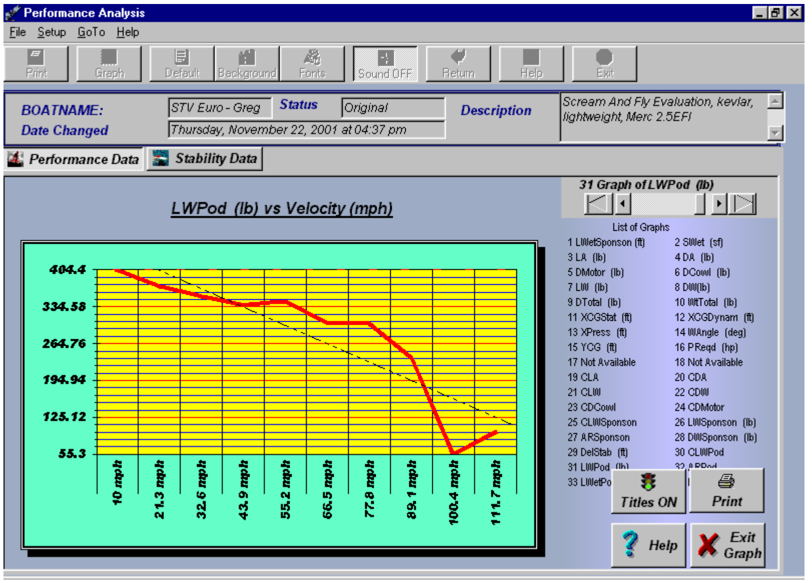
3. Of course tunnel boat drivers know that if you could keep giving it "up" trim forever without blowing over, the speed would be fantastic. The angle of attack that is required to attain higher velocities is shown in the graph WAngle (deg.) vs. Velocity. The graph shows that the <u>*required*</u> angle of attack of the STV Euro 19 increases more and more as speed approaches 100 mph. At 112 mph, the <u>*required*</u> angle of attack is 2X more than it was at 75-80 mph and the <u>*rate of*</u> change of the angle is 4½ X what is was at 75-80 mph. ***We can conclude that <u>112 mph</u> is about the velocity where the driver will have to react more quickly, and should have driving skill and experience before driving at these speeds in this or any similar high performance boat.*** There's still more indicators…



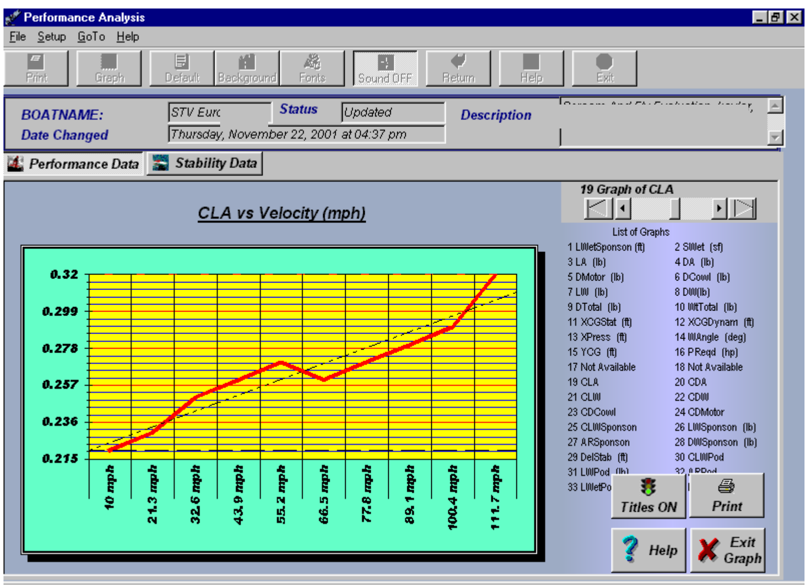
4. There is another easy clue in the sponson lift coefficient. If we look at the graph of the hydrodynamic lift coefficient (CLW vs. Velocity), we see that the CLW really jumps up at about 100 mph, and again at 112 mph. The sponson lifting efficiency improves, which means that the boat will start to exhibit more instability than at lower speeds, as the sponsons "skip" across the wave surfaces, with this higher efficiency occurring intermittently - ON… OFF… ON… OFF. Tunnel drivers know that this feeling at high speeds as a signal to pay very close attention.



5. The hydrodynamic (water) lift (LW) decreases as the aerodynamic (air) lift (LA) becomes more significant. For speed, this is a good thing – and is the beauty of the tunnel hull design. The sponson (and lower unit drives) contact with the water, however, is the best control surface the hull has. As the LW decreases, the boat "flies" more. The rate at which LW decreases is a good indication of stability. Our case shows the rate of decrease becoming more prominent at 100 mph, and even more advanced at 112 mph. This is the stage at which and the driver will have to react much more quickly to compensate for having more aerodynamic lift, and less (LW) control surface.

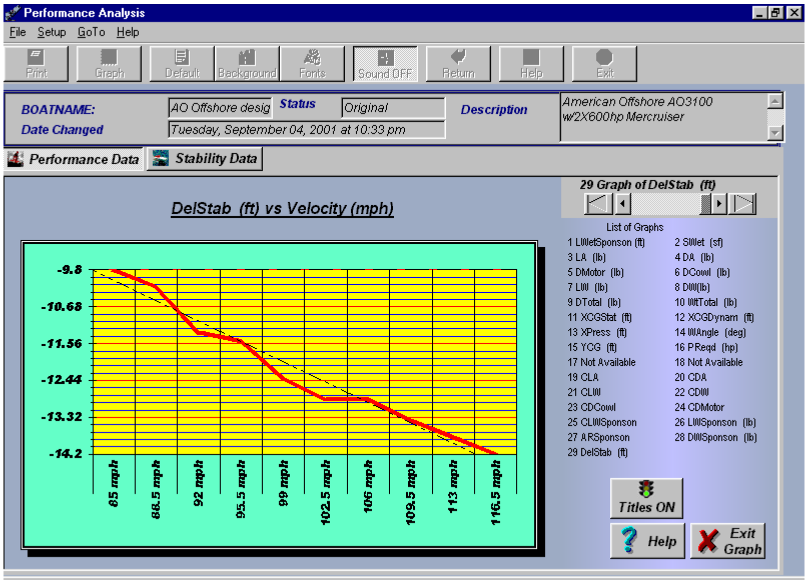


6. The water lift generated by the centerpod (LWPod) shows a similar onset of instability as the outside sponsons. In the 90-100 mph zone, the lift really starts dropping off as aerodynamic lift increases. It is interesting to note that the function of the center pod is now much less one of lift, and now is one more of a dampening function as the hull sees perturbations (waves) in the seas. Nevertheless, the onset of a lessened inherent stability at the 112 mph point is evident.



7. The coefficient of aerodynamic lift (CLA) is very stable up to about 94 mph, then begins to increase a lot at about 97 mph, and starts to intensify at an increasing rate at about 110 mph. This means that the hull is going to find it ever easier to "fly". We saw the impact of this earlier, when we looked at the hydrodynamic lift (LW), showing that our conclusions are consistent.

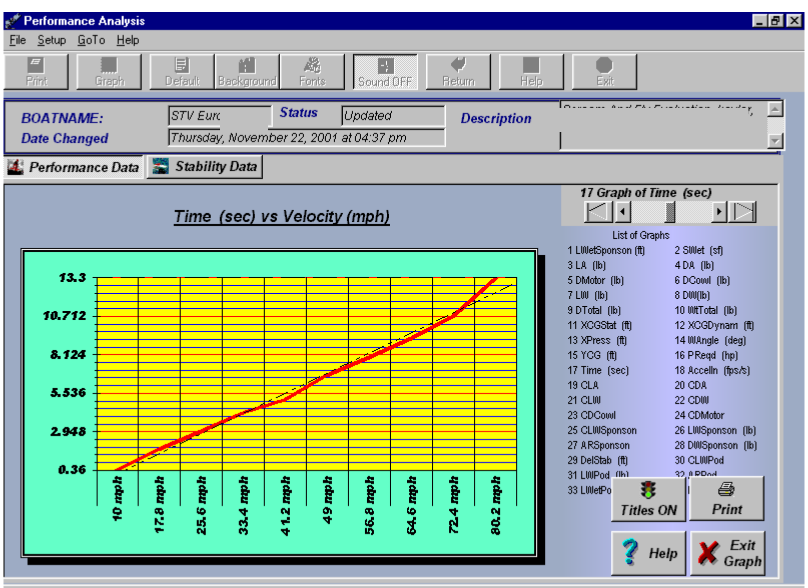
So, conclusion: ***maximum velocity for this hull should be a relatively easy 100 mph, with very good stability. The smoothness of operation in this range is a real attribute of this boat. This is consistent with the conclusions of the HB test in 1994. Our analysis also shows that the STV Euro 19 should have the capability up to 112+ mph in good water conditions, and with a very experienced driver. This is a bit different from the speed that the HB fellows saw. WOW - what a machine!***



8. There is a further note that I feel is worth amplifying for this hull. I pointed out earlier that I use a measure of stability that references the dynamic CG of the hull (the centre of balanced moments of all forces under running conditions). This dynamic CG will change throughout the range of operating velocities. To maximize stability at operating velocity, XCGDYNAM should be as close to the Static CG (deadweight balance) and ahead of the aerodynamic centre, XPRESS). This ideal situation is pretty well impossible for any boat, and so the rate of change of the XCGDYNAM compared to the XPPRESS is a great measure of how challenging the hull will be to maintain stability. This “change” is called DELSTAB vs. Velocity, and is shown in the chart above. **Our observation here is that the STV EURO 19 exhibits no dramatic changes in DELSTAB through the critical high speed operating range. This will make the “feel” of the hull one of stability, and will contribute to a more confident ride, with good control, by the driver. Excellent balance of aerodynamic and hydrodynamic design.**

Let us look now at acceleration simulation …

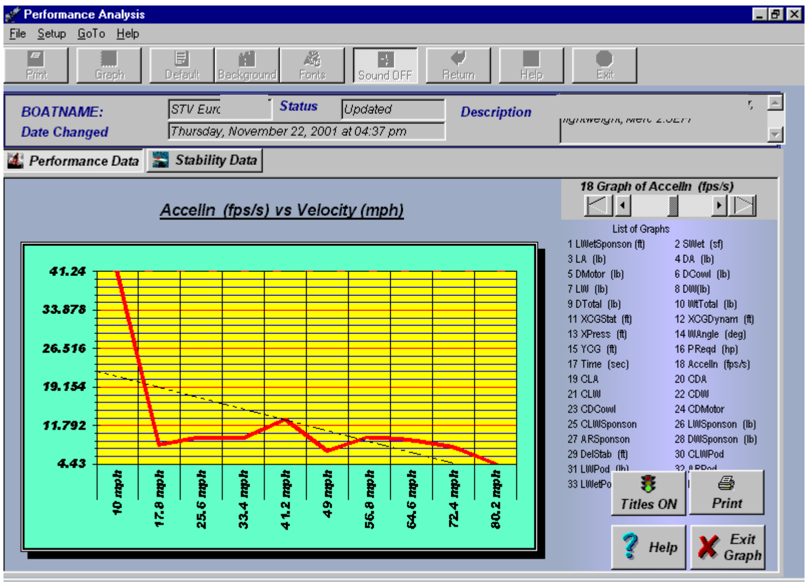
The TBDP© does a simulation of elapsed time and acceleration. Many factors influence these performance characteristics. The TBDP© assumes ideal hull/motor setup (maximum efficiency) and ideal driving skills.



9. I analysed the same velocity range that the HB mag did during their boat test. Based on some assumptions (every acceleration run will be somewhat different) of a controlled increase in angle of attack (WAngle), we predict the elapsed times for acceleration through the 30 mph to 80 mph range to be as shown in the Graph "Time (sec) vs. Velocity".

In short, this is one <u>quick</u> boat. The elapsed times predicted by the TBDP© software are very similar to those that were recorded in the HB boat magazine tests:

	TBDP© Prediction	**HB mag Boat test**
0 - planing speed	1.78 sec	1.7 sec
0 - 98 mph	18.9 sec	18.1 sec
0 to 30 mph	3.7 sec	3.9 sec
0 to 40 mph	4.96 sec	5.0 sec
0 to 60 mph	8.47 sec	8.6 sec
0 to 80 mph	13.1 sec	13.5 sec



10. The acceleration graph is merely a result of the elapsed time analysis. It is interesting to see that the acceleration or rate of increasing velocity (feet per second per second) is relatively constant up to around 60 mph, and then <u>decreases</u> (but slowly) up to 80 mph. This is evidence of the unwieldy power of the Merc 2.5efi. It is also interesting to note the disruption of the "smooth" acceleration rates between 40 mph to 60 mph. This intermediate velocity range is called the *transition zone*, and exists on all tunnel boats, but is different for each hull and setup. I will bet that the Hot Boat mag boys saw this "transition" (often experienced on tunnel boats as porpoising) start in about 40 mph and lasting until 60-65 mph when the feeling of "torque" would really become evident with this rig.

Following are the design input used and performance output from the TBDP© software, used in my review of the STV Euro-19.

TUNNEL BOAT DESIGN PROGRAM©
Version 6.5.1 - Copyright 1999-2001 by AeroMarine Research/Jim Russell

AeroMarine Research "Leaders in Tunnel Boat Design"

BoatName: STV Euro -
Description: Evaluation, kevlar, lightweight, Merc 2.5EFI
Counter: 525 DateChanged: Thursday, November 22,2001 04:37 pm
Status: Updated Page 1 (Printed Thursday, November 22,2001 04:48 pm)

Hull Design					
1 TunnelHeight:	6.5	(inches)	2 TunnelWidth	49.5	(inches)
3 WingChord	15	(feet)	4 WingThickness	12	(inches)
5 PadWidth	8.3	(inches)	6 PadDeadrise	12	(degrees)
7 DeckWidth	85	(inches)			
Steps					
8 Step Selection	No Step	(selected)	9 StepLength1		(feet)
10 StepLength2		(feet)	11 StepHeight		(inches)
CentrePod					
12 CtrPodSelect	Yes	(selected)	13 CtrPodLength	14	(feet)
14 PodWidth	10	(inches)	15 PodDeadrise	0.5	(degrees)
16 PodHeight	1	(inches)			
Spray Rails					
17 SprayHeight	10	(inches)	18 SprayWidth	2	(inches)
19 SprayFac	0.7	(factor)			
AeroFoil					
20 AngleInc	1.03	(degrees)	21 AeroType	Medium Camber	(selected)
Lengths					
22 BoatLength	19.6	(feet)	23 DriverLength	10	(feet)
24 MotorLength	-1.2	(feet)	25 FuelLength	2.2	(feet)
26 MiscLength	2	(feet)	27 MotorHeight	37	(inches)
Weights					
28 BoatWeight	625	(pounds)	29 DriverWeight	200	(pounds)
30 FuelWeight	168	(pounds)	31 MiscWeight	100	(pounds)
32 MotorWeight	375	(pounds)			
Cowlings/Cockpit					
33 CowlType	None	(selected)	34 CowlHeightRear		(inches)
35 CowlHeightFront	10	(inches)	36 Cockpit Width	53	(inches)
Design Analysis					
37 Optimize	Power	(selected)	38 Accuracy	5	(percent)
39 StartVelocity	10	(mph)	40 VelocityInc	7.8	(mph)
41 StartAngle	2.20	(degrees)	42 Accel Model	User Fit	(selected)
Conditions					
43 PowerMax	260	(hp)	44 PowerEffyFac	0.9	(percent)
45 Altitude	10	(feet ASL)	46 WaterType	Salt	(selected)
Drive Unit(s)					
47 Number of Drives	One Drive	(selected)	48 SkegWidth	10.5	(inches)
49 SkegLength	9.25	(inches)	50 SkegThickness	0.125	(inches)
51 TorpedoDiam	5	(inches)	52 TorpedoLength	18	(inches)
53 Drive Type	Merc 2.5 EFI	(selected)	54		

TUNNEL BOAT DESIGN PROGRAM©
Version 6.5.1 - Copyriaht 1999-2001 by AeroMarine Research/Jim Russell
BoatName: STV Eurc
Description ‾ Evaluation, kevlar, lightweight, Merc 2.5EFI
Counter: 525 DateChanged: Thursday, November 22,2001 04:37 pm
Status: Updated Page 2 (Printed Thursday, November 22,2001 04:48 pm)

Output Data: Optimized for Specified WAngle

Velocity (Mph)	10	17.8	25.6	33.4	41.2	49	56.8	64.6	72.4	80.2
LWetSponson (ft)	19.60	19.60	19.60	19.60	19.60	17.01	8.20	4.71	2.90	2.20
SWet (sf)	5,564.42	1,234.27	402.32	174.74	78.45	51.83	24.98	14.36	8.84	6.70
LA (lb)	3.14	10.37	22.73	40.80	67.13	94.95	129.42	167.41	210.28	258.02
DA (lb)	4.22	13.37	27.67	47.14	71.83	101.60	136.56	176.64	221.87	272.25
DMotor (lb)	1.41	4.24	8.53	14.23	21.32	29.78	39.61	50.78	63.29	77.13
DCowl (lb)	2.71	8.59	17.76	30.23	46.00	65.06	87.42	113.08	142.04	174.29
LW (lb)	1,464.86	1,457.63	1,445.27	1,427.20	1,400.87	1,379.41	1,346.34	1,313.46	1,266.11	1,221.74
DW(lb)	7,655.48	5,052.66	3,292.54	2,384.03	1,618.33	1,510.01	1,052.75	828.46	675.41	641.72
DTotal (lb)	7,661.11	5,070.27	3,328.74	2,445.40	1,711.48	1,641.39	1,228.92	1,055.88	960.57	991.10
WtTotal (lb)	1,468.00	1,468.00	1,468.00	1,468.00	1,468.00	1,468.00	1,468.00	1,468.00	1,468.00	1,468.00
XCGStat (ft)	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62
XCGDynam (ft)	9.80	9.81	9.81	9.83	9.85	8.66	4.70	3.33	2.80	2.82
XPress (ft)	8.83	8.90	9.00	9.10	9.25	9.25	9.28	9.28	9.28	9.28
WAngle (deg)	0.60	0.80	1.10	1.40	1.90	1.90	2.00	2.00	2.00	2.00
YCG (ft)	1.21	1.23	1.26	1.29	1.35	1.35	1.36	1.36	1.36	1.36
PReqd (hp)	204.30	240.67	227.24	217.80	188.03	214.48	186.14	181.89	185.45	211.96
Time (sec)	0.36	1.78	2.99	4.21	5.09	6.76	7.95	9.22	10.72	13.30
Accelln (fps/s)	41.24	8.04	9.47	9.35	12.93	6.88	9.63	8.95	7.62	4.43
CLA	0.2358	0.2460	0.2607	0.2749	0.2973	0.2973	0.3015	0.3015	0.3015	0.3015
CDA	0.0628	0.0628	0.0630	0.0631	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634
CLW	0.0012	0.0017	0.0026	0.0034	0.0049	0.0052	0.0078	0.0102	0.0128	0.0132
CDW	0.0064	0.0060	0.0058	0.0057	0.0057	0.0057	0.0061	0.0065	0.0068	0.0070
CDCowl	0.1066	0.1066	0.1066	0.1066	0.1066	0.1066	0.1066	0.1066	0.1066	0.1066
CDMotor	0.0088	0.0084	0.0082	0.0080	0.0079	0.0078	0.0077	0.0077	0.0076	0.0075
CLWSponson	0.0011	0.0016	0.0024	0.0032	0.0047	0.0050	0.0073	0.0093	0.0115	0.0129
LWSponson (lb)	1,072.0	1,059.2	1,060.3	1,055.8	1,045.4	1,008.7	995.7	1,007.5	1,066.0	1,186.0
ARSponson	0.0564	0.0564	0.0564	0.0564	0.0564	0.0650	0.1349	0.2347	0.3811	0.5029
DWSponson (lb)	6,256.0	4,003.9	2,594.6	1,878.6	1,275.3	1,152.8	830.9	698.6	633.1	640.6
DelStab (ft)	1.0	0.9	0.8	0.7	0.6	-0.6	-4.6	-6.0	-6.5	-6.5
CLWPod	0.0018	0.0023	0.0032	0.0042	0.0059	0.0059	0.0096	0.0152	0.0322	0.2268
LWPod (lb)	392.9	398.4	384.9	371.4	355.5	370.7	350.6	305.9	200.1	35.8
ARPod	0.0716	0.0611	0.0595	0.0595	0.0595	0.0595	0.1433	0.3582	1.6182	83.3333
LWetPod (lb)	11.6	13.6	14.0	14.0	14.0	14.0	5.8	2.3	0.5	0.0

STV 19' Euro Ski: Specifications

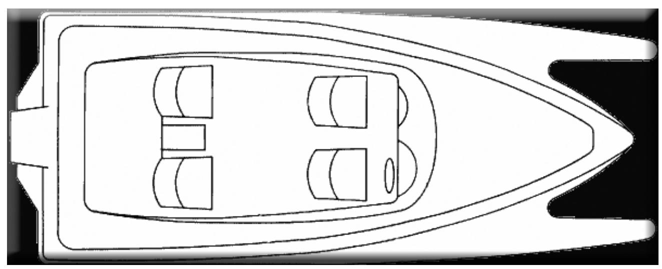
Length: 19'
Beam: 84"
Bottom: Modified tunnel
Weight as tested: 1,425 lbs.
Base retail price (less Motor): $8,220
Standard Features:
Two gelcoat colors, black windshield, snap-in seats, dual steering, stainless/aluminum hardware, Momo wheel, 28-gallon tank, stainless hand rail, foot throttle, Gil Marine battery holder.

Options on Test Boat:
Ski tow ($450), rear deck pad ($550).
Power/Drive
Mercury 2.6 outboard (265 hp)
Performance
Top speed, radar: 100 mph
Planing time: 1.7 seconds
0-30: 3.9 seconds
0-40: 5.0 seconds
0-60: 8.6 seconds
0-80: 13.5 seconds

Technical data from:
Hot Boat Magazine,
Feb 1994

Performance Test
STV Euro 19'

* Picture from STVOwners.com web site



* Picture from STVTriad.com website

***References*:**

- **www.hotboat.net**
- **www.stvtriad.com**
- **www.screamandfly.com**
- **www.aeromarineresearch.com**

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About the author:

Jim Russell is a professional engineer with a mechanical and aeronautics background. Currently living in Canada, he has done extensive aerodynamic research at University of Michigan, MI and University of Toronto, Canada and marine research at the NRC water channel laboratory in Ottawa, Canada. His published papers are highly acclaimed, specifically related to the aerodynamics and hydrodynamics of high performance catamarans, tunnel boats, vee hulls and vee-pad hulls. Russell has designed, built and raced tunnel boats, and consulted on design of many recreational, racing, commercial offshore and government hull designs. He has appeared on SpeedVision's Powerboat Television as a guest expert on 'Tunnel Hulls', and was performance/design technical consultant on National Geographic's 'Thrill Zone-Extreme Powerboats' TV show.

As a professional race driver, he piloted tunnel boats to Canadian and North American championships. He has written power boating articles for many worldwide performance boat magazines and has covered UIM and APBA powerboat races. Russell is the author of the "Secrets of Tunnel Boat Design", "History of Tunnel Boat Design" book, and the "Secrets of Propeller Design." books. His company has designed and published the well-known powerboat design software, "Tunnel Boat Design Program©", and “Vee Boat Design Program©” software, specifically for the design and performance analysis of tunnel boats, powered catamarans, and performance vee hulls; and the “PropWorks2” software for propeller selection/speed prediction.